T

THE ENCYCLOPÆDIA BRITANNICA

FOURTEENTH EDITION

THE ENCYCLOPÆDIA BRITANNICA

FIRST EDITION	1768
SECOND EDITION	1777
THIRD EDITION	1788
FOURTH EDITION	1801
FIFTH EDITION	1815
SIXTH EDITION	1823
SEVENTH EDITION	1830
EIGHTH EDITION	1853
NINTH EDITION	1875
TENTH EDITION	1902
ELEVENTH EDITION	1910
TWELFTH EDITION	1922
THIRTEENTH EDITION	1926
FOURTEENTH EDITION	1929, 1932

THE ENCYCLOPÆDIA BRITANNICA

FOURTEENTH EDITION

A NEW SURVEY OF UNIVERSAL KNOWLEDGE

VOLUME 15

MARY, DUCHESS OF BURGUNDY TO MUSHET STEEL

THE ENCYCLOPÆDIA BRITANNICA COMPANY, LTD.
LONDON
ENCYCLOPÆDIA BRITANNICA, INC.
NEW YORK

INITIALS AND NAMES OF CONTRIBUTORS IN VOLUME XV WITH THE ARTICLES WRITTEN BY THEM.

A. Be.	AUGUSTIN BERNARD. Professor of Geography and of Colonization of the Peoples of North Africa, at the Sorbonne, Paris. Author of *L'Archipel de la Nouvelle Calédonie; Les Régions naturelles de l'Algérie;* etc.	Morocco (*in part*).
A. C. D. C.	ANDREW CLAUDE DE LA CHEROIS CROMMELIN, D.Sc., B.A. Assistant at Royal Observatory, Greenwich, 1891 to 1927. President of the Royal Astronomical Society, 1929. Author of *The Star World; Catalogue of Comets*, a sequel to Galle's *Cometenbahnen.* Part-Author of *Science in Modern Life; Splendour of the Heavens; The Orbit of Halley's Comet from 1759 to 1910;* etc.	Minor Planet.
A. C. H.	ALFRED CORT HADDON, Sc.D., F.R.S. Fellow of Christ's College, Cambridge. Late reader in Ethnology in the University of Cambridge. Author of *The Races of Man and Their Distribution; The Wanderings of Peoples.*	Migration (*in part*).
A. C. R.	ALBERT C. RITCHIE. Governor of Maryland. Professor of Law, University of Maryland Law School, 1907–20.	Maryland.
A. D. I.	A. D. IMMS, M.A., D.Sc. Chief Entomologist, Rothamsted Experimental Station, Harpenden, Hertfordshire, England. Formerly Forest Zoologist to the Government of India and Professor of Biology, University of Allahabad. Author of *A General Textbook of Entomology;* etc.	May-Fly; Mosquito.
A. E. G.	REV. A. E. GARVIE, M.A., D.D. Principal of Hackney and New College, Hampstead. Editor of the *Westminster New Testament.* Author of *Studies in the Inner Life of Jesus;* etc.	Miracle.
A. E. Hu.	ALBERT EDWARD HUMPHRIES, HON.LL.D. Member of the Royal Commission on Wheat Supplies and Flour Mills Control, 1917–21. President of the Incorporated National Association of British and Irish Millers, 1906–7, 1917–8, 1918–9.	Middlings.
A. E. J.	ARTHUR ERNEST JOLLIFFE, M.A. Professor of Mathematics at King's College, London. Formerly Fellow of Corpus Christi College, Oxford.	Maxima and Minima.
A. E. R.	ALBERT EDWARD RICHARDSON, F.S.A., F.R.I.B.A. Professor of Architecture, London University. Architect to the Prince of Wales for the Duchy of Cornwall Estates in the West of England. Author of *London Houses; Monumental Architecture;* etc.	Modern Architecture (*in part*).
A. Fer.	LIEUTENANT-COLONEL A. FERRERO. Assistant Instructor of Tactics in the Scuola di Guerra, Turin.	Mountain Warfare (*in part*).
A. G. D.	ARTHUR G. DOUGHTY, C.M.G., LITT.D., F.R.HIST.S., F.R.S.C. Deputy Minister of the Public Archives of Canada, Ottawa, and Director of War Archives. Author of *The Siege of Quebec and the Battle of the Plains of Abraham; The Acadian Exiles; Under the Lily and the Rose; The Cradle of New France;* etc.	Meighen, Arthur.
A. G. D. W.	ARTHUR GILBERT DIXON WEST, M.A., B.Sc. Chief Research Engineer, British Broadcasting Corporation.	Microphone.
A. G. M. B.	A. G. M. BATTEN. The Alliance Assurance Company, London. Fellow of the Chartered Insurance Institute. Sometime Stanley Brown Prizewinner of the Chartered Insurance Institute.	Motor Vehicle Insurance (*in part*).
A. Ha.	ADOLF HARNACK. German Theologian. Author of *Lehrbuch der Dogmengeschichte; Das Mönchtum, seine Ideale und seine Geschichte;* etc. *See* the biographical article: HARNACK, ADOLF.	Millennium; Montanism (*in part*).
A. H. W.	CAPTAIN A. H. WALKER, R.N. Director of Torpedoes and Mining, Admiralty, Oct. 1926 to Jan. 1929.	Mines, Minelaying and Minesweeping.
A. Hy.	ALEXANDER HAY, N.D.A., N.D.D. Senior Lecturer, East Anglian Institute of Agriculture, Wye, Kent.	Milk (*in part*).
A. L. K.	A. L. KROEBER, PH.D. Professor of Anthropology, University of California. Author of *Zuni Kin and Clan; Anthropology;* etc.	Micmac.
A. Ln.	ARNOLD LUNN. Editor, British Ski Year Book since 1919. Author of *Alpine Ski-ing; A History of Ski-ing; The Alps;* etc.	Mountaineering (*in part*).
A. L. S.	ANDRÉ L. SIMON, Of Messrs. Pommery and Greno, Ltd. Author of *The Blood of the Grape; Wine and the Wine Trade.*	Médoc Wines; Moselle Wines.

A. Ma. — A. Mavrogordato.
Fellow in Industrial Hygiene, South African Institute for Medical Research, Johannesburg.
— **Miners' Phthisis.**

A. M. C. — Agnes M. Clerke.
Late Hon. Member, Royal Astronomical Society. Author of *A Popular History of Astronomy During the 19th Century; The System of the Stars; Problems in Astrophysics.* *See* the biographical article: Clerke, Agnes M.
— **Mayer, Johann Tobias** (*in part*).

A. M. Du — A. M. Dudley, B.S. in E.E.
Engineering Supervisor of Development, Westinghouse Electric and Manufacturing Company, Pittsburgh. Author of *Connecting Induction Motors; Induction Motor Practice.*
— **Motor, Electric.**

A. N. J. W. — A. Neville J. Whymant, Ph.D., Litt.D.
Professor of Chinese and Oriental Philosophy in Hosei University, Tokyo. Member of Council of Asiatic Society of Japan. Sometime Davis Chinese Scholar, University of Oxford. Member of the Editorial Staff, London, 14th Edition, *Encyclopædia Britannica.* Author of *The Oceanic Theory of the Origin of the Japanese Language and People.*
— **Mass** (*in part*); **Mongolian Language and Literature** (*in part*); **Mongols** (*in part*).

A. N. W. — Alfred North Whitehead, Sc.D., F.R.S.
Professor of Philosophy, Harvard University. Professor of Applied Mathematics, Imperial College of Science, London, 1914–24. Author of *A Treatise on Universal Algebra; Science and the Modern World; Introduction to Mathematics;* etc.
— **Mathematics, Nature of.**

A. P. C. — Alfred Philip Chalkley, B.Sc., A.M.I.C.E.
Editor of *The Motor Ship and the Motor Boat.*
— **Motor-Boat** (*in part*).

A. S. — A. Safrastian.
Formerly British Vice-Consul at Bitlis, Kurdistan.
— **Mosul** (*Vilayet*) (*in part*).

A. S. E — Sir Arthur Stanley Eddington, D.Sc., F.R.S.
Plumian Professor of Astronomy, Cambridge University. Director of the Observatory, Cambridge. President of the Royal Astronomical Society, London, 1921–3. Editor of the Astronomy section, 14th Edition, *Encyclopædia Britannica.* Author of *Stellar Movements and the Structure of the Universe; Stars and Atoms;* etc.
— **Micrometer.**

A. V. H. — A. V. Hill, O.B.E., Sc.D., F.R.S.
Foulerton Research Professor of the Royal Society, London. Hon. Professor of Physiology, University College, London. Hon. Fellow, King's College, Cambridge. Nobel Prize for Medicine, 1922. Author of *Muscular Activity; Living Machinery; Muscular Movement in Man.*
— **Muscle and Muscular Exercise.**

A. W. Ma. — Alexander W. Mair, Litt.D.
Late Professor of Greek, Edinburgh University. Lecturer, Aberdeen University, 1898–9; Edinburgh University, 1899–1903. Classical Examiner to London University, 1919–23. Author of *Callimachus; Hesiod: Introduction, Translation and Appendices.*
— **Menander.**

A. Wo. — Abraham Wolf, M.A., D.Litt.
Professor of Logic and Scientific Method in the University of London. Sometime Fellow of St. John's College, Cambridge. Fellow of University College, London. Author of *The Oldest Biography of Spinoza; Textbook of Logic.* Editor of the Philosophy and Psychology section, 14th Edition, *Encyclopædia Britannica.*
— **Meaning; Mechanism; Metaphysics; Monism.**

A. W. R. — Sir Alexander Wood Renton, G.C.M.G., M.A., LL.B.
Puisne Justice Supreme Court and Procureur and Advocate-General, Mauritius, 1901–5; Ceylon, 1905–14. Chief Justice, 1914, etc. Author of *Law and Practice of Lunacy.* Editor of *Encyclopaedia of English Law;* etc.
— **Maxims, Legal.**

B. E. W. C. — Major-General Sir Borlase Elwood Wyndham Childs, K.C.M.G., K.B.E., C.B.
Formerly Assistant Commissioner, Metropolitan Police.
— **Military Law** (*in part*).

B. H. L. H. — Captain B. H. Liddell Hart, F.R.Hist.S.
Military Historian and Critic. Military Correspondent to the *Daily Telegraph,* London. Editor of the Military and Military History section, 14th Edition, *Encyclopædia Britannica.*
— **Militia** (*in part*); **Mongol Campaigns.**

B. M. — Budgett Meakin.
Author of *The Moors; The Land of the Moors; The Moorish Empire.*
— **Morocco** (*in part*).

B. T. D. S. — Rev. B. T. D. Smith, M.A., B.D.
University Lecturer in Divinity and Fellow of Sidney Sussex College, Cambridge. Examining Chaplain to the Bishop of Lichfield.
— **Matthew, St.; Matthew, Gospel of St.**

C. A. — Christopher Addison, P.C., M.D., B.S., F.R.C.S.
Parliamentary Secretary to the Ministry of Agriculture, 1929. Minister of Munitions, 1916–7. Minister in Charge of Reconstruction Board, 1919. First Minister of Health, 1919–21. Minister without Portfolio, 1921. Author of *The Betrayal of the Slums; Politics from Within; Practical Socialism;* etc.
— **Munitions, Ministry of.**

C. A. C. — Claude A. Claremont, B.Sc.
Assistant to Dr. Montessori (Montessori Diploma). Interpreter in his 2nd International Training Course, 1914.
— **Montessori System.**

C. A. Co. — Charles Abel Corwin.
Staff Artist, Field Museum of Natural History, Chicago. Formerly Instructor on staff of the Chicago Art Institute.
— **Museums of Science** (*in part*).

C. A. M.	CARLILE AYLMER MACARTNEY. Scholar of Trinity College, Cambridge. H.B.M. Acting Vice-Consul for Austria, 1921–6. Passport Control Officer for Austria, 1922–5. Intelligence Officer, League of Nations Union, 1926. Author of *The Social Revolution in Austria; Survey of International Affairs for 1925, part II,* (in part).	Military Frontier.
C. B. De M.	CECIL BLOUNT DE MILLE. Playwright, Actor and Moving Picture Producer. Has produced several successful plays for David Belasco. Productions: "Ten Commandments"; "Feet of Clay"; "Road to Yesterday"; etc.	Motion Pictures (*in part*).
C. Cr.	CHARLES CREIGHTON, M.A., M.D. Author of *A History of Epidemics in Britain; Jenner and Vaccination; Plague in India;* etc.	Monster (*in part*).
C. Da.	MAJOR CYRIL JAMES DAVENPORT, F.S.A., F.L.A. Late Superintendent of Book-binding, British Museum. Editor, Connoisseurs' Library. Author of *The English Regalia; Cameos; Mezzotints; Miniatures; British Heraldry;* etc.	Mezzotint.
C. D. T.	CARL D. THOMPSON, M.A., B.D. Secretary, Public Ownership League of America. Author of *Municipal Ownership;* etc.	Municipal Trading (*in part*).
C. E. C.	MAJOR-GENERAL SIR CHARLES EDWARD CALLWELL, K.C.B. Director of Military Operations at the War Office, London, 1914–6. Author of *Small Wars; The Dardanelles;* etc.	Mesopotamia, Operations in.
C. E. H.	CHARLES EVANS HUGHES, M.A., LL.B. American Lawyer and Statesman. Secretary of State for America, 1921–5. Author of *Addresses and Papers; Conditions of Progress in Democratic Government;* etc.	Monroe Doctrine, The.
C. E. K. M.	CHARLES EDWARD KENNETH MEES, D.Sc. Director of the Research Laboratory, Eastman Kodak Co., Rochester, New York. Author of *Photography of Coloured Objects; The Atlas of Absorption Spectra; The Fundamentals of Photography;* etc.	Motion Pictures (*in part*).
C. E. T.	CECIL EDGAR TILLEY, B.Sc., PH.D., F.G.S. Lecturer in Petrology, University of Cambridge.	Metamorphism; Metasomatism; Mica-schist; Microline; Monzonite; Moonstone; Mullite.
C. F. Ke.	CHARLES FRANKLIN KETTERING, E.E., M.E., D.E., D.Sc. General Director, General Motors Research Laboratories. Vice-President and Director, General Motors Corporation, Pontiac, Mich.	Motor Car (*in part*).
C. Gi.	CEDRIC GIBBONS. Art Students League, New York City. Art Director, Metro-Goldwyn-Mayer Studios, Culver City, California.	Motion Pictures (*in part*).
C. H. H.	CARLTON HUNTLEY HAYES, A.M., PH.D. Professor of History in Columbia University, New York. Member of the American Historical Association.	Matilda, Countess of Tuscany.
C. H. Ha.	CHARLES HENRY HALL, B.A. Editor of *Motor Boat*, 1924–9. Formerly Editor of *Shipping Illustrated; Sea Power.*	Motor-Boat (*in part*).
C. H. Ku.	MAJOR C. H. KUHNE, R.A.O.C., D.S.O., O.B.E. Deputy Assistant Director of Mechanisation, Mechanisation Directorate, The War Office, London.	Motor Transport, Military (*in part*).
C. J. Ff.	CONSTANCE JOCELYN FFOULKES. Translator of Morelli's *Italian Painters;* etc.	Morelli, Giovanni (*in part*).
C. J. L.	SIR CHARLES JAMES LYALL, K.C.S.I., C.I.E., LL.D. Late Secretary, Judicial and Public Department, India Office, and Fellow of King's College, London. Secretary to Government of India in Home Department, 1889–94. Chief Commissioner, Central Provinces, India, 1895–8. Author of *Translations of Ancient Arabic Poetry;* etc.	Mofaḍḍalīyāt.
C. K. W.	CHARLES KINGSLEY WEBSTER, M.A., LITT.D. Wilson Professor of International Politics, University of Wales, Aberystwyth. Professor of Modern History, Liverpool University, 1914–22. Secretary, Military Section, British Delegation, Conference of Paris, 1918–9. Author of *British Diplomacy, 1813–5; The Foreign Policy of Castlereagh, 1815–22.* Contributions to the *Cambridge Modern History* on British Foreign Policy.	Minorities (*in part*).
C. Mon.	WILLIAM COSMO MONKHOUSE. English Poet and Art Critic. Author of *The Italian Pre-Raphaelites; British Contemporary Artists;* etc. *See* the biographical article: MONKHOUSE, WILLIAM COSMO.	Millais, Sir John Everett (*in part*).
C. Pf.	CHRISTIAN PFISTER, D.-ÈS-L. Professor at the Sorbonne, Paris. Chevalier of the Legion of Honour. Author of *Etudes sur le règne de Robert le Pieux.*	Mayor of the Palace.
C. P. O.	CHARLES P. OLIVIER, M.A., PH.D. Director of Flower Observatory, University of Pennsylvania, Philadelphia. Founder of American Meteor Society. Author of *Meteors.*	Meteor.
C. R. B.	CHARLES RAYMOND BEAZLEY, M.A., D.LITT., F.R.G.S., M.R.A.S. Professor of History, University of Birmingham. Late Fellow of Merton and University Lecturer in History and Geography, Oxford. Formerly on Council of R. G. S., and of Hakluyt and African Societies, and a member of the House of Laymen. Member of Advisory Committees of British Labour Party for International Affairs and for Education. Member of Executive of Birmingham Labour Party. Author of *History of Russia; Nineteenth Century Europe.*	Monte Corvino, Giovanni di.

A. Ma.	A. Mavrogordato. Fellow in Industrial Hygiene, South African Institute for Medical Research, Johannesburg.	**Miners' Phthisis.**
A. M. C.	Agnes M. Clerke. Late Hon. Member, Royal Astronomical Society. Author of *A Popular History of Astronomy During the 19th Century; The System of the Stars; Problems in Astrophysics. See* the biographical article: Clerke, Agnes M.	**Mayer, Johann Tobias** (*in part*).
A. M. Du	A. M. Dudley, B.S. in E.E. Engineering Supervisor of Development, Westinghouse Electric and Manufacturing Company, Pittsburgh. Author of *Connecting Induction Motors; Induction Motor Practice.*	**Motor, Electric.**
A. N. J. W.	A. Neville J. Whymant, Ph.D., Litt.D. Professor of Chinese and Oriental Philosophy in Hosei University, Tokyo. Member of Council of Asiatic Society of Japan. Sometime Davis Chinese Scholar, University of Oxford. Member of the Editorial Staff, London, 14th Edition, *Encyclopædia Britannica.* Author of *The Oceanic Theory of the Origin of the Japanese Language and People.*	**Mass** (*in part*); **Mongolian Language and Literature** (*in part*); **Mongols** (*in part*).
A. N. W.	Alfred North Whitehead, Sc.D., F.R.S. Professor of Philosophy, Harvard University. Professor of Applied Mathematics, Imperial College of Science, London, 1914–24. Author of *A Treatise on Universal Algebra; Science and the Modern World; Introduction to Mathematics;* etc.	**Mathematics, Nature of.**
A. P. C.	Alfred Philip Chalkley, B.Sc., A.M.I.C.E. Editor of *The Motor Ship and the Motor Boat.*	**Motor-Boat** (*in part*).
A. S.	A. Safrastian. Formerly British Vice-Consul at Bitlis, Kurdistan.	**Mosul** (*Vilayet*) (*in part*).
A. S. E	Sir Arthur Stanley Eddington, D.Sc., F.R.S. Plumian Professor of Astronomy, Cambridge University. Director of the Observatory, Cambridge. President of the Royal Astronomical Society, London, 1921–3. Editor of the Astronomy section, 14th Edition, *Encyclopædia Britannica.* Author of *Stellar Movements and the Structure of the Universe; Stars and Atoms;* etc.	**Micrometer.**
A. V. H.	A. V. Hill, O.B.E., Sc.D., F.R.S. Foulerton Research Professor of the Royal Society, London. Hon. Professor of Physiology, University College, London. Hon. Fellow, King's College, Cambridge. Nobel Prize for Medicine, 1922. Author of *Muscular Activity; Living Machinery; Muscular Movement in Man.*	**Muscle and Muscular Exercise.**
A. W. Ma.	Alexander W. Mair, Litt.D. Late Professor of Greek, Edinburgh University. Lecturer, Aberdeen University, 1898–9; Edinburgh University, 1899–1903. Classical Examiner to London University, 1919–23. Author of *Callimachus; Hesiod: Introduction, Translation and Appendices.*	**Menander.**
A. Wo.	Abraham Wolf, M.A., D.Litt. Professor of Logic and Scientific Method in the University of London. Sometime Fellow of St. John's College, Cambridge. Fellow of University College, London. Author of *The Oldest Biography of Spinoza; Textbook of Logic.* Editor of the Philosophy and Psychology section, 14th Edition, *Encyclopædia Britannica.*	**Meaning;** **Mechanism;** **Metaphysics;** **Monism.**
A. W. R.	Sir Alexander Wood Renton, G.C.M.G., M.A., LL.B. Puisne Justice Supreme Court and Procureur and Advocate-General, Mauritius, 1901–5; Ceylon, 1905–14. Chief Justice, 1914, etc. Author of *Law and Practice of Lunacy.* Editor of *Encyclopaedia of English Law;* etc.	**Maxims, Legal.**
B. E. W. C.	Major-General Sir Borlase Elwood Wyndham Childs, K.C.M.G., K.B.E., C.B. Formerly Assistant Commissioner, Metropolitan Police.	**Military Law** (*in part*).
B. H. L. H.	Captain B. H. Liddell Hart, F.R.Hist.S. Military Historian and Critic. Military Correspondent to the *Daily Telegraph,* London. Editor of the Military and Military History section, 14th Edition, *Encyclopædia Britannica.*	**Militia** (*in part*); **Mongol Campaigns.**
B. M.	Budgett Meakin. Author of *The Moors; The Land of the Moors; The Moorish Empire.*	**Morocco** (*in part*).
B. T. D. S.	Rev. B. T. D. Smith, M.A., B.D. University Lecturer in Divinity and Fellow of Sidney Sussex College, Cambridge. Examining Chaplain to the Bishop of Lichfield.	**Matthew, St.;** **Matthew, Gospel of St.**
C. A.	Christopher Addison, P.C., M.D., B.S., F.R.C.S. Parliamentary Secretary to the Ministry of Agriculture, 1929. Minister of Munitions, 1916–7. Minister in Charge of Reconstruction Board, 1919. First Minister of Health, 1919–21. Minister without Portfolio, 1921. Author of *The Betrayal of the Slums; Politics from Within; Practical Socialism;* etc.	**Munitions, Ministry of.**
C. A. C.	Claude A. Claremont, B.Sc. Assistant to Dr. Montessori (Montessori Diploma). Interpreter in his 2nd International Training Course, 1914.	**Montessori System.**
C. A. Co.	Charles Abel Corwin. Staff Artist, Field Museum of Natural History, Chicago. Formerly Instructor on staff of the Chicago Art Institute.	**Museums of Science** (*in part*).

C. A. M.	CARLILE AYLMER MACARTNEY. Scholar of Trinity College, Cambridge. H.B.M. Acting Vice-Consul for Austria, 1921–6. Passport Control Officer for Austria, 1922–5. Intelligence Officer, League of Nations Union, 1926. Author of *The Social Revolution in Austria; Survey of International Affairs for 1925, part II,* (in part).	**Military Frontier.**
C. B. De M.	CECIL BLOUNT DE MILLE. Playwright, Actor and Moving Picture Producer. Has produced several successful plays for David Belasco. Productions: "Ten Commandments"; "Feet of Clay"; "Road to Yesterday"; etc.	**Motion Pictures** (*in part*).
C. Cr.	CHARLES CREIGHTON, M.A., M.D. Author of *A History of Epidemics in Britain; Jenner and Vaccination; Plague in India;* etc.	**Monster** (*in part*).
C. Da.	MAJOR CYRIL JAMES DAVENPORT, F.S.A., F.L.A. Late Superintendent of Book-binding, British Museum. Editor, Connoisseurs' Library. Author of *The English Regalia; Cameos; Mezzotints; Miniatures; British Heraldry;* etc.	**Mezzotint.**
C. D. T.	CARL D. THOMPSON, M.A., B.D. Secretary, Public Ownership League of America. Author of *Municipal Ownership;* etc.	**Municipal Trading** (*in part*).
C. E. C.	MAJOR-GENERAL SIR CHARLES EDWARD CALLWELL, K.C.B. Director of Military Operations at the War Office, London, 1914–6. Author of *Small Wars; The Dardanelles;* etc.	**Mesopotamia, Operations in.**
C. E. H.	CHARLES EVANS HUGHES, M.A., LL.B. American Lawyer and Statesman. Secretary of State for America, 1921–5. Author of *Addresses and Papers; Conditions of Progress in Democratic Government;* etc.	**Monroe Doctrine, The.**
C. E. K. M.	CHARLES EDWARD KENNETH MEES, D.Sc. Director of the Research Laboratory, Eastman Kodak Co., Rochester, New York. Author of *Photography of Coloured Objects; The Atlas of Absorption Spectra; The Fundamentals of Photography;* etc.	**Motion Pictures** (*in part*).
C. E. T.	CECIL EDGAR TILLEY, B.Sc., PH.D., F.G.S. Lecturer in Petrology, University of Cambridge.	**Metamorphism; Metasomatism; Mica-schist; Microline; Monzonite; Moonstone; Mullite.**
C. F. Ke.	CHARLES FRANKLIN KETTERING, E.E., M.E., D.E., D.Sc. General Director, General Motors Research Laboratories. Vice-President and Director, General Motors Corporation, Pontiac, Mich.	**Motor Car** (*in part*).
C. Gi.	CEDRIC GIBBONS. Art Students League, New York City. Art Director, Metro-Goldwyn-Mayer Studios, Culver City, California.	**Motion Pictures** (*in part*).
C. H. H.	CARLTON HUNTLEY HAYES, A.M., PH.D. Professor of History in Columbia University, New York. Member of the American Historical Association.	**Matilda, Countess of Tuscany.**
C. H. Ha.	CHARLES HENRY HALL, B.A. Editor of *Motor Boat,* 1924–9. Formerly Editor of *Shipping Illustrated; Sea Power.*	**Motor-Boat** (*in part*).
C. H. Ku.	MAJOR C. H. KUHNE, R.A.O.C., D.S.O., O.B.E. Deputy Assistant Director of Mechanisation, Mechanisation Directorate, The War Office, London.	**Motor Transport, Military** (*in part*).
C. J. Ff.	CONSTANCE JOCELYN FFOULKES. Translator of Morelli's *Italian Painters;* etc.	**Morelli, Giovanni** (*in part*).
C. J. L.	SIR CHARLES JAMES LYALL, K.C.S.I., C.I.E., LL.D. Late Secretary, Judicial and Public Department, India Office, and Fellow of King's College, London. Secretary to Government of India in Home Department, 1889–94. Chief Commissioner, Central Provinces, India, 1895–8. Author of *Translations of Ancient Arabic Poetry;* etc.	**Mofaḍḍalīyāt.**
C. K. W.	CHARLES KINGSLEY WEBSTER, M.A., LITT.D. Wilson Professor of International Politics, University of Wales, Aberystwyth. Professor of Modern History, Liverpool University, 1914–22. Secretary, Military Section, British Delegation, Conference of Paris, 1918–9. Author of *British Diplomacy, 1813–5; The Foreign Policy of Castlereagh, 1815–22.* Contributions to the *Cambridge Modern History* on British Foreign Policy.	**Minorities** (*in part*).
C. Mon.	WILLIAM COSMO MONKHOUSE. English Poet and Art Critic. Author of *The Italian Pre-Raphaelites; British Contemporary Artists;* etc. *See* the biographical article: MONKHOUSE, WILLIAM COSMO.	**Millais, Sir John Everett** (*in part*).
C. Pf.	CHRISTIAN PFISTER, D.-ÈS-L. Professor at the Sorbonne, Paris. Chevalier of the Legion of Honour. Author of *Etudes sur le règne de Robert le Pieux.*	**Mayor of the Palace.**
C. P. O.	CHARLES P. OLIVIER, M.A., PH.D. Director of Flower Observatory, University of Pennsylvania, Philadelphia. Founder of American Meteor Society. Author of *Meteors.*	**Meteor.**
C. R. B.	CHARLES RAYMOND BEAZLEY, M.A., D.LITT., F.R.G.S., M.R.A.S. Professor of History, University of Birmingham. Late Fellow of Merton and University Lecturer in History and Geography, Oxford. Formerly on Council of R. G. S., and of Hakluyt and African Societies, and a member of the House of Laymen. Member of Advisory Committees of British Labour Party for International Affairs and for Education. Member of Executive of Birmingham Labour Party. Author of *History of Russia; Nineteenth Century Europe.*	**Monte Corvino, Giovanni di.**

C. R. L.	C. R. Lucato. Of the firm of Morris Motors (1926), Ltd.	Morris Motors (1926), Ltd.
C. R. M.	Charles Robert Moulton, M.S.A., Ph.D. Director, Department of Nutrition, Institute of American Meat Packers, and Lecturer, University of Chicago. Co-Author and Editor of *The Service of Science in the Packing Industry; The Animal as a Converter of Matter and Energy.*	Meat.
C. R. R.	Charles Russel Richards. Director of American Association of Museums. Author of *Art in Industry;* etc.	Modern Tendencies in Applied Art.
C. Si.	Charles Singer, M.D., D.Litt., F.R.C.P., F.S.A. Late Lecturer in History of the Biological Sciences at Oxford, and now Lecturer in the History of Medicine in the University of London. Author of *Greek Biology and Greek Medicine; A Short History of Medicine;* etc.	Medicine, History of.
C. W. C. O.	Sir Charles William Chadwick Oman, K.B.E., F.S.A., F.B.A. M.P. for Oxford University. Chichele Professor of Modern History, Oxford, and Fellow of All Souls. President, Royal Historical Society, 1917–21, Royal Numismatic Society, 1919, and Royal Archaeological Institute, 1927.	Mohammedan Campaigns.
C. W. H.	Charles Wilson Hackett, M.A., Ph.D. Professor of History, University of Texas.	Mexico (*in part*).
D. B.	David Baxendall, A.R.C.S., F.R.A.S. Deputy Keeper of the Science Division, Science Museum, South Kensington. Author of numerous papers on the history of scientific instruments.	Mathematical Instruments.
D. Bru.	Captain D. Brunt. Superintendent, Army Division, Meteorological Office, Air Ministry, London.	Meteorology.
D. D. C. T.	Mrs. D. D. Cottington Taylor. Certificate Household and Social Science, King's College for Women, London. First Class Teaching Diplomas for Cooking, Laundrywork, Housewifery, High Class Cookery, National Training School of Cookery, London. Director of *Good Housekeeping.*	Menus.
D. E. S.	David Eugene Smith, Ph.D. Professor Emeritus of Mathematics, Teachers College, Columbia University, New York. Editor of the Mathematics section, 14th Edition, *Encyclopædia Britannica.* Author of *A History of Mathematics; Progress of Arithmetic in Twenty-Five Years.*	Mathematics, History of.
D. F. T.	Donald Francis Tovey, M.A., Mus.Doc. Reid Professor of Music in Edinburgh University. Author of *Essays on Musical Analysis* comprising *The Classical Concerto, The Goldberg Variations,* and analyses of many other classical works. Editorial Adviser for Music, 14th Edition, *Encyclopædia Britannica.*	Mass (*in part*); Melody; Mendelssohn-Bartholdy, Jakob Ludwig Felix; Monteverdi, Claudio; Motet; Mozart, Wolfgang Amadeus
D. Ma.	David Masson, LL.D. Late Historiographer Royal for Scotland. Professor of Rhetoric and English Literature, Edinburgh University, 1865–93. Author of *Life of Milton. See* the biographical article: Masson, David.	Milton, John (*in part*).
D. M. S. W.	David Meredith Seares Watson, M.Sc., F.R.S. Jodrell Professor of Zoology and Comparative Anatomy, University College, London. Author of many papers on Vertebrate Palaeontology and connected subjects in *Proceedings of the Zoological Society, Journal of Anatomy;* etc.	Mastodon; Morphology.
D. R.	Dunbar Rowland, B.S., LL.D. Director of Mississippi State Department of Archives and History.	Mississippi.
D. S. Ma.	David Samuel Margoliouth, M.A., D.Litt., F.B.A. Laudian Professor of Arabic, Oxford. Fellow of New College. Author of *Arabic Papyri of the Bodleian Library; Mohammed and the Rise of Islam; Early Development of Mohammedanism.*	Mohammed (*in part*).
E. A.	Captain Edward Altham, C.B., R.N. Secretary and Chief Executive Officer, Royal United Service Institution since 1927. Senior Naval Officer, Archangel River Expeditions, 1918–9. Secretary and Editor of the *Journal of the Royal United Service Institution.* Editor of the Naval section, 14th Edition, *Encyclopædia Britannica.*	Midshipman (*in part*); Monitor: Naval.
E. A. S.	Rev. E. A. Shattock, M.A., B.Litt., F.R.Anthrop.I. Vicar of St. Mark, Woodcote, Purley.	Morality, Primitive.
E. Bg.	Eskil Berg, M.E. General Electric Company, Schenectady, N. Y. Author of papers on thermodynamics, steam turbines and ship propulsion.	Mercury-Vapour Boiler.
E. B. Po.	Edward Bagnall Poulton, M.A., D.Sc., LL.D., F.R.S. Hope Professor of Zoology in the University of Oxford. Fellow of Jesus College, Oxford. Author of *Colours of Animals; Essays on Evolution;* etc.	Mimicry.
E. Ca.	Emile Cammaerts, C.B.E., Hon.LL.D., F.R.Hist.S. Chevalier de l'Ordre de Léopold. Professor of French Literature at Queen's College, London.	Mercier, Désiré.
E. C. B.	Rt. Rev. Edward Cuthbert Butler, O.S.B., D.Litt. Abbot of Downside Abbey, Bath, 1906–22.	Maurists; Mechitharists; Mendicant Movement and Orders (*in part*).

Ed. M.	EDUARD MEYER, D.LITT. Professor of Ancient History in the University of Berlin. Author of *Geschichte des Alterthums;* etc.	**Media; Mithradates** (*in part*).
E. D. R.	SIR EDWARD DENISON ROSS, C.I.E., PH.D., F.R.G.S., M.R.A.S., F.S.A.B. Director, School of Oriental Studies, London, and Professor of Persian in the University of London.	**Mongolian Language and Literature** (*in part*).
E. E. A.	EUGENE E. AGGER, A.M., PH.D. Professor of Economics and Director of Bureau of Economic and Business Research, Rutgers University, New Brunswick, N. J. Author of *The Budget in the American Commonwealth; Organized Banking.*	**Money Market** (*in part*).
E. E. L.	EDWARD E. LONG, C.B.E. Formerly Director of Eastern Propaganda. Officer in Charge, Eastern Section, News Department, Foreign Office, 1918–21. *The Times* (London) Correspondent in Northern India. Late Editor of *The Indian Daily Telegraph; The Rangoon Times;* etc.	**Mentawei.**
E. E. Sm.	ERNEST E. SMITH, PH.D., M.D. Specialist in Experimental Medicine and Clinical Pathology. Author of many papers on chemical and medical subjects.	**Medical Jurisprudence** (*in part*).
E. E. T.	E. E. THUM, E.M. Associate Editor, *The Iron Age*, New York. Author of *Elementary Metallurgy.*	**Molybdenum** (*in part*); **Mushet Steel.**
E. F.	EVELYN FOX. Honorary Secretary, Central Association for Mental Welfare.	**Mental Deficiency** (*in part*).
E. F. S. D.	LADY DILKE. Author of *French Painters of the Eighteenth Century;* etc.	**Millet, Jean François** (*in part*).
E. G. Bu.	EDWARD G. BUDD. Budd Wheel Company and E. G. Budd Manufacturing Company, Philadelphia.	**Motor Car** (*in part*).
E. Hi.	EVA HIBBERT, M.SC.TECH. Assistant Lecturer in Applied Chemistry, Faculty of Technology, University of Manchester.	**Mercerizing.**
E. Ja.	EDGAR JADWIN, HON.D.E. Major-General, Chief of Engineers, United States Army, Washington.	**Michigan, Lake; Mississippi River** (*in part*); **Missouri River.**
E. N. da C. A.	EDWARD NEVILLE DA COSTA ANDRADE, D.SC., PH.D., F.INST.P. Quain Professor of Physics in the University of London. Author of *The Structure of the Atom; The Mechanism of Nature;* etc. Editor of the Physics section, 14th Edition, *Encyclopædia Britannica.*	**Michelson-Morley Experiment.**
E. R. D.	ELIZABETH RICHEY DESSEZ. Director of the Educational Department of Pathé Exchange, Inc., New York. Author of many magazine and newspaper articles dealing with the use of motion pictures by social, religious and educational groups.	**Motion Pictures** (*in part*).
E. Ste.	ETHELBERT STEWART. Chief Statistician, Bureau of Labor Statistics, 1913–8. United States Commissioner of Labor Statistics.	**Minimum Wage** (*in part*).
E. W. MacB.	ERNEST WILLIAM MACBRIDE, M.A., D.SC., LL.D., F.R.S. Professor of Zoology at the Imperial College of Science, London. Formerly Strathcona Professor of Zoology at McGill University, Montreal. Author of *A Textbook of Zoology.*	**Metamorphosis** (*in part*).
E. W. W.	REV. CANON EDWARD WILLIAM WATSON, D.D. Canon of Christ Church, Oxford, and Regius Professor of Ecclesiastical History in the University of Oxford.	**Ministry, The Christian.**
F. A. E. C.	F. A. E. CREW, M.D., PH.D., D.SC., F.R.S.E. Professor of Animal Genetics and Director of the Animal Breeding Research Department, University of Edinburgh. Co-Editor of the *British Journal of Experimental Biology.*	**Mendelism.**
F. A. Lu.	FREDERIC AUGUSTUS LUCAS, SC.D. Formerly Curator, U. S. National Museum, 1893–1904. Director of American Museum of Natural History, New York, 1911–23.	**Museums of Science** (*in part*).
F. Bn.	FRANK BRANGWYN, R.A., R.P.E., R.S.A. Officer and Cross of the Legion of Honour. Commander and Cross of the Order of St. Maurice and St. Lazarus, Italy. Commander and Cross of the Order of Leopold of Belgium. President of Graphic Arts Society; Royal Society of Painters in Water Colour; Académie Royale des Beaux Arts, Antwerp; Franco-British Union of Architects.	**Mural Painting.**
F. G. K.	SIR FREDERIC GEORGE KENYON, K.C.B., G.B.E. Director and Principal Librarian, British Museum.	**Museums and Art Galleries** (*in part*).
F. G. M. B.	FREDERICK GEORGE MEESON BECK, M.A. Formerly Fellow and Lecturer in Classics, Clare College, Cambridge.	**Mercia.**
F. G. P.	FREDERICK GYMER PARSONS, F.R.C.S., F.S.A. Professor of Anatomy, University of London. President, Anatomical Society of Great Britain and Ireland. Lecturer on Anatomy at St. Thomas' Hospital and the London School of Medicine for Women. Formerly Hunterian Professor at the Royal College of Surgeons.	**Mouth and Salivary Glands; Muscular System, Anatomy of.**
F. H.	FRED HORNER. Consulting Engineer. Contributor to *The Times Engineering Supplement; Engineering; Machinery.*	**Milling Machines.**

F. J. G. Du.	FRANK J. G. DUCK, B.S., CH.E. Of the Worthington Pump and Machinery Corporation, New Jersey. Member of the American Institute of Chemical Engineers. Co-Author of original edition of *Coal Miner's Handbook.*	Mercurochrome; Mining Engineer.
F. J. McC.	FRANCIS J. MCCONNELL, PH.D., D.D., LL.D. Bishop of the Methodist Church, New York. Author of *Diviner Immanence; Religious Certainty; Christian Focus; The Increase of Faith; The Christ-like God.*	Methodism (*in part*).
F. Ki.	FISKE KIMBALL, A.B., PH.D. Director, Pennsylvania Museum and School of Industrial Art. Author of *Jefferson and the First Monument of Classical Revival.* Editor of *Foundations of Classic Architecture.*	Modern Architecture (*in part*).
F. L. D.	F. L. DENDY, A.B. Editorial Staff (New York), 14th Edition, *Encyclopædia Britannica.* Formerly Professor of Public Speaking and Director of Dramatics at Davidson College, Davidson, New York.	Museums and Art Gallerie (*in part*).
F. Ll. G.	F. LLEWELLYN GRIFFITH, M.A., PH.D., F.S.A. Professor and Reader in Egyptology, Oxford University. Editor of the *Archaeological Survey* and *Archaeological Reports* of the Egypt Exploration Fund.	Meroe; Meroitic Language and Writing; Moeris, Lake of.
F. L. P.	FREDERIC LOGAN PAXSON, PH.D., A.M., B.S. Professor of History, University of Wisconsin, Madison, Wis. Author of *Recent History of the United States; History of the American Frontier.*	Middle West, The.
F. M. P.	FREDERICK MAURICE POWICKE, M.A., LITT.D., F.B.A. Regius Professor of Modern History, University of Oxford. Late Fellow of Merton College, Oxford. Author of *The Loss of Normandy; Stephen Langton;* etc.	Middle Ages, The.
F. P. R.	FRANK PLUMPTON RAMSEY, M.A. University Lecturer in Mathematics and Fellow of King's College, Cambridge.	Mathematics, Foundations of.
F. S. B.	F. S. BOAS, M.A., HON.LL.D. Divisional Inspector of English Language and Literature to the London County Council, 1905–27. Fellow and Professor of the Royal Society of Literature. Vice-President of the English Association. Author of *Shakespeare and His Predecessors;* etc.	Medwall, Henry (*in part*).
F. T. G.	FRANCIS TEMPLE GREY, M.A. Of Wadham College, Oxford, and of Lincoln's Inn, Barrister-at-Law. Assistant Honorary Secretary of the International Law Association and of the Grotius Society. Member of the representative body of the British Medical Association. Assistant Deputy Coroner, County of London. Late Surgeon, Royal Navy.	Medical Jurisprudence (*in part*).
F. W. Ha.	FRANK W. HALLIDAY, A.M. Major, Judge-Advocate General's Department, United States Army.	Military Law (*in part*).
F. W. La.	FREDERICK WILLIAM LANCHESTER, M.INST.C.E., M.INST.M.E., M.INST.A.E., F.R.S. Consulting Engineer and Technical Adviser to the Birmingham Small Arms Co., Ltd., and the Daimler Co., Ltd. Author of *Aerial Flight; Aircraft in Warfare;* etc.	Motor Car (*in part*).
G. Ab.	GRACE ABBOTT, PH.B., A.M. Chief of United States Children's Bureau, Washington. Author of *Immigrant and the Community,* and articles and reports on child welfare.	Maternity and Infant Welfare (*in part*).
G. B. Ev.	GEORGE B. EVERITT. President, Montgomery Ward & Company, Chicago.	Montgomery Ward & Co., Inc.
G. C. E.	GEORGE C. ENGERRAND, B.S. Associate Professor of Anthropology, University of Texas, Austin, Tex. Formerly Chief Geologist, Instituto Geologico Nacional, Mexico. Author of *Six Leçons de Prehistoire.*	Mexico (*in part*).
G. C. R.	GUY COLWIN ROBSON, M.A. Assistant Keeper in the Department of Zoology, British Museum.	Mollusca.
G. C. W.	GEORGE CHARLES WILLIAMSON, LITT.D. Chevalier of the Légion d'Honneur. Author of *Portrait Miniatures; Life of Richard Cosway, R.A.; George Engleheart;* etc. Editor of *Bryan's Dictionary of Painters and Engravers.*	Miniature Painting (*in part*).
G. D. H. C.	GEORGE DOUGLAS HOWARD COLE, M.A. University Reader in Economics, Oxford. Author of *The World of Labour; Self Government in Industry; Guild Socialism Restated; Social Theory;* etc.	Minimum Wage (*in part*).
G. F. B.	GEORGE FREDERICK BARWICK, B.A. Keeper of Printed Books, British Museum, 1914–9. Assistant Keeper and Superintendent, Reading Room, British Museum, 1900–14.	Midhat Pasha.
G. F. Z.	GEORGE FREDERICK ZIMMER, A.M.INST.C.E. Consulting Engineer and Joint Editor of *Engineering and Industrial Management.* Author of *Mechanical Handling;* etc.	Mechanical Handling; Monorails and Telphers.
G. G.	GEORGE GLASGOW. Author and Publicist. Author of *The Minoans; Ronald Burrows, a Memoir;* etc.	Masaryk, Thomas Garrigue.
G. G. A.	MAJOR-GENERAL SIR GEORGE G. ASTON, K.C.B. Lecturer on Naval History, University College, London. Formerly Professor of Fortification at the Royal Naval College, Greenwich. Author of *Sea, Land and Air Strategy; Memories of a Marine; The Navy of Today.* Editor of *The Study of War.*	Morocco (*in part*).
G. G. Si.	GEORGE GAYLORD SIMPSON, PH.D. Assistant Curator of Vertebrate Palaeontology, The American Museum of Natural History, New York. Author of *A Catalogue of the Mesozoic Mammalia in the Geological Department of the British Museum.*	Multituberculata.

G. H. B.	REV. GEORGE HERBERT BOX, M.A., HON.D.D. Rector of Sutton, Beds. Hon. Canon of St. Albans. Davidson Professor of Old Testament Studies in the University of London.	**Messiah.**
G. L. B.	GUY LESLIE BUCKERIDGE, M.R.C.S., L.R.C.P. Surgeon-Commander in the Royal Navy.	**Medical Service, Navy** (*in part*).
G. Sa.	GEORGE EDWARD BATEMAN SAINTSBURY, LL.D., D.LITT., F.B.A. Professor of Rhetoric and English Literature at Edinburgh University, 1895–1915. Author of *Essays on French Novelists; Short History of French Literature; Short History of English Literature. See* the biographical article: SAINTSBURY, G. E. B.	**Mérimée, Prosper.**
G. Sc.	G. SCHOTT. Oceanographer. German Naval Observatory, Hamburg. Hon. Professor of Oceanography, University of Hamburg.	**Mediterranean Sea** (*in part*).
G. S. D.	GEOFFREY SPENCE DAVISON. Technical Journalist. Late Assistant Editor of *Motor Cycling.*	**Motorcycles** (*in part*).
G. T. M.	GILBERT T. MORGAN, O.B.E., D.Sc., F.I.C., F.R.S. Director, Chemical Research Laboratory, Department of Scientific and Industrial Research, London. Formerly Mason Professor of Chemistry, University of Birmingham, Professor in the Faculty of Applied Chemistry, Royal College of Science for Ireland, and Professor of Applied Chemistry, Technical College, Finsbury. Author of *Organic Compounds of Arsenic and Antimony.* Editor of the Chemistry section of the 14th Edition of the *Encyclopædia Britannica.*	**Mercury; Methyl Alcohol.**
G. T. P.	GEORGE THURLAND PRIOR, D.Sc., F.G.S., F.R.S. Keeper of the Department of Mineralogy, Natural History Museum, South Kensington, London, 1909–27. President of Mineralogical Society since 1927.	**Meteorite.**
G. W. Cu.	G. W. CUSSONS. Of the firm of Messrs. G. Cussons Ltd., makers of scientific and technical apparatus for education, research and industry, Manchester.	**Mathematical Models.**
G. W. W.	GEORGE W. WATSON, M.I.MECH.E. Past President of the Institute of Automobile Engineers.	**Motor Vehicles, Commercial** (*in part*).
H. A.	HARRISON ATWOOD, A.B. Vice-President, The H. K. McCann Company, New York.	**Merchandise Marks** (*in part*).
H. Ah.	HAKON AHLBERG. Professor of Ornamental Architecture, Royal Technical College, Stockholm University.	**Modern Architecture** (*in part*).
H. C.	HUGH CHISHOLM, M.A. Editor of the 11th and 12th Editions of *The Encyclopædia Britannica.*	**Meredith, George.**
H. Ca.	HELEN CAM, M.A., F.R.HIST.S. Lecturer in History, Girton College, Cambridge. Probationer and University Lecturer in History, University of Cambridge. Author of *Studies in the Hundred Rolls.*	**Mayor** (*in part*).
H. Co.	HUGH L. COOPER. Hydraulic Engineer. Chief Engineer, Mississippi River Power Co. Hon. Professor of Civil Engineering, Republic of Brazil Government School of Engineering. Designed 612,000-h.p. water-power project at Muscle Shoals, Alabama.	**Muscle Shoals.**
H. D. A. M.	REV. HENRY DEWSBURY ALVES MAJOR, D.D., F.S.A. Principal of Ripon Hall, Oxford. Examining Chaplain to the Bishop of Birmingham. Editor of the *Modern Churchman.* Author of *English Modernism.*	**Modernism.**
H. D. K. D.	H. D. K. DREW, D.Sc., PH.D., F.I.C. Lecturer in Chemistry and Superintendent of the Microanalytical Laboratory, University of Birmingham.	**Microanalysis, Chemical.**
H. Fo.	HENRY FORD. Organiser and President of the Ford Motor Co. Author (with Samuel Crowther) of *My Life and Work.*	**Mass Production.**
H. G. B.	HARRY G. BEASLEY. Founder of the Cranmore Ethnographical Museum. Author of *Pacific Island Records.*	**Micronesia.**
H. Goe.	HERMANN GOETZ, PH.D. Volunteer Assistant in Charge of the Mohammedan Collections, Museum of Ethnology, Berlin.	**Mohammedan Architecture; Mohammedan Art.**
H. H. Go.	HENRY HERBERT GODDARD, A.M., PH.D. Professor of Abnormal and Clinical Psychology, Ohio State University, Columbus, Ohio. Formerly Director of Research at the Training School for Mental Defectives, Vineland, N. J. Author of *Feeblemindedness, Causes and Consequences.*	**Mental Deficiency** (*in part*).
H. H. L. B.	HUGH HALE LEIGH BELLOT, M.A., D.C.L. Late Associé de l'Institut de Droit International and Honorary Secretary, International Law Association, and Grotius Society. Sometime Acting Professor of Constitutional Law, University of London. Author of *Commerce in War; Permanent Court of International Justice.*	**Master of the Rolls; Mediation** (*in part*); **Money-Lending** (*in part*); **Most Favoured Nation Clause.**
Hi. Br.	HENRI BRENIER. Director-General of the Chamber of Commerce, Marseilles. General Secretary to the National Colonial Exhibition of Marseilles, 1922, and to the Colonial Organisation Congress, 1922.	**Morocco** (*in part*).
H. Ja.	SIR HERBERT JACKSON, K.B.E., F.R.S. Director of Research, British Scientific Instruments Research Association. Emeritus Professor of Chemistry, University of London. Formerly Daniell Professor of Chemistry, King's College, London.	**Microscope** (*in part*); **Microscopy** (*in part*).
H. J. Ch.	HENRY JAMES CHANEY, I.S.O. Late Superintendent of the Standards Department of the Board of Trade, and Secretary of the Royal Commission on Standards.	**Measures and Weights** (*in part*).

H. J. C. H.	HERBERT J. C. HENDERSON. Director of Sales, Advertising and Service of the Fisher Body Corporation, Detroit.	**Motor Car** (*in part*).
H. K. C.	HENRY KING CARROLL, LL.D. Author of *Religious Forces in the United States; Missionary Growth of the Methodist Episcopal Church.*	**Mennonites** (*in part*); **Moravian Brethren** (*in part*)
H. Mo.	H. MOORE, D.Sc. Assistant Director of Research, British Scientific Instrument Research Association.	**Microscope** (*in part*); **Microscopy** (*in part*).
H. M. St.	HENRY MORSE STEPHENS, M.A., LITT.D. Late Professor of History in the University of California. Author of *History of The French Revolution;* etc.	**Mazarin, Jules** (*in part*); **Mirabeau, Honoré Gabriel Riqueti.**
H. M. T.	HORACE M. TOWNER, LL.B. Governor of Porto Rico.	**Mayagüez.**
H. N.	H. NISBET, F.T.I. Textile Technologist and Consultant. Author of *Grammar of Textile Design.*	**Moiré.**
H. N. D.	HENRY NEWTON DICKSON, M.A., D.Sc., F.R.G.S., F.R.S.E. Late Professor of Geography, University College, Reading. Author of *Meteorology; Papers on Oceanography;* etc.	**Mexico, Gulf of.**
H. Pal.	HOWARD PALMER, B.A., LL.B., F.R.G.S. Explorer. Author of *Mountaineering and Exploration in the Selkirks;* etc.	**Mountaineering** (*in part*).
H. R.	SIR HUMPHRY DAVY ROLLESTON, K.C.B., M.D., HON.D.Sc., LL.D., D.C.L. Physician-in-Ordinary to the King. Regius Professor of Physic, University of Cambridge. Consulting Physician to the Royal Navy. Examiner in the Universities of Oxford, Cambridge, London, etc. Formerly President of the Royal College of Physicians. Author of *Clinical Lectures;* etc., and Joint-Editor (with Sir Clifford Allbutt) of 2nd Edition of *A System of Medicine.*	**Medicine, General.**
H. S. H.	H. S. HARRISON, D.Sc. Curator, The Horniman Museum, London.	**Material Culture.**
H. St.	HENRY STURT, M.A. Author of *Idola Theatri; The Idea of a Free Church; Personal Idealism.*	**Metempsychosis** (*in part*).
H. W. C. D.	HENRY WILLIAM CARLESS DAVIS, M.A. Late Director, *Dictionary of National Biography*, Regius Professor of Modern History and Fellow and Tutor of Balliol College, Oxford.	**Montfort, Simon de** (*in part*).
H. W. H.	HOPE W. HOGG, M.A. Late Professor of Semitic Languages and Literatures in the University of Manchester.	**Mesopotamia** (*in part*).
H. Wit.	HARTLEY WITHERS. Editor of the *Economist* (London), 1916–21. Director of Financial Enquiries in the Treasury, 1915–6. Sometime City Editor of *The Times* and *Morning Post* (London). Author of *Money; International Finance;* etc.	**Money Market** (*in part*).
H. W. L. E.	H. W. L. EVANS, O.B.E. Superintendent of the Royal Mint.	**Mint** (*in part*).
H. Wo.	HUMBERT WOLFE, C.B., C.B.E. Poet and Writer. Principal Assistant Secretary, Ministry of Labour. Substitute British Government Member, Governing Body, International Labour Office. Author of *London Sonnets; Circular Saws; The Unknown Goddess;* etc.	**Moore, George.**
H. W. R.	REV. HENRY WHEELER ROBINSON, M.A., D.D. Principal of Regent's Park College, London. Formerly Professor of Church History and the Philosophy of Religion in Rawdon College, Leeds. Author of *Hebrew Psychology in Relation to Pauline Anthropology* (in Mansfield College Essays); etc.	**Micah.**
I. A.	ISRAEL ABRAHAMS, M.A. Formerly Reader in Talmudic and Rabbinic Literature in the University of Cambridge. Author of *A Short History of Jewish Literature; Judaism;* etc.	**Menasseh Ben Israel.**
I. A. R.	IRMA A. RICHTER. Artist and Writer.	**Masaccio; Masolino da Panicale; Moretto, Il.**
Ja. H.	JAMES HENDERSON, M.A., B.Sc. Assistant Lecturer in Mathematics, King's College, University of London.	**Mathematical Tables.**
J. A. Si	JUDITH ANN SILBURN. Diplomée of Domestic Science, M.I.H. Formerly Trade Investigator, Ministry of Labour. Journalist and Domestic Science Consultant.	**Meat Cookery.**
J. A. Th.	SIR JOHN ARTHUR THOMSON, M.A., LL.D. Regius Professor of Natural History in the University of Aberdeen. Terry Lecturer, Yale University, 1924. Author of *The Study of Animal Life; Outlines of Zoology; Heredity; Darwinism and Human Life; What Is Man? Concerning Evolution.* Joint-Author (with Professor Patrick Geddes) of *Evolution; Sex; Biology.*	**Migration of Animals.**
J. A. V.	REV. J. A. VANES. Formerly Professor of New Testament Exegesis, Wesleyan College, Richmond.	**Methodism** (*in part*).
J. Bt.	JAMES BARTLETT. Late Lecturer on Construction, Architecture, Sanitation, Quantities, etc., at King's College, London. Author of *Quantities.*	**Masonry.**
J. C. L.	JOHN C. LONG, B.A. Manager, Educational Department, National Automobile Chamber of Commerce, New York. Author of *Public Relations; Motor Transport and Our Radial Frontier.*	**Motoring** (*in part*).
J. C. Pr.	JAMES C. PRYOR. Captain, Medical Corps, United States Navy. Senior Medical Officer, United States Naval Academy. Author of *Naval Hygiene.*	**Medical Service, Navy** (*in part*).

J. D. du S.	J. Dionis du Sejour. Managing Director, Compagnie des Messageries Maritimes.	**Messageries Maritimes, Compagnie des.**
J. D. M. S.	J. D. Main Smith, Ph.D., B.Sc., A.I.C. Late Research Assistant to the Professor of Chemistry, University of Birmingham. Late Assistant Examiner in Chemistry, University of London. Author of *Chemistry and Atomic Structure;* etc.	**Molecule, Chemical.**
J. E.	Rev. John Elsworth. Minister of the Wesleyan Methodist Church. Member of Committees for arranging the details of Methodist Reunion.	**Methodism** (*in part*).
J. E. A. D.	Commandant J. E. A. Doumenc. Officer of the Legion of Honour, Director of the French Army Mechanical Transport Service during the World War. Author of *Les Transports Automobiles sur le front français.*	**Motor Transport, Military** (*in part*).
J. E. S.	J. E. Sears, C.B.E., M.A., M.I.Mech.E., A.M.Inst.C.E., F.Inst.P. Deputy Warden of the Standards, Board of Trade, London, and Superintendent of the Metrology Department, National Physical Laboratory, Teddington, Middlesex.	**Metrology.**
J. F. C. F.	Colonel John Frederick Charles Fuller, C.B.E., D.S.O. Military Assistant to the Chief of the Imperial General Staff. Chief General Staff Officer, Tank Corps, 1917–8. Formerly Chief Instructor, Camberley.	**Mountain Warfare** (*in part*); **Munda, Battle of; Mursa, Battle of.**
J. G. R.	John George Robertson, M.A., Ph.D. Professor of German Language and Literature in the University of London. Author of *History of German Literature; Schiller After a Century;* etc.	**Meistersinger.**
J. H.	John Hilton. Director of Statistics, Ministry of Labour, London.	**Monopoly.**
J. Har.	J. Harada. Of the Imperial Household Museums, Japan. Formerly Professor in the Nagoya College of Technology and in the 8th Higher School. Imperial Japanese Government Commissioner, Panama-Pacific International Exposition, San Francisco, 1915.	**Museums and Art Galleries** (*in part*).
J. H. B.	Joseph H. Bonneville, A.M. Department of Banking and Finance, New York University School of Commerce, Accounts and Finance. Author of *Elements of Business Finance.*	**Money-Lending** (*in part*).
J. H. D.	J. H. Driberg. Author of *The Lango, a Nilotic Tribe of Uganda.*	**Masai.**
J. H. H.	J. H. Hutton, D.Sc., C.I.E. Director of Ethnology, Assam. Deputy Commissioner, Naga Hills. Author of *The Angami Nagas; The Sema Nagas;* etc.	**Meithei; Metempsychosis** (*in part*); **Moro.**
J. H. Mi.	John Henry Middleton, M.A., Litt.D., F.S.A., D.C.L. Author of *The Engraved Gems of Classical Times; Illuminated Manuscripts in Classical and Mediaeval Times.*	**Monreale** (*in part*).
J. Jn.	J. Jackson, M.A., D.Sc. Chief Assistant, Greenwich Royal Observatory.	**Moon.**
J. J. P.	General John Joseph Pershing, G.C.B. Chief of Staff, United States Army, 1921–4. Commander-in-Chief, American Expeditionary Forces in Europe, 1917–9.	**Meuse-Argonne Operation.**
J. J. Si.	J. J. Simpson, M.A., D.Sc. Free Public Museums, Liverpool.	**Museums of Science** (*in part*).
J. L. Ha.	John L. Haughton, D.Sc., F.Inst.P., F.R.A.S. Senior Assistant in the Metallurgy Department, National Physical Laboratory, Teddington.	**Metals.**
J. L. La.	Jesse L. Lasky. President, Jesse L. Lasky Feature Play Co. Vice-President, Famous Players Lasky Corporation.	**Motion Pictures** (*in part*).
J. L. W.	Jessie L. Weston, Litt.D. Author of *Arthurian Romances.*	**Merlin.**
J. M. M.	John Malcolm Mitchell, O.B.E., M.C., F.S.A. Secretary, Carnegie United Kingdom Trust. Vice-President, Library Association. Assistant Editor for Classics, Archaeology, Ancient History, 11th Edition, *Encyclopædia Britannica.*	**Mnemonics.**
J. Pa.	John Palmer. Formerly Dramatic Critic and Assistant Editor of the *Saturday Review.*	**Molière.**
J. P. M.	J. P. Mills, M.A., I.C.S. Assistant Commissioner, Makokehung, Assam.	**Mikir.**
J. P. V.-S.	Lieut.-Colonel J. P. Villiers-Stuart, C.B., D.S.O., O.B.E. Served N.W. Frontier, India, 1901–2; East Africa, 1903–4; European War, 1914–8.	**Mountain Warfare** (*in part*).
J. S. B.	John Sutherland Black, M.A., LL.D. Assistant Editor of 9th Edition, *Encyclopædia Britannica.* Joint-Editor of the *Encyclopaedia Biblica.*	**Mazzini, Giuseppe** (*in part*).
J. S. F.	Sir John Smith Flett, K.B.E., D.Sc., LL.D., F.R.S. Director, Geological Survey of Great Britain and Museum of Practical Geology. Formerly Lecturer on Petrology in Edinburgh University.	**Micropegmatite.**
J. S. Fa.	John Shields Fairbairn, M.B., B.Ch., F.R.C.S., F.R.C.P. Obstetric Physician and Lecturer on Midwifery and Diseases of Women, St. Thomas' Hospital. Physician, General Lying-in Hospital, London. Author of *A Textbook for Midwives; Gynaecology with Obstetrics;* etc.	**Menopause.**

J. S. H.	JULIAN SORELL HUXLEY, M.A. Hon. Lecturer, King's College, London. Fullerian Professor of Physiology in the Royal Institution. Author of *Essays of a Biologist;* etc. Editor of the Biology and Zoology section of the 14th Edition of the *Encyclopædia Britannica.*	**Metamorphosis** (*in part*).
J. T. A.	JAMES TRUSLOW ADAMS, A.M., LL.D., LITT.D. Member of the Massachusetts Historical Society. Author of *Founding of New England.*	**Massachusetts.**
J. Vi.	JONAS VILES, A.M., PH.D. Professor of American History, University of Missouri, Columbia, Mo. Author of *Archives of Missouri; History of Missouri.*	**Missouri.**
J. W. Ho.	J. W. HOLLOWAY, JR., B.A., LL.B. American Medical Association, Bureau of Legal Medicine and Legislation.	**Medical Legislation** (*in part*)
K. A. M.	KATE A. MEAKIN (Mrs. Budgett Meakin).	**Morocco** (*in part*).
K. B. M.	KENNETH BALLARD MURDOCK, A.M., PH.D. Assistant Professor of English, Harvard University. Author of *Portraits of Increase Mather.* Editor of *Selections from Cotton Mather.*	**Mather, Cotton; Mather, Increase; Mather, Richard.**
K. S. L.	KENNETH SCOTT LATOURETTE, M.A., PH.D., D.D. Professor of Missions and Oriental History, Yale University. Author of *The Development of China; History of Early Relations Between United States and China.*	**Mongolia** (*in part*).
L. A. W.	LEE A. WHITE, M.A. Associate Professor of Rhetoric, University of Michigan; formerly head of Department of Journalism, University of Washington.	**Michigan.**
L. C.	LON CHANEY. Director, Motion Picture Production.	**Motion Pictures** (*in part*).
L. C. M.	SIR LEO CHIOZZA MONEY, F.R.STAT.S., F.R.G.S., F.Z.S. Author and Journalist. Member of the War Trade Advisory Committee, 1915–8. Parliamentary Secretary to the Ministry of Shipping, 1916–8. Chairman of the Tonnage Priority Committee, 1917–8. Editor of the Economics, Engineering and Industries section of the 14th Edition of the *Encyclopædia Britannica.*	**Midland Bank Limited.**
L. D. C.	LOTUS DELTA COFFMAN, A.M., PH.D. President of the University of Minnesota.	**Minnesota, University of.**
L. D. S.	LAURENCE DUDLEY STAMP, D.SC., A.K.C., F.G.S., M.I.P.T. Reader in Economic Geography in the University of London. Author of *An Introduction to Stratigraphy.*	**Miocene.**
L. F. S.	L. F. SALZMAN, M.A., F.S.A. Of Pembroke College, Cambridge. Hon. Editor, Sussex Archaeological Society. Author of *Mediaeval English Industries; English Life in the Middle Ages; Mediaeval Byways.*	**Minstrel.**
L. Gi.	LILLIAN GISH. Leading Actress, Motion Pictures. Appeared in "Way Down East"; etc.	**Motion Pictures** (*in part*).
L. Gu.	LUTHER GULICK. Director of the New York Bureau of Municipal Research and of the National Bureau of Public Administration. Lecturer, Columbia University, New York.	**Mayor** (*in part*).
L. H. D. B.	L. H. DUDLEY BUXTON, M.A. Reader in Physical Anthropology in the University of Oxford.	**Mesopotamia** (*in part*); **Mongolia** (*in part*); **Mosul** (*in part*).
L. H. P.	L. H. POMEROY, M.I.MECH.E., M.I.A.E. Chief Engineer to the Associated Daimler Co., Ltd., Coventry, England.	**Motor Car** (*in part*).
L. J. B.	LAWRENCE J. BURPEE, F.R.G.S., F.R.S.C. Secretary for Canada, International Joint Commission. Sometime Private Secretary to three successive Ministers of Justice in the Dominion Government. Author of *Canadian Life in Town and Country;* etc.	**Montreal.**
L. J. S.	L. J. SPENCER, SC.D., F.G.S., F.C.S., F.R.S. Keeper of Department of Mineralogy, Natural History Museum, South Kensington. Formerly Scholar of Sidney Sussex College, Cambridge, and Harkness Scholar. Editor of *The Mineralogical Magazine.*	**Mica** (*in part*); **Mineralogy.**
L. S. Ma.	LIONEL S. MARKS, B.SC., M.M.E. Professor of Mechanical Engineering, Harvard University. Author of *Mechanical Engineers' Handbook;* etc.	**Mechanical Engineer.**
L. V.	LUIGI VILLARI. Italian Vice-Consul in New Orleans, 1906; Philadelphia, 1907; Acting-Consul, Boston, 1907–10. On the Secretariat of the League of Nations, 1920–3. Author of *Italian Life in Town and Country; The Fascist Experiment;* etc.	**Mazzini, Giuseppe** (*in part*).
L. W. B.	L. W. BALDWIN, B.S., C.E. President of the Missouri Pacific Railway Company, St. Louis, Mo.	**Missouri Pacific Lines.**
M. Bon.	RT. HON. MARGARET GRACE BONDFIELD. Minister of Labour, 1929. Parliamentary Secretary to the British Ministry of Labour, 1924. Labour Adviser to Labour Convention at Washington, 1919. Chairman, General Council of the Trades Union Congress, 1923.	**Maternity and Infant Welfare** (*in part*).
M. C. S.	MALCOLM CHARLES SALAMAN. Formerly Dramatic and Art Critic of *The Sunday Times*, London. Author of *Old English Colour-Prints; The Charm of the Etcher's Art; Modern Masters of Etching;* etc.	**Monotypes.**
M. H. C.	MONTAGUE HUGHES CRACKANTHORPE, K.C., D.C.L., M.A. Late President of the Eugenics Education Society. Formerly Member of the General Council of the Bar and Council of Legal Education.	**Mediation** (*in part*).

M. I. N.	MARION I. NEWBIGIN, D.SC. Editor of *The Scottish Geographical Magazine.* Author of *A Geographical Study of the Peace Terms; Mediterranean Lands;* etc.	Mediterranean Sea (*in part*).
M. Loc.	MARGERY LOCKET. Education Manager, British Instructional Films, Ltd., London.	Motion Pictures (*in part*).
M. of B.	JOHN WALTER EDWARD DOUGLAS SCOTT-MONTAGU, 2ND BARON MONTAGU OF BEAULIEU, K.C.I.E., C.S.I. Adviser on Mechanical Transport Services to Government of India, 1915–9. Founder and late Editor of *The Car.*	Motoring (*in part*); Motor Transport, Commercial.
M. Ss.	MILTON SILLS, A.B. Actor, Motion Pictures.	Motion Pictures (*in part*).
N. Ba.	N. BAROU. Member of the Russian Bar and Director of the Moscow Narodny Bank.	Moscow Narodny Bank, Ltd.
N. E. C.	NORMAN E. CRUMP. Statistical Correspondent to the *Financial Times,* London. Joint Author of *Clare's A. B. C. of the Foreign Exchanges.*	Mint Par of Exchange; Mint Price of Gold; Monetary Union.
N. P. C.	NATHAN P. COLWELL, M.D. Secretary of the Council on Medical Education of American Medical Association. Editor of *Federation Bulletin of State Medical Boards of the United States.*	Medical Education (*in part*).
O. G. S. C.	OSBERT GUY STANHOPE CRAWFORD, F.S.A. Archaeology Officer of the British Ordnance Survey. Author of *Man and His Past.*	Mound-Builders.
O. J. R.	MISS O. J. ROBINSON, M.SC., N.D.A., N.D.D. Part-Time Lecturer, East Anglian Institute of Agriculture.	Milk (*in part*).
O. Wo.	D. ORSON WOOD, M.SC., A.R.C.S., F.INST.P. Senior Lecturer in Physics, University of London.	Measures and Weights (*in part*).
P. C. M.	SIR PETER CHALMERS MITCHELL, C.B.E., LL.D., D.SC., F.R.S. Secretary to the Zoological Society of London. Author of *Outlines of Biology; The Childhood of Animals;* etc.	Monster (*in part*).
P. De Az.	P. DE AZCARATE. League of Nations, Geneva.	Minorities (*in part*).
P. Gr.	PHILIP GRAVES. Assistant Foreign Editor of *The Times,* London. Correspondent of *The Times* at Constantinople, 1908–14. Author of *The Land of Three Faiths.*	Mesopotamia (*in part*).
P. G. T.	PETER GUTHRIE TAIT, LL.D. Physicist. Professor of Natural Philosophy, Edinburgh University, 1860–1904.	Maxwell, James Clerk.
P. M. H.	P. M. HELDT. Engineering Editor of *Automotive Industries.* Author of *The Gasoline Automobile.*	Motor Vehicles, Commercial (*in part*).
P. M. R.	P. M. ROXBY, M.A. Professor of Geography in Liverpool University.	Mongolia (*in part*).
P. P. Cr.	PAUL PHILLIPPE CRET. Professor of Architectural Design, University of Pennsylvania, Philadelphia. Fellow, American Institute of Architects. Architect of Pan-American Union Building, Washington; Valley Forge Memorial Arch, Philadelphia.	Museum Architecture (*in part*).
P. V.	PASQUALE VILLARI. Italian Historian and Statesman. Author of *I primi due secoli della storia di Firenza;* etc. *See* the biographical article: VILLARI, PASQUALE.	Medici (*in part*).
P. Z. C.	MAJOR-GENERAL SIR PERCY Z. COX, G.C.M.G., K.C.S.I., G. C.I.E., F.R.G.S. Acting British Minister to Persia, 1918–20. High Commissioner in Mesopotamia, 1920–3; Secretary, Foreign Department, Government of India, 1914. Consul and Political Agent, Muscat, Arabia, 1899–1904.	Meshed.
R. C. A.	R. C. ARCHIBALD, M.A., PH.D., LL.D. Professor of Mathematics, Brown University, Providence, R. I. Fellow of American Academy of Arts and Sciences.	Mathematical Societies and Periodicals.
R. C. An.	ROY CHAPMAN ANDREWS, M.A., SC.D. Curator-in-Chief, Division of Asiatic Exploration and Research, American Museum of Natural History, New York. Leader of Asiatic Expeditions. Author of *Across Mongolian Plains;* etc.	Mongolia (*in part*).
R. Ch.	ROBERT CHAMBERS, M.A., PH.D. Research Professor of Biology, New York University, and Chairman of the Department of Biology, Washington Square College.	Micromanipulation.
R. C. S.	RALPH C. SMITH. Assistant Secretary, American Association of Museums. Author of *A Bibliography of Museums and Museum Work;* etc.	Museum Architecture (*in part*).
R. Dy.	ROMAN DYBOSKI, PH.D. Professor of English Literature in the University of Cracow (Poland). Corresponding Member of the Polish Academy.	Mickiewicz, Adam.
R. F. W.	R. F. WOODHULL. National President of the Motion Picture Theatre Owners of America, New York.	Motion Picture Theatre.
R. G.	RICHARD GARNETT, C.B., LL.D. Librarian and Author. Late Superintendent of the Reading Room, British Museum, and Keeper of the Printed Books. Co-Editor (with Edmund Gosse) of *English Literature.* Author of *A Chaplet from the Greek Anthology; Emerson; Milton;* etc.	Müller, Max (*in part*).
R. G. H.	RALPH GEORGE HAWTREY. Assistant Secretary to the Treasury, London. Author of *Currency and Credit;* etc.	Money.

R. H. Ch.	REV. ROBERT HENRY CHARLES, M.A., D.D., LITT.D., F.B.A. Archdeacon of Westminster. Late Grinfield Lecturer and Lecturer in Biblical Studies, Oxford. Professor of Biblical Greek at Trinity College, Dublin, 1898–1906.	**Moses, Assumption of.**
R. H. R.	SIR R. HENRY REW, K.C.B. Board of Agriculture and Fisheries, 1898; Assistant Secretary, 1906–18. Secretary to the Ministry of Food, 1916–7. Chairman, Inter-Departmental Committee on Unemployment Insurance in Agriculture, 1925–6.	**Meat Trade** (*in part*).
R. K. D.	SIR ROBERT KENNAWAY DOUGLAS. Author of *The Language and Literature of China; The Life of Jenghiz Khan;* etc.	**Mongols** (*in part*).
R. N. B.	ROBERT NISBET BAIN. Assistant Librarian, British Museum, 1883–1909. Author of *Scandinavia: The Political History of Denmark, Norway and Sweden, 1513–1900; Slavonic Europe: The Political History of Poland and Russia from 1469 to 1766;* etc.	**Menshikov, A. D.** (*in part*)
R. Sc.	ROBERT SCOTT, M.B., CH.B. Barrister-at-Law. Formerly Major in the R.A.M.C.	**Medical Legislation** (*in part*)
R. S. Cl.	R. S. CLAY, D.SC., F.INST.P. Principal, Northern Polytechnic, Holloway, London. President of Optical Society. Author of *Practical Exercises in Light; Treatise on Practical Light.*	**Mirror.**
R. S. L.	R. S. LEWIS, A.B., E.M. Department of Mining, University of Utah, Salt Lake City, Utah. Author of section on Boring, *Peele's Mining Engineers' Handbook.*	**Mining, Metalliferous.**
R. Sm.	REED SMOOT. American Senator from Utah. Member of the World War Foreign Debt Commission. Regent of the Smithsonian Institution.	**Mormonism; Mormons or Latter-Day Saints.**
R. V. S.	RICHARD VYNNE SOUTHWELL, M.A., F.R.S. University Lecturer in Mathematics and Fellow of Trinity College, Cambridge. In charge of Non-Rigid Airships Design at R.N. Air Station, Kingsnorth, 1915–8, and of Aerodynamic and Structural Experiments at the Royal Aircraft Establishment, Farnborough, 1918–9. Late Superintendent of the Aerodynamics Department, National Physical Laboratory, Teddington.	**Materials, Strength of; Mechanics.**
R. W. M.	ROY WALDO MINER. Curator of the Marine Life section of the division of Zoology and Zoogeography, American Museum of Natural History.	**Museums of Science** (*in part*).
R. W. P.	RAYMOND WILLIAM POSTGATE. Editorial Staff, London, of the 14th Edition of the *Encyclopædia Britannica.* Author of *Revolution from 1789–1906; The Builders' History;* ed. *Pervigilium Veneris.*	**Municipal Trading** (*in part*)
R. W. Pe.	SIR ROBERT WILLIAM PERKS, BART. Chairman of the Metropolitan District Railway, 1902–6. Treasurer, Wesleyan Methodist Twentieth Century Million Fund. M.P. for the Louth Division of Lincolnshire, 1892–1910.	**Methodism** (*in part*).
R. W. S.-W.	ROBERT WILLIAM SETON-WATSON, LITT.D. Masaryk Professor of Central European History at King's College, University of London. Founder of and Joint-Editor of *The New Europe*, 1916–20. Joint-Editor of *The Slavonic Review.* Author of *The Rise of Nationality in the Balkans;* etc.	**Montenegro.**
S. A. C.	STANLEY ARTHUR COOK, M.A., LITT.D. University Lecturer in Hebrew and Aramaic. Fellow and Lecturer in Hebrew and Syriac, Gonville and Caius College, Cambridge. Co-Editor of the *Cambridge Ancient History.* Editor for Palestine Exploration Fund.	**Moab; Moloch** (*in part*); **Moses** (*in part*).
S. Au.	S. AUERBACH. Secretary, Metallgesellschaft, Frankfurt.	**Metallgesellschaft A.G.**
S. C.	SIR SIDNEY COLVIN, M.A. English Literary and Art Critic. Late Slade Professor of Fine Art, Cambridge University. Keeper of the Department of Prints and Drawings, British Museum, 1884–1921. *See* the biographical article: COLVIN, SIR SIDNEY.	**Michelangelo** (*in part*).
S. C. H. D.	S. C. H. DAVIS. Of Autocar, London.	**Motor Racing** (*in part*).
S. Cu.	STEWART CULIN. Brooklyn Museum of Art and Sciences, Brooklyn, N. Y. Author of *Korean Games; Games of the American Indians.*	**Masks** (*in part*).
S. G. B.-B.	REV. GRAHAM BRADE-BIRKS, D.SC., F.Z.S. Lecturer in Zoology and Geology, South-Eastern Agricultural College, Wye, Kent.	**Millipede.**
S. H. H.	S. H. HAMER. Secretary of the National Trust for Places of Historic Interest or Natural Beauty, 1911. Author of *The Story of the Ring; Whys and Other Whys; The Jungle School;* etc.	**Monuments, Preservation of** (*in part*).
S. J. Bu.	SOLON JUSTUS BUCK, PH.D. Superintendent of the Minnesota Historical Society. Professor of History in the University of Minnesota. Author of *The Granger Movement; Illinois in 1818;* etc.	**Minnesota.**
S. L.	STEPHEN HERBERT LANGDON, M.A., B.D., PH.D. Professor of Assyriology, Oxford, since 1919. Curator in the University Museum, Babylonian section, Philadelphia, 1916–8. Director of the Weld-Blundell and Field Museum Expedition to Mesopotamia since 1922.	**Mesopotamia** (*in part*).
S. Le.	STUART LEWIS, A.M., PH.D., D.C.L., M.F.S. Professor of Law, New Jersey Law School. Author of *Party Principles and Practical Politics; An Outline of American Federal Government.*	**Mason and Dixon Line.**
S. S. R.	REAR-ADMIRAL SAMUEL S. ROBISON, U.S.N. Superintendent of United States Naval Academy. Formerly in command of United States Fleet.	**Midshipman** (*in part*).

S. W. S.	SAMUEL WESLEY STRATTON, D.Sc., LL.D., PH.D. President of Massachusetts Institute of Technology, Boston.	**Massachusetts Institute of Technology, The.**
T. A.	THOMAS ASHBY, D.LITT., F.B.A., F.S.A., HON.A.R.I.B.A. Formerly Director of the British School at Rome. Author of *Turner's Visions of Rome; The Roman Campagna in Classical Times;* Revised and completed for press a *Topographical Dictionary of Ancient Rome* (by the late Prof. J. B. Plattner).	**Megara Hyblaea; Messina; Metaurus; Monreale** (*in part*)**; Monteleone Di Calabria.**
T. E. L.	THOMAS EAST LONES, M.A., LL.D. Formerly Senior Examiner in H.M. Patent Office. Author of *Aristotle's Researches in Natural Science; Zinc and Its Alloys.*	**Meters, Electric.**
T. E. R. P.	REV. THEODORE EVELYN REECE PHILLIPS, M.A., F.R.A.S., F.R.MET.S. Secretary, Royal Astronomical Society, 1919–26; President, 1927 and 1928. Joint-Editor of the *Splendour of the Heavens.*	**Mercury.**
T. F. H	TALBOT F. HAMLIN, B.A., B.ARCH. Instructor in the History of Architecture, Columbia University, New York. Chairman, City Plan Committee of the Merchants' Association, New York.	**Minaret; Mosaic; Mosque; Moulding.**
T. G. B.	THOMAS GREGOR BRODIE, M.D., F.R.S. Late Professor of Physiology at St. Thomas's Hospital Medical College, University of London.	**Muscle, Structure of.**
Th. N.	THEODOR NÖLDEKE, PH.D. German Semitic Scholar. Late Professor of Oriental Languages at Strasbourg. Author of *Geschichte des Korans* and numerous essays.	**Moʻallaqāt** (*in part*).
T. H. R.	THEODORE H. ROBINSON, M.A., D.D. Professor of Semitic Languages, University College of South Wales and Monmouthshire.	**Moses** (*in part*).
T. J. W.	T. J. WALSH. American Lawyer and Senator.	**Montana.**
T. K. R.	SIR THOMAS KIRKE ROSE, D.Sc., A.R.S.M. Chemist and Assayer at the Mint, 1902–26. President, Institution of Mining and Metallurgy, 1915–6. Author of *The Metallurgy of Gold; The Precious Metals.*	**Mint** (*in part*).
T. Ra.	TERRY RAMSAYE. Editor-in-Chief of Eastern Production for Pathé Exchange, Inc., New York. Author of *A History of the Motion Picture.*	**Motion Pictures** (*in part*).
T. R. Pi.	T. R. PIRTLE. Department of Information, United States Department of Agriculture, Washington. Author of *History of the Dairy Industry; Handbook of Dairy Statistics.*	**Milk** (*in part*).
T. W.	THOMAS WOODHOUSE. Head of Weaving and Textile Designing Department, Technical College, Dundee.	**Matting.**
T. W. A.	SIR THOMAS WALKER ARNOLD, C.I.E., M.A., LITT.D., F.B.A. Professor of Arabic, University of London. Formerly Professor of Philosophy, Government College, Lahore.	**Miniature Painting** (*in part*).
V. H. B.	VERNON HERBERT BLACKMAN, Sc.D., F.R.S. Professor of Plant Physiology and Pathology, Imperial College of Science and Technology, London. Editor of the Botany section of the 14th Edition of the *Encyclopædia Britannica.*	**Millet.**
W. A. Ba.	WALTER A. BARDGETT. Editor of cycling papers since 1915. Former Racing Cyclist, Manager of bicycle tracks and referee at cycle race meets.	**Motorcycles** (*in part*)**; Motor Racing** (*in part*).
W. A. G.	WILLIAM A. GANOE, A.M., M.A. Major, United States Army. Author of *The History of the United States Army.*	**Monterrey.**
W. A. Ha.	WILLIAM A. HAMOR. Assistant Director of Mellon Institute of Industrial Research. Author of *The Examination of Petroleum; American Fuels;* etc.	**Motor Car Engines: Their Operation and Care.**
W. A. P.	W. ALISON PHILLIPS, M.A. Lecky Professor of Modern History, Dublin University.	**Mephistopheles.**
W. B. P.	WILLIAM BELMONT PARKER, A.B. Editor of *South Americans of Today.*	**Maximilian; Medina, José Toribio; Mendoza, Antonio De; Mitre, Bartolomé.**
W. B. Sh.	WILFRED B. SHAW. General Secretary, Alumni Association, University of Michigan. Author of *History of the University of Michigan.*	**Michigan, University of.**
W. D. M.	WILLIAM DILLER MATTHEW, A.M., PH.D., F.R.S. Professor of Palaeontology. Director of Museum of Palaeontology, University of California. Author of various scientific treatises on fossil vertebrates.	**Megatherium.**
W. E. I.	MAJOR-GENERAL SIR WILLIAM EDMUND IRONSIDE, K.C.B., C.M.G., D.S.O. G. O. C. Meerut District, India, since 1928. Commander-in-Chief, British Troops in Russia, 1918–9. Commandant, Staff College, Cambridge, 1922–6. Author of *Tannenberg: The First Thirty Days in East Prussia.*	**Masurian Lakes, Battles of the.**
W. F. S.	WILLIAM FLEETWOOD SHEPPARD, Sc.D., M.A., LL.M. Senior Examiner in the Board of Education. Formerly Fellow of Trinity College, Cambridge.	**Mensuration.**
W. G. Co.	WILLIAM GEORGE CONSTABLE, M.A. Assistant Keeper of the National Gallery, London. Lecturer at the Wallace Collection. Fellow of St. John's College, Cambridge.	**Museums and Art Galleries** (*in part*).

W. G. Ma.	SIR WILLIAM GRANT MACPHERSON, K.C.M.G., M.B., D.P.H. Late Major-General, Army Medical Service. Editor-in-Chief, *Medical History of the War*. Served at the War Office as Deputy Director-General of the Army Medical Service, and as a member of the Advisory Board for Medical Services.	**Medical Service, Army.**
W. Gt.	W. GARNETT, B.Sc. Of the Overseas Settlement Committee, London.	**Migration** (*in part*).
W. Ha.	WESLEY HARDENBERGH, B.LITT. Vice-President, Institute of American Meat Packers, Chicago.	**Meat Trade** (*in part*).
W. H. Di.	WILLIAM HEPWORTH DIXON. Chief of the Research Department, Messrs. Bryant and May, Ltd., London.	**Match** (*in part*).
W. H. Ma.	WILLIAM HERRICK MACAULAY, M.A. Fellow and Tutor of King's College, Cambridge.	**Motion, Laws of.**
W. J. B.-L.	W. J. BASSETT-LOWKE. Messrs. Bassett-Lowke, Ltd., Locomotive Engineers, Northampton, England.	**Models and Model-Making.**
W. K. G.	WILLIAM KING GREGORY, A.M., PH.D. Curator of the Departments of Comparative Anatomy and Ichthyology, American Museum of Natural History. Professor of Vertebrate Palaeontology, Columbia University. Author of *The Orders of Mammals;* etc.	**Monotremata.**
W. K. L. C.	REV. WILLIAM KEMP LOWTHER CLARKE, D.D. Editorial Secretary of the Society for Promoting Christian Knowledge. Author of *St. Basil the Great;* etc.	**Matthias** (Disciple).
W. M. C.	SIR W. MARTIN CONWAY. English Art Critic and Mountaineer. Director-General of the Imperial War Museum since 1917. Author of *The Alps from End to End; With Ski and Sledge over Arctic Glaciers;* etc.	**Mountaineering** (*in part*).
W. Me.	WILFRED MEYNELL. Editor of *The Collected Works of Francis Thompson.*	**Meynell, Alice.**
W. M. F. P.	SIR WILLIAM M. FLINDERS PETRIE, D.C.L., LITT.D., PH.D., LL.D., F.R.S. Edwards Professor of Egyptology, University College, London. Founder of the British School of Archaeology in Egypt. *See* the biographical article: PETRIE, SIR WILLIAM MATTHEW FLINDERS.	**Measures and Weights, Ancient.**
W. N. Ha.	WILLIAM N. HASKELL, D.S.M. Major-General, New York National Guard. Head of American Relief Missions to Rumania and Russia. Red Cross Commissioner in Greece, 1922–3.	**Militia** (*in part*).
W. Pa.	REV. W. PATON. Joint-Editor of *The International Review of Missions.*	**Missions.**
W. R. Be.	WILLIAM R. BENET, PH.B., M.A. Associate Editor of *Saturday Review of Literature*, New York.	**Masters, Edgar Lee.**
W. R. D.	WARREN R. DAWSON, F.R.S.E., F.S.A. Author of numerous articles on Egyptology and the History of Medicine.	**Mummy.**
W. R. Ho.	W. R. HODGKINSON, C.B.E., PH.D., F.R.S.E. Formerly Professor of Chemistry and Metallurgy, Artillery College, Woolwich. Part-Author of Valentine-Hodgkinson's *Practical Chemistry;* etc.	**Mercury, Fulminate of.**
W. Rn.	WALTER ROSENHAIN, D.SC., F.R.S. Superintendent of the Department of Metallurgy in the National Physical Laboratory, Teddington, Middlesex. Member of the International Committee on Nomenclature of Iron and Steel. Author of *Introduction to the Study of Physical Metallurgy.*	**Metallography; Metallurgy.**
W. R. S.	W. ROBERTSON SMITH, LL.D. Editor of the 9th Edition of the *Encyclopædia Britannica.*	**Moloch** (*in part*).
W. R. Sm.	WILLIAM ROY SMITH, M.A., PH.D. Associate Professor of History, Bryn Mawr College, Pennsylvania.	**Missouri Compromise.**
W. S. H.	WILLIAM S. HARLEY, B.S. Harley Davidson Motor Company, Milwaukee, Wisconsin.	**Motorcycles** (*in part*).
W. S. L.-B.	WALTER SYDNEY LAZARUS-BARLOW, B.A., M.D., F.R.C.P. Member of the Cancer Committee, Ministry of Health. Formerly Professor of Experimental Pathology, Middlesex Hospital Medical School, London University. Editor, Medicine section, 14th Edition, *Encyclopædia Britannica.*	**Medical Research; Medicine; Mirror-Writing; Mouth and Salivary Glands.**
W. T. B.	WLADYSLAW THEODORE BENDA. Illustrator and Painter. Illustrates for leading American periodicals, *Century Magazine, Scribners;* etc. Creator of Benda Masks used on stage in Europe and America.	**Masks** (*in part*).
W. Tho.	WALLACE THOMPSON, B.SC., LITT.D. Editor-in-Chief of *Ingenieria International* (New York). Fellow of the Royal Geographical Society. Author of *The People of Mexico; Trading with Mexico;* etc.	**Mosquito Coast.**
W. T. W.	WILLIAM TEMPLETON WAUGH, M.A., B.D. Kingsford Professor of History and Chairman of the Department of History, McGill University, Montreal. Author of *The Monarchy and the People;* etc.	**Montcalm, Louis-Joseph de Montcalm-Gozon.**
W. Wa.	W. WARDLAW, D.SC., F.I.C. Lecturer in Chemistry, University of Birmingham.	**Molybdenum** (*in part*).
W. W. P.	W. WYATT PAINE, J.P., F.S.A. Author and Editor of numerous legal textbooks.	**Master and Servant.**
X.	Initial Used for Anonymous Contributors.	

THE ENCYCLOPÆDIA BRITANNICA

FOURTEENTH EDITION

VOLUME 15

MARY, DUCHESS OF BURGUNDY TO MUSHET STEEL

MARY (1457–1482), duchess of Burgundy, only child of Charles the Bold, duke of Burgundy, and his wife Isabella of Bourbon, was born on Feb. 13, 1457. As heiress of the rich Burgundian domains her hand was eagerly sought by a number of princes. When her father fell upon the field of Nancy, on Jan. 5, 1477, Louis XI. of France took possession of the duchy of Burgundy as a fief lapsed to the French crown, and also of Franche Comté, Picardy and Artois. He was anxious that Mary should marry the Dauphin Charles and thus secure the inheritance of the Netherlands for his descendants. Mary declined the French alliance, and turned to her Netherland subjects for help. She obtained the help only at the price of signing (Feb. 11, 1477) "the Great Privilege," by which the provinces and towns of the Netherlands recovered all the local and communal rights abolished by the arbitrary decrees of the dukes of Burgundy.

Mary had to undertake not to declare war, make peace, or raise taxes without the consent of the States, and not to employ any but natives in official posts. Mary now married the archduke Maximilian of Austria, afterwards the emperor Maximilian I., at Ghent on Aug. 18, 1477. Affairs now went more smoothly in the Netherlands, the French aggression was checked, and internal peace was in a large measure restored, when the duchess died, of a fall from her horse, on March 27, 1482. Three children had been the issue of her marriage, and her elder son, Philip, succeeded to her dominions under the guardianship of his father.

See E. Münch, *Maria von Burgund, nebst d. Leben v. Margaretha v. York* (2 vols., Leipzig, 1832), and the *Cambridge Mod. Hist.* (vol. i., c. xii., bibliography, 1903).

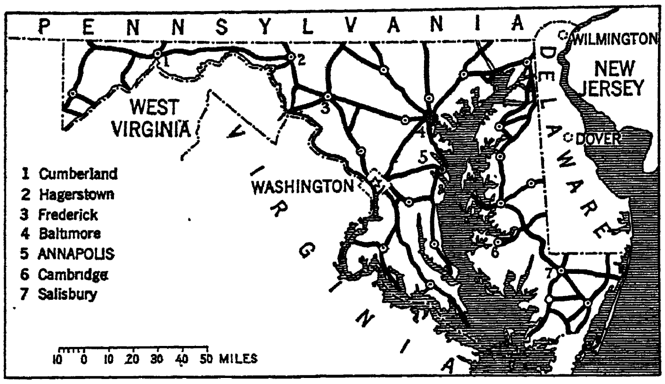
MARYBOROUGH, a coastal town in the south-east of Queensland, Australia, situated 167 miles by rail north of Brisbane on the banks of the Mary river, *c.* 20 miles from its mouth. The lowlands here extend as far north as Bundaberg (*q.v.*), on the south to Gympie (*q.v.*), and inland (west) beyond Gayndah. Its extensive hinterland includes a variety of natural possibilities, mineral, forestal, pastoral and agricultural. (Av. ann. temps. 86°–49° F; av. ann. rainfall: 46 in.). In the Wide Bay district is the Burrum (Cretaceous; bituminous) coal-field. The ten coal-mines of the Maryborough district produced *c.* 100,000–120,000 tons (1925–26). The Gympie and Kilkivan mining fields also find their outlet at Maryborough. Inland, valuable timbers (*e.g.*, "Queensland kauri") are cut (Kingaroy district) and cattle and sheep rearing is carried on (*e.g.*, Gayndah area). Around the town, sugar (Isis district) and fruit growing, dairying and mixed farming are progressing, while Maryborough itself is noted for its foundry and railway engineering works, and other industries of the area are sugar milling and butter-making. A good deep-water port exists at Urangan (29 miles N.E.) and, besides local lines (Gayndah, Nanango, etc.), Maryborough is connected by the North Coast Railway with Brisbane and the coastal towns further north. The population (1926–27) is *c.* 12,000.

MARYBOROUGH, county town of co. Leix, Ireland. Pop. (1926) 3,382. It lies on the river Triogue and is 51 m. W.S.W. of Dublin by the Great Southern railway. Its charter was granted in 1570, and a bastion of the ancient castle remains. There are flour-mills and a considerable general trade. On Dunamase or Dunmall rock, about 3 m. from the town, are ruins of a castle belonging to the kings of Leinster, but probably built by William Bruce (*c.* 1200) and dismantled in 1650 by Cromwell's troops.

MARYLAND (mĕr'ĭ-lạnd), the "Old Line State," is one of the original thirteen States of the United States of America. It is situated on the Atlantic coast and extends along the Chesapeake bay beween lat. 37° 53′ and 39° 43′ 26·3″ N., the northern boundary being the Mason and Dixon line, and between long. 75° 4′ and 79° 29′ 15″ W. It is bounded north by Pennsylvania and Delaware; east by Delaware and the Atlantic ocean; south and west by the Potomac river and its north branch, which separates the State, except on the extreme west border, from Virginia and West Virginia; west by West Virginia. It is one of the small States of the Union—only seven are smaller—its total area being 12,327 sq.m., of which 2,386 sq.m. are water surface. The name Maryland was given to the original county palatine in honour of Queen Henrietta Maria, wife of Charles I. of England. The popular name "Old Line State" has been applied to Maryland because of the distinguished service of the Maryland Line during the Revolutionary War.

Physical Features.—Maryland is crossed from north to south by each of the leading topographical regions of the east section of the United States—the Coastal plain, the Piedmont plateau, and the Appalachian region; hence its great diversity of surface. The portion within the Coastal plain embraces nearly the whole of the south-east half of the State and is commonly known as tidewater Maryland. It is marked off from the Piedmont plateau by a "fall line" extending from Washington (D.C.) north-east through

Baltimore to a point a little south of the north-east corner of the State, and is divided by the Chesapeake bay into two parts known as the eastern shore and the western shore. The eastern shore is a low, level plain, the least elevated section of the State. Along its entire Atlantic border extends the narrow sandy Sinepuxent beach which encloses a shallow lagoon or bay also called Sinepuxent at the north and Chincoteague at the south. On the



MAP SHOWING THE MAIN ROADS IN MARYLAND

entire peninsula between the Delaware and the Chesapeake the land is low, rising northward to a height of about 100 ft. near the fall line. A water-parting extending from north-east to south-west and close to the Atlantic border separates the eastern shore into two drainage systems, though that next to the Atlantic is insignificant. That on the Chesapeake side is drained chiefly by the Chester, Choptank, Nanticoke and Pocomoke rivers together with their numerous branches, the general direction of all of which is south-west. The branches, as well as the upper parts of the main streams, flow through broad and shallow valleys.

The western shore is somewhat more undulating than the eastern and also more elevated. Its general slope is from north-west to south-east, and along the west border are points 300 ft. or more in height. The principal rivers crossing this section are the Patuxent and the Potomac, the right or southern bank of the latter forming the State's southern boundary. These rivers, lined in most instances with terraces 30 to 40 ft. high on one or both sides, flow south-east into the Chesapeake bay through valleys bounded by low hills. The fall line, which forms the boundary between the coastal plain and the Piedmont plateau, is a zone in which a descent of about 100 ft. or more is made in many places within a few miles, and in consequence is marked by waterfalls and rapids.

The part of Maryland within the Piedmont plateau extends west from the fall line to the base of Catoctin mountain, or the west border of Frederick county, and has an area of about 2,500 square miles. In general it has a broad rolling surface. It is divided into two sections by an elevated strip known as Parr's ridge, which extends from north-east to south-west a short distance west of the middle. The east section rises from about 450 ft. along the fall line to from 850 to 900 ft. along the summit of Parr's ridge. Its principal streams are those that cross the western shore of the Coastal plain and here wind their way from Parr's ridge rapidly toward the south-east in narrow steep-sided gorges and broad limestone valleys. To the west of Parr's ridge the surface for the most part slopes gently down to the east bank of the Monocacy river, and then from the opposite bank rises rapidly toward the Catoctin mountain; but just above the mouth of the Monocacy on the east side of the valley is Sugar Loaf mountain (1,250 feet).

The portion of the State lying within the Appalachian region is commonly known as western Maryland. To the eastward it abounds in mountains and valleys, but in the extreme western portion is a rolling plateau. West of Catoctin mountain (1,800 ft.) is Middletown valley with Catoctin creek running through it from north to south and the Blue Ridge mountains (2,400 ft.), near the Pennsylvania border, forming its west slope. Farther west the serrated crests of the Blue Ridge overlook the Greater Appalachian valley, here 73 m. in width, the broad gently-rolling slopes of the Great Cumberland or Hagerstown valley occupying its eastern and the Appalachian ridges its western portion. Through the eastern portion Antietam creek to the east and Conococheague creek to the west flow in meandering trenches that in places exceed 75 ft. in depth. The Appalachian ridges of the western portion begin with North mountain on the east and end with Wills mountain on the west. They reach a maximum height in Martin's ridge of more than 2,000 feet. Overlooking them from the west are the higher ranges of the Alleghanies among which the Savage, Backbone and Negro mountains reach elevations of 3,000 ft. or more. In the extreme western part of the State these mountains merge as it were into the rolling Appalachian plateau, having an average elevation of 2,500 feet. All rivers of western Maryland flow south into the Potomac except in the extreme west where the waters of the Youghiogheny and its tributaries flow north into the Monongahela, a tributary of the Ohio.

Climate.—The climate of Maryland in the south-east is influenced by ocean and bay, while in the west it is influenced by the mountains. The prevailing winds are westerly but generally north-west in winter in the west section and south-west in summer in the south section. In the south the normal winter is mild, the normal summer rather hot; in the west the normal winter is cold, the normal summer cool. The normal average annual temperature for the entire State is between 53° and 54° F, ranging from 48° at Grantsville in the north-west to 53° at Darlington in the north-east, and to 57° at Princess Anne in the south-east. The normal annual precipitation for the State is about 43 inches.

Soils.—The great variety of soils is one of the more marked features of Maryland. On the eastern shore to the north is a marly loam overlying a yellowish-red clay subsoil, to the south is a soil quite stiff with light-coloured clay, while here and there, especially in central and southern Maryland, are considerable areas both of light sandy soils and tidal marsh loams. On the western shore the soils range from a light sandy loam in the lower levels south from Baltimore to rather heavy loams overlying a yellowish clay on the rolling uplands and on the terraces along the Potomac and the Patuxent. Crossing the State along the lower edge of the fall line is a belt heavy with clay, but so impervious to water as to be of little value for agricultural purposes. The soils of the Piedmont plateau east of Parr's ridge are, like the underlying rocks, exceptionally variable in composition, texture and colour. For the most part they are considerably heavier with clay than are those of the Coastal plain, and better adapted to general agricultural purposes. West of Parr's ridge in the Piedmont the principal soils are those the character of which is determined either by decomposed red sandstone or by decomposed limestone. In the east portion of the mountainous region the soil, so well adapted to peach culture, contains much clay together with particles of Cambrian sandstone. In the Hagerstown valley are rich red or yellow limestone-clay soils. The Alleghany ridges have only a thin stony soil but good limestone, sandstone, shale and alluvial soils occur in the valleys and in some of the plateaux of the extreme west.

Government.—The present State Constitution was adopted in 1867 and has been frequently amended, this requiring merely a three-fifths vote of all of the members elected to each of the two houses of the general assembly, followed by a majority of the votes cast when submitted to the State electorate. It is further provided that once in 20 years, beginning with 1930, the wish of the people in regard to calling a convention for altering the Constitution shall be ascertained by a poll. The law provides for direct primary elections.

The chief executive authority is vested in a governor elected by popular vote for a term of four years. Since becoming a State Maryland has had no lieutenant-governor except from 1864 to 1867. The office of governor is to be filled in the case of a vacancy by such person as the general assembly may elect; the president of the senate serving as governor in the meanwhile. No veto power whatever was given to the governor until 1867, when, in the present Constitution, it was provided that no bill vetoed by him should become a law unless passed over his veto by a three-fifths vote of the members elected to each house.

In 1922, in consequence of a plan prepared by Governor Albert C. Ritchie, the administrative branch of the State Government

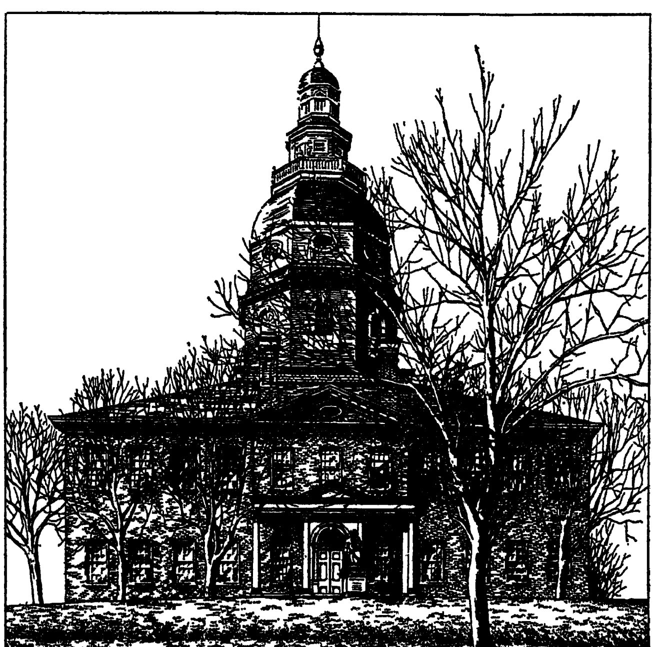
was completely reorganized by consolidating more than 80 State agencies, according to their functions, into 18 major departments and commissions. This reorganization plan has saved several hundred thousand dollars annually in the operation of the government of the State and the various local subdivisions thereof. A merit system was established for the selection of State employees and in 1926 85% of all State employees were in the classified service.

The legislature, or general assembly, meets biennially, on the first Wednesday in January in odd-numbered years, at Annapolis, and consists of a senate and a house of delegates. Senators are elected, one from each of the 23 counties and one from each of the six legislative districts of the city of Baltimore, for a term of four years, the terms of one-half expiring every two years. Delegates are elected for a term of four years.

The administration of justice is entrusted to a court of appeals, circuit courts, special courts for the city of Baltimore, orphans' courts and justices of the peace. Exclusive of the city of Baltimore, the State is divided into seven judicial circuits, in each of which are elected for a term of 15 years one chief judge and two associate judges, excepting the third judicial circuit which elects one chief judge and three associate judges. The seven chief judges so elected, together with one elected from the city of Baltimore, constitute the court of appeals, the governor with the advice and consent of the senate designating one of the eight as chief judge of that court. The court has appellate jurisdiction only.

Finance.—Maryland was one of the first States in the Union to adopt the executive budget to control its finances. A constitutional amendment providing for such a fiscal plan was adopted in 1916. The governor prepares the budget and submits it in the form of a budget bill to the legislature. The legislature can reduce or eliminate appropriation items, but cannot increase them. The bill, when passed by the legislature, fixes appropriations, and becomes a law without the approval of the governor.

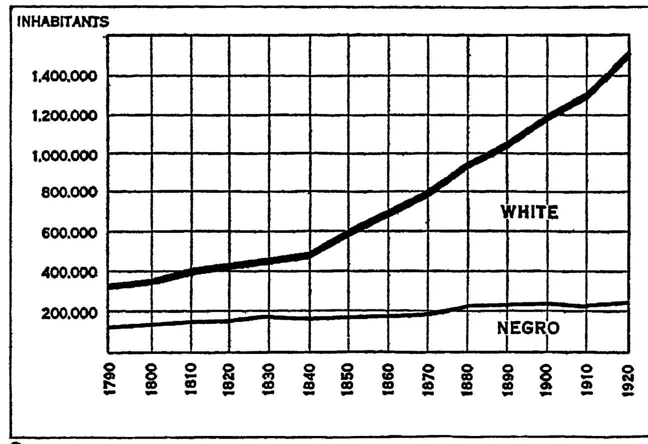
The comptroller's report for the year ended Sept. 30, 1927, showed receipts $32,270,056, disbursements $32,057,479, and a



THE STATE CAPITOL AT ANNAPOLIS

balance in the treasury of $7,741,655. The net debt after deducting the sinking fund was $22,288,270. The chief sources of revenue, other than bonds, were: a general direct property tax; the motor licence fees; a motor vehicle fuel tax; a tax on the gross receipts of corporations; an inheritance tax; traders' licences; and franchises on ordinary business corporations. The main expenditures in the order of their importance were: payments on the public debt, $7,115,371; highway maintenance, $4,898,010; education, $4,382,721; maintenance of hospitals, homes and asylums, $2,256,943; and for the general government, $1,386,329.

Population.—The population of Maryland at certain selected censuses was as follows: 319,728 in 1790; 341,548 in 1800; 447,040 in 1830; 687,049 in 1860; 934,943 in 1880; 1,042,390 in 1890; 1,188,044 in 1900; 1,449,661 in 1920; and 1,631,526 in 1930. Of the total population of the State in 1920 there were 1,204,737



GRAPH OF GROWTH OF POPULATION IN MARYLAND, 1790–1920, SHOWING RELATIVE PROPORTIONS OF NEGRO AND WHITE AT EACH CENSUS

whites, 244,479 negroes and 445 of all other races. Of the whites, 102,177 or 8·5% were foreign-born.

The population of those cities in Maryland having in 1930 more than 12,000 inhabitants was as follows:

	1930	1920	1910
Baltimore	804,874	733,826	558,485
Cumberland	37,747	29,837	21,839
Hagerstown	30,861	28,064	16,507
Annapolis	12,531	11,214	8,609
Frederick	14,434	11,066	10,411

The Roman Catholic Church, which was prominent in the early history of Maryland, has the greatest membership. Other denominations in the order of their numerical strength are: Methodist Episcopal; Protestant Episcopal; Lutheran, General Synod; Baptist; Methodist Protestant; and Presbyterian.

Charities and Corrections.—State institutions controlled by boards appointed by the governor comprise two penal institutions, a training school for boys and another for girls, one for feeble-minded and one for the deaf; three hospitals for white insane and one for coloured; two general hospitals and four tubercular hospitals, three for white and one for coloured. The State-aided institutions include a school and workshop for the blind, reformatories for coloured boys and girls, tuberculosis sanatoria, homes for children and the aged, schools, colleges and hospitals.

Education.—A completely revised code of school laws was passed by the legislature of 1916, supplanting the common-school system established by the act of 1865. At the head of the educational system is a State board of seven lay members appointed by the governor. This board elects the State superintendent for a term of four years.

The State's population between the ages of 5 and 17, inclusive, was 388,462 in 1926. In 1927, the enrolment in the public schools was 267,831. Expenditures for public elementary and secondary education in 1927 amounted to $23,048,000.

The University of Maryland was formed in 1920 by an act of the legislature merging the University of Maryland, comprising the schools of law, medicine, pharmacy and dentistry at Baltimore, the Maryland State college, formerly known as Maryland Agricultural college, at College Park, and the eastern branch of the university, for coloured students, at Princess Anne. The State board of agriculture and the State horticultural department are also connected with the university.

Johns Hopkins university (*q.v.*), Baltimore, which was established from a fund of nearly $7,000,000 left by Johns Hopkins,

upon his death in 1873, for the purpose of founding a university and a hospital, is one of the leading educational institutions of the United States. Other institutions of higher learning in the State, with the names of such religious bodies as were originally responsible for them, are: St. John's college, at Annapolis; Washington college, at Chestertown; Western Maryland college (Methodist Protestant), at Westminster; Blue Ridge College (Church of the Brethren), at New Windsor; Mount St. Joseph's and Mount St. Mary's college (Roman Catholic), at Emmitsburg; St. Mary's seminary and Loyola college (Roman Catholic), at Baltimore; Hood college (Reformed Church), at Frederick; Goucher college (Methodist), at Baltimore; the U.S. Naval academy, at Annapolis; Morgan college (coloured Methodist), at Baltimore; and several professional schools, mostly in Baltimore. Other institutions of an educative character in Baltimore are Peabody Conservatory of Music (established in 1866); Maryland Institute for the Promotion of Fine and Mechanic Arts; and Enoch Pratt free library (established 1886).

Public Health.—The State board of health of eight members consists of the attorney general of the State, health commissioner of Baltimore and six members appointed by the governor, with the consent of the senate. Of those appointed by the governor, four are physicians, one a civil engineer and one a certified pharmacist. The governor designates one of the four physicians as chairman who thereby becomes director of health. The gross death rate for the State in 1927 was 13·51 per 1,000.

Agriculture.—Agriculture is an important industry in Maryland, and statistics show that the average yields of all the staple crops have increased. There has also been a tendency towards smaller sized farms, cultivated more intensively for the production of food for human consumption, such as vegetables, fruits, dairy products, butter, eggs and meats. The soils and climate of Maryland are well suited to this class of products, and there are good transportation facilities for reaching the big centres of population in the eastern States.

The land area of the State is 6,362,240 ac., of which 4,433,398 is in farms. This is divided into 49,001 farms; 73·6% of these are operated by the owners. White farmers operated 42,280 farms and coloured farmers 6,721. The total value placed on all farm property within the State in 1925 was $397,092,000.

The following table presents some detailed figures concerning the principal agricultural products for the year 1927:

	Acreage	Production	Value
Wheat	525,000	9,188,000 bu.	$11,669,000
Indian corn	515,000	22,660,000 „	18,128,000
Oats	51,000	1,708,000 „	922,000
Hay	446,000	728,000 tons	11,204,000
Tobacco	32,000	26,176,000 lb.	4,973,000
Tomatoes (fresh)	7,050	1,107,000 bu.	886,000
„ (commercial)	34,410	151,400 tons	2,162,000
Peas, canning	8,000	11,200 „	672,000
Strawberries	12,780	28,666,000 qt.	3,440,000

The value of all live stock on Jan. 1, 1928, was $37,000,000, dairy cattle being the most numerous. The total value of dairy products produced in 1924 was $13,408,598.

The live stock, wheat and Indian corn sections of the State are in the Piedmont plateau, the Hagerstown valley and the central portion of the eastern shore. Garrett county, in the extreme north-west, however, raises the largest number of sheep. Most of the tobacco is grown in the southern counties of the western shore. The great centre for vegetables and small fruit is in the counties bordering on the north-west shore of the Chesapeake, and in Howard, Frederick and Washington counties.

Sea Foods and Game.—The conservation department has full supervision and control over all the natural resources of the State, including oysters, crabs, fish, clams and terrapin, as well as wild fowl, birds and game. In 1925, 11,680 persons were engaged in the fishing industry, using equipment valued at $3,431,591. The production in that year was 56,977,985 lb., valued at $4,863,419, the chief products being distributed as follows: oysters, 4,252,860 bu., valued at $3,255,507; crabs, hard and soft, 9,646,361 lb. valued at $567,783; shad, 1,260,152 lb., valued at $264,388; striped bass, 1,413,999 lb., valued at $240,388.

Garrett, Allegany and western Washington counties furnish the home for the wild turkey, white-tailed deer and the ruffed grouse. Bob-white quail, cottontail rabbit and the gray squirrel are found in every county. On the Chesapeake bay and its tributaries practically every species of wild duck that migrates east of the Mississippi river is to be found.

Forests.—Maryland's forest resources consist of 2,228,000 ac. of woodland, or nearly 35% of the total land area of the State. Less than 2% of this area is virgin forests,—practically all of the woodlands having been cut over one or more times. The lumber production for the year 1925, from the 723 mills, most of them of the small portable type, was 129,138,000 board feet.

There are over 150 different species of trees, most of them of commercial importance, embracing the yellow pine, cypress, cedar and red gum in the south-western part of the State, and spruce, white pine, hemlock, beech, birch and maple in the mountains.

The State maintains a forestry department, whose chief functions are to provide a system of forest protection; give assistance to woodland owners in the management of their forest properties; administer the six State forests (about 5,000 ac.) and the State forest nursery; and care for trees along all public highways.

Minerals.—Maryland ranked 13th among the States of the Union in the total value of mineral products in 1926. In that year, the product of all mines and quarries in the State was $24,067,000. The principal products in the order of their value were coal, clay products, cement, sand, gravel and stone. The coal-producing area is confined to the counties of Allegany and Garrett. There are five or six workable seams of coal, the most important being the Big Vein which is correlated with the Pittsburgh coal of western Pennsylvania.

Maryland building stone, of which there is an abundance of good quality, consists chiefly of granites, limestones, slates, marble and sandstones, the greater part of which is quarried in the east section of the Piedmont plateau though some limestones, including those from which hydraulic cement is manufactured, and some sandstones are obtained from the western part of the Piedmont plateau and the east section of the Appalachian region. Brick, potter's and tile clays are obtained most largely along the west border of the coastal plain, and fire clay from the coal region of western Maryland. Materials for porcelain, including flint, feldspar and kaolin, are found in the east portion of the Piedmont plateau.

Transportation.—There are 2,700 m. of modern roadway all of which are maintained in excellent condition throughout the year. In 1927, 106 m. of new construction was completed and in addition 90 m. of concrete shoulders were laid adjacent to existing roadway.

Tidewater Maryland is afforded very unusual facilities of water transportation by the Chesapeake bay, with its deep channel, numerous deep inlets and navigable tributaries, together with the Chesapeake and Delaware canal, which crosses the State of Delaware and connects the Chesapeake bay with the Delaware bay. Baltimore (*q.v.*), was the second foreign trade port of the United States in 1926. It also has a great inter-coastal traffic, especially with the Pacific ports. Baltimore is the railway centre of the State, and it was here in Feb. 1827 that the Baltimore and Ohio, one of the first railroads in the United States, was projected. In 1927, in Maryland there were 1,518 m. of steam and 639 m. of electric railway.

Manufacturing.—Manufacturing is by far the State's chief industry and is constantly increasing in importance. The number of persons engaged in manufacturing in 1925 was 125,787, or 8·2% of the total population. The total value of manufactures in 1914 was $377,749,078, and in 1925 it was $926,251,640. Of the 1925 production, $678,947,199, or 73·3%, was the product of Baltimore plants alone. In the period 1914–25, the value of Maryland's manufactures advanced 145·2%. The following table shows the value of the products of the leading industries in 1925, with the two exceptions noted:

Products	Value
Men's clothing	$57,705,043
Iron and steel, steel works and roller mills	42,285,879*
Slaughtering and meat packing	38,425,638
Petroleum refining	34,844,903*
Canning and preserving fruit and vegetables	32,678,257
Fertilizers	28,150,127
Printing and publishing	28,066,818
Tinware	27,120,481
Car and general shop construction and repairs, for steam railways	26,407,348
Foundry and machine-shop products	23,257,362

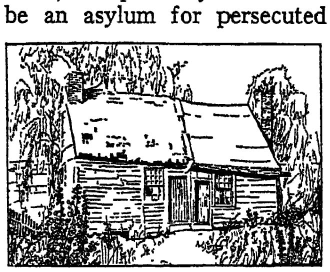
*1923 figures; corresponding figures for 1925 are not available.

Baltimore's industries are widely diversified with no single line employing over 10% of the city's industrial workers. There are 26 classifications, each of which employs over 1,000 men.

HISTORY

In the year 1632 King Charles I. granted a charter to George Calvert, first Lord Baltimore (*c.* 1580–1632), conveying to him almost unlimited territorial and governmental rights in a tract of land between the Potomac river and the 40th parallel, and styling him absolute lord and proprietor thereof. Subsequent clauses of the charter so circumscribed the proprietor's power that, in effect, it differed little from other colonial patents granted by Charles I. George Calvert died before the charter had passed the Great Seal and, in the same year, the charter was issued to his oldest son, Cecil. In Nov. 1633, two vessels, the "Ark" and the "Dove," carrying at least 200 colonists under Leonard Calvert, a brother of the proprietor, as governor, sailed from Gravesend. They arrived in Maryland late in March of the following year, and the colonists established a settlement on a promontory between the Potomac river and the Chesapeake bay. For several years their relations with the Indians were friendly, but eventually the colony suffered severely from Indian wars. More serious was the hostility of William Claiborne (*c.* 1589–1676), secretary of the Colony of Virginia, who, under a trader's licence, had purchased Kent island in the Chesapeake bay from the Indians and had in 1631 established a settlement there. As a result of Claiborne's refusal to recognize the jurisdiction of Lord Baltimore over Kent island, in which he was supported by the council of Virginia, an enmity developed between him and Leonard Calvert which resulted in a long feud between the Maryland settlers and Claiborne's men, marked by continual attacks and reprisals. The Colony enjoyed peace from 1660 until 1688.

The province of Maryland presented an early and successful example of tolerance toward the religious beliefs of its inhabitants. Lord Baltimore was a Roman Catholic, and probably it was his intention that Maryland should be an asylum for persecuted members of that body. He desired Protestant colonists also, however, and to this end promised and, so far as he could, established and enforced religious toleration in its full sense. With the growth of a Puritan party in the province, fearing that he would soon lose control of affairs, he proposed to the assembly the famous act concerning religion which was passed in 1649. It extended tolerance and protection only to bodies professing trinitarian Christianity, and was thus somewhat less liberal than the policy which the proprietor had earlier pursued.



BY COURTESY OF MARKEN & BIELFELD, INC.
OLD HOUSE IN FREDERICK, MD., LOCALLY KNOWN AS WASHINGTON'S HEADQUARTERS

Although the charter reserved to the proprietor the right of calling an assembly of the freeman or their delegates when and as he should choose, the colonists obtained from him in 1638 the surrender of his claim to the sole right of initiating legislation. This is one of the most striking examples of the effort to secure local self-government shown in any of the 13 Colonies. By 1650 the assembly had been divided into two houses. One of these, the consent of which was necessary before a bill might become law, was composed entirely of the representatives of the freeman, and annual sessions as well as triennial elections were becoming usual. In 1670 the governor, Charles Calvert, sought to check growing opposition to his policy by disfranchising all freeman who did not have a freehold of 50 ac. or a visible estate of £40 sterling. This step caused impassioned complaints against him in which it was alleged that he was interfering in elections and keeping the government in the hands of Roman Catholics, mostly members of his own family. About this time also the northern and eastern boundaries of the province began to suffer from the encroachments of William Penn. The territory now forming the State of Delaware was within the limits defined by the Maryland charter, but in 1682 it was transferred to Penn by the Duke of York, and in 1685 Lord Baltimore's claim to it was denied by an order in council on the ground that it had been inhabited by Christians before the Maryland grant was made. Later a controversy over the northern boundary arose. Although Cecil Calvert's patent specified the parallel of 40° N. as the northern boundary of his grant, Penn's charter set forth that Pennsylvania should extend southward to the "beginning of the fortieth degree of Northern Latitude." A difference of interpretation of this expression led to much litigation which was not settled until Charles Mason and Jeremiah Dixon, English mathematicians, between 1763 and 1767, established the line, since named after them, which followed the parallel 39° 43′ 26·3″.

While the proprietor was absent defending his claim against Penn, the English Revolution of 1688 occurred. Owing to the death of a messenger, proclamation of the new monarchs in Maryland was long delayed and this, together with a rumour of a Popish plot to slaughter Protestant colonists, caused the overthrow of the proprietary government. In 1692 the Crown, in the interests of trade, set up a royal government but permitted the proprietor to retain his territorial rights. Under government by the Crown the Church of England was established. When a Protestant became heir to the proprietorship in 1715, proprietary government was restored. Roman Catholics were disfranchised.

The first serious dispute between proprietor and colonists after the restoration of 1715 concerned the extension of the English statutes to Maryland. The popular chamber of the assembly contended that all such statutes except those expressly excluded extended to the province, and the lord proprietor insisted that only those in which the dominions were expressly mentioned were in force there. Other disputes followed; and when France and England joined in a final struggle for territory in America, a deadlock between the two houses of the assembly prevented Maryland from responding to urgent appeals from England for help in the closing stage of the war.

In the years immediately preceding the Declaration of Independence, the practice of self-government became so intensely an ideal of the people of Maryland that on occasion they offered resistance not only to the proprietary, the royal governor, parliament and the king, but also to what they considered the unwarrantable encroachments of the Continental Congress. Maryland was not, however, actually invaded or physically oppressed by the British, and probably for that reason the instructions to her delegates to the Continental Congress, bidding them not to vote for independence, were left unchanged until the Colony found itself almost alone in holding back. The new Constitution drawn and adopted in 1776 to replace the royal charter was far from democratic in character. By its provisions the property qualification for suffrage was a freehold of 50 ac. or £30 current money; the property qualifications for delegates £500, for senators £1,000, and for governor £5,000. Four delegates were chosen from each county and two each from Annapolis and Baltimore. In 1802 negroes were enfranchised. In 1810 property qualifications for suffrage were abolished. With the growth of the city of Baltimore, the prevailing disproportionate representation began to be attacked, but the slave-holding minority in the counties of southern Maryland, fearing the attitude of the majority toward slavery, prevented any change until 1837. In that year the enthusiasm over internal improvements enabled the opposition to obtain the adoption of amendments which provided for the election of the governor and senators by direct vote of the people, a slight

increase in the representation accorded the city of Baltimore and the larger counties, and a slight decrease in that of the less populous. Serious financial straits caused by debt incurred through the State's promotion of internal improvements caused a demand for the limitation of the power of the assembly to contract debts. The result was the Constitution of 1851 which established proportional representation for the counties and increased the number of delegates from Baltimore. This was, however, an unsatisfactory compromise. When, during the Civil War, Maryland was largely under Federal control and a demand arose for the abolition of slavery by the State, a constitutional convention held in 1864 framed a Constitution disfranchising all those who had given aid to the rebellion, and allowing only those possessing the suffrage under the proposed instrument to vote on its adoption. This was too ill-considered to endure, and in 1867 it was superseded by the present Constitution.

In national affairs Maryland, at an early date, took a stand which had far-reaching consequences. Her delegates refused to sign the Articles of Confederation until the States claiming territory between the Allegheny mountains and the Mississippi and north of the Ohio—Virginia, New York, Massachusetts and Connecticut—should surrender their claims. Her opposition caused those States to yield, and strengthened the Union because it brought into the possession of the United States the first territory in which all the States had a common interest and out of which new States could be created. In the War of 1812 Havre de Grace and Frenchtown were burned by the British, but Baltimore was successfully defended at North Point against a formidable attack by a British army, and a strong British fleet failed to reduce Fort McHenry after a bombardment of 24 hours. The latter event inspired Francis Scott Key, who was detained aboard a British vessel, to compose "The Star-Spangled Banner."

In 1861 Maryland was divided on the question of secession, the southern and eastern parts generally favouring the cause of the seceding States; but the majority in the northern and western counties, as well as the fact that the State lay north of Washington and quickly came under the control of the Federal Government, kept the State from joining the Confederacy. Maryland was, however, opposed to coercing the seceded States. Maryland was twice invaded by Southern armies, but the only battle of importance fought on her soil was that of Antietam or Sharpsburg on Sept. 16 and 17, 1862.

Since the Civil War, the State's history is a record of quiet but steady progress. A boundary dispute of more than 200 years duration was settled in 1879 when Maryland and Virginia agreed to accept the award of a commission of arbitrators. Possibly the greatest disaster that ever befell the State occurred in Feb. 1904, when a fire destroyed the business district of Baltimore, burning more than 1,300 buildings in the heart of the city. But a new and modernized city soon appeared.

The State was in the forefront of World War activities, from the time the United States declared war on April 6, 1917. The total contribution by the State to the military and naval forces of the United States was about 63,000: approximately 52,000 to the army, 10,000 to the navy and 1,200 to the marine corps.

As between political parties, from 1820 to 1860 the Whigs were generally a trifle stronger; but from 1866 until the present the Democrats have always controlled the State, except for two administrations, although recently it has voted Republican occasionally on national issues.

Bibliography.—One of the latest historical and biographical works dealing with Maryland is *The Tercentenary History of Maryland* (1925), by M. P. Andrews. A concise history of the State is J. M. Gambrill's *Leading Events of Maryland History* (revised 1917). Other works dealing with history in general or with special topics are: F. S. Adams, *Taxation in Maryland,* Johns Hopkins University Studies (1900), an historical account of the sources of the State's revenue and the administration of its taxing system; A. V. Bryan, *History of State Banking in Maryland,* Johns Hopkins University Studies (1899), a careful study of the State's experience with banks from 1790 to 1864; J. L. Bozman, *History of Maryland from 1633 to 1660* (1837), a compilation of much of the more important material relating to the early history of the province; J. V. L. McMahon, *An Historical View of the Government of Maryland from its Colonization to the Present Day* (1833), an able treatment of the subject by a learned jurist; J. T. Scharf, *History of Maryland* (1879), the most extensive general history of the State, but containing numerous errors and poorly arranged; W. H. Browne, *Maryland: the History of a Palatinate* (1884 and 1895), an excellent outline of the colonial history; N. D. Mereness, *Maryland as a Proprietary Province* (1901), a constitutional history of the province in the light of its industrial and social development, with a bibliography; and B. C. Steiner, *Maryland during the English Civil War* (1906–07), one of the Johns Hopkins University Studies. Two able articles with valuable critical essays on sources are found in the volumes of J. Winsor's *Narrative and Critical History of America;* the first by W. T. Bantly, "The English in Maryland, 1632–1691" in vol. iii., and the second by J. Winsor, "Maryland and Virginia" in vol. v. Source material is found in the *Archives of Maryland* edit. by W. H. Browne (1883–87); in *Revolutionary Records of Maryland* by G. M. Brunbough and M. R. Hodges (1924); and in the *Annual Reports and Publications* of the Maryland Historical Society.

The best source of ready information respecting the State's officials and governmental organization is *The Maryland Manual, A Compendium of Legal, Historical and Statistical Information* (yearly). Other sources are the *Annotated Code of Public Civil Law;* the *Industrial Directory* of the State board of labour and statistics; and the reports of the State board of education, the treasurer and the public utility commission. *The Fourteenth United States Census,* the 1925 *Census of Manufactures* and the 1925 *Census of Agriculture* contain statistical information regarding the State. The physical features and economic sources are treated in the *Publications of the Maryland Geological Survey* (1897 *et seq.*). In the latter are also historical studies of the Baltimore-Penn controversy leading to the Mason & Dixon line. *See* also *Old Maps and Map Makers* and *County Boundaries* by E. B. Mathews. (A. C. R.)

MARYLEBONE, ST., commonly Marylebone (mă′rĭ-bŏn), a north-western metropolitan borough of London, bounded north by Hampstead, east by St. Pancras and Holborn, south by the City of Westminster and west by Paddington. Pop. (1931) 97,620. The boundary runs along Oxford Street, on the south, crossing Regent Street at Oxford Circus, and Edgware Road on the west; Marylebone Road crosses from east to west. St. Marylebone was in the manor of Tyburn, which takes name from the Tyburn, a stream which flowed south to the Thames through the centre of the present borough. The church was called St. Mary at the Bourne. The name Tyburn (*q.v.*) was notorious chiefly as applied to the gallows which stood near the existing junction of Edgware Road and Oxford Street (Marble Arch). The manor at the Domesday Survey was in the possession of the nunnery at Barking, but the borough includes several estates, such as the manor of Lyllestone in the west, the name of which is preserved in Lisson Grove. From 1738 to 1776 Marylebone Gardens (which had existed under other names from the close of the 17th century) became one of the most favoured evening resorts in London. They extended east of High Street as far as Harley Street, but by 1778 the ground was being built over.

The borough includes almost the whole of Regent's Park, with a portion of Primrose Hill north of it. The park, originally Marylebone Park, was enclosed by James I., and received its modern name from the Prince Regent, afterwards George IV. It contains the Zoological Gardens. Here are also the gardens of the Royal Botanic Society, incorporated in 1839. The Toxophilite Society, founded in 1781, has also occupied grounds here since 1883. Another famous enclosure is Lord's Cricket Ground, St. John's Wood Road. Marylebone station is a terminus of the L.N.E.R. The borough returns one member to parliament. Area 1,473 acres.

MARY OF LORRAINE (1515–1560), generally known as Mary of Guise, queen of James V. and afterwards regent of Scotland, was born at Bar on Nov. 22, 1515. She was the eldest child of Claude of Guise and Antoinette of Bourbon, and married in 1534 Louis II. of Orleans, duke of Longueville, to whom in 1535 she bore a son, Francis (d. 1551). The duke died in 1537, and Mary was sought in marriage by James V., and by Henry VIII. after the death of Jane Seymour. Henry persisted in his offers after her betrothal to James V. Mary, who was made by adoption a daughter of France, married James at St. Andrews. Her two sons, James (b. May 1540) and Robert or Arthur (b. April 1541), died within a few days of one another in April 1541, and her husband died in Dec. 1542, within a week of the birth of his heiress, Mary, Queen of Scots. The regency fell to the heir presumptive James, earl of Arran, who favoured England and the Protestant party, and who hoped to secure the infant princess for his son.

Mary of Lorraine was approached by the English commissioner, Sir Ralph Sadler, to induce her to further her daughter's marriage contract with Edward VI. The marriage treaty between Mary, not then one year old, and Edward was signed in July at Greenwich, and guaranteed that Mary should be placed in Henry's keeping when she was ten. (*See* MARY QUEEN OF SCOTS.)

In 1550 Mary of Lorraine visited France and obtained from Henry II. the confirmation of the dukedom and revenues of Châtelherault for the earl of Arran, in the hope of inducing him to resign the regency. Arran refused to relinquish the regency until 1554, when he resigned after receiving an assurance of his rights to the succession. Mary had now to deal with an empty exchequer and with a strong opposition to her daughter's marriage with the dauphin. The first revolt against her authority arose from an attempt to establish a standing army. When she provoked a war with England in 1557 the nobles refused to cross the border. In matters of religion she tried to hold the balance between the Catholics and Protestants and allowed the Presbyterians the practice of their religion so long as they refrained from public preachings in Edinburgh and Leith, but the marriage of Francis II. and her daughter Mary in 1558 strengthened her position, and in 1559 she adopted the religious policy of her relatives, the Guises. She was reconciled with Archbishop Hamilton, and took up arms against the Protestants of Perth, who, incited by Knox, had destroyed the Charterhouse with the royal tombs. They submitted on condition that no foreign garrison was imposed on Perth and that the religious questions should be brought before the Scottish parliament. Mary of Lorraine broke the spirit of this agreement by garrisoning Perth with Scottish troops in the pay of France. The lords of the Congregation soon assembled in considerable force on Cupar Muir. Mary retreated to Edinburgh and thence to Dunbar, while Edinburgh opened its gates to the reformers, who issued a proclamation (Oct. 21, 1559) claiming that the regent was deposed. The lords of the Congregation sought help from Elizabeth, while the regent had recourse to France. The strength of her opponents was increased by the defection of Châtelherault and his son Arran, and by the betrayal of her plans by her secretary Maitland to the lords of the Congregation. In Oct. 1559 they made an unsuccessful attack on Leith. Mary entered Edinburgh and conducted a campaign in Fife.

When an English army under Lord Grey entered Scotland in March 1560, the regent received an asylum in Edinburgh castle, which was held strictly neutral by John Erskine. Before her death (June 11, 1560) Mary sent for the lords of the Congregation, with whom she pleaded for the maintenance of the French alliance. She was buried in the church of the nunnery of St. Peter at Reims.

The chief sources for her history are the Calendar of State Papers for the reigns of Henry VIII. and Edward VI. in the Rolls Series; A. Teulet, *Papiers d'état . . . relatifs à l'histoire de l'Ecosse au XVIe siècle* (3 vols., 1851), for the Bannatyne club; *Hamilton Papers,* ed. J. Bain (2 vols., 1890–99); *Calendar of State Papers relating to Scotland and Mary Queen of Scots, 1547–1603* (2 vols., 1898–1900), etc. The Life in Miss Strickland's *Queens of Scotland* (vols. i.–ii.) is based on original documents. Miss M. Wood has edited *The Foreign Correspondence with Marie de Lorraine, Queen of Scotland* (2 vols., 1923 and 1925) and Miss A. I. Cameron has edited *The Scottish Correspondence of Mary of Lorraine* (1927).

MARY OF MODENA [MARIA BEATRICE ANNE MARGARET ISABEL D'ESTE] (1658–1718), queen of the English king James II., and daughter of Alphonso IV., duke of Modena, and the Duchess Laura, of the Roman family Martinozzi, was born at Modena on Oct. 5, 1658. She was married by proxy to James, then duke of York, on Sept. 30, 1673, and in November reached England where she was regarded as an agent of the pope. During the Popish Plot, she went abroad with her husband. When her son, James Francis Edward, was born on the 10th of June (o.s.) 1688, it was said that the child was not really hers, and that a fraud had been perpetrated to secure a Roman Catholic heir. At the outbreak of the revolution she made the disastrous mistake of consenting to escape to France (Dec. 10, 1688) with her son. She urged her husband to follow her when it was his manifest interest to stay in England, and when he went to Ireland she pressed for his return. Her daughter, Louisa Maria, was born at St. Germain on June 28, 1692. When her husband died on Sept. 6, 1701, she induced King Louis to recognize her son as king of England, an act which precipitated the war of the Spanish Succession. Surviving her husband for 17 years, Mary lived at St. Germain or at Chaillot, in a house of the Visitation, where she eventually died on May 7, 1718.

See Miss Strickland, *Queens of England* (vols. 9 and 10, 1846); Campana di Cavelli, *Les Derniers Stuarts à Saint-Germain en-Laye* (London, 1871); and M. Haile *Mary of Modena* (1905).

MARYPORT, a market town and seaport in Cumberland, England, 25 m. W.S.W. of Carlisle, on the railway. Pop. of urban district (1931) 10,182. It is built on the shore of the Irish sea, at the mouth of the river Ellen. Before the harbour was built there in 1750 Maryport consisted of a few huts. In 1892 Maryport became an independent port with Workington, Whitehaven and Millom subordinate to it. On the hill north of the town is the Roman fort of Uxellodunum.

MARYSVILLE, a city of north-central California, U.S.A., on the Yuba river, near its confluence with the Feather, 47 m. N. of Sacramento; the county seat of Yuba county. It is served by the Sacramento Northern (electric), the Southern Pacific and the Western Pacific railways, and by auto-stage and motor-truck lines. Pop. 5,461 in 1920; in 1930, 5,763 by Federal census. A mile west is Yuba City (pop. in 1928 estimated at 3,400), the county seat of Sutter county. Marysville is the commercial, educational and social centre of a productive fruit-growing region, specializing in clingstone peaches, pears, prunes and grapes. Settlement dates from 1842, when Theodore Cordua leased from Gen. John A. Sutter the present site of Marysville and established a trading post. In the days of '49 it became an important town, as it was at the head of river traffic to the mines and on the trail running north and south through the Sacramento valley. For several years 30 or 40 stages arrived and departed daily, and large pack trains carried supplies into the mountains. The present name was adopted in 1850, in honour of the wife of one of the settlers.

MARYVILLE, a city of north-western Missouri, U.S.A., on Federal highway 71, and served by the Burlington and the Wabash railways; the county seat and commercial centre of Nodaway county and the seat of the North-west Missouri State Teachers college. Pop. 4,711 in 1920; and 5,217 in 1930. The city was settled in 1845 and incorporated in 1856. Since 1919 it has had a commission-manager form of government.

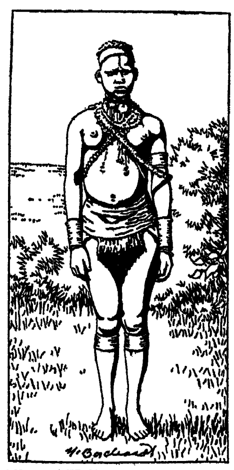
MASACCIO, properly TOMASO GUIDI (1401–*c.* 1428) Florentine painter, born on Dec. 21, 1401, at Castel S. Giovanni di Val d'Arno, near Florence, son of a notary of the family of the Scheggia, was nicknamed Masaccio (for Tomasaccio) on account of his careless habits. In 1422 he was enrolled in the guild of Speziali, or druggists, to which painters belonged, and in 1424 in the guild of St. Luke. He was one of the great pioneers of the Italian Renaissance who did for painting what Donatello had done for sculpture and Brunelleschi for architecture.

With the work of Masaccio began the search for the rendering of three dimensional space and for the placing therein of figures plastically conceived. The newly-discovered laws of perspective were applied, the drawing of foreshortened parts was correct, the anatomy of the human body was well understood. According to Vasari, Masaccio owed his artistic education to Masolino, but Masaccio, although he died 20 years before his master, carried the advance in naturalism further. Unfortunately much of his work has been destroyed, and what remains is often in poor condition. His earliest extant works are the "St. Anne, the Virgin and Child," removed from the Church of S. Ambrogio to the Uffizi; and a fresco of the "Virgin Enthroned Between Two Saints" in the Oratorio of Montemarciano, near his birthplace. On Feb. 19, 1426, he was commissioned to paint an altarpiece for the Church of the Carmine at Pisa by the notary, Giuliano di Colino degli Scarzi. This work had disappeared in 1750. It is described by Vasari, and portions of it have recently been identified. The Berlin museum possesses three pieces of the predella, the "Epiphany," the "Death of the Baptist," and the "Crucifixion of St. Peter," also "Four Saints," which formed part of the framework and were formerly in

the Butler Collection, London. The Museo Civico at Pisa has a "St. Paul," and at Vienna there is a "St. Andrew," the Naples museum has a "Crucifixion," the central panel, representing a "Madonna and Child with Angels," was said by Berenson to be a picture in the possession of Canon Sutton of Brant Broughton, Lincoln, from whom it was bought for the National Gallery. Masaccio's once much admired fresco of the Trinity is to be seen in a very damaged condition on the entrance wall of S. Maria Novella at Florence. Originally painted over the altar of St. Ignatius, it was for a long time covered over with a painting of Vasari, and then brought to light again. The artist's standard work is in the Brancacci chapel in the Carmine at Florence. Here Masolino had left unfinished a series of frescoes which Masaccio was asked to continue. Six paintings can be ascribed to him with certainty. They represent the "Expulsion from Eden," an expressive painting where Eve cries aloud in anguish while Adam covers his face; "Peter and the Tribute-Money," a large and harmonious composition; "Peter and John Healing the Sick"; "Peter Almsgiving" and "Peter Baptizing"; the "Raising of the King's Son," in which the saint and the group on the left are in part by him, the remainder being by Filippino Lippi. These frescoes created a sensation; they became the training school of Florentine painters of the succeeding generations, of Michelangelo with the rest. Masaccio did not complete the decoration of the chapel. In 1428 he left for Rome, and was reported dead soon afterwards.

BIBLIOGRAPHY.—G. Vasari, *Le Vite de' più eccellenti Pittori* (edit. G. Milanesi; 2nd ed., Florence, 1868; trans. by A. B. Hinds in the Everyman Library, 1927); B. Berenson, *The Florentine Painters of the Renaissance* (1896; 3rd ed., rev. and enlarged, 1909); J. A. Crowe and G. B. Cavacaselle, *A History of Painting in Italy*, 6 vol. (edit. L. Douglas, etc.; 2nd ed., 1903–14); A. H. Lanyard, *The Brancacci Chapel and Masolino, Masaccio, and Filippino Lippi*, published by the Arundel Society (1868); A. Schmarsow, *Masaccio, der Begründer des klassischen Stils der italienischen Malerei*, 5 pts. (Kassel, 1895–1900); W. Suida, *L'altare di Masaccio già nel Carmine a Pisa*, in *l'Arte*, vol. ii. (1906); E. Somaré, *Masaccio* (with bibl. and plates, Milan, 1924). (I. A. R.)

MASAI. The most important members of the Nilo-Hamitic group are the Masai, Nandi, Keyo, Suk, Turkana, Iteso, Karamojong, Dodoth, Didinga, Topotha and Ajie. While they are, generally speaking, homogeneous the following distinctions have to be noted: 1. The Suk and the tribes to the south and east, the Masai, the Nandi and their neighbours, practise circumcision and clitoridectomy, while the tribes north of the Suk do not. 2. The Masai, Turkana and Ajie are nomadic; the Nandi, Keyo and Iteso are sedentary and have adopted agriculture in addition to the pastoral life; the rest are semi-nomadic.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

A GIRL OF THE MERU-MASAI TRIBE, IN EAST AFRICA

The Masai are a tall, well-built, slender people with good features and well-defined noses. The two lower incisors are removed. The heads of the women are shaved, as are the heads of married and of uninitiated men. The warriors wear their hair plaited into queues hanging down the back and over the forehead. The women are scrupulously clothed from girlhood to old-age with dressed skins and leather petticoats. Beads, metal armlets, necklets and bracelets, are popular with both sexes.

Their dwellings are of a peculiar type, long, continuous houses (not more than 6ft. in height) which are built round the inside of a circular thorn fence. They are flat roofed and are divided into separate compartments for families, each with a door. During their period of service the warriors, who may not yet marry, live in separate barracks or villages, where they are visited by the unmarried girls. The Masai keep cattle (of the humped Zebu type), sheep and goats, donkeys and dogs, and the cattle cult is a feature of their culture. Domestic animals are branded with the brand of their owner's clan. Women and old men eat flour and vegetables in addition to the milk, blood and meat which form the staple diet of the tribe. An intoxicating honey mead is drunk by old men, and all except the warriors smoke tobacco and use snuff. Their weapons are spears (both broad- and narrow-bladed), clubs and a peculiar sword.

The Masai are divided into a number of patrilineal, exogamous clans grouped into four endogamous sections, and inheritance is normally to the eldest son who has to support his father's wives and his own brothers and sisters.

The system of initiation and age-grades (*q.v.*) is the basic feature of Masai social life and has produced a most effective military organization. The tribe is divided into young men or boys and groups of initiated men who pass through successive stages as warriors and elders, differentiated by duties, privileges and details of costume. The centre of political gravity is with the warrior class and there are no chiefs. The elders, whose ranks are replenished by time-expired warriors, act as advisers and with the tribal magician form the judicial and legislative authority, but the executive authority remains with the warriors. The magician (*ol-oiboni*), a hereditary office, is the chief adviser.

BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE SON OF A MERU CHIEF WITH HUNTING WEAPONS

Religion is a mixture of ancestor-worship and the worship of *Engai*, the "sky." (Other members of the group have substituted different natural phenomena for *Engai*. The Nandi, for instance, worship *Asis*, the "sun": the Suk, *Torotut*, the "thunder": the Didinga, *Tamukujen*, the "rain.") The ancestor cult is associated with certain trees, notably the fig, and with a reverence for snakes, the python and cobra predominating. These are considered tutelary beings, and at marriage a man is careful to introduce his bride to his tutelary snake.

BIBLIOGRAPHY.—A. C. Hollis, *The Masai* (1905); M. Merker, *Die Masai* (1904). (J. H. D.)

MASANIELLO, an abbreviation of TOMMASO ANIELLO (1622–1647), an Amalfi fisherman, who became leader of the revolt against Spanish rule in Naples in 1647. A revolt broke out at Palermo in May 1647, and the people of Naples followed the example of the Sicilians. The immediate occasion of the latter rising was a new tax on fruit, the ordinary food of the poor, and the chief instigator of the movement was Masaniello, who led the malcontents. On July 7, 1647 there was a riot at the city gates between the fruit-vendors of the environs and the customs officers, and the customs office was burnt. The rioters then poured into Naples and forced their way into the palace of the viceroy, the hated Count d'Arcos, who fled.

Masaniello was elected "captain-general"; and the revolt was even spreading to the provinces. On July 13, through the mediation of Cardinal Filomarino, archbishop of Naples, a convention was signed between D'Arcos and Masaniello as "leader of the most faithful people of Naples," by which the rebels were pardoned, the more oppressive taxes removed, and the citizens granted certain rights, including that of remaining in arms until the treaty should have been ratified by the king of Spain. Masaniello was murdered while haranguing a mob in the market-place on July 16, 1647.

Masaniello's insurrection formed the subject of several operas, of which the most famous is Auber's *La Muette de Portici* (1828).

See Saavedra, *Insurreccion de Napoli en 1647* (2 vols., Madrid, 1849); A. von Reumont, *Die Caraffa von Maddaloni* (2 vols., Berlin, 1849); Capasso, *La Casa e famiglia di Masaniello* (Naples, 1893); V. Spinazzola, *Masaniello e la sua famiglia, secondo un codice bolognese del sec. xvi.* (in the review *Flegrea*, 1900); A. G. Meissner, *Masaniello* (in German); E. Bourg, *Masaniello* (in French); F. Palermo, *Documenti diversi sulle novità accadute in Napoli l'anno 1647* (in the *Archivio storico italiano*, 1st series, vol. ix.).

MASARYK, THOMAS GARRIGUE (1850–), first president of Czechoslovakia, was born on March 7, 1850, in the Moravian border-town Hodonin. His father was a coachman employed on one of the Austrian Imperial estates, a native of Kop-

čany in Slovakia (Slovakia then being a part of Hungary); his mother came from a semi-Germanized Czech family of Hustopeč, in the Moravian plains. In his boyhood Masaryk was taught Czech and a smattering of German, and was educated at a Czech school in Čejkovice. His parents sent him for two years to the lower German Realschule of Hustopeč, with the intention of making him a teacher.

The object being abandoned, he became first a locksmith's apprentice in Vienna, then a blacksmith at Čejč. In 1865 his former schoolmaster induced his parents to resume their first idea of making him a teacher, and in that year Masaryk passed the entrance examination to the second grade of the "gymnasium," and began studying at Brno. He supported himself, as did many poor students, by tutoring. He developed a rebellious disposition, disagreed with some of the dogmas of the Roman Catholic Church and refused to go to confession. As a result he had to leave the gymnasium, and he continued his studies in Vienna, where he graduated first from the gymnasium with honours, then from the university, where in 1879 he became a lecturer in philosophy. He spent a year in Leipzig, where he met his future wife, Charlotte Garrigue, daughter of the president of the Germania Insurance Company of New York. In 1881 he published in German his first great sociological work, *Suicide as a Phenomenon of Modern Civilisation.* In 1882, when the University of Prague was divided into two parts, the one Czech, the other German, he was appointed to one of the Czech professorships. In 1885 he published his larger work on *Concrete Logic.*

The Forged Mss. and "Realism."—In 1883 Masaryk founded a critical monthly review *The Athenaeum,* which soon sprang into prominence by becoming the battle ground on which the famous mss. of Krláové Hradec and Zelená (Koeniginhof and Gruenberg) were attacked and proved to be forgeries, manufactured in the early 19th century by two well-meaning men, whose object was to provide texts to prove that in the Middle Ages there had been a high standard of literary culture in Bohemia. The authenticity of the mss. had before been doubted by Slav philologists, but it was not until 1886, when Masaryk invited the great Czech philologist Gebauer to analyse the mss. philologically, himself analysing them sociologically, that they were conclusively proved to be forgeries.

The fight over the mss. was the real beginning of the so-called "realist" revolution in Czech politics, literature and philosophy, the guiding principle of which was the application of the scientific method to letters and politics. While at Prague university, Masaryk founded in 1893 a monthly review *Naše Doba* (Our Epoch). He became a member and instructor of the "Sokols." He started lecturing in Prague clubs and societies on unconventional subjects and published unpopular books. His sociological work led him to a study of Marxism, whose historical materialism he criticised in *The Social Question* (1898, in Czech and in German).

Masaryk's political career started in the early 'eighties. In 1887 his friends founded a fortnightly paper *Cas* ("Time"), which two years later he took over and transformed into a political weekly. At that time the so-called Old Czech (Conservative) party was losing ground, and Masaryk, invited by the Young Czech (Liberal) party to be a candidate, was elected to parliament in 1891. He soon resigned his seat (1893) to devote himself to a crusade of moral education among the Czech people.

Although his opinions on nationalist questions were unpopular —an unpopularity which increased when in 1899 he fearlessly withstood a popular anti-Semitic superstition as manifested in the so-called "ritual murder trial" of a Jew named Hilsner—his ideas made a deep impression. They became the rallying cry of the younger generation not only of the Czechs, but of the Yugoslavs and other Slavs who flocked to Prague.

Political Leadership.—In 1900 his followers founded a political party which was officially named the "Progressive party," but which continued popularly to be known as the Realist party. The programme was founded on the principles enunciated in Masaryk's books. As a candidate of the Realist party he was reelected to parliament in 1907. In parliament he soon began to criticize Austria's passive subjection to Germany and her own aggressive policy in the Balkans, especially as manifested in the annexation of Bosnia-Hercegovina. In the notorious "high treason" trial of Agram (1909), by which the Austrian foreign minister, Count Aehrenthal, tried to justify his annexation policy, and in the Friedjung trial (1909) which followed, Masaryk played a decisive part. He proved, on the basis of his private investigations, that the case for the Crown rested on documents forged at the Austro-Hungarian Legation in Belgrade. His fearless disclosures in the Austrian Reichsrat (May 1909) and in the Austro-Hungarian delegations (1910) forced the proceedings in the Agram trial to be quashed, compelled Friedjung to retract his accusations against the Serbs, and unmasked the methods of Austro-Hungarian diplomacy. Masaryk incurred the intense displeasure of the official and court circles in Vienna, but made a reputation abroad.

Propaganda.—During the World War he developed his case against Austria-Hungary in detail, and at the end, in his work, *The New Europe,* characterized it as a corrupt, imperialist, militarist, pretentious and senseless relic of the middle ages. When the war broke out he was still a member of the Austrian parliament. In Dec. 1914 he escaped from Austria, and in the following four years conducted a political and propagandist campaign in Switzerland, France, England, Italy, Russia and the United States on behalf of Czechoslovak liberation from Habsburg rule. He founded the propagandist journals *La Nation Tchèque,* which was edited in Paris by Ernest Denis, and *Ceskoslovenska Samostatnost* (Czechoslovak Independence), which was produced in the small town of Annemasse in Savoy, and he was one of the original board of Dr. R. W. Seton-Watson's *The New Europe,* which was founded in London in 1916.

Masaryk's stand against Austria was publicly proclaimed in his Hus anniversary speech made in Geneva in July 1915, and reaffirmed in his revolutionary manifesto, issued by him with the sanction of the Czech political leaders at home, on Nov. 14, 1915. The signatories of that manifesto, who included representatives of Czech residents in France, Great Britain, America and Russia, formed a central revolutionary committee called the Czechoslovak National Council, of which Masaryk acted as president and Benes as secretary. Finding his work in Switzerland hampered by enemy spies, he settled in London, where, at the invitation of Ronald Burrows, principal of King's college, he joined the staff of that college. Here he worked for two years combating, with the help of his friends, Wickham Steed and R. W. Seton-Watson, the German-Magyar propaganda, and familiarizing Western opinion with Czechoslovak aspirations.

The Russian revolution of 1917 enabled him to go to Russia. Several thousand Czech soldiers—prisoners of war—had gone over to the Russians, and wanted to organize themselves into active military units. After some difficulty Masaryk induced the revolutionary Russian Government to agree to the formation and equipment of an independent Czechoslovak army (92,000), whose exploits as they marched eastwards from Siberia to Vladivostok were one of the impressive later episodes of the war. He transferred some of them to the western front.

President.—He went to the United States in May 1918. The result was the Lansing declaration (May 29, 1918) of sympathy with the cause of Czechoslovak and Yugoslav independence. The Allied Governments associated themselves with that declaration on June 3, 1918. The ice being thus broken, the Allied Powers and America recognized Masaryk's national council as the *de facto* Government of the future Czechoslovak State. Masaryk was elected first president of the Czechoslovak republic on Nov. 14, 1918, and re-elected on May 27, 1920. He had been sentenced to death *in contumaciam,* and in 1923 occurred the death of his wife, largely the result of persecution to which the Government had subjected his family. He was elected president for a second term of seven years on May 1, 1927. For his work as president of the Republic from 1918 onwards *see* CZECHOSLOVAKIA.

Masaryk ranks equally high as a philosopher and as a statesman. His philosophical treatises were the result of his study of Czech history. His pronounced realism was a reaction both against the Teutonic idealism which developed moral speculation with-

out reference to the practical affairs of life and against the Tolstoyan Slav philosophy of non-resistance to evil. Masaryk, as philosopher, stands for a unified conception of life, in which the spiritual and religious take their place with the intellectual and the political as aspects of an integral whole. The following are the chief of his many philosophical, sociological and political works:—*O Hypnotismu,* On Hypnotism (1880); *Sebevražda,* Suicide and Modern Civilization (1881, also in German); *Theorie Pravděpodobnosti a Humeova Skepse,* the Theory of Probability and Hume's Scepticism (1882, Ger. trans. 1884); *Blaise Pascal* (1883); *Theorie dězin dle zásad T. H. Buckle,* the Theory of History according to T. H. Buckle (1884); *Zakladové Konkretin Logiky,* Essay on Concrete Logic (1885, Ger. trans. 1886); *Slavjanofilism I. S. Kirejevskeho* (1889); *Česká Otázka,* the Czech Question (1895); *Karel Havlíček* (1896); *Otázka sociální, filosofické a sociální základy marxismu,* The Philosophical and Sociological Foundation of Marxism (1898, also in German); *Jan Hus* (1899); *Rusko a Evropa,* Russia and Europe (1913, Eng. trans. *The Spirit of Russia,* 1919, etc.); *The Problem of the Small Nations in the European crisis* (1916); *The New Europe* (1918, French trans. 1918, Czech 1919, German 1922); *Světová Revoluce* (1925, German trans. by C. Hoffmann, 1927, Eng. trans., *The Making of a State: Memories and Observations 1914–18* [1927]).

BIBLIOGRAPHY.—Herben, Sychrava Cisař, etc., *Masaryk Osvoboditel* (Prague, 1919); Anon, *Thomas G. Masaryk: A Biographical Sketch* (1923); Anon, *President T. G. Masaryk: His Work as a Constructive Statesman* (1923); Edvard Beneš and others, *T. G. Masaryk* (Prague, 1925); Herben, Hartl, Blaha, *T. G. Masaryk: Sa Vie, Sa Politique, Sa Philosophie* (Prague, 1923); T. G. Masaryk, *The Making of a State; Memoirs and Observations,* 1914–18 (Eng. version with introd. by H. W. Steed, 1927). (G. G.)

MASAYA, an important interior town of Nicaragua, capital of the department of the same name. Pop. (1928) about 20,000. Masaya is on the main line of the Pacific railway, 13 m. west of Granada, and 106 m. from Corinto. Lake Masaya, a crater lake on whose shore has risen the intermittently active volcano of the same name, adjoins the town, and round about it is a fertile region producing tobacco, beans, rice, maize, sugar and in the hills, coffee. A branch line of the railway, 27 m. long, connects at Masaya, the terminus being "Los Pueblos," an important coffee section. Masaya has a large Indian population.

MASCAGNI, PIETRO (1863–), Italian operatic composer, was born at Leghorn, the son of a baker, and educated for the law; but he neglected his legal studies for music, taking secret lessons at the Instituto Luigi Cherubini. There a symphony by him was performed in 1879, and a kindly uncle helped him to study at the Milan Conservatoire. But Mascagni chafed at the discipline, and went off with a touring operatic company. After much hardship he suddenly leapt into fame by the production at Rome in 1890 of his one-act opera *Cavalleria Rusticana,* to a libretto based on a peasant story by Giovanni Verga (*q.v.*) containing a tuneful "intermezzo," which became widely popular. *Cavalleria Rusticana* was performed everywhere.

MASCARA, chief town of an arrondissement in the department of Oran, Algeria, 60 m. S.E. of Oran. It lies 1,800 ft. above the sea, on the southern slope of the mountains of Beni-Chougran, and occupies two small hills separated by the Wad Tudman. Mascara is a town of the French colonial type, few vestiges of the Moorish period remaining. Among the public buildings are two mosques, in one of which Abd-el-Kader preached the *jihad.* The principal industry is the making of wine, the white wines of Mascara being held in high repute. There is also a considerable trade in grains and oil. A branch railway eight miles long connects Mascara with the line from the seaport of Arzew to Ain Sefra. Access is also gained by this line to Oran, Algiers, etc. The population is 28,033 of whom 12,822 are Europeans.

Mascara (*i.e.,* "mother of soldiers") was the capital of a Turkish beylik during the Spanish occupation of Oran from the 16th to the close of the 18th century; but for the most of that period it occupied a site about two miles distant from the present position. On the removal of the bey to Oran its importance rapidly declined; and it was an insignificant place when in 1832 Abd-el-Kader, who was born in the neighbourhood, chose it as the seat of his power. It was laid in ruins by the French under Marshal Clausel and the duke of Orleans in 1835, the amir retreating south. Being reoccupied by Abd-el-Kader in 1838, Mascara was again captured in 1841 by Marshal Bugeaud.

MASCARENE ISLANDS (occasionally Mascarenhas), the collective title, derived from their discoverer, a Portuguese navigator Mascarenhas, of a group in the Indian ocean east of Madagascar, viz., Mauritius, Réunion and Rodriguez (*q.v.*).

MASCARON, JULES (1634–1703), French preacher, was the son of a barrister at Aix. Born at Marseilles in 1634, he early entered the French Oratory, and obtained a great reputation as a preacher. Paris confirmed the judgment of the provinces; in 1666 he was asked to preach before the court, and became a great favourite with Louis XIV., who said that his eloquence was one of the few things that never grew old. In 1671 he was appointed bishop of Tulle; and in 1679 bishop of Agen. He still continued, however, to preach regularly at court, being especially in request for funeral orations. A panegyric on Turenne, delivered in 1675, is considered his masterpiece.

Six of his most famous sermons were edited, with a biographical sketch of their author, by the Oratorian Borde in 1704.

MASCART, ÉLEUTHÈRE ÉLIE NICOLAS (1837–1908), French physicist, was born on Feb. 20, 1837, near Valenciennes. He was educated at Paris and held the post of professor of physics in the lycées of Metz, Paris and Versailles. In 1872 he succeeded Regnault as professor of physics at the Collège de France, he also became director of the Central Bureau of Meteorology in 1878. Mascart retired in 1907 and died at Paris on Aug. 26, 1908.

His early investigations were on optics; he constructed a quartz spectrograph and applied photography to the mapping of spectra. Mascart investigated a number of spectra further into the ultra violet. He also made determinations of standard wave-lengths. His memoir on the effect of the proper motion of the earth on optical phenomena was awarded the Grand Prix des Sciences Mathématiques in 1874. Mascart made a number of determinations of electrical units and determined the electro-chemical equivalent of silver. Mascart was interested in the teaching of practical electricity and in its application to industry; he acted as adviser to the Government in many matters. He was created a Grand Officer of the Legion of Honour, a foreign member of the Royal Society, and was awarded many honours. He wrote *Éléments de mécanique* (1866), *Traité d'électricité statique* (1896), *Traité d'optique* (vols. i.–iv., 1889–93), *Leçons sur l'électricité et le magnétisme* (with Joubert, 1889), *Traité de magnétisme terrestre* (1900).

See obituary notice by Janet in *Revue générale de Science,* xx. (1909).

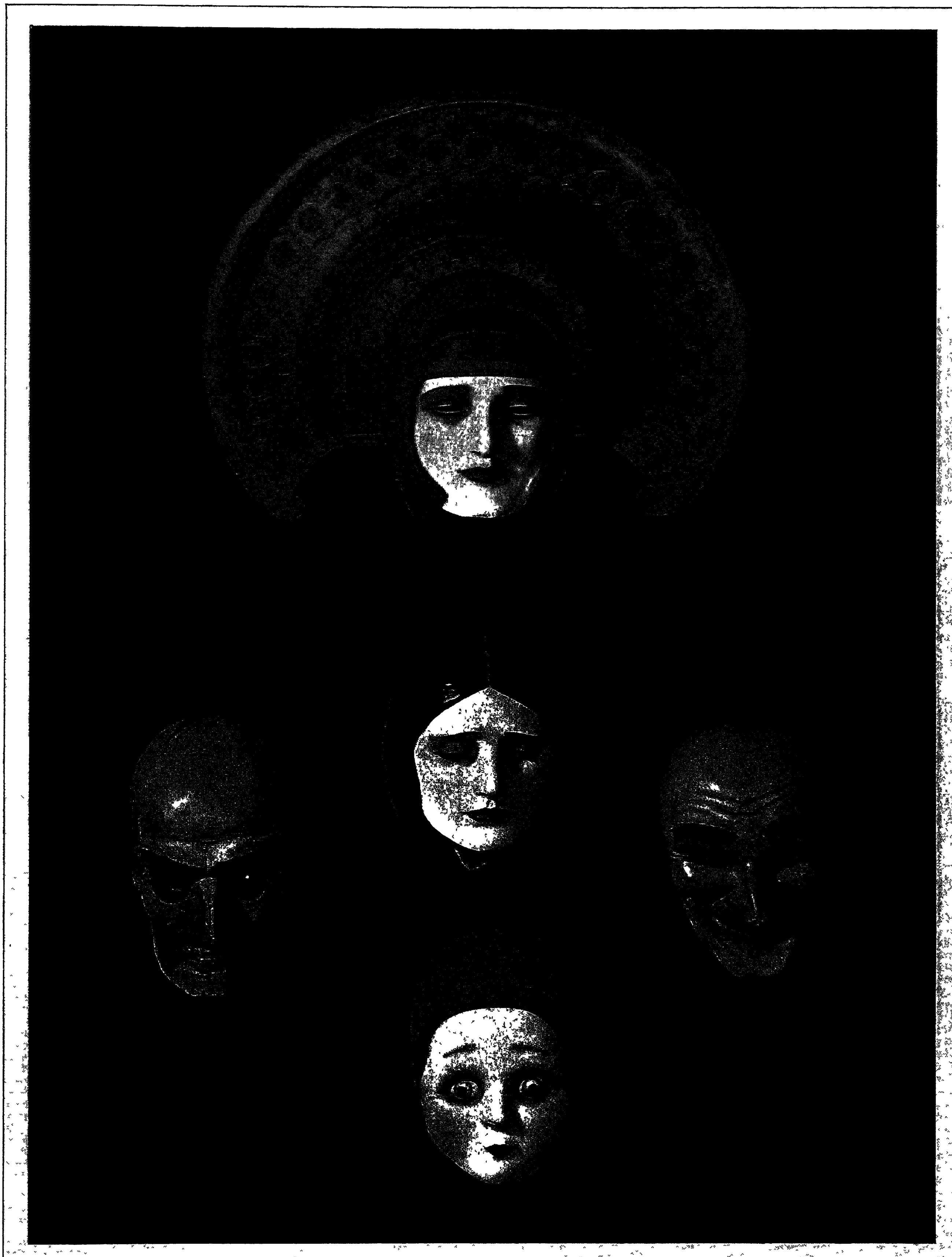
MASCHERONI, LORENZO (1750–1800), Italian geometer, was professor of mathematics at the University of Pavia. He published a variety of mathematical works, the best known of which is his *Geometria del compasso* (Pavia, 1797), a collection of geometrical constructions in which he uses the compass only, many of the solutions being most ingenious.

There is a French translation by A. M. Carette (1798), who also wrote a biography of Mascheroni. *See* Poggendorff, *Biog. Lit. Handwörterbuch.*

MASCOT, the term for any person, animal or thing supposed to bring luck (Fr. slang: perhaps from Port. *mascotto,* "witchcraft"). The word was first popularized by Edmond Audran through his comic opera *La Mascotte* (1880), but it had been common in France long before among gamblers. It has been traced back to a dialectic use in Provence and Gascony, where it meant something which brought luck to a household.

MASDEU, JUAN FRANCISCO DE (1744–1817), Spanish historian and Jesuit. His *Historia critica de España y de la cultura española* (1783–1805) is written in a critical spirit and with a regard for accuracy rare in his time, but its author is more concerned with small details than with the philosophy of history.

MASEFIELD, JOHN (1878–), British poet and novelist, was born in Ledbury and spent his early years in many countries and occupations, serving before the mast at sea, and earning a living as best he could in America. The activity of these years



MODERN MASKS

BY WLADYSLAW T. BENDA

At the top is a naturalistic mask with headdress attached. That at the centre and that to the right are realistic, though representing different types of humanity. The death's-head mask is typical of the grotesque sort, the treatment of the eye, in which a small glass globe is suspended on wire so as to allow it movement when the head is turned from side to side, being of special interest. In the lower mask, which is a caricature, the face is made smaller than that of the wearer, necessitating the introduction of eye-holes above the actual eyes. *See* text-cut figure two

was reflected in his work from the first, as *Salt-Water Ballads* (1902) or *Ballads* (1903) show. His early novels, *Jim Davis* (1911), *Captain Margaret* (1908) and *Multitude and Solitude* (1909), were excellent tales of action and spirit, but he found his natural expression in narrative poetry and drama. *The Everlasting Mercy* made something of a sensation in 1911; it was followed quickly by *The Widow in the Bye Street* (1912); *Dauber* (1913); and *The Daffodil Fields* (1913), all narrative poems in a key of stern realism. Meantime Masefield had written two plays, *The Tragedy of Nan* (1909) and *Pompey the Great* (1910), the first allied in subject and setting to his long poems of village life, the second historical in theme. *Lollingdon Downs* (1917) included a noteworthy sonnet sequence, and *Reynard the Fox* (1919) proved one of the most successful of his verse narratives. Here the country life that he knows so well is reflected faithfully and vividly, without the somewhat excessive gloom of *Nan* and the *Everlasting Mercy.* The gradual awakening of the village on the morning of the meet, followed by the gathering of the hunt, the stir and movement of horses and hounds, make a picture among the best things he has ever done. *Right Royal* (1920), a similar poem, is less successful. Later work includes *A King's Daughter,* a verse tragedy (1923); *Sard Harker,* a novel (1924); *The Trial of Jesus,* a play (1925); *Odtaa* (1926) and *The Hawbucks* (1929), novels. He published some able prose War sketches in *Gallipoli* (1916) and *The Old Front Line* (1917). He was made poet laureate in May, 1930, as successor of Robert Bridges.

MASERU, town, the capital of Basutoland and the headquarters of the Government, 29° 21′ S., 27° 31′ E., altitude 4,942 feet. Pop. (1921) 399 Europeans, 1,890 natives and 30 other coloured persons. It is situated near the Caledon River, most of the houses being built of the local, cream coloured sandstone. It is connected by railway with the South African system. There are several churches, an industrial school, a hospital and a number of stores. (*See* BASUTOLAND.)

MASHAM, ABIGAIL, LADY (d. 1734), favourite of Anne, queen of England, was the daughter of a London merchant, and cousin of Sarah Jennings, duchess of Marlborough, who procured her an appointment in the queen's household about 1704. The queen's presence at Abigail's private marriage to a gentleman of the royal household named Samuel Masham, first led the duchess to suspect that Abigail was supplanting her in the queen's favour. This suspicion was confirmed in 1710 when the queen compelled Marlborough to give an important command to Colonel John Hill, Abigail's brother; and when Sunderland, Godolphin, and the other Whig ministers were dismissed from office. In the following year the duchess was also dismissed from her appointment at court, and Abigail became keeper of the privy purse, shortly before her husband was created a peer. Finally, in July 1714, Anne, influenced by Lady Masham, dismissed Oxford from his office of lord high treasurer, and gave the staff to the duke of Shrewsbury. When the queen died on Aug. 1, Lady Masham retired into private life. She died on Dec. 6, 1734. (*See* ANNE, QUEEN; MARLBOROUGH.)

MASHAM, SAMUEL CUNLIFFE LISTER, 1ST BARON, cr. 1891 (1815–1906), English inventor, born at Calverley Hall, near Bradford, on Jan. 1, 1815, was the fourth son of Ellis Cunliffe (1774–1853), who successively took the names of Lister and Lister-Kay, and who was the first member of parliament elected for Bradford after the Reform Act of 1832. In 1838 Samuel and his elder brother John started as worsted spinners and manufacturers at Manningham, and he turned his attention to the problem of mechanical wool-combing. Two years of hard work spent in modifying and improving existing devices enabled him to produce a machine which worked well; and he consolidated his position by buying up rival patents, as well as by taking out additional ones of his own.

In 1855 he was sent a sample of silk waste (the refuse left in reeling silk from the cocoons) and asked whether he could find a way of utilizing the fibre it contained. The task occupied his time for many years and brought him to the verge of bankruptcy, but at last he succeeded in perfecting silk-combing appliances which enabled him to make yarn that in one year sold for 23s. a pound, though produced from raw material costing only 6d. or 1s. a pound. Another important and lucrative invention in connection with silk manufacture was his velvet loom for piled fabrics. In 1886 an Albert medal was awarded him for his inventions. He died at Swinton Park on Feb. 2, 1906.

MASHONA: *see* KARANGA.

MASKELYNE, NEVIL (1732–1811), English astronomer royal, was born in London, on Oct. 6, 1732. He was educated at Westminster school and Trinity college, Cambridge, where he graduated as seventh wrangler in 1754. He was ordained in 1755, but his interest in astronomy had been aroused by the eclipse of July 25, 1748, and in 1761, on Bradley's recommendation, he was deputed by the Royal Society to observe the transit of Venus in St. Helena. During the voyage he experimented upon the determination of longitude by the method of "lunars," and introduced this method into navigation by publishing in 1763 the *British Mariner's Guide.* In 1765 he succeeded Bliss as astronomer royal. Maskelyne's chief aim was the practical improvement of the art of navigation and in 1766 he published the first volume of the *Nautical Almanac.* He continued the superintendence of this, his greatest work, until his death on Feb. 9, 1811.

Maskelyne's first contribution to astronomical literature was "A Proposal for Discovering the Annual Parallax of Sirius," published in 1760 (*Phil. Trans.,* li. 889). Subsequent volumes of the same series contained his observations of the transits of Venus (1761 and 1769), on the tides at St. Helena (1762), and on various astronomical phenomena at St. Helena (1764), and at Barbados (1764). In 1772 he suggested to the Royal Society the famous Schehallion experiment for the determination of the earth's density and carried out his plan in 1774 (*Phil. Trans.,* l. 495). From Maskelyne's observations Chas. Hutton deduced a density for the earth 4·5 times that of water (Ib. lxviii. 782).

See *The Royal Observatory, Greenwich* (1900), which gives an account of his life and work.

MASKS, coverings for the face, taking various forms, used either as a protective screen or as a disguise. In the latter sense masks are mostly associated with the artificial faces worn by actors in dramatic representations (*see* DRAMA) or assumed in savage rites for exciting terror.

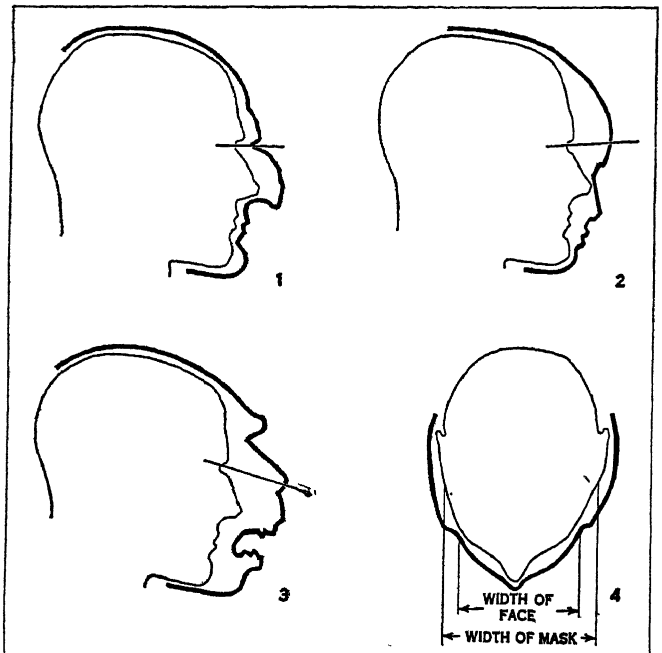
The mask was primarily a ceremonial and religious object, its secular and festival employment being secondary. Man made gods in his own image, but their early, if not their first, dwellings were the bodies of human creatures. Auto-suggestion and drugs were used to secure divine possession and the appearance of the destined individual was made inviting. Clothes, adornments and, above all, facial masks were used for this purpose, the latter bearing a special significance in that the countenance was regarded as the most definite symbol of divine intelligence. Masks were employed also to perpetuate the appearance of the living after death and placed upon the mummy, as among the Egyptians, to aid in its revivification.

Our own culture is not directly and deeply rooted in primitive conditions, nor was that of the Greeks and Romans from whom we derive the great mass of our literary and artistic traditions. We know the mask as they knew it—as an appliance of the theatre, and as a festal object. As such it exists in Tibet, China, Japan, Burma, Siam, Ceylon and Java, identified with dances and dramatic performances comparable to the miracle plays of mediaeval Europe.

Greece.—Among the Greeks the origin of the mask is looked for in the grotesque jocularities of the Dionysian worship. The drama adopted masks of painted canvas. Owing to the large size of the Greek theatre, acoustical and optical means had to be applied to convey the words and gestures of the actors to the more distant rows of spectators. One of the latter was the apparent increase of the actor's size by means of the cothurnus and high masks. The development of the mask into a covering, not only of the face but of the whole head, with side and front hair attached to it, was ascribed to Aeschylus. Openings were left for the mouth and eyes, the latter not being larger than the pupil of the eye and the former only just wide enough to afford egress to the voice. This was the case at least in tragedy. Comic masks, on the other hand, showed distorted features, and a mouth widely

opened, the lips serving as a kind of speaking trumpet. Several of the manuscripts of the plays of Terence contain illustrations of the masks used by actors. In all cases the mouth appears to be fashioned in the form of a large bivalve shell for the sake of resonance. They were attached to a sort of cap which covered the head.

Among the remains of the Greeks and Romans is a very large and constantly increasing series of artistic representations drawn



FIGS. 1–4.—DIAGRAM SHOWING SOME OF THE POSSIBLE VARIATIONS OF SIZE IN THE FACES OF MASKS

1. Mask face slightly larger than that of wearer
2. Mask face considerably smaller than wearer's, vision aperture in hair
3. Mask face considerably larger than that of wearer
4. Horizontal section showing mask with narrower face than that of wearer

from the stage and exhibiting, especially in the comic and satyric line, every conceivable variety of character. In some cases these characters are the same as may be seen in our day, *e.g.*, the punchinello. It would not be fair to the ancients, particularly the Greeks, if we judged their notions of the effect of a mask by our standards. Apart from their employment in the drama, the foremost usage of masks about which there is some certainty is sepulchral. In the tombs opened by Schliemann at Mycenae he found gold masks over the faces of the dead. These could not have been portraits unless they were intended to represent the deceased persons as they looked when dead, for there is a death-like expression on them and on all other masks hitherto discovered on or beside the faces of the dead in Roman and Greek tombs. Murray suggests they were made with some resemblance to cover the face during the interval between death and interment when relatives and friends were admitted to see the body, or in the case of the Romans when the body was publicly conveyed to the market place previous to combustion. This conjecture is still more applicable in those cases where masks, always with a death-like expression, are attached to helmets in such a way as to cover the head entirely.

The terra-cotta masks occasionally discovered in Greek tombs, which vary in scale and hardly ever attain life size, appear to have been hung up against the walls in the interior of the tomb. Most of them represent a female face which has been taken as intended for Persephone, the goddess of the lower world, and in that case the mask may have been meant to propitiate her.

Japan.—Masks are said to have been introduced into Japan from China about the 7th or 8th century, probably in connection with Buddhism, and exist there in a greater variety of definite forms than in any other country in the world. The best known and largest number are used in the Nō, a form of drama which originated in Japan at the beginning of the 14th century and was inspired by Buddhist priests of the Zen sect and the pleasure-loving Shogun Yoshimasa (*see* Nō DRAMA). One of the oldest masked dances, is the sambasso, said to have originated in a religious performance which took place at Nara in 807 to stop the progress of fissures which suddenly opened in the earth.

Masked dances imported from China existed in the Japanese court from early times under the general name of Bu-gaku, or court dances. They were executed in the palace or temples; the performers were court nobles. The music, imported from China, was highly complicated and the masks of very large size. These dances, which were revived at the beginning of the 19th century, may be regarded as the progenitors of the Nō. There are some 250 Nō plays, the same masks, of which there are over 100 named varieties, often being used in a number of different plays. Human beings, men and women, gods, demons and animals are represented. The more ancient, dating from the 12th and 13th centuries, have hard, strong features and remarkably large noses. Only the principal performers are masked. The actors are all professional, and as there are no women among them the female parts are taken by men.

The material of the Nō masks is wood, with a coating of plaster which is lacquered and gilded. The name is generally written inside, often in red. Many bear the name of the carver and fine old specimens are highly valued. In addition to the Nō masks and others of a ritual character, there are a variety of masks used as toys by children, some of the latter, like the fox mask, emanating from shrines where they are sold at festivals. A defensive mask of wrought iron was attached to the helmet. This served not only as a defence, like the visor on the European helmet, but was made fierce in aspect in order to terrify the enemy. Such use of masks, as for example the Gorgon or Medusa's head, occurs in classical antiquity. Masks were used for this purpose in the decoration of shields, such as the Chinese basket-shield bearing the head of a red-faced monster with long, gleaming teeth, a device which has been traced from China to the Dyaks in Borneo.

Tibet.—In Tibet were the sacred dramas illustrating the former births of Buddha, and similar events are performed by lay actors; a mystery play with manifestations of gods and demons by awe-inspiring masks is performed exclusively by the priests or Lamas at fixed seasons of the year. This play appears to have been a devil-dancing cult for exorcising malignant demons which was given a Buddhistic dress and is still called the "Dance of the Red Tiger Devil," a deity of the Bön or pre-Buddhistic religions of Tibet. The masks used in this play in Tibet are made of papier mâché and cloth and occasionally of gilt copper. In Sikhim and Bhotan, where wood is abundant and the damp climate destructive, they are carved of durable wood, in all cases fantastically painted, and provided with a wig of yak-tail of different colours. Waddell classes them in five groups: (1) the king of the ogres, with a hideous mask of huge size with projecting tusks and three eyes; (2) the ten awful ogres and ten ogresses, with a variety of animal masks, bull, tiger, lion, roc or garuda, monkey, stag and yak; (3) the ghouls with skull masks and clothes representing skeletons; (4) the earth-master-demons with large hideous masks but only one pair of eyes, as representing their subordinate position; (5) the teachers who represented the early Indian priests who brought Buddhism to Tibet, the buffoons or jesters of the play. They wear small cloth masks of ordinary size and of white clay or black colour. With them are included a personator of Hiuen Tsang, the famous Chinese Buddhist monk of the 8th century, who wears a huge silly-looking mask.

The sacred dramas, based upon the Jatakas or former births of Buddha, and performed by professional lay actors and actresses, are very popular. The buffoons who wear blue masks adorned with cowls are usually the so-called hunters, but sometimes, as in the old Hindu dramas, are Brahmins.

China.—Masks usually made of papier mâché are employed in the Chinese theatre, but for the greater part the actors make up their faces like masks with cosmetics and paint. These painted masks are of different colours, used singly or in combination, and have a traditional significance. For example, a corrupt ruler is given a white mask, a just man a red, and a violent and brutal

BY COURTESY OF (1, 2, 3) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (4) THE DEPARTMENT OF FINE ARTS, BROOKLYN MUSEUM, (5) THE TRUSTEES OF THE BRITISH MUSEUM

ANCIENT MASKS

1. Egyptian tragic masks made of faience (*c.* 100 A.D.). From Medinet-el-Fayum
2. Female tragic mask of terracotta; Greek, of the Hellenistic period. From Thebes
3. Colossal tragic mask of marble; Roman period
4. Ancient Tibetan Mask; probably used by a devil dancer
5. Bronze helmet found at Ribchester, Lancashire. In the Townley Collection, British Museum

MASKS

BY COURTESY OF THE DEPARTMENT OF FINE ARTS, BROOKLYN MUSEUM

ANCIENT MASKS

1. Fire God mask. Zuñi Indians, New Mex. 2. Ant bear mask. Belgian Congo. 3. Rainbow mask. Keres Indians, New Mex. 4. Yeibichai mask. Navajo Indians, New Mex. 5. Congo mask of carved wood. 6. Gorilla mask. Belgian Congo. 7. Antelope mask. Belgian Congo. 8. Japanese war mask. 9. Elephant mask. Belgian Congo. 10. Carneo mask. Liberia. 11. Mask from Nigeria. 12. Clown mask. Zuñi Indians. 13. Long horn mask. Zuñi Indians. 14. Mask of Wupamu. Hopi Indians, New Mex. 15. Tobodzistsini, Navajo War God, mask. 16. Mask of the Apache Indian

man, a black mask. There are no special theatre buildings, but almost every temple has a stage erected in a convenient part devoted to the performance of theatrical representations. In addition to the secular and historical dramas, which are extremely popular, there are plays and other performances in which masks are used all more or less bound up with Buddhism. Masks are also used in various ways by children in traditional observances.

In Tibet, China, Japan and other adjacent countries to which Buddhism extended, the so-called lion dance is popular. In Tibet the head and shoulders of the lion are formed by a framework which one man manipulates from the interior while another man occupies its hind quarters. A harlequin mummer with a variety of rough and tumble antics introduces the beast, which enters with leaps and bounds and goes through a variety of manoeuvres. In China, where this sport is common, a ball in imitation of an immense pearl is carried by some one who runs in front of the beast or darts across its path. The lion is believed to be extremely fond of playing with the ball. A similar amusement is practised in China and Japan by itinerant players who carry a red mask of a lion on a pole, their bodies being concealed by a dependent red cloth. The mask and cloth are manipulated violently as if the animal was in pursuit, to the taps of a small drum. The lower jaw of this mask is movable and is made to emit a loud continuous clacking by means of a string. The same mechanism is used in the goat mask found in the Tyrol and among the Slavs and again in the giant masks of the Zuni Indian, shalako.

Ceylon and Java.—In Ceylon masks are used in plays, masquerades and devil-dancing. Those representing various diseases are employed by dancers in exorcising the spirits who are believed to cause them. The masks used in these performances are of carved wood, painted in brilliant colours, yellow and red preponderating. Some, like that of the great demon of fatal diseases, all of which are attributed to the derangement of the three humours, wind, phlegm and bile, are composite and of enormous size. The demon of cattle, who causes cattle sickness, is represented with horns and tusks and is clothed in a garment of leaves. The Gara is a demon who possesses newly-built houses, and before a house can be fully occupied a ceremony is generally performed. The masks are not intended to drive the devils away but rather to attach them to the spot.

In Java wooden masks, *tupeng,* are used in certain of the theatrical performances that are extremely popular. These plays, developed from the shadow puppet plays of the 18th century, are performed not only as amusements but to safeguard the people from all kinds of calamities. The stories are in part derived from ancient Sanskrit literature, the Mahabharata and the Ramayana, although the Javanese are now Mohammedans. This use of masks is exceptional, for masks, being forbidden under the prohibition of images, are practically unknown in the Mohammedan East.

Melanesia.—Masks of bark and carved wood play an important part among the Papuans where they are worn by members of the native secret societies. There societies such as the Quatu of New Hebrides, the Tamate of the Banks islands, the Malambala of Floridà, the Dukduk of New Britain, etc., are characteristic of Melanesia and are accessible only to men.

Africa.—Carved wooden masks are used by the natives of the Congo and by the adjacent tribes on the west coast of Africa. They may be divided into three principal classes: war masks, dance masks and masks of the *féticheur,*—that curious personage who combines the attributes of high priest, magistrate and physician. Whatever their use, they are more or less connected directly with the medicine man and are religious rather than festal. The face or head of carved wood is usually painted and supplemented by an enormous fringe of fibre attached at the base of the mask and hanging over the shoulders. In their expression the African carved wood masks have an artistic distinction above those of any living people.

Eastern Europe.—Masks survive among the Slav peasants of eastern Europe in connection with heathen festivals connected with the winter solstice that have been transferred to Christmas and Easter. The carved and painted wooden masks of the peasants of the Austrian Tyrol, among which those of the so-called Judas play are conspicuous, frequently bore branching stag horns, and are reminiscent of an earlier, heathen period, as are the masks used in the May dances by the peasants in other parts of Europe. Little or no information exists concerning the use of masks in Europe after the decline of the classic drama until they reappear in the mediaeval mystery plays, and their use evolved through the mimes and Italian popular comedy into pantomime. The masquerade came from Italy where the domino, a loose cloak with a half mask, was introduced from Venice.

America.—Whatever may be the status of the mask in the culture of the Old World, it is surpassed in America where it was a fundamental object in the religious life of many aboriginal tribes. As such it culminated in the ancient civilization of Mexico where it not only distinguished the personalities of the gods but supplied the foundation of the system of picture writing in which the individual characters consist for the most part of grotesque masks of different divinities. While all but a very few of the old masks have perished, they may be studied in the minutest detail from the pictures in the manuscripts and from sculpture and pottery. Sculptured stone masks with holes at the upper corners for attachment or suspension are common among Mexican antiquities, and while their use is not fully understood, actual masks of carved wood entirely encrusted with turquoise are preserved in museum collections.

The primitive culture of the Americas appears to belong to an earlier and fresher stratum than that of the oldest historic civilizations; it exhibits processes of growth and development that are elsewhere lacking. This is especially true of the mask, for which we find a direct explanation which, while it may not apply to all masks, reveals materials and conditions out of which the thing came into being.

While the use of the mask among the American Indians was widespread, the Eskimo, the tribes of the north-west Pacific coast and the village dwellers of the south-western United States are now our chief sources of information. Idols or images of the gods are inconspicuous in the religious life of the existing Indian who himself personates his deities. He identifies himself with the divinity by painting himself, or by his costume, the essential feature of which among the Indians of the South-west is the mask. Much the same kilts, girdles and other accessories are worn with different masks. The Eskimos believe that in early days all animated beings had a dual existence, assuming at will either human or animal form. When an animal wished to become human it raised its forearm or wing and pushed up its muzzle or beak as if it were a mask, the creature becoming instantly manlike in form and features. The manlike form thus appearing is supposed to represent the thinking part of the creature and at death becomes its shade. The masks of the Pacific coast with double faces illustrate this belief, the muzzle or beak of the animal fitting over and concealing the face of a man and being so constructed as to swing open and symbolize the transformation at a certain place in the ceremony.

The primal and dominant type of mask employed by the Indians of the south-western United States is a cylinder, closed at the top, that fits over the head and rests on the shoulders. It suggests and is comparable to the top of a carved post. Another mask, a section of the foregoing, covers only the face. These are worn alike by the Zuni, the Hopi, the Keres, Tewa and other Pueblo tribes. To-day they are made of leather, of old saddles, or of raw hide, and are humanized and adorned by a variety of adjuncts. The eyes are represented by round or square incisions or by two buckskin balls filled with deer hair and tied with deer sinew which passes through holes. The nose is commonly of buckskin rolled up and tied in place with sinew, or of a corn-cob or a corn-cob dart or a miniature dart directed at a ring which forms the mouth. The mouth is a little hole with a ring of buckskin or is indicated by a braided corn husk simulating teeth. Not infrequently it has a projecting wooden cylinder for a bill, or the stem of a gourd cut with teeth for a snout. Ears consist of a hemispheric disc of wood perforated for earrings and attached with sinew or buckskin strings, or flowers of the

colour-vision producing datura made of wool or cotton yarn of different colours, or datura flower buds of wood, on one or both sides. On others painted discs representing datura flowers with segments of different colours are substituted. Horns are attached to some masks. Others are surmounted by wooden rainbows or rectangular tablets. A feather plume is frequently affixed at the top. Wooden arrows, lightning sticks and cloud terraces are among the other adjuncts.

These masks are painted in colours: blue, green, white, black, pink, red, yellow, brown, purple and grey, and are adorned with plumes and beads. All have sex, masculine or feminine, which is not determined by the beard. In graphic representations the round heads are masculine and the square, feminine. The masks are collected by a head man at his house before each dance and decorated for the occasion. After the dances they are dismantled and taken, each to its owner's home where they are kept in a back room tied in a cloth. The same mask may be used in different dances, painted and adorned in accordance with their requirements. Masks are regarded as sacred and the spirit of the divinity they represent is thought to reside in them. Altars formed of them set in a row are sprinkled with sacred meal. Men invoked their masks, thanking them for services rendered. The wearer of the mask believes he is transformed into the mythic creature it represents. When he removes it he feels obliged to wash and purify himself. Among the Hopi a ceremony is performed to make this removal effective, through fear that the spirit may remain and disturb its possessor.

Masks and masked dances were articles of traffic between individuals and different Indian tribes. The Yeibichai dance of the Navajo is closely inter-related to the shalako dance of the Zuni Indians in which tall giants appear. In the shalako, the personators carry the masks upon poles, their heads and bodies being covered with a huge crinoline, painted to simulate feathers, through which holes are cut for their eyes. The masks used by the Navajo in the Yeibichai, as the night chant is called, are copies of the cylinder and face masks of the Pueblos, but are made of soft buckskin, great care being taken in their manufacture which is attended with elaborate ceremonies. Among the Pueblo Indians who have remained more or less under Christian influences, their old masked ceremonies are celebrated in a much modified form on the days of Christian church festivals and such is the custom generally among the Indian tribes in Mexico, who for the most part are Catholics.

No traces of masks are found among the remains in the Cliff Dwellings and it may be presumed that their existence among the Pueblos dates from a comparatively recent time and that they were introduced from old Mexico, their original source, at or about the time of the conquest. The gods they represent were originally bird-tree-gods, and the masks sections of trees. Made now of leather they were originally of hollow wood. Bird-tree-gods, personifications of the Four Directions, play a dominant part in the mythology of the native people of Mexico and Central America.

Among the tribes of the north-west coast two kinds of masks are distinguished: dancing masks and masks attached to house-fronts and heraldic columns. All masks of the latter kind are clan masks, usually three to five feet high, and have reference to the crest of the house or post owner. The dancing masks are those used at the Potlatch, the festival at which property is given away, and the masks of the mimical performances in winter when dances representing the traditions of the clan are acted. Some have human and others animal faces, bear, wolf, dog, beaver, crane, puffin and killer whale, represented in their mythology. They are commonly made of cedar wood, many are elaborately carved.

Carved wooden masks survive in use among Iroquois Indians in New York State and in Ontario, Canada, and archaeological remains indicate their use among the Indians of the eastern United States. Being perishable, the older masks of the aboriginal inhabitants of America have for the most part disappeared, but a suggestion that they may have existed widely is found in the carved and painted wooden masks discovered by Cushing at Marco, Florida.

Masks are less common among the South American Indians than in North America, although archaeological remains indicate that they had an important part in the old culture of Ecuador and Peru. Masks are used by the tribes of Guiana and on the Amazon, and in Tierra del Fuego bark and seal hide dance masks representing fish, suggesting the New Mexican Pueblo Indian masks, are used by the Yaghan. Actual masks are extremely rare among Peruvian remains, although terra cotta masks have been found in graves and Gigilioli reports two masks made from the facial portion of human skulls as having been discovered in an ancient cemetery near Lima. These objects, which appear to be true masks and used as such, are analogous to the skull masks of New Britain, the only other locality outside of ancient Mexico in which such masks are known to be employed.

It was the custom of certain of the old Peruvians like the ancient Egyptians to place above or before the envelopes of their dead, destined to a natural and not an artificial mummification, a rough image of the deceased when living. This was a wooden face, fixed with a peg on the upper part of the envelope in which the corpse was bound up, usually painted and adorned with a wig of human hair and a more or less complicated head-dress. (*See* THEATRE; DANCE; PANTOMIME; DRAMA.)

BIBLIOGRAPHY.—V. F. Weber, *Ko-ji Hō-ten* (1823); Guhl and Kohner, *The Life of the Greeks and Romans* (1875); William H. Dall, *Masks and Labrets*, Third Annual Report, Bureau of Ethnology, Washington, D.C. (1884); Albert Grünwedel, "Sinhalesische Masken," *Internationales Archiv. für Ethnographie*, vi. p. 71 (Leiden, 1893); L. Austine Waddell, *The Buddhism of Thibet* (1895); F. W. K. Müller, *T'oung Pao* (Japanese Masks) (1897); L. Frobenius, *Die Masken und Geheimbunde Afrikas* (Halle, 1898); Matilda Coxe Stevenson, *The Zuñi Indians*, 23rd Annual Report of the Bureau of American Ethnology, Washington (1904); Henri L. Joly, *Legend in Japanese Art* (list of Nō masks) (1908); Kenneth Macgowan, *Masks and Demons* (1923). (S. Cu.)

MODERN MASKS AND THEIR USES

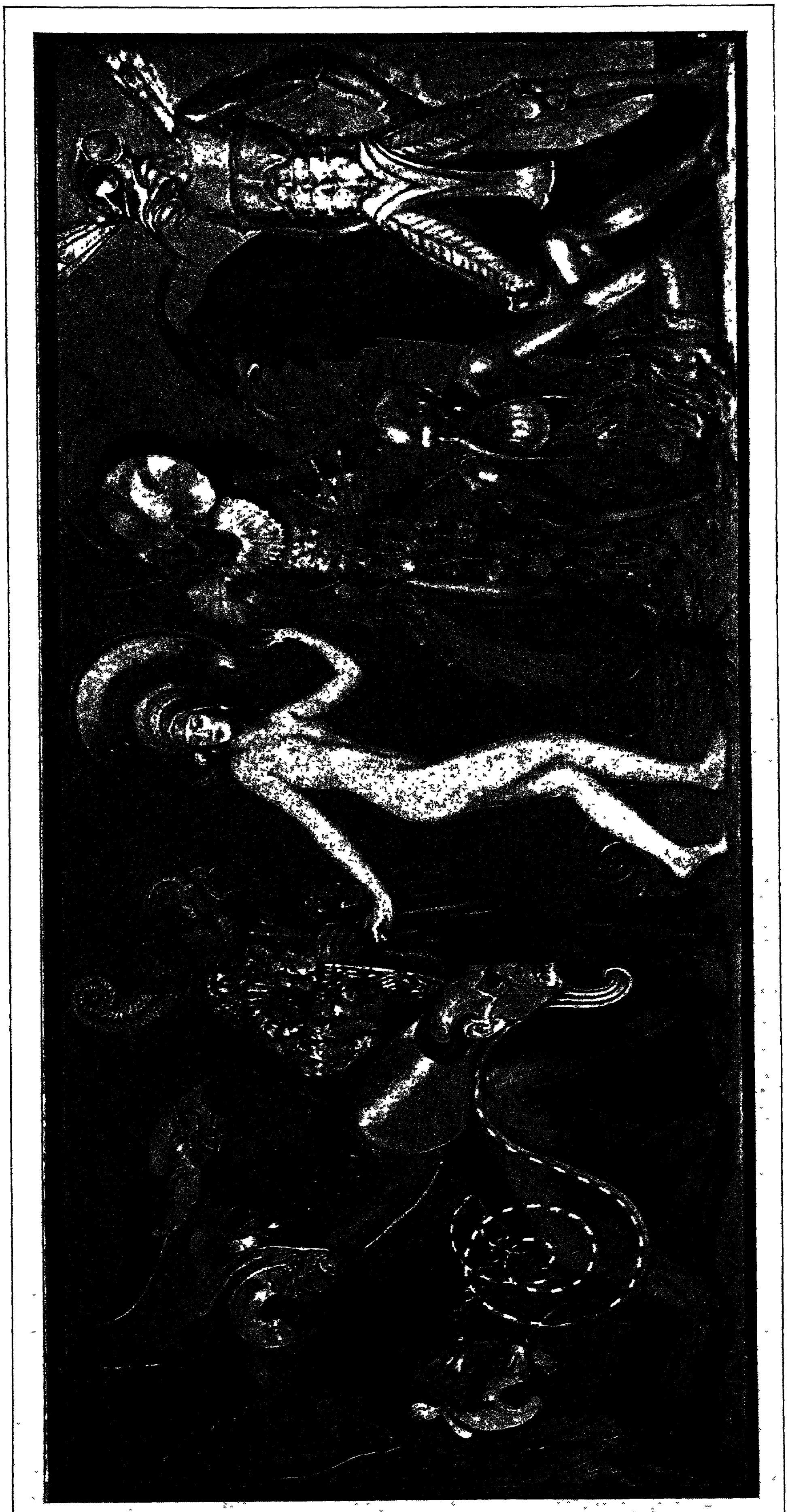
Our civilized world has neglected and forgotten the use of masks and it is only in this century that the interest in them has revived. We are here concerned solely with modern masks as the products of artists' imagination, taste and skill—masks that have quality which makes them different from and superior to all trivial products of manufacture and all banalities of the sort popularly called "false faces."

Early Significance.—Although the ritual and religious significance that prevailed in antiquity and exists now among primitive and barbaric people is unknown to us, there remains the mystery that envelops the mask, the same mystery that is at the bottom of all the supernatural meanings with which the ancients and the modern primitive people surrounded the masks and gave them such prominent part in their religious ceremonies; for when a person, no matter how sophisticated or naive, confronts a masked man, that person will be mystified. The mask may or may not fascinate, it may or may not terrify, it may appeal to the sense of humour or fail to do so, but it will never fail to mystify.

Psychological Effects.—This strange mystifying quality of the mask, the way it deceives and impresses us, the way we react to its inscrutable charm, when we see it worn by someone, and the way the wearer of a mask is influenced by the mask he is wearing, constitute a strange psychological phenomenon. The moment a person puts on a mask he changes into another being; his whole body seems to change its appearance, its proportion and character, and the onlooker immediately forgets his real features, even if the masked person is an old friend.

As various masks are put on the same person his figure will seem to alter. Its proportions and character become in the eyes of the spectator the figure belonging to the mask, and this is most convincing when the figure is nude. An ugly face makes the whole figure appear ungainly, just as a beautiful physiognomy will bring to our consciousness its beauty and grace.

There are of course certain obvious and simple facts which every art student knows and which are dominant in this deception. One of them is the proportion of the size of the head to the height of the body: a large face dwarfs the figure and a



MODERN DRAMATIC MASKS

MURAL PAINTING BY WLADYSLAW T. BENDA SHOWING THE DRAMATIC USE OF MASKS AS THEY ARE EMPLOYED IN GROTESQUE PANTOMIME

small head makes the figure appear taller. More exactly, if the length of the head is less than one-eighth of the whole figure the figure will appear very tall. This can be done, because, paradoxical as it may seem, it is possible to fit a mask with a smaller face over a larger face as the diagram shows in fig. 3.

A mask in action seems to change its expression. This is a strange delusion which can be explained in the first place by the

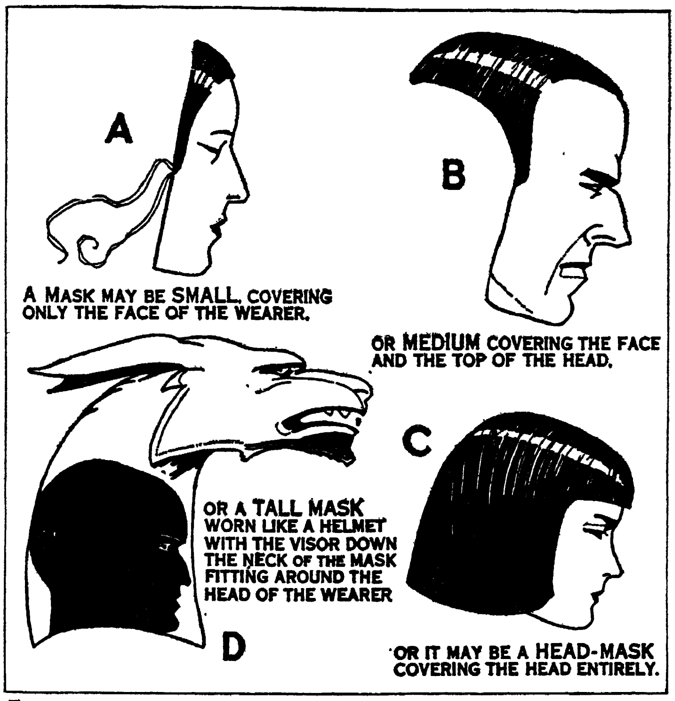


FIG. 5.—VARIOUS TYPES OF MASKS COVERING THE WHOLE OR PART OF THE HEAD

fact that the so-called facial expressions are not due to the contraction of the facial muscles, but are brought about by the movement and position of the head and the neck in relation to the rest of the body. This may be seen in Plate V., fig. 1, 2, 3 and 7, 8 and 9. Thus when the masked actor changes the position of his head we are under the impression that something has changed in the expression of the mask. A frowning man when his head is up looks aggressive, proud, pugnacious and commanding; but that same frown will give him an expression of sorrow and suffering if the head is lowered.

All this constitutes the effect that masks have on the onlooker. The wearer of masks is subject to another strange influence: as soon as he puts on a mask and starts to interpret its character through the action of his body, he will find his face unconsciously imitating the expression of the mask and he will find it difficult to stop this wasted mimicry. It would be amusing to see the rugged or stern masculine face of the wearer endeavouring to conform itself to the delicate and alluring femininity of the mask that covers it; or twisting itself into the snarling fierceness of an ape, if that happens to be the mask he is wearing. But it is natural that the face must co-ordinate itself with the action of the body, and, moreover, the expression of the mask is reflected in the faces of the spectators and back to the wearer. For instance, a man wearing the mask, with the supercilious expression shown in Plate V. would find that people looking at him were all grinning in response and he in his turn would grin at them even though his face was hidden.

DESIGN AND CONSTRUCTION

The creator of masks finds a great thrill and constant stimulus in the wide scope before him; in the limitless variety of types and expressions; in the degree of realism or fantastic exaggeration; in all shades of tragedy, comedy and burlesque. All the long gamut from noble countenances and alluring feminine beauty to terrifying demons, hobgoblins and all sorts of fantastic beings of utmost grotesqueness, besides the infinite possibilities of colour, are at his disposal. This variety may be divided into three distinct categories: (1) Masks representing in a more or less realistic manner types of men and women. (2) Grotesque masks, demons, gargoyles and fantastic representations of animal characteristics (*see* Plate III.). (3) Caricature.

The masks of the first category may portray single individuals or generalized types, and these last based on synthetic studies of human characteristics are the most interesting problems for the creator. There is therefore no excuse for indulging in meaningless creations, thoughtless imitations or other such banalities that would bring the standard of the modern mask back to the trivialities of recent products of manufacture that degrade it. Each mask should be the result of a thrilling inspiration and long and careful meditation based on accumulated knowledge. It must be impressive and full of significance; it must be more impressive and interesting than a human face,—all of which means that it must be a work of art. A modern maker of masks should get well acquainted with the wonderful masks of the ancients, and those of the barbaric peoples and primitive tribes, not to imitate them but to try to emulate their excellent qualities, their vigour and significance.

Imagination and the ability to model and paint could not go far in creating masks without the support of the knowledge of anatomy, zoology and anthropology, an understanding of racial differences, of the psychology of the human physiognomy and of humanity as a whole. The mask must be convincing to be effective; therefore it must be based on the study of nature. This

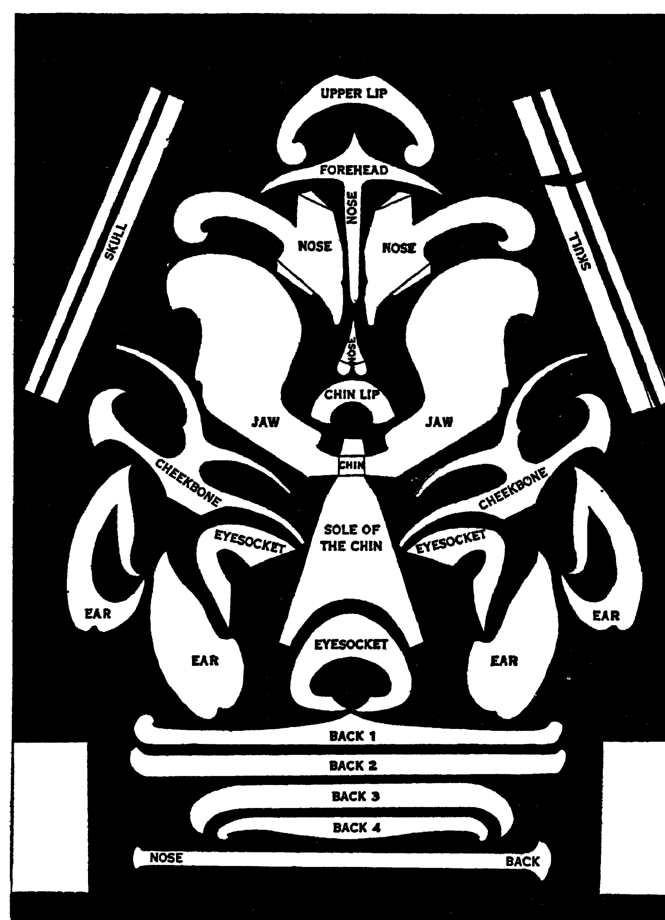


FIG. 6.—SECTIONS OF A GROTESQUE MASK

does not mean that it should always be naturalistic and realistic but even the most fantastic exaggerations in the grotesque masks should be based on that knowledge. Their structure, no matter how bizarre, should be evolved from real forms that exist in nature, human or animal. We must feel the bone construction of the face, the tenseness or relaxation of the facial muscles and the quality of the skin. And all this does not mean that there is

need of infinitesimal details. On the contrary, the effectiveness of a mask depends largely on the mystification by elimination of unimportant details and on the emphatic statement of everything that is essential in the type and expression.

Materials.—A mask to be practical should be: (1) durable—it should not break, crack, tear, warp, melt or stretch; (2) waterproof; (3) light in weight; (4) adjustable. Furthermore, it should have openings for the eyes and for breathing, and, in all cases, a surface that can be cleaned and washed.

To make a mask strong a durable material must be chosen, and then the mask so constructed that the durability can be ensured. This durable material should have other qualities that allow freedom of execution. Metals, wood, paper, rubber, silk, linen and papier mâché are possible materials.

Papier mâché is the poorest material for such masks. It is weak and perishable and does not yield itself to refined finish. It is impossible to work into it delicate details or sharp edges. Wood is the material that has been used in all parts of the world. Japanese, American Indians, African tribes and South Sea Islanders carved masks out of wood. Although some of the most beautiful masks have been made of this material, it has a drawback in that the mask must be thick to prevent splitting, and consequently is not easily adjustable. That happens often—the beautiful Japanese Nō masks often split. Wood, however, remains one of the best mediums. Tough paper tightly glued in layers and covered outside and inside with waterproof varnish and oilpaint is better and stronger than wood; it cannot split, and the masks made of it can be thin and adjustable.

Modelling.—It is hardly possible to make a life-size mask that would fit well any size and shape of head, yet it should be made so that it can be worn on most heads, and this is not an easy thing to achieve. A mask may be made to cover only the face of the wearer (fig. 5-A), to cover the face and the top of the head (B), or it may be a headmask, covering the entire head (C) as well as at times including the neck and worn like a helmet with the visor down, the neck of the mask fitting around the head of the wearer (D).

The wearer of the mask must be able to breathe and to see. Consequently, the eyes and nostril orifices should be as wide as it is possible to make them without sacrificing the appearance of the mask. There are, as we see, many practical materials and consequently many ways of making masks, and as modern maskmaking is so new it is still in an experimental stage and therefore there is no uniform method. One successful method, developed by the author, is as follows: After the drawings are completed the whole surface of the proposed mask is divided in a number of definite planes which of course will be of various shapes. These planes are then carefully drawn and cut out of Bristol-board or, preferably, the trunkmaker's fibre-board. The diagram (fig. 6) will explain this. The pieces are then glued together with small strips of rough paper or linen on the outside and on the inside. The whole mask thus constructed is then covered with additional layers of paper glued as lightly as possible and subsequently the inside and outside surface is given several coats of varnish and finally, when thoroughly dry, painted with oil colours. Smaller and more realistic masks may be constructed of small pieces of tough paper glued tightly together, starting with stiffer paper and building at first as a foundation a few of the most essential planes of the construction of the head, as for instance forming the forehead of a number of long strips, then the shape of the lower jaws, and a narrow strip, definite and firm, representing the profile, attached to the middle of the forehead and meeting the jaws at the chin. Around these fundamental planes the rest of the mask can be formed, taking care all the time that every bit of paper is tightly glued. Additional layers of the same material will improve the details and will give the mask the desired firmness. Any further improvement of the modelling can be done by cutting off with a razor blade any undesired protuberances and filling with more layers of tiny pieces of paper the cavities that are not wanted. The whole mask is then varnished and painted with oil colours. After it is perfectly dry its surface is still far from being satisfactory. All the defects that could not be seen before the painting are now obvious, and cutting, filling undesired depressions and polishing will be necessary to obtain the desired surface. The sharp incisions will have to be improved if they are clogged by varnish and paint. Then the mask will be ready for final painting.

An easier but less direct and less interesting way of making masks is to begin by modelling the head in clay or plasteline, casting the result, and pressing small pieces of paper into the mould, and glueing them securely. This must be done slowly and the paper must be kept as dry as possible to avoid shrinking and warping. Then the rest of the work is the same reinforcing, varnishing, painting, cutting, filling and polishing as in the preceding method.

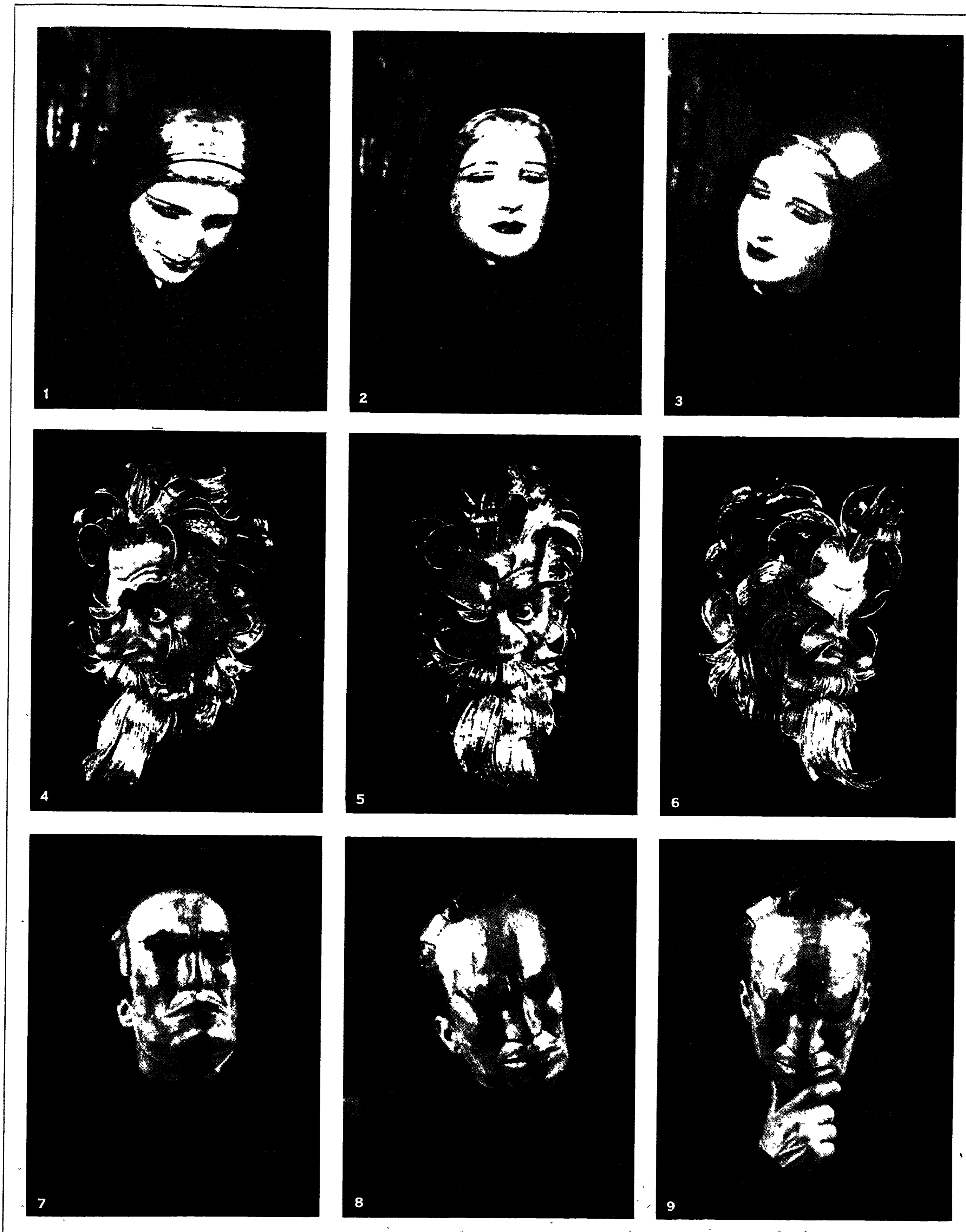
Modern Uses.—Since the time when the ancient Greek actors appeared masked in the tragedy the use of the masks on the stage has been, with a few exceptions, forgotten in Europe and the drama of our civilized world had no place for it. Only recently, within the 20th century, has the interest in masks on the stage revived. Much has been written lately on that subject, but mostly about the desirability, or, as some more impulsive reformers of the theatre have put it, the necessity of the use of masks in dramatic performances. Edward Gordon Craig, the most enthusiastic promoter of this innovation, in his *The Theatre Advancing*, repeatedly expresses his conviction that masks must come back and he goes as far as to say: "Masks, that paramount means of dramatic expression without which acting was bound to degenerate!"

Much has been said about the importance of reviving the use of masks on the stage, but the question of how that could be successfully accomplished has been neglected. Attempts at masking one or several actors in a drama for some particular reason or under some special pretext, have been frequent; yet, plays that are deliberately and entirely masked, without special reasons, are still a thing of the future. In the spoken drama there is the difficulty that the mask muffles the sound and in other ways interferes with the speech; conversely, the speech spoils the effect of the mask, as one expects the words to be accompanied by the motion of the lips and other facial mobility which are absent in the mask. This difficulty did not exist in the ancient Greek drama where large masks together with the *cothurni* were intended to enhance and magnify the impressiveness of the actor who on the open-air stage was a considerable distance from his audience. The large mask was not enclosing his face, but was affixed about two inches away from it and spoke or rather chanted through a funnel which connected his mouth with the wide-open mouth of the mask.

The masked pantomime is different from all other pantomimes. The immobility of the mask demands greater poise and extreme restraint of motion. The acting must be limited to the most essential and significant, and there must be a rigorous elimination of all meaningless gestures or even the slightest unnecessary movements to harmonize with the mask in which nothing but the essential and significant is expressed. There must be more repose than in any other kind of acting, and all movements, all gestures, must be much slower. The value of this slow tempo is seen as soon as the mask is put on. Then the acting, the costumes, and the stage settings must be as strange and unnatural as the masks are themselves.

(*See* also DRAMA; ACTING; PANTOMIME.) (W. T. B.)

MASOLINO DA PANICALE (1383–1447), Florentine painter, born at Panicale di Valdelsa, near Florence, is assumed to be identical with Tommaso, son of Aristoforo Fini. He was one of the most distinguished representatives of the Early Renaissance. There is nothing to confirm Vasari's statement that he was a pupil of Lorenzo Ghiberti, but the statement that he studied under Gherardo Starnina, a later Giottesque master, of whom little is known, is not unlikely. In 1423 he was admitted to the guild of *speziali* or druggists, to which painters belonged. The only authenticated works by Masolino were recovered from a coating of whitewash in 1843 at Castiglione d'Olona, near Varese. They consist of two series of frescoes, which he executed for Cardinal Branda Castiglione. The earlier work, in the choir



MODERN MASKS BY BENDA

Three masks by W. T. Benda showing the changes of expression which occur as the head is seen at different inclinations and from various sides

MASKS

BY COURTESY OF (1) STAATLICHE PORZELLAN MANUFAKTUR, (2, 5) EMIL PIRCHAN, (3, 4, 6) THE DEPARTMENT OF FINE ARTS, BROOKLYN MUSEUM

MODERN MASKS

1. Modern mask designed and made by Professor Max Esser and also used by Harold Kreutzberg in a dance in a Berlin Opera
2, 5. Masks made by Emil Pirchan for the Ballet "Die Nachtlichen"; 3, 4, 6. Modern masks designed by Richard Teschner of Vienna

vaulting of the church, represents scenes from the life of the Virgin. It is signed "Masolinus de Florentia pinxit," and was probably painted about 1423, when he was 40 years of age.

The later work, in a small baptistery adjoining the church, is dated 1435. These frescoes are adapted to the architecture of the interior. The serene conception, the light and harmonious colour scheme, the graceful movement and expression of the figures are essentially the result of the master's trecentist training, while the attempt, however primitive, to represent three-dimensional space by applying the newly discovered laws of perspective, the study of the nude, and the individual character of the heads are inspired by the incoming Renaissance. The paintings are well preserved and constitute one of the finest monuments of Florentine Art of that time.

Between 1424 and 1426 he worked in the Brancacci chapel, in the church of the Carmine at Florence. As Masaccio and, somewhat later, Filippino Lippi also painted in this chapel, the discussion as to what particular share was done by each still continues, but the following paintings may, with a considerable degree of certainty, be attributed to Masolino: The "Preaching of St. Peter," the "Healing of the Cripple," the "Raising of Tabitha," and the "Fall of Adam and Eve."

He later painted frescoes representing the "Crucifixion" and scenes from the Legends of St. Catherine and of St. Ambrogio, in the church of San Clemente at Rome, for the same Cardinal Branda, for whose Lombard home at Castiglione d'Olona he executed the works described above. The works at San Clemente show the influence of Masaccio, to whom they are sometimes ascribed. Among the few panel pictures which may be attributed to Masolino we must mention the two well preserved pictures in the museum at Naples, the "Madonna and Christ in Glory" and the "Founding of S. Maria Maggiore."

Masolino's art shows a constant search after truthful representation. Starting from the Giottesque tradition, he took part in the great naturalistic movement emanating from Florence. He probably learned much from his brilliant young pupil, Masaccio, whom he outlived by 20 years. But, while Masaccio belongs entirely to the Renaissance, Masolino never quite freed himself from the traditions of the preceding age.

See A. H. Layard, *The Brancacci Chapel* (Arundel Society, 1868); P. Toesca, *Masolino da Panicale* (1907); Crowe and Cavalcaselle, edit. by L. Douglas, *History of Painting in Italy* (1910). (I. A. R.)

MASON, GEORGE (1725–1792), American statesman, was born in Fairfax county, Va., in 1725. His colonial ancestors held official positions in the civil and military service of Virginia. Mason was a near neighbour and a lifelong friend of George Washington. His large estates and high social standing, together with his personal ability, gave Mason great influence among the Virginia planters, and he became identified with many enterprises, such as the organization of the Ohio company and the founding of Alexandria (1749).

He became a member of the Virginia house of burgesses in 1759. In 1769 he drew up a series of non-importation resolutions, which were presented by Washington and adopted by the Virginia legislature. In July 1774 he wrote for a convention in Fairfax county a series of resolutions known as the Fairfax Resolves, in which he advocated a congress of the colonies and suggested non-intercourse with Great Britain, a policy adopted by Virginia and later by the Continental Congress. He was a member of the Virginia committee of safety from Aug. to Dec. 1775, and of the Virginia convention in 1775 and 1776. In 1776 he drew up the Virginia Constitution and the famous Bill of Rights, a radically democratic document which had great influence on American political institutions. The Federal Government laid claim to the hinterland; *i.e.*, to territory north and north-west of the Ohio river, which Virginia conceded in 1780 on the basis of a plan worked out by Mason. He was a member of the Virginia house of delegates (1776–88). He took an active part in the Constitutional Convention in Philadelphia in 1787. Particularly notable was his opposition to the compromises in regard to slavery and the slave-trade. Indeed, like most of the prominent Virginians of the time, Mason was strongly in favour of the gradual abolition of slavery. He objected to the large and indefinite powers given by the completed Constitution to Congress, so he joined with Patrick Henry in opposing its ratification in the Virginian convention (1788). Failing in this, he suggested amendments, the substance of several of which was afterwards embodied in the present Bill of Rights. Declining an appointment as a U.S. senator from Virginia, he retired to his home, Gunston Hall (built by him and named after the family home in Staffordshire, England). A radical republican, he believed that local government should be kept strong and central government weak; his democratic theories had much influence in Virginia and other southern and western States. He died on Oct. 7, 1792 at Gunston Hall.

See Kate Mason Rowland, *Life and Writings of George Mason* (1892).

MASON, JAMES MURRAY (1798–1871), American lawyer and political leader, was born in Fairfax county (Va.), on Nov. 3, 1798, the grandson of George Mason (1725–92). Educated at the University of Pennsylvania and the College of William and Mary, he was admitted to the bar in 1820. He was a member of the Virginia house of delegates (1826–32) of the State constitutional convention of 1829, of the national House of Representatives (1837–39) and of the U.S. Senate from 1847 until the outbreak of the Civil War when he resigned to take part in the Virginia secession convention. He was a staunch Democrat, upholding States' rights and slavery; the author of the Fugitive Slave Act of 1850.

He was appointed in Aug. 1861 commissioner of the Confederate States to Great Britain. The British ship "Trent," upon which he and John Slidell, the commissioner to France, sailed, was intercepted by a U.S. ship-of-war, and the two commissioners were seized and carried as prisoners to Boston but were released two months later, through the demands of Great Britain. The incident is well known as the "Trent affair." Arriving at London Mason was unable to secure official recognition, and his commission to Great Britain was withdrawn late in 1863.

He died at Alexandria, Va., on April 28, 1871.

See Virginia Mason (his daughter), *The Public Life and Diplomatic Correspondence of James M. Mason, with some Personal History* (1903).

MASON, SIR JOHN (1503–1566), English diplomatist, was born of humble parentage at Abingdon, and was educated at Oxford, where he became Fellow of All Souls in 1521. Ordained before 1531, he was employed on the continent in collecting information for four successive Tudor sovereigns, and in 1537 became secretary to the English ambassador at Madrid. Under Mary he was appointed in 1553 ambassador at the court of the emperor Charles V., of whose abdication in 1555 he wrote a vivid account. Under Elizabeth, he influenced foreign policy until his death, on April 20, 1566.

See J. A. Froude, *History of England* (12 vols., 1856–70); C. Wriothesley, *Chronicle of England during the Reigns of the Tudors*, ed. W. D. Hamilton (Camden Soc., 2 vols., 1875).

MASON, JOHN (1586–1635), founder of New Hampshire, was born in King's Lynn, Norfolk, England. He was governor of the English colony in Newfoundland (1615–21) and published the first map of that region. In 1622 he obtained from the council for New England a grant of the territory (Mariana) between the Salem and Merrimac rivers, and he and Sir Fedinando Gorges received a grant of the region between the Merrimac and Kennebec rivers and extending 60 m. inland (Province of Maine).

In 1629 Mason and Gorges agreed upon a division of the territory held jointly, and Mason received a separate grant of the tract between the Merrimac and the Piscataqua, which he named New Hampshire. With Gorges and a few associates, he also secured a grant of the region named Laconia, including Lake Champlain, and in 1631 the Pescataway grant, bordering on the Piscataqua river. He was vice-president of the council for New England in 1632, and in 1635 was appointed vice-admiral for New England, but died in London in Dec. 1635, before crossing the Atlantic. He was buried in Westminster Abbey.

See *Captain John Mason, the Founder of New Hampshire* (1887,

published by the Prince Society).

MASON, JOHN YOUNG (1799–1859), American political leader and diplomatist, was born in Greensville county (Va.) on April 18, 1799. He served in the Virginia house of delegates (1823–27), in the State constitutional convention (1829–30), the national house of representatives (1831–37), and as judge of the U.S. district court for Virginia (1837–44). From 1844–49 he was a member of the cabinet of both President Tyler and President Polk, as secretary of the navy, serving for an interval as attorney-general. He was president of the Virginia constitutional convention of 1850, and from 1853, was minister to France. He joined with James Buchanan and Pierre Soulé, ministers to Great Britain and Spain respectively, in drawing up (Oct. 1854) the famous Ostend manifesto (*q.v.*). He died at Paris Oct. 3, 1859.

MASON, MAX (1877–), American educationalist and inventor, was born at Madison (Wis.), on Oct. 26, 1877. He graduated from the University of Wisconsin in 1898, continuing his studies at the University of Göttingen. After being instructor in mathematics at the Massachusetts institute of technology 1903–04, he became assistant professor of mathematics at the Sheffield scientific school, Yale university, in 1904. He was appointed professor of mathematical physics at the University of Wisconsin in 1908. He also lectured at Harvard university, 1911–12. During the World War he was a member of the staff of the Naval experimental station, New London (Conn.), and also on the submarine committee of the National research council, 1917–19. He invented several devices for the detection of submarines. He was president of the University of Chicago, 1925–28; he then became director of natural sciences and in 1929 president of the Rockefeller Foundation.

MASON, WILLIAM (1725–1797), English poet, son of William Mason, vicar of Holy Trinity, Hull, was born on Feb. 12, 1725, was educated at St. John's college, Cambridge, and took holy orders. In 1744 he wrote *Musaeus*, a lament for Pope in imitation of *Lycidas*, and in 1749 through the influence of Thomas Gray he was elected a fellow of Pembroke college. He became a devoted friend and admirer of Gray, who addressed him as "Skroddles," and corrected the worst solecisms in his verses. In 1748 he published *Isis*, a poem directed against the supposed Jacobitism of the University of Oxford, which provoked Thomas Warton's *Triumph of Isis*. Mason wrote two plays in a pseudo-classical style: *Elfrida* (1752) and *Caractacus* (1759), produced with some alterations at Covent Garden in 1772 and 1776 respectively. Horace Walpole described *Caractacus* as "laboured, uninteresting, and no more resembling the manners of Britons than of Japanese"; while Gray declared he had read the manuscript "not with pleasure only, but with emotion." Mason received many preferments, including a canonry of York and a prebend of Driffield. When Gray died in 1771 he made Mason his literary executor. In the preparation of the *Life and Letters of Gray*, which appeared in 1774, he had much help from Horace Walpole, with whom he corresponded regularly until 1784, when Mason opposed Fox's India Bill, and offended Walpole by thrusting on him political advice unasked. The correspondence was not renewed until 1795. Mason died at Aston on April 7, 1797.

His poems were collected in 1764 and 1774, and an edition of his *Works* appeared in 1811. His poems with a *Life* are included in Alexander Chalmers's *English Poets*. His correspondence with Walpole was edited by J. Mitford in 1851; and his correspondence with Gray by the same editor in 1853.

MASON AND DIXON LINE, in America, the boundary line (lat. 39° 43′ 26·3″ N.) between Maryland and Pennsylvania, United States; popularly the line separating "free" and "slave" States before the Civil War, and also distinguishing in popular parlance the "North" from the "South," east of the Ohio river. The line derives its name from Charles Mason (1730–87) and Jeremiah Dixon, two English astronomers, whose survey of it to a point about 244m. west of the Delaware between 1763 and 1767 marked the close of the protracted boundary dispute (arising upon the grant of Pennsylvania to William Penn in 1681) between the Baltimores and Penns, proprietors respectively of Maryland and Pennsylvania.

The dispute arose from the designation, in the grant to Penn, of the southern boundary of Pennsylvania mainly as the parallel marking the "beginning of the 40th degree of northerne latitude," after the northern boundary of Maryland had been defined as a line "which lieth under the 40th degree of north latitude from the equinoctial." The eastern part of the line as far as Sideling hill in the western part of the present Washington county, was originally marked with milestones brought from England, every fifth one of which bore on one side the arms of Baltimore and on the other those of Penn; but the difficulties in transporting them to the westward were so great that many were not set up.

The use of the term "Mason and Dixon Line" to designate the boundary between the free and the slave states (and in general between the North and the South) dates from the debates in Congress over the Missouri Compromise in 1819–20. As so used, it may be defined as not only the Mason and Dixon Line proper, but also the line formed by the Ohio river from its intersection with the Pennsylvania boundary to its mouth, thence the eastern, northern and western boundaries of Missouri, and thence westward the parallel 36° 30′—the line established by the Missouri Compromise to separate free and slave territory in the "Louisiana Purchase," except as regards Missouri. (S. LE.)

MASON BEE, the name given to bees of the sub-family Osmiinae (fam. Megachilidae), which construct earthen cells, sometimes mixed with sand, pebbles or wood, each cell containing a single egg, together with honey and pollen as food for the larva. Ten to 20 cells are usually found together. In Europe the commonest genus is *Chalicodoma,* in the United States, *Osmia.* (*See* BEE, HYMENOPTERA.)

See J. H. Fabre, *Insect Life* (1901).

MASON CITY, a city of northern Iowa, U.S.A., on Lime creek, at an altitude of 1,124 ft.; the county seat of Cerro Gordo county. It is on Federal highways 18 and 65, and is served by the Chicago and North Western, the Chicago Great Western, the Chicago, Milwaukee, St. Paul and Pacific, the Minneapolis and St. Louis, the Rock Island and electric railways. Pop. (1920) was 20,065 (85% native white), and was 23,304 in 1930 by Federal census. It is the commercial centre of a rich farming, dairying and stock-raising region. There are valuable deposits of fireclay and sandstone near by, and the city is noted for its hollow building tile and large output of Portland cement (2,000 bbl. daily). Other important industries are pork-packing and the manufacture of beet-sugar (30,000,000 lb. annually). The aggregate factory product in 1925 was valued at $23,965,371. There are 40 wholesale and jobbing houses. Mason City owes its name to the fact that it was settled (1853) by a group of members of the Masonic fraternity. It was incorporated as a town in 1870 and as a city in 1881. Since 1927 it has had a council-manager form of government.

MASONRY, the art of building in stone. The English word "mason" is from the French, which appears in the two forms, *machun* and *masson* (from the last comes the modern French form *maçon,* which means indifferently a bricklayer or mason).

The earliest remains of masonry (apart from the primitive work in rude stone—*see* STONE MONUMENTS; ARCHAEOLOGY, etc.) are those of the ancient temples of India and Egypt. Many of these early works were constructed of stones of huge size, and it still remains a mystery how the ancients were able to quarry and raise to a considerable height above the ground blocks 700 or 800 tons in weight. Many of the early buildings of the middle ages were entirely constructed of masses of concrete, often faced with a species of rough cast. The early masonry seems to have been for the most part worked with the axe and not with the chisel. The methods of working and setting stone were much the same as at present, except that owing to difficulties of conveyance the stones were used in much smaller sizes.

Mason's Tools.—The mason's tools may be grouped under five heads—hammers and mallets, saws, chisels, setting-out and setting tools, and hoisting appliances.

There are several different kinds of iron hammers used by the stone worker; the mash hammer has a short handle and heavy head for use with chisels; the iron hammer, used in carving, in shape resembles a carpenter's mallet but is smaller; the waller's

hammer is used for roughly shaping stones in rubble work; the spalling hammer for roughly dressing stones in the quarry; the scabbling hammer, for the same purpose, has one end pointed for use on hard stone; the pick has a long head pointed at both ends, weighs from 14 to 20 lb., and is used for rough dressing and splitting; the axe has a double wedge-shaped head and is used to bring stones to a fairly level face preparatory to their being worked smooth; the patent axe, or patent hammer, is formed with a number of plates with sharpened edges bolted together to form a head; the mallet of hard wood is used for finishing the chisel work and carving; and the dummy is of similar shape but smaller.

A hand saw similar to that used by the carpenter is used for cutting small soft stones. Larger blocks are cut with the two-handed saw worked by two men. For the largest blocks the frame saw is used, and is slung by a rope and pulleys fitted with balance weights to relieve the operator of its weight. The blade is of plain steel, the cutting action being supplied by sand with water as a lubricant constantly applied.

There are, perhaps, even more varieties of chisels than of hammers. The point and the punch have very small cutting edges, a quarter of an inch or less in width. The former is used on the harder and the latter on the softer varieties of stone after the rough hammer dressing. The pitching tool has a wide thick edge and is used in rough dressing. Jumpers are shafts of steel having a widened edge, and are used for boring holes in hard stone. Chisels are made with edges from a quarter-inch to one and a half inches wide; those that exceed this width are termed boasters. The claw chisel has a number of teeth from one-eighth to three-eighths wide, and is used on the surface of hard stones after the point has been used. The drag is a semicircular steel plate, the straight edge having teeth cut in it. It is used to level down the surfaces of soft stones. Cockscombs are used for the same purpose on mouldings and are shaped to various curves.

The implements for setting out the work are similar to those used by the bricklayer and other tradesmen, comprising the rule, square, set square, the bevel capable of being set to any required angle, compasses, spirit level, plumb-rule and bob and mortar trowels. Gauges and moulds are required in sinking moulds to the proper section.

Hoisting Appliances.—The *nippers* (fig. 1), or *scissors*, as they are sometimes termed, have two hooked arms fitting into notches in the opposite sides of the block to be lifted. These arms are riveted together in the same way as a pair of scissors, the upper ends having rings attached for the insertion of a rope or chain which when pulled tight in the operation of lifting causes the hooked ends to grip the stone. *Lewises* (fig. 2) are wedge-shaped pieces of steel which are fitted into a dovetailed mortise in the stone to be hoisted. They are also used for setting blocks too large to be set by hand, and are made in several forms.

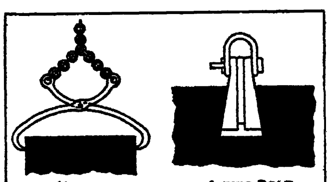


FIG. 1 FIG. 2

Scaffolding.—For rubble walls, single scaffolds, resting partly on the walls, similar to those used for brickwork (*q.v.*), are employed; for ashlar and other gauged stonework (*see* below) self-supporting scaffolds are used with a second set of standards and ledgers erected close to the wall, the whole standing entirely independent. The reason for the use of this double scaffold is that otherwise holes for the putlogs to rest in would have to be left in the wall, and obviously in an ashlar stone wall it would be impossible properly to make these good on the removal of the scaffold (*see* further SCAFFOLD).

Seasoning.—Stone freshly quarried is full of sap, and thus admits of being easily worked. On being exposed to the air the sap dries out, and the stone becomes much harder in consequence. For this reason, and because carriage charges are lessened by the smaller bulk of the worked stone as compared with the rough block, the stone for a building is often specified to be quarry-worked. In the erection of St. Paul's cathedral, Sir Christopher Wren required that the stone after being quarried should be exposed for three years on the sea-beach before use.

Setting.—All beds and joints should be truly worked and perfectly level. If the surface be convex it will give rise to wide unsightly joints; if concave the weight thrown on the stone will rest on the edges and probably cause them to "flush" or break off and disfigure the work. Large stones are placed in position with the aid of hoisting appliances and should be tried in position before being finally set. Great care should be taken to avoid fracturing or chipping the stone in the process of handling, as it is impossible to make good such damage. All stratified stones—and this includes by far the largest proportion of building stones—when set in a level position should be laid on their natural bed, *i.e.*, with their laminae horizontal. The greatest strength of a stone is obtained when the laminae lie at right angles to the pressure placed upon it. In the case of arches these layers should be parallel with the centre line of the voussoirs and at right angles to the face of the arch. For cornices (except the corner-stones) and work of a like nature, the stone is set with the laminae on edge and perpendicular to the face of the work. With many stones it is easy to determine the bed by moistening with water, when the laminae will become apparent. Some stones, however, it is impossible to read in this way, and it is therefore advisable to have them marked in the quarry.

For the shafts of columns especially it is necessary to have the layers horizontally placed, and a stone should be selected from a quarry with a bed of the required depth.

Of whatever quality the stone may be of which a wall is built, it should consist as much of stone and as little of mortar as possible. Only fine mortar is admissible if we are to obtain as thin joints as possible. The joints should be well raked out and pointed in Portland cement mortar. This applies only to some sandstones, as marbles and many limestones are stained by the use of Portland cement. For these a special cement must be employed, composed of plaster of Paris, lime and marble or stone-dust.

Bond is of not less importance in stone walling than in brickwork. In ashlar-work the work is bonded uniformly, the joints being kept perpendicularly one over the other; but in rubble-work, instead of making the joints recur one over the other in alternate courses they should be carefully made to lock, so as to give the strength of two or three courses or layers between a joint in one course and the joint that next occurs vertically above it in another course. In the through or transverse bonding of a wall a good proportion of header stones running about two-thirds of the distance through the width of the wall should be provided to bind the whole structure together. The use of through stones, *i.e.*, stones running through the whole thickness of the wall from front to back, is not to be recommended. Such stones are liable to fracture and convey damp to the internal face.

As with brickwork so in masonry great care must be exercised to prevent the different parts of a building settling unequally. When two portions of a building differing considerably in height come together, it is usual to employ a slip or housed joint instead of bonding the walls into each other. This arrangement allows the heavier work to settle to a greater extent than the low portion without causing any defect in the stones.

The footings of stone walls should consist of large stones of even thickness proportionate to their length; if possible they should be the full breadth in one piece. Each course should be well bedded and levelled.

Rubble and Ashlar.—There are, broadly speaking, two classes of stone walling: rubble and ashlar. Rubble walls are built of stones more or less irregular in shape and size and coarsely jointed. Ashlar walls are constructed of carefully worked blocks of regular dimensions and set with fine joints.

Random rubble (fig. 3) is the roughest form of stonework. It is built with irregular pieces of stone usually less than 9in. thick, loosely packed without much regard to courses, the interstices between the large stones being occupied by small ones, the remaining crevices filled up with mortar. Bond stones or headers should be used frequently in every course. This form of walling is much used in stone districts for boundary walls and is often set dry

without mortar. For this work the mason uses no tool but the trowel to lay on the mortar, the scabbling hammer to break off the most repulsive irregularities from the stone, and the plumb-rule to keep his work perpendicular.

Coursed rubble (fig. 4) is levelled up in courses 12 or 18in. deep, the depth varying in different courses according to the sizes of the stones. The stones are dressed by the workman before he begins building, to obtain a level bed and perpendicular face.

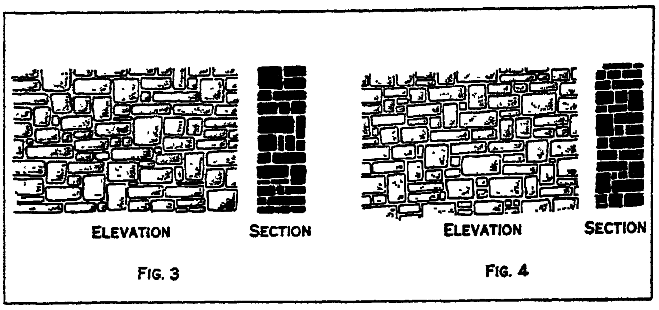


FIG. 3.—RANDOM RUBBLE WALLING
FIG. 4.—COURSED RUBBLE WALLING

Irregularly coursed squared rubble is a development of uncoursed random rubble, the stones in this case being squared with the hammer and roughly faced up with the axe. The courses jump from one level to another as the sizes of the blocks demand; the interstices are filled in with small pieces of stone called "snecks."

For coursed squared rubble the stone is faced in a similar manner and set in courses, the depth of each course being made up of one or more stones. In regular coursed rubble all the stones in one course are of the same height.

Block-in-course is the name applied to a form of stone walling that has some of the characteristics of ashlar but the execution of which is much rougher. The courses are usually less than 12in. high. It is much used by engineers for waterside and railway work where a good appearance is desired.

The angles or quoins of rubble-work are always carefully and precisely worked and serve as a gauge for the rest of the walling. Frequently the quoins and jambs are executed in ashlar, which gives a neat and finished appearance and adds strength to the work.

The name ashlar is given, without regard to the finish of the face of the stone, to walling composed of stones carefully dressed, from 12 to 18in. deep, the mortar joints being about an eighth of an inch or less in thickness. No stone except the hardest should exceed in length three times its depth when required to resist a heavy load and its breadth should be from one and a half to three times its depth. The hardest stone may have a length equal to four or perhaps five times its depth and a width three times its depth. The face of ashlar-work may be plain and level, or have rebated, chamfered or moulded joints.

Backing to Stonework.—The great cost of this form of stonework renders the employment of a backing of an inferior nature very general. This backing varies according to the district in which the building operations are being carried on, being rubble stonework in stone districts and brick or concrete elsewhere, the whole being thoroughly tied together both transversely and longitudinally with bondstones. In England a stone much used for backing ashlar and Kentish rag rubble-work is a soft sandstone called "hassock." In the districts where it is quarried it is much cheaper than brickwork. (For brickbacking *see* BRICKWORK.) Ashlar facing usually varies from 4 to 9in. in thickness. The work must not be all of one thickness, but should vary in order that effective bond with the backing may be obtained. If the work is in courses of uneven depth the narrow courses are made of the greater thickness and the deep courses are narrow. It is sometimes necessary to secure the stone facing back with iron ties, but this should be avoided wherever possible, as they are liable to rust and split the stonework. When it is necessary to use them they should be covered with some protective coating. The use of a backing to a stone wall, besides lessening the cost, gives a more equable temperature inside the building and prevents the transmission of wet by capillary attraction to the interior.

All work of this description must be executed in Portland cement, mortar of good strength, to avoid as much as possible the unequal settlement of the deep courses of stone facing and the narrower courses of the brick or rough stone backing. If the backing is of brick it should never be less than 9in. thick, and whether of stone or brick it should be levelled up in courses of the same thickness as the ashlar.

Walling.—There are many different sorts of walling, or modes of structure, arising from the nature of the materials available in various localities. That is, perhaps, of most frequent occurrence in which either squared, broken or round flints are used. This, when executed with care, has a distinctly decorative appearance. To give stability to the structure, lacing courses of tiles, bricks or dressed stones are introduced, and brick or stone piers are built at intervals, thus forming a flint panelled wall. The quoins, too, in this type of wall are formed in dressed stone or brickwork.

Uncoursed rubble built with irregular blocks of ragstone, as unstratified rock quarried in Kent, is in great favour for facing the external walls of churches and similar works.

Pointing.—As with brickwork this is generally done when the work is completed and before the scaffolding is removed. Suitable weather should be chosen, for if the weather be either frosty or too hot the pointing will suffer. The joints are raked out to a depth of half an inch or more, well wetted, and then refilled with a fine mortar composed specially to resist the action of the weather. This is finished flat or compressed with a special tool to a shaped joint, the usual forms of which are shown in fig. 5.

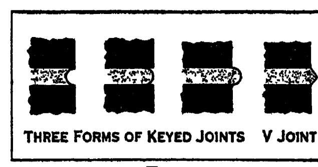


FIG. 5

To give a uniform appearance to the stonework and preserve the finished face until a hardened skin has formed, it is usual to coat the surface of exposed masonry with a protective compound of ordinary limewhite with a little size mixed in it, or a special mixture of stone-dust, lime, salt, whiting and size with a little ochre to tone it down. After six months or more the work is cleaned down with water and stiff bristle or wire brushes. Sometimes muriatic acid much diluted with water is used.

Technical Terms.—Of the following technical terms, many will be found embodied in the drawing of a gable wall (fig. 6), which shows the manner and position in which many different members are used.

Apex Stone.—The topmost stone of a gable forming a finial for the two sloping sides; it is also termed a "saddle" (fig. 6).

Blocking Course, a heavy course of stone above a cornice to form a parapet and weigh down the back of the cornice (fig. 7).

Bed.—The *bed* surface upon which a stone is set or bedded should be worked truly level in every part. Many workmen to form a neat thin joint with a minimum amount of labour hollow the bed and thus when the stone is set all weight is thrown upon the edges with the frequent result that these are crushed.

Coping.—The *coping* or *capping* stones are placed on the top of walls not covered by a roof, spanning their entire width and throwing off the rain and snow, thus keeping the interior of the wall dry. The fewer the number of joints the better the security, and for this reason it is well to form copings with as long stones as possible. To throw water off clear, and prevent it from running down the face of the wall, the coping should project an inch or two on each side and have a throat worked on the underside of the projections (fig. 6).

Cornice, a projecting course of moulded stone crowning a structure, forming a cap or finish and serving to throw any wet clear of the walls. A deep drip should always be worked in the upper members of a cornice to prevent the rain trickling down and disfiguring the moulding and the wall (fig. 7).

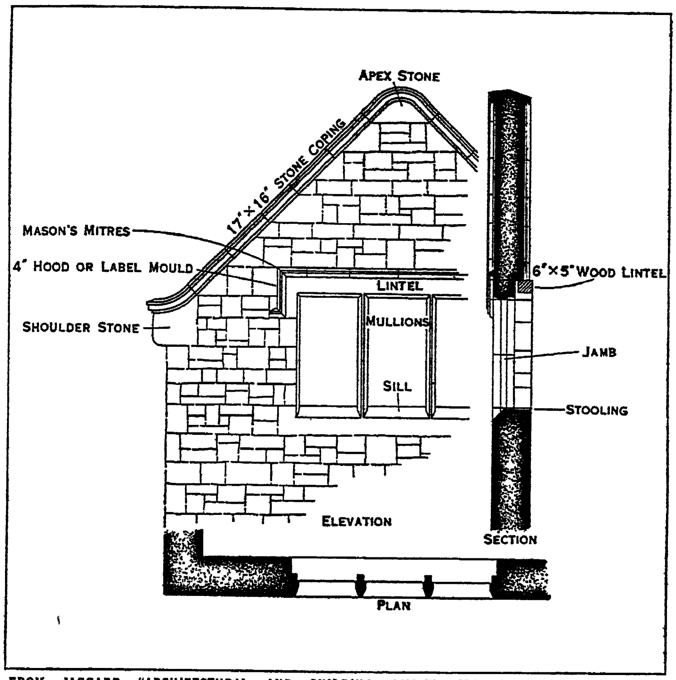
Corbel, a stone built into a wall and projecting to form a cantilever, supporting a load beyond the face of the wall.

Skew Corbel, a stone placed at the base of the sloping side of a gable wall to resist any sliding tendency of the sloping coping.

Stones placed for a similar purpose at intervals along the sloping side, tailing into the wall, are termed "kneelers" and have the section of the coping worked upon them.

Corbel Table, a line of small corbels placed at short distances apart supporting a parapet or arcade. This forms an ornamental feature which was much employed in early Gothic times. It probably originates from the machicolations of ancient fortresses.

Dressings, the finished stones of window and door jambs and quoins. For example, a "brick building with stone dressings"



FROM JAGGARD "ARCHITECTURAL AND BUILDING CONSTRUCTION PLATES" (CAMBRIDGE UNIVERSITY PRESS)

FIG. 6

would have brick walls with stone door and window jambs, heads and sills, and perhaps also stone quoins.

Diaper, a square pattern formed on the face of the stonework by means of stones of different colours and varieties or by patterns carved on the surface.

Finial, a finishing ornament applied usually to a gable end.

Gablet, small gable-shaped carved panels frequently used in Gothic stonework for apex stones, and in spires, etc.

Gargoyle, a detail, not often met with in modern work, which consists of a waterspout projecting so as to throw the rain-water from the gutters clear of the walls. In early work it was often carved into grotesque shapes of animal and other forms.

Galleting.—The joints of rubble are sometimes enriched by having small pebbles or chips of flint pressed into the mortar whilst green. The joints are then said to be "galleted."

Jamb.—Window and door jambs should always be of dressed stone, both on account of the extra strength thus gained and in order to give a finish to the work. The stones are laid alternately as stretchers and headers; the former are called outbands, the latter inbands (fig. 6).

Label Moulding, a projecting course of stone running round an arch. When not very large it is sometimes cut on the voussoirs, but is usually made a separate course of stone. Often, and especially in the case of door openings, a small sinking is worked on the top surface of the moulding to form a gutter which leads to the sides any water that trickles down the face of the wall.

Lacing Stone.—This is placed as a voussoir in brick arches of wide span, and serves to bond or lace several courses together.

Lacing Course, a course of dressed stone, bricks or tiles, run at intervals in a wall of rubble or flint masonry to impart strength and tie the whole together (fig. 6).

Long and Short Work, a typical Saxon method of arranging quoin stones, flat slabs and long narrow vertical stones being placed alternately. Earls Barton church in Northamptonshire is an example of their use in old work. In modern work, long and short work, also termed "block and start," is little used (fig. 6).

Parapet, a fence wall at the top of a wall at the eaves of the roof. The gutter lies behind, and waterways are formed through the parapet wall for the escape of the rain-water.

Plinth, a projecting base to a wall serving to give an appearance of stability to the work.

Quoin, the angle at the junction of two walls. Quoins are often executed in dressed stone.

Rag-bolt, the end of an iron bolt when required to be let into stone is roughed or ragged. A dovetailed mortise is prepared in the stone and the ragged end of the bolt placed in this, and the mortise filled in with molten lead or sand and sulphur (fig. 8).

Sill, the stone which forms a finish to the wall at the bottom of an opening. Sills should always be weathered, slightly in the case of door sills, more sharply for windows, and throated on the underside to throw off the wet. The weathering is not carried through the whole length of the sill, but a stool is left on at each end to form a square end for building in (fig. 6).

String Courses (*q.v.*) are horizontal bands of stone, either projecting beyond or flush with the face of the wall.

Scontions are the dressed stones forming the inside angles of the jamb of a window or door opening.

Spalls, small pieces chipped off whilst working a stone.

Templates, slabs of hard stone set in a wall to take the ends of a beam or girder so as to distribute the load over a larger area of the wall.

Throat, a groove worked on the underside of projecting external members to intercept rain-water and cause it to drop off the member clear of the work beneath (fig. 7).

Weathering.—The surface of an exposed stone is weathered when it is worked to a slope so as to throw off the water. Cornices, copings, sills and string courses should all be so weathered.

Methods of Finishing Face of Stones.—The *self face* or *quarry face* is the natural surface formed when the stone is detached from the mass in the quarry or when a stone is split.

Saw-face, the surface formed by sawing.

Hammer-dressed, Rock-faced or Pitch-faced.—This face is used for ashlar-work, usually with a chisel-draughted margin around each block. It gives a very massive and solid appearance, and is, therefore, the cheapest face to adopt for ashlar-work (fig. 6).

Broached and Pointed Work.—This face is also generally used with a chisel-draughted margin. The stone as left from the

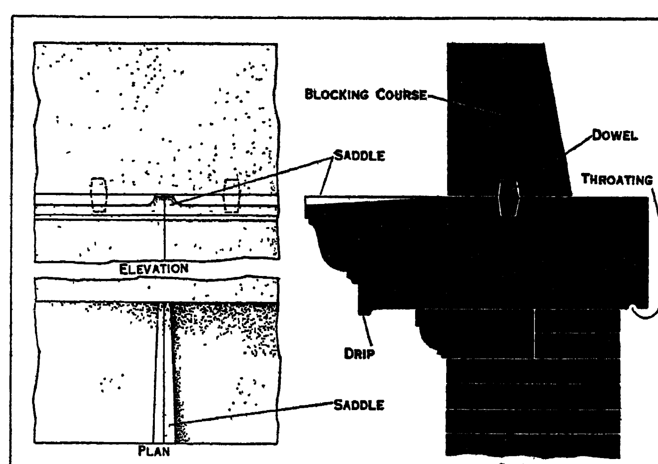
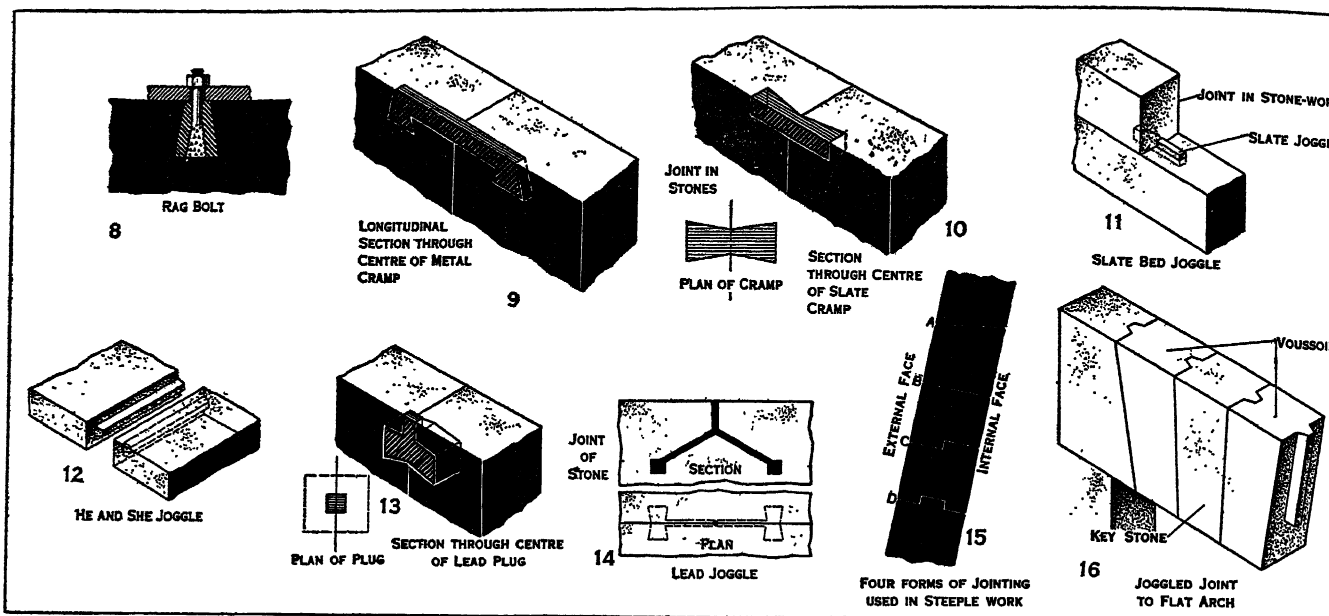


FIG. 7

scabbling hammer at the quarry has its rocky face worked down to an approximate level by the point. In broached work the grooves made by the tool are continuous, often running obliquely across the face of the block. In pointed work the lines are not continuous; the surface is rough or fine pointed according as the point is used over every inch or half-inch of the stone. The point is used more upon hard stones than soft ones (fig. 6).

Tooth-chiselled Work.—The cheapest method of dressing soft



FIGS. 8–16

stones is by the toothed chisel which gives a surface very much like the pointed work of hard stones.

Droved Work.—This surface is obtained with a chisel about two and a half inches wide, no attempt being made to keep the cuts in continuous lines.

Tooled Work is somewhat similar to droved work and is done with a flat chisel, the edge of which is about four inches wide, care being taken to make the cuts in continuous lines across the width of the stone.

Combed or Dragged Work.—For soft stones the steel comb or drag is often employed to remove all irregularities from the face and thus form a fine surface. These tools are specially useful for moulded work, as they are formed to fit a variety of curves.

Rubbed Work.—For this finish the surface of the stone is previously brought with the chisel to a level and approximately smooth face, and then the surface is rubbed until it is quite smooth with a piece of gritstone aided by fine sand and water as a lubricant. Marbles are polished by being rubbed with gritstone, then with pumice, and lastly with emery powder.

Besides these, the most usual methods of finishing the faces of stonework, there are several kinds of surface formed with hammers or axes of various descriptions.

The *toothed axe* has its edges divided into teeth, fine or coarse, according to the work to be done. It is used to reduce the face of limestones and sandstones to a condition ready for the chisel. The *bush hammer* has a heavy square-shaped double-faced head, upon which are cut projecting pyramidal points. It is used to form a surface full of little holes, and with it the face of sand and limestones may be brought to a somewhat ornamental finish. The *patent hammer* is used on granite and other hard rocks, which have been first dressed to a medium surface with the point. The fineness of the result is determined by the number of blades in the hammer, and the work is said to be "six-," "eight-," or "ten-cut" work according to the number of blades inserted or bolted in the hammer head. The *crandall* has an iron handle slotted at one end with a hole ⅜in. wide and 3in. long. In this slot are fixed by a key ten or 11 double-headed points of ¼in. square steel about 9in. long. It is used for finishing sandstone and soft stones after the surface has been levelled down with the axe or chisel. It gives a fine pebbly sparkling appearance.

Vermiculated Work.—This is formed by carving a number of curling worm-like lines over the face of the block, sinking in between the worms to a depth of a fourth of an inch. The surface of the strings is worked smooth, and the sinkings are pock-marked with a pointed tool.

Furrowed Work.—In this face the stone is cut with a chisel into a number of small parallel grooves or furrows (fig. 6).

Reticulated Face is a finish somewhat similar to vermiculated work, but the divisions are more nearly square.

Face Joints of Ashlar.—The face joints of ashlar stonework are often sunk or rebated to form what are termed rusticated joints; sometimes the angles of each block are moulded or chamfered to give relief to the surface or to show a massive effect.

Joints in Stonework.—The joints between one block of stone and another are formed in many ways by cramps, dowels and joggles of various descriptions, several of the most common of which are illustrated in figs. 8–16.

Cramps and Dowels.—The stones of copings, cornices and works of a similar nature, are often tied together with metal cramps to check any tendency of the stones to separate under the force of the wind (figs. 9 and 10). Cramps are made of iron (plain or galvanized), copper or gun-metal, of varying sections and lengths to suit the work. A typical cramp would be about 9in. long, 1 or 1½in. wide, and from ¼ to ½in. thick, and turned down about 1½in. at each end. A dovetailed mortise is formed at a suitable point in each of the stones to be joined and connected by a chase. The cramp is placed in this channel with its turned-down ends in the mortises, and it is then fixed with molten lead, sulphur and sand, or Portland cement. Lead shrinks on cooling, and if used at all should be well caulked when cold. Double dovetailed slate cramps bedded in Portland cement are occasionally used (fig. 10).

Dowels are used for connecting stones where the use of cramps would be impracticable, as in the joints of window mullions, the shafts of small columns, and in similar works.

Joggles.—There are many ways of making a joggle joint. The joggle may be worked on one of the stones so as to fit into a groove in the adjoining stone, or grooves may be cut in both the stones and an independent joggle of slate, pebbles, or Portland cement fitted, the joggle being really a kind of dowel. The pebble joggle joint is formed with the aid of pebbles as small dowels fitted into mortises in the jointing faces of two stones and set with Portland cement; but joggles of slate have generally taken the place of pebbles. Portland cement joggles are formed by pouring cement grout into a vertical or oblique mortise formed by cutting a groove in each of the joining surfaces of the stones. What is known as a he-and-she joggle, worked on the edges of the stones themselves, is shown in fig. 12.

Plugs or dowels of lead are formed by pouring molten lead through a channel into dovetailed mortises in each stone (figs. 13 and 14). When cold the metal is caulked to compress it tightly into the holes.

The saddle joint is used for cornices, and is formed when a

portion of the stone next the joint is left raised so as to guide rain-water away from the joint (fig. 7).

Two forms of rebated joints for stone copings and roofs are common. In one form (shown in fig. 6) the stones forming the coping are thicker at their lower and rebated edge than at the top plain edge, giving a stepped surface. The other form has a level surface and the stone is of the same thickness throughout and worked to a rebate on top and bottom edges. In laying stone roofs the joints are usually lapped over with an upper slab.

Joints in Spires.—Four forms of jointing for the battering stonework of spires are shown in fig. 15. A is a plain horizontal joint. B is a similar joint formed at right angles to the face of the work. This is the most economical form of joint, the stone being cut with its sides square with each other; but if the mortar in the joint decay, moisture is allowed to penetrate. With these forms dowelling is frequently necessary for greater stability. The joints C and D are more elaborate and much more expensive on account of the extra labour involved in working and fitting.

Where a concentrated weight is carried by piers or columns the bed joints are in many cases formed without the use of mortar, a thin sheet of milled lead being placed between the blocks of stone to fill up any slight inequalities.

Moulded Work.—The working of mouldings in stone is an important part of the mason's craft, and forms a costly item in the erection of a stone structure. Much skill and care is required to retain the arrises sharp and the curved members of accurate and proportionate outline. As in the case of wood mouldings, machinery now plays an important part in the preparation of stone moulded work. The process of working a stone by hand labour is as follows: The profile of the moulding is marked on to a zinc template on opposite ends of the stone to be worked; a short portion, an inch or two in length, termed a "draught," is at each end worked to the required section. The remaining portion is then proceeded with, the craftsman continually checking the accuracy of his work with a straight-edge and zinc templates. A stone to be moulded by machinery is fixed to a moving table placed under a shaped tool which is fixed in an immovable portion of the machine, and is so adjusted as to cut or chip off a small layer of stone. Each time the stone passes under the cutter it is automatically moved a trifle nearer, and thus it gradually reduces the stone until the required shape is attained.

Iron in Stonework.—The use of iron dowels or cramps in stonework, unless entirely and permanently protected from oxidation, is attended by the gravest risks; for upon the expansion of the iron by rusting the stone may split, and perhaps bring about a more or less serious failure in that portion of the building. A case in point is that of the church of St. Mary-le-Strand, London, where the ashlar facing was secured to the backing with iron cramps; these were inefficiently protected from damp and many of the blocks have been split from rusting. Smeaton in his Eddystone lighthouse used dowels of Purbeck marble.

Stone Arches.—Stone arches are very frequently used both in stone and brick buildings. (*See* ARCH; for general definitions and terms *see* BRICKWORK.)

Stone Tracery; Carving.—The designs of Gothic and other tracery stonework are almost infinite, and there are many methods, ingenious and otherwise, of setting out such work. Nearly all diagrams of construction are planned on the principle of geometrical intersections, and the jointing is a matter which must be carefully considered in order to avoid any waste of stone or labour.

Ordinarily in stone tracery the joints should be "mason's joints"; that is to say, the moulding is stopped and returned, the joint being at right angles to a member when it occurs in a straight part of a member and, when it occurs in a curved member, being a continuation of the radius or the mean of the continuation of the two radii. In stone-work the joints are not "scribed" or "mitred" as in joinery. All the upper construction of windows and doors and of aisle arches should be protected from superincumbent pressure by strong relieving arches above the labels, which should be worked with the ordinary masonry, and so set that the weight above should avoid pressure on the fair work, which would be liable to flush the joints of the tracery.

Stone carving is a craft quite apart from the work of the ordinary stonemason, and like carving in wood needs an artistic feeling and special training. Carving-stone should be of fine grain and sufficiently soft to admit of easy working. The Bath stones in England and the Caen stone of France are largely used for internal work, but if for the exterior they should be treated with some chemical preservative. Carving is frequently done after the stone is built into position, the face being left rough—"boasted"—and projecting sufficiently for the intended design.

BIBLIOGRAPHY.—E. Viollet-le-Duc, *Dictionnaire raisonné de l'architecture Française* (1869); W. R. Purchase, *Practical Masonry* (1904); M. A. Howe, *Symmetrical Masonry Arches* (1906), *Masonry* (1915); C. F. Mitchell, *Brickwork and Masonry* (2nd ed. 1908); I. O. Baker, *A Treatise on Masonry Construction* (10th ed. 1909); *Building Construction*, "The Architect's Library" (edit. F. M. Simpson, 1910–13); C. C. Williams, *The Design of Masonry Structures and Foundations* (1922); F. P. Spalding, A. L. Hyde and E. F. Robinson, *Masonry Structures* (1926). (J. BT.)

MASPERO, GASTON CAMILLE CHARLES (1846–1916), French Egyptologist, was born in Paris on June 23, 1846, his parents being of Lombard origin. He was in his second year at the École Normale in 1867 when he met Mariette, who was then in Paris as commissioner for the Egyptian section of the exhibition. Mariette encouraged his studies, and in 1869 he became a teacher (*répétiteur*) of Egyptian language and archaeology at the École des Hautes Études; in 1874 he was appointed to the chair of Champollion at the Collège de France.

In Nov. 1880 Professor Maspero went to Egypt as head of an official archaeological mission, which ultimately developed into the well-equipped Institut Français de l'Archéologie Orientale. Maspero then succeeded as director-general of excavations and of the antiquities of Egypt. He held this post till June 1886; in these five years he had organized the mission, and had discovered the great cache of royal mummies at Deir el-Bahri in July 1881. Maspero now resumed his professorial duties in Paris until 1899, when he returned to Egypt in his old capacity as director-general of the department of antiquities. He found the collections in the Cairo museum enormously increased, and he superintended their removal from Gizeh to the new quarters at Kasr en-Nil in 1902. The vast catalogue of the collections made rapid progress under Maspero's direction. Twenty-four volumes or sections were already published in 1909. The repairs and clearances at the temple of Karnak led to the most remarkable discoveries in later years (*see* KARNAK). He died in Paris on June 30, 1916.

Among his best-known publications are: *Histoire ancienne des peuples de l'Orient classique* (3 vols., Paris, 1895–97), displaying the history of the whole of the nearer East from the beginnings to the conquest by Alexander; a smaller *Histoire des peuples de l'Orient*, 1 vol., of the same scope, which has passed through six editions from 1875 to 1904; *Études de mythologie et d'archéologie égyptiennes* (1893, etc.), a collection of reviews and essays originally published in various journals, and especially important as contributions to the study of Egyptian religion; *L'Archéologie égyptienne* (latest ed., 1907), of which several editions have been published in English.

Maspero also wrote: *Les Inscriptions des pyramides de Saqqarah* (Paris, 1894); *Les Momies royales de Deir el-Bahari* (1889); *Les Contes populaires de l'Égypte ancienne* (3rd ed., 1906); *Causeries d'Égypte* (1907), translated by Elizabeth Lee as *New Light on Ancient Egypt* (1908).

MASQUERADE, a form of entertainment or a costume ball where the personages are masked or disguised. The abbreviated form of the word, "masque" or "mask" (*q.v.*), applies more particularly to certain varieties of drama which flourished during Elizabethan times. *See* DRAMA.

MASS, a name for the Christian eucharistic service, practically confined since the Reformation to that of the Roman Catholic Church. (Eccl. Lat. *Missa.*) The various orders for the celebration of Mass are dealt with under LITURGY; a detailed account of the Roman order is given under MISSAL; and the general development of the eucharistic service, including the mass, is described in the article EUCHARIST. In the 4th century *Pilgrimage of Etheria* (*Silvia*) the word *missa* is used indiscriminately of the Eucharist, other services, and the ceremony of dismissal. F. Kattenbusch (Herzog-Hauck, *Realencyklop. s.v.* "Messe") ingeniously, but with little evidence, suggests that the word may have had a double

origin and meaning: (1) in the sense of *dimissio*, "dismissal"; (2) in that of *commissio* "commission," "official duty," *i.e.*, the exact Latin equivalent of the Greek λειτουργία (*see* LITURGY), and hence the conflicting use of the term. It is, however, far more probable that it was a general term that gradually became crystallized as applying to that service in which the dismissal represented a more solemn function. In the narrower sense of "Mass" it is first found in St. Ambrose (*Ep.* 20, 4, ed. Ballerini) where the *Missa* is identified with the sacrifice. It continued, however, to be used loosely, though its tendency to become proper only to the principal Christian service is clear from a passage in the 12th homily of Caesarius, bishop of Arles (d. 542). (*See* also Isadore of Seville, *Etym.* v. 19.)

Whatever its origin, the word Mass had by the time of the Reformation been long applied only to the Eucharist; and, though in itself a perfectly colourless term, and used as such during the earlier stages of the 16th century controversies concerning the Eucharist, it soon became identified with that sacrificial aspect of the sacrament of the altar which it was the chief object of the reformers to overthrow. In England, so late as the first Prayer Book of Edward VI. it remained one of the official designations of the Eucharist, which is there described as "The Supper of the Lorde and holy Communion, commonly called the Masse." Bishops Ridley and Latimer denounced "the Mass" with unmeasured violence; Latimer said of "Mistress Missa" that "the devil hath brought her in again"; Ridley said "I do not take the Mass as it is at this day for the communion of the Church, but for a popish device," etc. (*Works*, ed. Parker Soc. pp. 120, *seq.*). Clearly the word mass had ceased to be a colourless term generally applicable to the eucharistic service; it was, in fact, not only proscribed officially, but in the common language of English people it passed entirely out of use except in the sense in which it is defined in *Johnson's Dictionary, i.e.*, that of the "Service of the Romish Church at the celebration of the Eucharist." In connection with the Catholic reaction in the Church of England, which had its origin in the "Oxford Movement" of the 19th century, efforts have been made by some of the clergy to reintroduce the term "Mass" for the Holy Communion in the English church.

See Du Cange, *Glossarium, s.v.* "Missa"; F. Kattenbusch in Herzog-Hauck, *Realencyklopädie* (ed. 1903) *s.v.* "Messe, dogmengeschichtlich." Fortesque, *Catholic Encyclopaedia* vol. ix. *s.v.* "Mass." For the facts as to the use of the word "mass" at the time of the Reformation *see* the article by J. H. Round in the *Nineteenth Century* for May, 1897. (*See* ART, MUSIC.) (A. N. J. W.)

MASS IN MUSIC

Musical settings of the Mass are of central importance in the history of music during the 15th and 16th centuries.

1. **Polyphonic Masses.**—As an art-form the musical Mass is governed by the structure of its text. The supremely important parts of the Mass are those which have the smallest number of words, namely the opening *Kyrie;* the *Sanctus* and *Benedictus*, embodying the central acts and ideas of the service; and the concluding *Agnus Dei.* A 16th century composer could best write highly developed music when words were few and such as would gain rather than lose by repetition. Now the texts of the *Gloria* and *Credo* were more voluminous than any others which 16th century composers attempted to handle in a continuous scheme. The practical limits of the Church service made it impossible to break them up by setting each clause to a separate movement, a method by which Josquin and Lasso contrived to fill a whole hour with a penitential psalm. Accordingly the great masters evolved for the *Gloria* and *Credo* a style midway between that of the elaborate motet (adopted in the *Sanctus*) and the homophonic reciting style of the Litany.

This gave the Mass a range of style which made it to the 16th century composer what the symphony is to the great instrumental classics. Moreover, as being inseparably associated with the highest act of worship, it severely tested the composer's depth and truthfulness of expression. The story of archaic and decadent corruptions in polyphonic Masses is touched upon elsewhere. (*See* MUSIC, section 3, and PALESTRINA.) In the 20th century a decree of Pius X. again inculcated the restoration of the Palestrina style to its proper position in liturgical music. But the trouble with modern settings of the Mass is not the decadence of an old art but a fundamental incompatibility between the modern orchestra and a good liturgical style.

The 16th century Mass was often written for a definite day, and when the composer bases its theme on those of his setting of an appropriate motet (*q.v.*) for that day, the whole musical service becomes a single tissue of significant themes. Thus, Victoria wrote for All Saints' Day a motet *O quam gloriosum est regnum*, and a Mass with the same title and on the same themes. The motet is given as an illustration to the article on that subject; and the accompanying example shows the relation between the themes of the Mass and those of the motet.

Themes of Victoria's *Missa: O quam gloriosum est regnum.* The words quoted above each theme are those of the motet of the same name. See illustration to MOTET

I *Kyrie* ("In quo cum Christi")

Also recognizable in the Gloria at "in gloria Dei Patris"; in the Credo at "et vitam venturi saeculi" and in the Agnus Dei at "Qui tollis peccata mundi"

2. **Instrumental Masses in the Neapolitan Style.**—The Neapolitan composers who created classical tonality and instrumental art-forms (*see* MUSIC, sec. 5) created a style of Church music best known (but not always best represented) in the Masses of Mozart and Haydn. By this time the resources of music were such that a reasonably expressive setting of the *Gloria* and *Credo* would overbalance the scheme. Only a very small proportion of Mozart's and Haydn's Mass music may be said to represent ideas of religious music at all, though Haydn defended himself by saying that the thought of God always made him feel irrepressibly cheerful, and he hoped God would not be angry with him for worshipping Him accordingly. The best (and least operatic) features of such unabashed music are those which develop the polyphonic aspect of the Neapolitan style. Thus Mozart's most perfect example is his extremely terse Mass in F, written at the age of 17, and scored for four-part chorus and solo voices accompanied by the organ and two violins mostly in independent real parts. This scheme, with the addition of a pair of trumpets and drums, and occasionally oboes, forms the normal orchestra of 18th century Masses. Trombones often played with the three lower voices.

3. **Symphonic Masses.**—The enormous dramatic development in the symphonic music of Beethoven made the problem of the Mass with orchestral accompaniment liturgically insoluble. Yet Beethoven's second Mass (in D, op. 123) is not only the most dramatic ever penned, but is, perhaps, the last classical Mass that is thoughtfully based upon the liturgy. It was intended for the installation of the archduke Rudolph as archbishop of Olmütz; and, though not ready until two years after that occasion, it shows much thought for the meaning of a church service, unique in its occasion and therefore exceptionally long. Immense as was Beethoven's dramatic force, it was equalled by his power of

sublime repose; and he was accordingly able once more to put the supreme moment of the music where the service requires it to be, viz., in the *Sanctus* and *Benedictus*. In the *Agnus Dei* he writes as one who has lived in a beleaguered city. Beethoven read the final prayer of the Mass as a "prayer for inward and outward peace," and, giving it that title, organized it on the basis of a contrast between terrible martial sounds and the triumph of peaceful themes.

Schubert's Masses show rather the influence of Beethoven's not very impressive first Mass, which they easily surpass in interest, though Schubert did not take pains, like Beethoven, to get his Latin text correct. The last two are later than Beethoven's Mass in D and contain many splendid passages, besides a dramatic (though not realistic) treatment of the *Agnus Dei*.

Weber's two Masses (G and E flat) are excellent works; the larger one (in E flat) achieving an ecclesiastical style as good as Cherubini's and much less dry. Otherwise the five Masses and two Requiems of Cherubini (*q.v.*) are the most important works of their period. Those that were written within Beethoven's lifetime made him regard Cherubini as the greatest master of the day. Since Schubert's time the Viennese tradition of Mass music has been worthily represented by Bruckner (*q.v.*). Dame Ethel Smyth's Mass (1890) owes nothing to tradition, but is undoubtedly a work inspired by its text.

4. **Lutheran Masses.**—Music with Latin words is not excluded from the Lutheran Church, and the *Kyrie* and *Gloria* are frequently sung in succession and entitled a Mass. Thus the four Short Masses of Bach are called short, not because they are on a small scale (which they are not), but because they consist only of the *Kyrie* and *Gloria*. Bach treats each clause of his text as

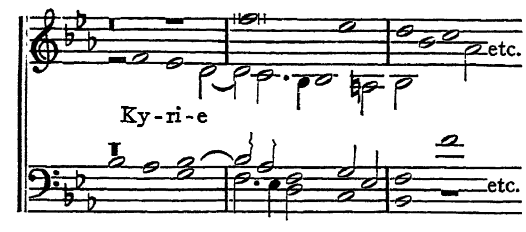
II Christe ("quocumque ierit")

Also in the Gloria at "Filius Patris"

a separate movement, alternating choruses with groups of arias; a method independently adopted by Mozart in a few early works and in the great unfinished Mass in C minor. This method, carried throughout an entire Mass, will fit into no liturgy; and Bach's B minor Mass must be regarded as an oratorio.

The most interesting case is the setting of the words: "Et exspecto resurrectionem mortuorum et vitam venturi saeculi.—Amen." The greatest difficulty in any elaborate instrumental setting of the *Credo* is the inevitable anti-climax after the *Resurrexit*. Bach contrives to give this anti-climax a definite artistic value; all the more from the fact that his *Crucifixus* and *Resurrexit*, and the contrast between them, show him at the height of his power. To the end of his *Resurrexit* chorus he appends an orchestral *ritornello*, formally summing up the material of the chorus and thereby destroying all sense of finality as a member of a large group. After this the aria "Et in spiritum sanctum," in which five dogmatic clauses are enshrined like relics in a casket, furnishes a beautiful decorative design, as a point of repose. Then comes a voluminous ecclesiastical fugue, "Confiteor unum baptisma," leading, as through the door and world-wide spaces of the Catholic Church, to that veil which is not all darkness to the eye of faith. At the words "Et exspecto resurrectionem mortuorum" the music plunges suddenly into sublime and mys-

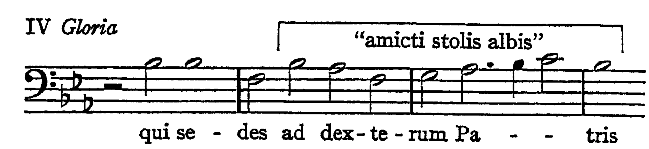
III Kyrie ("sequuntur Agnum")



Also in the Gloria at "tu solus sanctus" and in Agnus Dei at "miserere nobis."

terious modulations in a slow tempo, until it breaks out as suddenly into a vivace e allegro of broad but terse design, which comes to its climax rapidly and ends as abruptly as possible, the last chord being carefully written as a short note without a pause. This gives finality to the whole *Credo* and contrasts admirably with the coldly formal instrumental end of the *Resurrexit* three movements further back. Now, such subtleties might be thought beyond the power of conscious planning. But Bach's vivace e allegro is an arrangement of the second chorus of a church cantata, *Gott man lobet dich in der Stille;* and in the cantata the

IV *Gloria*

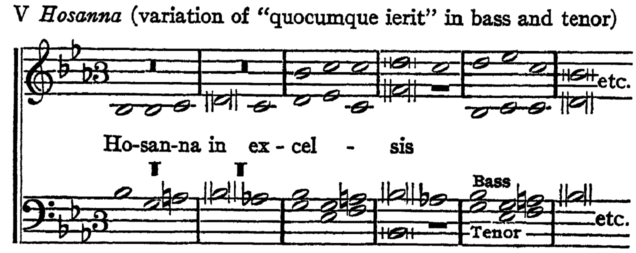


chorus has introductory and final symphonies and a middle section with a *da capo!*

Until fairly late in the 19th century the Sing-Akademie of Berlin (and perhaps other choral societies in Germany) maintained a laudable tradition according to which its director glorified his office in a Lutheran Mass (*Kyrie* and *Gloria*) for 16-part unaccompanied chorus. Some of these works (notably that of C. F. C. Fasch) are very fine.

5. **The Requiem.**—The *Missa pro defunctis* or Requiem Mass has tended to produce special musical forms for each individual

V *Hosanna* (variation of "quocumque ierit" in bass and tenor)



case. The text of the *Dies Irae* imperatively demands either a dramatic elaboration or none at all. Even in the 16th century it could not possibly be set to continuous music on the lines of the *Gloria* and *Credo*. Fortunately, its Gregorian *canto fermo* is very beautiful and formal; and the 16th century masters either, like Palestrina, left it to be sung as plain-chant, or set it in versicles (like their settings of the *Magnificat* and other canticles) for two groups of voices alternatively, or for the choir in alternation with the plain chant of the priests.

A *Dies Irae* with orchestral accompaniment cannot avoid illus-

trating its tremendous text regardless of ecclesiastical style. But it is a sour view that denies the title of great Church music to the sublime unfinished *Requiem* of Mozart (the Italian antecedents of which would be an interesting subject) and the two important works by Cherubini. These latter, however, tend to be funereal rather than uplifting.

Of later settings, Schumann's belongs to the days of his failing power; Henschel's is a work of great sincerity and reticent beauty; while the three other outstanding masterpieces renounce all ecclesiastical style. Berlioz seizes his opportunity like a musical E. A. Poe; Dvořák is eclectic; and Verdi towers above both in flaming sincerity, no more able to repress his theatrical idioms than Haydn could repress his cheerfulness.

Brahms's *Deutsches requiem* has nothing to do with the Mass for the dead, being simply a large choral work on a text compiled from the Bible by the composer. (D. F. T.; X.)

MASSA, a town of Tuscany, Italy, the joint capital with Carrara of the province of Massa and Carrara, and sharing with it the episcopal see, 20 m. S.E. of Spezia by rail, 246 ft. above sea-level. Pop. (1921) 22,599 (town); 34,166 (commune). The Palazzo Ducale (now the prefecture) was erected in the 16th century by the Cybo-Malaspina family, who also built the old castle above the town. Marble from the hills round the town is shipped at the Marina di Massa.

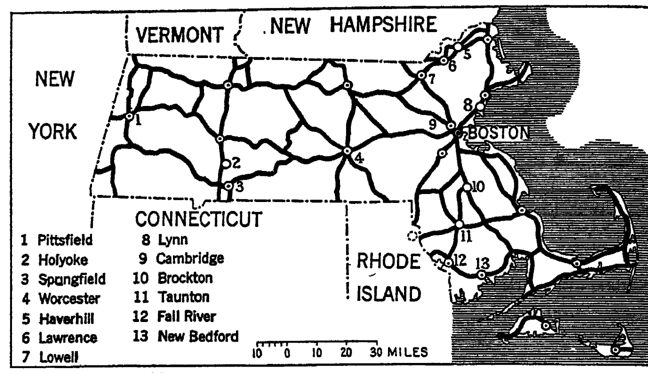
MASSACHUSET, the Algonkin tribe formerly about Boston, from whom the bay and state of Massachusetts were named. They may once have numbered 3,000, but were reduced by pestilence before the colonial settlement began, continued to decrease, although they avoided conflict with the whites, became Christians and soon lost their tribal identity.

MASSACHUSETTS, popularly known as the "Bay State," is one of the New England group of the United States of America. The name Massachusetts was derived from that of an Indian tribe. It was one of the earliest English colonies in America and one of the original 13 States forming the American Union.

Until 1819 it included what is now the State of Maine but as since constituted it is bounded on the north by Vermont and New Hampshire, on the east by the Atlantic ocean, on the south by the ocean, Rhode Island and Connecticut, and on the west by New York. Owing to its peculiar form, these boundaries are only approximate in the east. Its main portion forms a parallelogram about 130m. from east to west and 46m. from north to south, its straight southern boundary being almost coincident with the parallel of 42 N. In the east, the State spreads out, extending considerably south and somewhat north of the lines of the parallelogram, the counties of Plymouth and Barnstable forming the peculiar "pot-hook" of Cape Cod. The State extends approximately from 69° 57′ to 73° 30′ W. Boston, the capital and principal city, is in about the same latitude as Rome. The total area is 8,266sq. m., of which about 227 are water.

Physical Features.—These can be understood in their full significance only by a slight reference to those of New England as a whole. The Appalachian mountain barrier which extends from south-west to north-east parallel to most of the eastern coast-line of the United States continues through western New England in the Berkshire hills and the Green and White mountains. From the base of these ranges a gently sloping upland descends south and eastward to Long Island sound and the Atlantic ocean. The only large river, navigable for any considerable portion, is the Connecticut, which flows southward from the Green mountains of Vermont to the Sound. As Massachusetts in form is a long narrow strip extending westward from the ocean, it runs at right angles, so to speak, to these principal New England features of mountains and river. Its eastern two-thirds is mostly made up of the sloping upland. West of that the State is divided by the Connecticut valley, the best portion and maritime outlet of which is in Connecticut, and west of that again lie the mountainous western counties.

There are several small ranges, each with local names, in the Berkshires. The more eastern is that known as the Hoosac hills which have an elevation of only 1,200 to 1,600ft. and divide the valley of the Connecticut river from that of the smaller but more picturesque Housatonic. Bordering the lowlands of the Connecticut a few well-known hills rise to a marked height above the general level, such as Mt. Tom (1,214ft.), Mt. Holyoke (954ft.), and Mt. Toby (1,275ft.). West of this, in what is known locally as more particularly the Berkshire region, we find such peaks as Mt. Williams (3,040ft.) and Greylock (3,535ft.). From the Connecticut valley eastward the elevations steadily decrease to the coast and the extreme south-eastern portion is low-lying and sandy.



MAP OF MAIN ROADS IN MASSACHUSETTS

There are a few exceptions, such as Mt. Lincoln (1,246ft.), Mt. Wachusett (2,108ft.) and the Blue hills. These, like those mentioned in the western section, appear to be residual peaks of an original mountain range which covered the entire State in the geological era before the whole had been levelled to the plain which was then, by the secondary process already noted, carved into its present features. The existence of this original mountain range is also indicated by the structure and extremely complicated disorder of the gneiss and crystalline schist of the uplands. On the other hand, the valley of the now much shrunken Connecticut river is composed mainly of shale and soft sandstone. The evidences of the glacial period occur everywhere, the entire State having been covered by the ice-sheet, with resultant glaciation of the rocks, as far as the Cape Cod peninsula where we find traces of the terminal moraine.

The eastern part of the State can be described almost wholly in terms of the junction of sea and land, though there is one small river, the Merrimack, which is important not on account of its very short navigable portion but for the water-power it provides by its fall. The coast-line, owing to its peculiar form, extends for about 250m., with a number of good harbours. The enormous water area included between the two points of Cape Ann and Cape Cod is known as Massachusetts bay, with the designation Cape Cod bay for its southern portion. Among the harbours, all of which are excellent, may be mentioned those of Salem, Gloucester, Marblehead, Boston and Provincetown on the east, and Buzzard's Bay, a popular yachting resort, on the south. The northern part of the eastern shore is somewhat rocky and picturesque, whereas the long "pot-hook," or encircling arm of Cape Cod peninsula (Barnstable county), is low and sandy. Almost the entire coast is lined with summer resorts, those gathered north of Boston giving to that section the nickname of the "Gold Coast," owing to the great wealth concentrated there, whereas Cape Cod is as yet somewhat simpler, attracting the more conservative old families and the intellectual and aesthetic, including a somewhat noted artistic and literary colony at Provincetown. At Wood's Hole on Buzzard's bay is the U.S. Bureau of Fisheries station with a marine biological laboratory. Leaving the mainland, there are several islands to the south, two of them, Martha's Vineyard and Nantucket, being of considerable size and importance. Martha's Vineyard, a little the larger (about 9 by 20m.), has a good harbour which, aside from summer yachting, is resorted to by storm-bound vessels avoiding the dangerous shoals which lie to the south-east of the State.

The physical features thus briefly described, have had a marked effect upon the history of Massachusetts at every period. In the colonial days, when waterways provided the only means of travel, the absence of any large river leading to the interior retarded development of the sections lying back of the coast, prevented the

development of the fur trade and led the people to look to fisheries and commerce for their livelihood, an influence which was strengthened by the rather poor soil of most of the State. This latter fact also determined that Massachusetts farms should be mostly small, and prevented, as did the climate, the growth of large estates and a slave economy as in the South. The broken character of the eastern upland has had a marked effect also, the richer valleys having afforded moderate ease and comfort, which resulted in conservative politics, whereas the "hill towns" were poorer, radical in politics, and largely abandoned when a changed economic situation and western expansion opened new opportunities for their dwellers. The fact that the Connecticut river merely ran through the State, flowing thence into another, led the inhabitants of this richest of all sections to ally themselves rather with their neighbours to the south in Connecticut than with their own fellow-citizens to the east. To the west of this, the mountainous and somewhat rugged land gave special character to its inhabitants who have always shown themselves more democratic and radical than those in the mercantile towns of the seaboard. As a whole, the mountain barrier to the west long tended to isolate New England from the rest of the country, to preserve the New England type, and to produce a certain provinciality of outlook in which Massachusetts shared. Although railways overcame this isolation to some extent, the great traffic from the west goes to New York rather than Boston, and both commerce and manufactures are declining relatively to those in competing States. On the other hand, the beautiful scenery and charm of summer life are attracting more and more people and the motor car is bringing unexpected prosperity to villages which two decades ago seemed doomed.

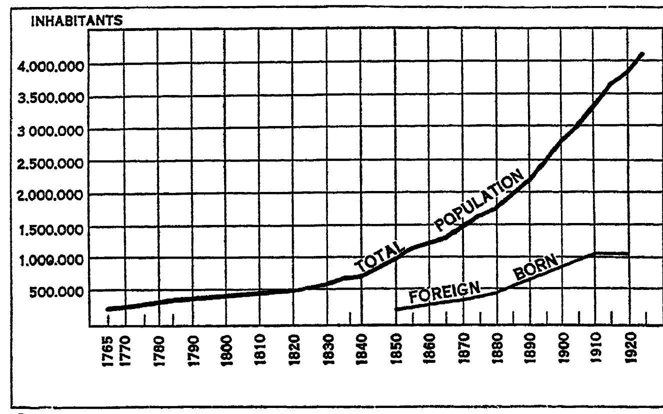
Climate.—The winters are long and extremely severe, passing through a very short spring abruptly into summer, a winter which Henry Adams said is "always the effort to live" and a summer which is "tropical licence." The autumn is apt to be fine, and the air, especially in the Berkshire hills, dry, cool and bracing. Although varying in different parts of the State, the annual extremes of temperature are about 20° below zero to 100° or more above, with a mean average at Boston of 48 degrees. The mean summer average throughout the State is 70° and the winter (at Williamstown) 23 degrees. The lowest recorded temperature is —28° in the Connecticut valley. The annual precipitation varies from 38 to 48in., evenly distributed through the year. There is much fog along the coast. Nantucket and portions of Cape Cod are located in a somewhat different climatic belt in which the temperatures are milder with a larger proportion of sunshine in the year.

Fauna and Flora.—There is little that is distinctive in either as differentiated from New England as a whole. The State is a meeting place, however, for many southern and northern species of which it forms respectively, the northern and southern limits. It is, for example, the northern limit of such trees as the holly and Tupelo, the latter occasionally found in southern New Hampshire also. There is a small colony of prickly pear cactus in Nantucket. It is also the northern limit of many insects, notably the 17-year locust. Among the birds likewise limited are the seaside sparrow, blue-winged warbler, prairie warbler and quail. On Martha's Vineyard there is a rapidly dwindling colony of the almost extinct heath hen. The most remarkable feature of the State from the standpoint of its fauna and flora is the influence of Cape Cod which stretches out to sea and deflects the current of the Gulf stream. To the south of the Cape are found many southern fishes and other marine creatures, including the Portuguese man-of-war. In the cold waters on the north side of the Cape the fish and invertebrates are entirely different so that it is said that no other barrier makes so sharp a dividing line in ocean faunas.

Population.—On April 1, 1930, the population was 4,249,614, or 528·6 persons per sq.m., the density having steadily increased from 278·5 in 1890. It is the second most densely populated State in the Union. In 1925 90·2% of the population lived in communities numbering 5,000 and above, and 66·5% in places of 25,000 and above, 1,808,845 being in what is known as the Metropolitan area of Boston. In the year 1930 populations of the ten largest cities were respectively: Boston (proper), 781,188; Worcester, 195,311; Springfield, 149,900; Fall River, 115,274; Cambridge, 113,643; New Bedford, 112,597; Somerville, 103,908; Lynn, 102,320; Lowell, 100,234; Lawrence, 85,068.

The increase in population between 1910 and 1920 was irregularly distributed but every county showed an increase, the most notable being Middlesex where the increase was from 778,352 to 934,924, Norfolk from 219,081 to 299,426 and Suffolk from 835,522 to 879,536.

In 1920 98·7% of the population was white, 1·2% negro, and ·1% Indian and all others. Of the white population 31·9% was of



GRAPH SHOWING THE GROWTH OF POPULATION IN MASSACHUSETTS FROM 1765 TO 1920, WITH THE NUMBER OF FOREIGN BORN

native-born parentage, 28·4% of foreign parentage, 10·4% of mixed, and 28% foreign-born. Owing to their tendency to congregate in cities, the largest percentage of foreign-born, from 25 to 35%, is found in the counties of Essex, Middlesex, Bristol, Worcester and Hampden. The State (1920) contained 183,171 foreign-born Irish, 117,007 Italians, 92,034 Russians, 69,157 Poles, 153,330 Canadians (to which should be added 108,691 French-Canadians), 38,012 Swedes, 86,895 English, 28,474 Scotch, 28,315 Portuguese, 22,113 Germans, 20,441 Greeks, 20,789 Lithuanians, 14,570 Finns, 8,640 Armenians, 7,120 French, and smaller numbers of many other races.

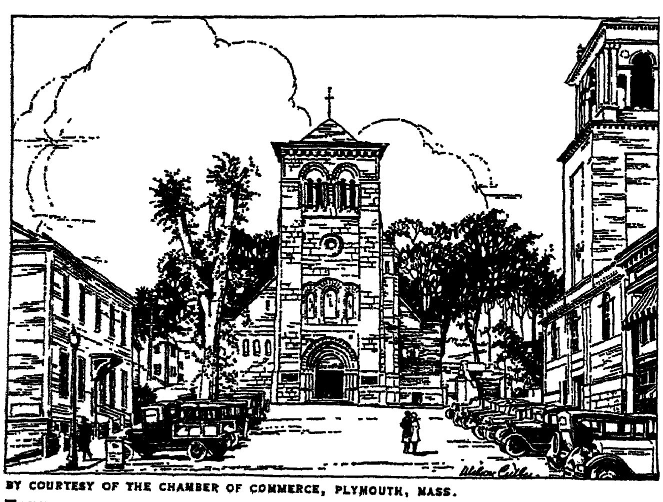
The preponderance of females over males is greater than in any other State in the Union, there being (1920) 1,890,014 males and 1,962,342 females. At 65 years or over, 91% of the population are or have been married; 301,245 families own their own homes, of which 126,312 are free of mortgage; 1,225,163 males are engaged in gainful occupations, of whom over one-half, 668,645, are engaged in manufacturing, and only 55,759 in agriculture, forestry and animal husbandry.

Until nearly the end of the 18th century the population was unusually homogeneous. In 1794 some apprehension was expressed over the numbers of Irish arriving but the great wave of Irish immigration did not occur until the decade 1830–40. The great increase in the Italian population has mainly taken place since 1885. By 1850 the native population had largely been driven out of manufacturing by the influx of foreigners who underbid them on wages. Owing to immigration the population has become overwhelmingly Roman Catholic.

Government.—The first government, other than that of the Plymouth settlement, was based upon the charter of 1629 which was intended to be merely the charter for a commercial company, but which was twisted by the colonists into a political constitution. The system of "towns" created became the most characteristic feature of the New England system. The word meant a "township," an area of considerable extent which might include several settlements, villages, etc. Each township had the right of sending deputies to represent it in the General court, as the legislature was styled. The affairs of the towns, including election of officers and representatives, were conducted in town meetings at which all citizens had the right to speak although the franchise was for long limited by religious requirements. The town meeting was a political school of prime importance and although the system has less significance now it has been abandoned slowly and with reluctance even in the larger places, Boston, for example,

refusing incorporation as a city until 1822 when it had a population of 47,000. Representative government dates from 1634 and the General court was divided into two chambers in 1644. The old charter was annulled in 1684 and a royal one, with a governor appointed by the Crown, substituted in 1691. The government functioned under this until the Revolutionary period when, first, committees and, next, a provincial congress took over the duties. The present constitution, adopted in 1780, is the oldest of all State constitutions still in force. There have been 70 amendments to it up to 1927. Townships ceased to be represented as such after 1856. The franchise is enjoyed by all citizens, male and female, over 21 years old (insane, etc., being excluded). The last religious test even for office-holders was abandoned 1821 and the last remnant of a property qualification 1891, and sex distinction 1924. A slight educational test can still be enforced. Massachusetts was the first State to adopt the blanket ballot in which the names of candidates are arranged alphabetically without party columns. A relic of colonial times is the council, a body elected to represent divisions of the State to assist the governor in executive functions. In 1916 the jurisdiction of district or municipal courts was extended to run throughout the State.

Massachusetts has been a leader in the creation of boards and commissions whose functions extend to almost every department, such as the board of education (1837); of agriculture (1852); of railroad commissioners (1869); of health (1869); of statistics of labour, fisheries, game and charity (1879); the dairy bureau (1891); and of insanity (1898). Others have to do with prisons, highways, insurance, banking, ballot-laws, voting machines, gas and electric companies, conciliation and arbitration in labour disputes, registration in dentistry, medicine, pharmacy, inspection of food and drugs, etc. Almost all State employees are under civil service regulations, even in the smaller political subdivisions. There are rigid laws to prevent stock-watering in all corporations of a semi-public sort. The Torrens system of land registration was adopted in 1898 and a court created for its administration. The death penalty has been carried out by electrocution since 1898. Municipal ownership of public utilities, particularly gas and electric light works is permitted and has grown steadily. As elsewhere, the State is gradually encroaching on the functions of municipalities and has done notable work for them in such matters as docks, parks and water supply. In a few cases, such as Boston



BY COURTESY OF THE CHAMBER OF COMMERCE, PLYMOUTH, MASS.

TOWN SQUARE, PLYMOUTH, SHOWING THE CHURCH OF THE PILGRIMS, TO THE RIGHT, AND THE TOWN HOUSE (1749), TO THE LEFT

and Fall River, the city police departments are in the hands of State Commissioners. In 1920 a State constabulary was organized. The influence of war-time conditions was reflected in legislative measures, such as that directing that emergency legislation should take effect immediately and that providing for absentee voting. In 1920 over 100 State departments were reorganized under 20 heads.

Finance and Banking.—The total bonded debt of the State on Nov. 30, 1927 was $126,455,150 of which $61,823,696 was held in sinking funds, leaving a net debt of $64,631,454. Although all of the debt is a direct obligation of the State, it is divided into two parts, one part of which has been incurred for the benefit of the entire State (amounting to $14,479,704 net), and another part has been incurred for the benefit of 40 cities and towns in the vicinity of and including Boston, called "the Metropolitan District." This has been incurred for water, sewer and park systems.

On Oct. 30, 1926, the assets of the 154 national banks were $1,465,195,000, and those in the State institutions under supervision of the State banking department $3,710,983,924. In the year of the entry of the United States into the World War, 1917, the latter stood at $2,054,551,710. There were 196 savings banks with assets of $1,879,332,985, which show an increase of $675,000,000 in deposits in the eight years succeeding the war, the average deposit being $594.96. Important changes were made in 1926 in the law regarding the nature of savings bank investments. There has been a rapid increase in recent years in the growth of co-operative banks, the assets of which in 1926 totalled over $425,000,000.

Education.—In the colonial period, Massachusetts took the lead in popular education, and was the first colony to found a college, but at no time in that period could Harvard compare with such other New World universities as those, *e.g.*, at Mexico or Lima. The quality of New England colonial education has been greatly over-estimated. The real beginning of the State's modern system dates from about 1840, when the extremely bad situation everywhere in the schools of the country had aroused great criticism. At that time 29 of the richest towns in the State maintained no schools at all as they should have in accordance with the law. The school board was organized in 1837 and under the leadership of Horace Mann conditions improved rapidly. The present system is conducted under the general laws relating to education passed in 1920, with some amendments. There is a department of education "under the supervision and control of a commissioner of education, and an advisory board of education of six members, of whom at least two shall be women and one shall be a school teacher." The commissioner is appointed by the governor and council. The system includes common, high and normal schools, and all have a high reputation. Manual training since 1894 has been part of the curriculum in all municipalities of over 20,000 population. There are also textile schools at Fall River, New Bedford and Lowell, a nautical school, and a State Agricultural college at Amherst. The first Normal school in the country was that founded at Lexington and there were in 1928 seven others, including one for art at Boston.

There are many private schools of high standing, such as Phillips Andover, Groton and Mt. Hermon. The Boston Latin school founded in the 17th century is one of the oldest in the country. Of the higher institutions of learning, besides Harvard (1636), may be mentioned Williams college (1793) at Williamstown, Amherst (1821) near Northampton, Boston university (Methodist Episcopal) at Boston (1867), Tufts college (1852) at Medford, and Clark university (1889) at Worcester. For women only there are Mount Holyoke (1837) at South Hadley, Smith college (1875) at Northampton, Wellesley college (1875) near Boston, Simmons college (1899) in Boston, and Radcliffe college (1879) in connection with Harvard. Technical instruction is given at Worcester Polytechnic institute, Worcester, and the Massachusetts Institute of Technology, Boston (both 1865).

In 1925 the total number of pupils enrolled in the public schools was 747,938 and the amount expended $75,385,000. In 1920 the school attendance for both sexes rose from 37% at five years of age to 97·4% at 11 and fell steadily to 10·2% at 20. At the last age 16·2% of those of native parentage were still being educated, and 10·8% of the foreign-born, whereas those of foreign-born parents fell to 7·6%.

Membership for teachers is compulsory in the retirement pension fund system, as is retirement after 70. Under some conditions provision is made for it at 60. In 1920 there were 19,085 teachers in public schools. Of the total number, 10,127 were of foreign-born parents and 2,757 themselves foreign-born. There are several sub-boards, each with a director and varying number

of advisors, serving without pay, such as the division on libraries, that on immigration and Americanization, and for the blind. Pupils of 14–16 years of age must have completed the sixth grade before being certified for employment.

Libraries and Museums.—The State is better supplied with important libraries than any other in the Union. Moreover there is a free public library in every city and town, 419 to 355 cities and towns. The annual circulation of books is 21,000,000 or five per capita. The Boston Public Library (the first city public library to be entirely supported by taxation) is one of the three great scholarly libraries of the country open to the public and is the largest municipal free library in the world, containing 1,388,439 volumes, and specialising in Shakespeare, Americana and Spanish literature. Among other libraries are: the Massachusetts Historical Society, rich in Americana mss.; the State Library (470,000 vols.) with one of the finest collections in the world of the laws of all foreign countries; the Boston Athenaeum (304,502 vols.) including Washington's library; the New England Historical Genealogical Society (60,000 vols. and nearly as many pamphlets) mainly devoted to family history; various libraries connected with Harvard university, totalling 2,497,200 vols.; Essex Institute, Salem (500,000 vols.) mainly on New England history and maritime commerce; American Antiquarian Society, Worcester (165,000 vols.; 270,000 pamphlets, 100,000 manuscripts, and 12,350 vols. of bound newspapers, in which last, as well as in other respects, it ranks first in the U.S.; it also contains the Mather library). There are other important technical libraries and many general ones of 100,000 or more volumes scattered throughout the State. In Boston there is the Museum of Natural History (1830), and the Museum of Fine Arts (1870) in which latter the collections of Chinese, Japanese and East Indian exhibits rank first in the country, as does also its Print collection and, in point of quality, its Egyptian and classical collections.

Charities and Houses of Correction.—The State is well supplied with charitable and reformatory institutions. Those under the Department of Public Welfare include a State infirmary at Tewksbury for dependents (1866); the Lyman School for Boys at Westboro, a reformatory school for boys under 15 years of age who are under the care of the trustees until they are 21, with a farm for younger boys at Berlin; an industrial school for boys over 15 at Shirley; a similar one for girls at Lancaster; and the Massachusetts Hospital school at Canton for the care and education of crippled and deformed children.

Under the department of health are four hospitals for consumptives at Rutland, Westfield, North Reading and Lakeville. Under the department of mental diseases are State hospitals for the insane at Worcester, Taunton, Northampton, Danvers, Westboro, Boston, Grafton, Medfield, Gardner, Foxborough; a hospital for epileptics at Monson, and schools for the feeble-minded at Waverley, Wrentham and Belchertown.

The department of correction supervises the Reformatory for Women at Sherborn, a State reformatory at Concord for men, a State prison at Charlestown, and a prison camp and hospital at Rutland; also a State farm for petty criminals, defective delinquents and insane criminals at Bridgewater. Many private charitable corporations (about 1,000 in 1927), report to the State Department of Public Welfare, and 131 infirmaries, caring for over 9,000 persons in 1926, are subject to visitation by an inspector from that department. The Perkins Institute for the Blind is memorable for its association with Samuel Howe Gridley.

The total net cost of public poor relief for the year ending March 31, 1926, was $9,561,690. This includes aid given by the State to 117,646 persons. The total expenditures of the four departments mentioned above for the year ending Nov. 30, 1926 were: Mental Diseases, $8,173,279; Public Welfare, $4,831,726; Public Health, $1,944,121; Correction, $1,593,381; or $16,542,507, equal to 33·6% of the total State expenses for that year.

Agriculture.—Conditions of soil and climate are favourable for the raising of apples, small fruits, berries, potatoes, onions, market-garden vegetables and some kinds of tobacco. For potatoes, onions, oats and tobacco the average yield is much above the average for the U.S. as a whole. In 1925 Massachusetts was a leading State in growing small fruits. There were in 1925, 33,454 farms, with a total acreage of 2,500,000 (nearly one-half the State). Value of all farm property was over $250,000,000, or about $7,500 per farm. Average value of all farm property, including buildings, equipment and live stock, was $107.50 per acre. Transportation facilities are excellent and farms are in close touch with markets. The refrigerator car has enabled the West and South to compete in some products but not the perishable ones during the season. The value of some of these was (1925): milk, $30,408,000; vegetables, $15,348,069 (1920); hay (tame and wild) $14,222,000; fruits, $9,510,000; eggs, $5,570,000; tobacco, $2,527,000. Hay makes up 76% of the total crop acreage, most of it being fed to dairy cattle, Worcester county taking the lead. Live stock (1924) included 43,537 horses, 192,131 cattle (145,631 dairy cows), and 63,810 swine. The value of all crops in 1925 was $36,305,000 compared with $31,509,000 in 1924.

Farming has long been a depressed industry but is gradually recovering. Every effort is being made to improve conditions and the commissioner of agriculture stated in 1926 that more young people at last appeared to be going from the cities to the farms than in the reverse direction. The New England Council has done noteworthy work, and in 1926 organized a New England marketing conference as a result of which a law was enacted establishing grades and standards for produce. An important law was also passed (1927) regulating the sale of seeds.

Manufactures.—There was little manufacturing in Massachusetts before the American Revolution. The State has always been the leader in the textile industry as well as others of importance. The first cotton mill was established at Beverly in 1788 and the first woollen mill at Byfield 1794. The first power loom was set up in 1814 at Waltham. With the improvement in machinery and the development of water power, the great centres of Lowell, Lawrence and Fall River arose in the 1830s.

In the last decade there have been vast changes in the industry of the State owing mainly to the transfer of much of the textile business to the South. Whole villages and towns, dependent on this one industry, have been almost wiped out, and for a while great pessimism prevailed as to the future of the State. It is probable that this pessimism has been carried too far, and a much more hopeful feeling prevails (1928) and appears to be justified. Various organizations, such as the Associated Industries of Massachusetts and the New England Council have been studying conditions scientifically. This spirit of hopefulness is shown by the fact that in 1926 $29,000,000 was expended in Massachusetts in the extension of manufacturing plants, a new high figure for such expenditures. Manufactures in Cambridge have increased 300% in the last decade. Although the total of products manufactured in 1925, $3,426,000,000, showed a decline from 1919 (really a war year) it is again increasing rapidly. Cotton goods in 1925 amounted to $345,864,000 as compared with $296,831,000 in 1924; knit goods increased about $8,000,000; silks over $9,000,000; dye and finishing products $42,000,000; worsted and woollens $29,000,000.

Minerals.—Granite and basalt or trap rock are by far the chief products of the quarries. The principal granite quarries were in Worcester, Essex, Norfolk and Berkshire counties. The best known is the "Quincy granite" which is found about 11m. south-east of Boston.

Commerce.—The cod-fisheries have always been of prime importance in the economics of the State and formed one of the bases of the earliest commerce to Europe. Until 1785, when trade was opened with China, and 1788 when trading began with the American north-west coast, trade was mainly with Europe, Africa and the West Indies and American coast ports. Ship-building was always an important industry and with the rise of the clipper ships and the rich trade to the Orient, merchants of Salem and Boston grew rapidly in wealth. Owing to great changes in the United States and in transportation facilities to the interior, Massachusetts has fallen behind many other States in foreign commerce. In 1925 it handled 2,684,349 tons (2,240 lb.) as compared with 11,591,068 in New York, 4,472,784 in Maryland, and 5,064,140 in Louisiana. The effects of the Panama canal are only beginning to be felt and will be very favourable to Boston. In some respects,

as wool, Boston has never lost its primacy, and is still the leading market in America and the second in the world. In 1922 190,951,655 lb. of domestic and 242,856,040 of foreign wool passed through the port. The following table gives the total value of all commodities for the years named:

	Imports.	Exports.
1901	$ 61,452,000	$143,708,000
1925	321,567,000	47,494,000
1926	305,879,000	41,283,000
1927	288,499,000	42,181,000

Boston is now the only Massachusetts port of importance in foreign trade although Fall River still maintains a fair trade.

Total imports and exports in tons, 1926: Beverly, 28,579; Boston, 2,862,709; Fall River, 336,161; Gloucester, 9,300; New Bedford, 18,750; Onset, 220; Plymouth, 17,592; Salem, 10,500; Vineyard Haven, 630; Weymouth, 942.

With the new spirit of optimistic aggressiveness coming to prevail in New England and with a better understanding of the great possibilities of the Panama canal, Massachusetts should make rapid gains in commerce.

Transportation.—The State in 1925 was served by 2,071m. of steam railway as compared with 2,131m. in 1915. The electric railway mileage also decreased during the same period from 3,056, to 2,571. The road mileage in the State highway system on Dec. 31, 1926, was 1,564, and of this total 1,551 were surfaced. There were 691,646 motor vehicles registered in 1926.

HISTORY

Early Settlements.—It is uncertain when Massachusetts was first visited by Europeans. In spite of conjecture there is no proof of anyone having been there before Bartholomew Gosnold in 1602, who visited Massachusetts bay and named Cape Cod. Two years later Champlain explored the coast and in 1614 John Smith also did so, naming many of the points along it. After that, visits became more frequent but it was not until many years after other settlements had been made in America that a permanent colony was planted there. This was at Plymouth, in 1620. Certain religious enthusiasts had fled from England to Holland some years before and from there decided to migrate to the New World. After considering Guiana and other places, they determined to try the territory owned by the Virginia company, and financial assistance was received from colonizing-speculators in London. The London promoters provided the money and when the Mayflower sailed, of its 102 passengers only 35 came from the Leyden religious group, and 67 from London. The leaders before landing drew up the famous "Mayflower Compact" to serve as the basis of government. There was no intention of making a new departure in the direction of a democratic constitution, and the short document was merely a modification of the customary form of church covenant to meet the temporary crisis in an unfamiliar situation. As, owing to mere stress of weather or some other unknown cause, the colonists landed in Massachusetts instead of Virginia, they had no other government than this formed by themselves, and the pure democracy thus inaugurated and later modified, was accidental. It became, however, the precursor of innumerable other written covenants in New England forming the basis of town and church government there. The troubles of the first winter were severe and half the colony died, including Governor Carver, whose place was taken by William Bradford. Fortunately for the colonists the Indian tribes had been decimated by illness a few years earlier and the settlement had little trouble on that score. The contract with the London promoters had called for ownership of property in common, but this was soon modified by stress of circumstances in favour of individual property. The colony, although it managed to survive its initial difficulties, was never financially successful and eventually all connection with the English company was terminated. After the adjustment of accounts with its financial sponsors, the colony succeeded in getting grants defining its territorial boundaries, and gradually the village of Plymouth threw off other little settlements, such as Scituate (1636) and Duxbury (1637), but was finally absorbed into the larger and more powerful colony of Massachusetts Bay in 1691.

Soon after the Plymouth settlement was made others were established along the coast, mostly by individuals, a number of whom from 1625 onward settled around Boston Harbor. A small fishing company tried to establish a foothold and business on Cape Ann which was the forerunner of a much more important colonizing movement than any yet made in North America. In England it was a time of much change and unrest, quite as much political and economical as religious. The Puritans were drawn to a great extent from country gentlemen and middle-class business men, all of whom were feeling the stress of the times severely. There was a great migration of the discontented to the New World, a migration by no means confined to New England. Between 1620 and 1642, for example, 18,600 persons went to Barbadoes as compared with only 14,000 to Massachusetts, and 18,000 to other West India Islands as compared with less than 4,000 to the rest of New England. The Massachusetts settlement was thus merely an episode in a much broader movement. Certain Puritans in England became interested in an attempt to revive the defunct fishing company at Cape Ann, and in 1628 a patent was received from the Council for New England and a number of settlers were sent out under John Endicott as governor. Meanwhile the number in England interested in a Massachusetts venture had increased, and in 1629 a rather strong group, including John Winthrop, obtained a charter as "The Governor and Company of the Massachusetts Bay in New England." The grant was similar to that of the Virginia Company in 1609, the patentees being joint proprietors, with rights of ownership and government. The intention of the Crown was evidently to create merely a commercial company with what, in modern parlance, we would call stockholders, officers and directors, but by a shrewd and legally questionable move, the patentees decided to transfer the entire management and the charter itself to Massachusetts, thus paving the way for not only making the management local, but also for the unwarranted assumption, pregnant with most important consequences, that the charter for a commercial company was in reality a political constitution for a new government with only indefinable dependence upon the imperial one at home.

FROM "PROCEEDINGS," MASSACHUSETTS HISTORICAL SOCIETY

THE GREAT SEAL OF MASSACHUSETTS DURING THE REIGN OF GEORGE II.

The religious motive was but one among others inducing even the leaders to emigrate to America. It was undoubtedly important, but even it looked merely to the establishment of a community in which the emigrants would be free to worship as they themselves wished, not to establish in any way a refuge for those who might wish to worship differently. Indeed, throughout the whole colonial period, the leaders of the colony fought religious liberty with every weapon in their power. The economic motives were also strong (as Winthrop clearly indicated in writing in his own case), the sudden increase in the cost of living in England with consequent unsettlement of established habits and social position, being a leading factor. In the summer of 1630 a fleet of ships carried over nearly 1,000 emigrants, including Winthrop as governor and Thomas Dudley as deputy governor, to Massachusetts bay, where they settled the towns of Boston, Charlestown, Dorchester, Medford, Watertown, Roxbury and Lynn. Such leaders as Winthrop, Dudley, Endicott and the Rev. John Cotton were strongly opposed to democracy, were zealous to prevent any independence in religious views, and had no trust in the people at large. Opposition showed itself now and then in the case of individuals, the General court or even a town (as Watertown). The first of the more noted cases was that of Roger Williams who was banished from the colony and settled in Rhode Island (1636). Almost simultaneously occurred the Antinomian Controversy in which Ann Hutchinson and Harry Vane the younger were the protagonists, and which ended in the banish-

ment of Mrs. Hutchinson and the return of Vane to England. There was much criticism in England, even among the friends of the colony, of the policy of repression adopted by the leaders, lay and clerical, but they pursued their course until halted by royal authority a generation later. The harshness of rule, narrow-mindedness and self-satisfaction which became characteristic of the Massachusetts colony cannot be ascribed wholly to Puritanism. As has been said, it was a period of great Puritan emigration and all the colonies both on the American mainland and in the West Indies were strongly Puritan in tone at first. In the South and on the islands, differing climatic and other conditions induced modifications in cultural life and thought, but even in New England both Rhode Island and Connecticut were far more liberal than Massachusetts.

Extension of settlements brought on troubles with the Indians and in 1637 there occurred the war with the Pequots, in which that race was practically annihilated. In the same year a synod of the clergy was held at Boston which listed 82 blasphemous, erroneous or unsafe opinions held in the colony. In 1643 a loose confederation of the four colonies of Massachusetts, Connecticut, Plymouth and New Haven, was effected under the title of the United Colonies of New England. It performed some useful work but its policies were largely dominated by Massachusetts and it gradually lost influence.

In 1644 laws were passed against the Baptists and several of them were cruelly dealt with. The Quakers also were persecuted, more particularly from 1656 to 1662, four being put to death and many others whipped, imprisoned, branded or banished. Finally, owing partly to a revulsion of public feeling and largely to action by the English Crown, a stop was put to the worst forms of persecution. During the Civil War and Cromwellian period in England, the colonies had for the most part been left to go their own way and Massachusetts had arrogated to herself an almost complete independence of the home government. It was obvious according to the ideas of the time that if the colony were to remain part of the empire a closer dependence would be essential, and after the Restoration it was decided to send out a Royal Commission to investigate conditions. In 1665 the Commission visited New England, and the following year the king sent a circular letter to all the colonies, expressing dissatisfaction with Massachusetts only. There was, indeed, a considerable and respectable party in the colony itself which was opposed to the extreme pretensions of the local government. That government, however, trusting to distance and the preoccupation of England with the European war, pursued its course.

In 1675 there occurred a second and much more serious Indian war, known as King Philip's War, due to the grasping land policy of the colonies and the desperation of the savages at seeing themselves more and more hemmed in by the whites. It was an inevitable conflict and although the whites were victorious they suffered severely. It was said that one man in every 16 of military age was killed and it was long before the frontier recovered. Meanwhile the case of Massachusetts was again taken up by the English government. The colony adopted the method of evasion and delay in meeting charges and complying with orders. This policy resulted in the annulment of the charter in 1684, in leaving the colony defenceless against the king, and with few or no friends in England to defend the course it had taken. In some respects, such as the end of the exclusion of non-church members from the franchise, the cause of liberty gained by the change. In 1686 a royal government was inaugurated by the arrival of Joseph Dudley, a native Massachusetts man, as president of a provisional government until a new one could be devised. He was soon supplanted by Sir Edmund Andros, whose government extended over all New England and New York. Although he was by no means the "tyrant" whom the earlier patriotic historians painted, he was lacking in tact and in the qualities of wise statesmanship, and his situation was an extremely difficult one. When word came that the Stuart dynasty had been overthrown in England in favour of William of Orange, a mild revolution occurred in Boston, and Andros and most of his government were imprisoned. Finally a new charter was procured for Massachusetts, 1691, to whose territory it added the province of Maine and the former colony of Plymouth. Although the new charter provided for a royal governor and in other ways greatly diminished the power of the old theocratic party it was a more reasonable governmental instrument than the anomalous commercial charter which the colony had for so long tried to twist into a political constitution. The first royal governor was a New England man, Sir William Phips, who had led an unsuccessful attack on Quebec in 1690. Massachusetts had carried out an easy raid upon Acadia which had inspired hopes of a larger conquest of French territory, with the sole result of almost bankrupting the colony by a debt of £200,000. The last decade of the 17th century was also marked by the witchcraft delusion, mainly in Salem village, during 1691–92. In all about 32 persons were executed, one by the horrible mediaeval penalty of being pressed to death under heavy weights. After the end of that delusion, the life of Massachusetts takes on a more modern tinge. Connecticut had shown the way to civil and Rhode Island to religious liberty. If the far more powerful colony of Massachusetts cannot lay claim to have been a leader in either of these directions, its founders had established the strongest colony in North America, had made creditable beginnings in public education, had developed the system of town government, and laid the foundation for the Congregational Church. Although the results of the intellectual repression of its first century were long to be felt, with the opening of the new century the colony swung more and more into the growing liberalism of thought of the 18th century.

It also shared more in the larger life of the empire. Several times, notably in the unfortunate expeditions against Jamaica (1702), against Canada (1709–11) and Cartagena (1740), Massachusetts troops played an honourable part, and to that colony must be given the main credit for the capture of Louisburg from the French in 1745. In the French and Indian war her soldiers also took part in the expedition against Oswego, took the chief part in the capture of Acadia, and also shared in the Crown Point and second Louisburg attacks. Meanwhile, the colony had been making rapid strides in wealth and was becoming markedly self-conscious politically. There had been serious trouble with the currency earlier in the century, owing to the colonists' insistence, perhaps necessary, upon the use of too large amounts of paper money, in which it was opposed by the English government. This trouble culminated in a crisis, including rioting, under Governor Belcher in 1740 but the repayment to the colony by England of about £183,000 in sterling to cover its expenses in the capture of Louisburg (1745) enabled it to retire about £2,000,000 of its depreciated bills and establish itself on a firm money basis, a fact of great importance in its subsequent commercial development. Fortunes were accumulating, business operations were growing much larger in scale, Harvard had become liberal in thought, and Connecticut, not Massachusetts, had now become the last stand of the old religious ideas.

During the war there had been much smuggling and trading with the enemy, and the British government became more stringent in trying to enforce trade regulations. In 1756 it introduced a system of general search warrants, such as Massachusetts itself had had in force for eight years. Merchants who saw their profits endangered protested, and in 1761 James Otis made his famous and impassioned attack in court upon these Writs of Assistance, the strict legality of which was hardly open to question. Following the peace of 1763 and the need for readjusting the cost of maintaining and defending the empire, came the fatal attempts to solve the problem. In 1765 Massachusetts was prominent among the colonies which resisted the Stamp Act. Samuel Adams of Boston, one of the ablest agitators and propagandists whom any country has produced, set himself to keep alive the flames of discontent, having made up his mind that the colonies should be wholly independent of England. In his skilful manipulation of public opinion and emotion, and in his organization of the Committees of Correspondence, he probably did more than any other man to arouse the opposition of certain elements against England and to prevent the possibility of any reconciliation. In 1768 royal troops were stationed in Boston and on March 5, 1770, a clash

occurred between them and some citizens of whom five were killed. The soldiers had been constantly subjected to taunts and abuse and on the whole had behaved well. In this incident a small mob, led by a half-breed negro, had been the aggressors. Officers and men at once surrendered to the civil authorities and upon trial by the local court were acquitted, except two who received slight penalties for technical homicide. Samuel Adams and his party made the most possible of the "atrocity" and dubbed it "the Boston massacre." In 1773 occurred the "Boston tea party" in which a band of citizens disguised as Indians boarded the ships carrying the tea and threw it overboard. In retaliation for this wanton destruction of private property (not considered necessary in any other colony), Parliament passed the Boston Port bill, closing the port to commerce. The increasing agitation and violence of the mobs during this decade presaged more serious armed conflict. Gen. Gage was made governor and in April 1775 sent an armed force to Lexington and Concord to destroy military stores gathered at those places by the Opposition. The force was attacked and completely routed by the country people, and Gage was practically besieged in Boston. In an effort to release himself the battle of Bunker Hill was fought June 17, resulting in a costly but psychologically complete victory for the Americans. The British loss was exceedingly heavy. In July Washington arrived at Cambridge to take command of all the troops, and soon after the scene of war shifted from Massachusetts and no important military action occurred within it for the rest of the struggle. During the whole of it Massachusetts contributed more liberally than any other colony in men and money though military leadership, except for Generals Henry Knox and Benjamin Lincoln, passed to other hands.

Two years of prosperity following the signing of peace in 1783 soon gave place to serious financial difficulty, particularly among the poor and heavily taxed farming class. Violence occurred in most counties and became especially serious in the western ones. Owing largely to the failure of the legislature either to suppress the insurrection or to redress grievances, the revolt gained headway. Many ex-Revolutionary soldiers and officers took part in it, among others Capt. Daniel Shays, and owing to his leadership the movement became known as Shays's rebellion. It was finally put down by aid of heavy forces under Gen. Lincoln. The incident was important as frightening the moneyed classes into accepting more readily the new Federal constitution. This was ratified by only a very small majority in Massachusetts which was considered a "pivotal state." After its adoption the State became strongly Federalist in politics. A group of its leading politicians, known as the "Essex Junto" and including such men as Fisher Ames, George Cabot, Timothy Pickering, John Lowell and others (all opponents of democracy and strongly reactionary) long dominated the politics of the State. They were utterly out of sympathy with the principles of the party in national power after 1800 and with the policy of war against England in 1812. On the whole, the part played by the State in that war was inglorious. As a commercial community it had suffered heavily from the embargo measures preceding it, but it is difficult to justify the extreme sectionalism and anti-nationalism displayed when the nation was actually at war. Although New England held most of the specie of the country it refused, in the main, to subscribe to the war loans and Boston took only $75,000 of that of 1813 as compared with $7,000,000 subscribed in Pennsylvania. Although great numbers of its citizens supported the Government, the policy of the State as a whole was distinctly obstructionist and disloyal. Rumours of secession, which had been heard at intervals from 1800, seemed to find confirmation with the convening of the Hartford Convention, mainly dominated by Massachusetts, in 1814. The more sober element prevailed, however, and the convention adjourned doing but little harm except to the reputations of those who had attended. The State also opposed the Mexican War as it had the policy leading to it. The period 1830–40 witnessed great social changes, among others the rise of the factory system and the substitution to a great extent of imported foreign for native American labour. It was a period of intellectual ferment and of social experiment. Utopian communities, such as Brook Farm, were undertaken, and although they all ended in failure, they left their mark on the thought and idealism of the times. Under the lead of Wm. Lloyd Garrison and Wendell Phillips, Massachusetts was in the van of the Abolitionist movement. Such citizens as C. F. Adams and Charles Sumner took leading parts in the formation of the Free Soil Party, and when at last the Civil War came, the State entered the contest whole-heartedly, rallying to the support of the Federal Government in a spirit utterly different from that which had marked the two preceding ones. It has been stated that of the 159,165 men (including re-enlistments) whom the State sent to the war less than 7,000 were drafted. In the Spanish-American War of 1898 the State also took an honourable part in spite of the lack of sympathy of notable leaders with the war and the imperialism following it. From the Civil War onward the state has always been strongly Republican in politics and devoted to protection and high tariffs. During the World War 198,863 citizens were credited with military or naval service. Of these 83,220 were drafted, the State showing a larger proportion of voluntary enlistments than any other except Oregon and Rhode Island.

Owing to the extraordinary number of able men, the influence of Massachusetts in the intellectual life of the nation has been out of all proportion to its size and population. The roll of historians has been notable, including John Winthrop and William Bradford in the settlement period, Thomas Hutchinson in the revolutionary one, and culminating with Bancroft, Sparks, Prescott, Motley, Parkman, Thayer and Rhodes, though the last was not born in the State. In poetry we have R. H. Dana, Bryant, Longfellow, Whittier, Lowell, Holmes and Amy Lowell; in philosophy and theology, Jonathan Edwards, Channing, Emerson, Parker and William James; in fiction, Mrs. Stowe and Hawthorne; in education, Horace Mann and Charles W. Eliot; in oratory and statesmanship, James Otis, John Adams, John Quincy Adams, Webster, Choate, Everett, Sumner, and Wendell Phillips; in law, Story, Parsons and Shaw.

Bibliography.—*Topography.*—W. M. Davis, *Physical Geography of Southern New England* (1896); U.S. Geological Survey, *Bulletin 116*, H. Gannett, "Geographic Dictionary of Massachusetts"; M. Keir, "Some Influences of the Sea upon the Industries of New England," *American Geographical Review,* vol. v. *Minerals.*—U.S. Census *Reports,* and U.S. Geological Survey annual volumes on *Mineral Resources. Agriculture.*—U.S. and Mass. State *Census Reports;* reports and other publications of the State board of agriculture, the Agricultural college, and of the Experiment Station at Amherst; and P. W. Bidwell, "The Agricultural Revolution in New England," *American Historical Review,* vol. xxvi. *Manufactures.*—U.S. Census *Reports;* annual reports of the State Bureau of Statistics of Labour; M. T. Copeland, *The Cotton Manufactures in the U.S.* (1912); V. S. Clark, *History of Manufactures in the U.S.* (1916); E. B. Hazard, *Organization of the Boot and Shoe Industry in Mass. before 1875* (1921); pamphlets and reports issued by the New England Council. *Fisheries.*—R. McFarland, *A History of the New England Fisheries* (1911).

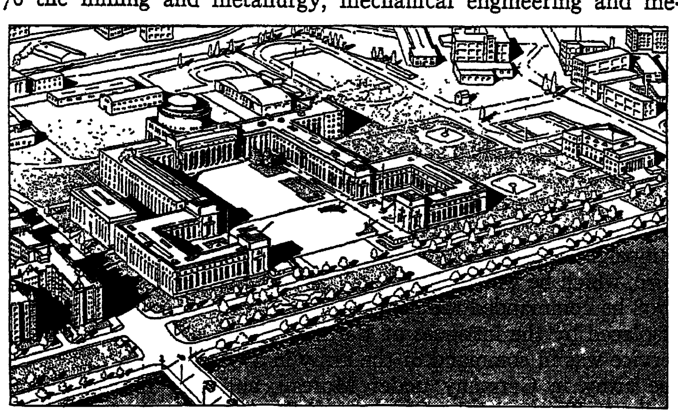
Commerce, Communications, etc.—U.S. Census, *Reports;* Reports of the State Railway Commission: E. Stanwood, *American Tariff Controversies in the 19th Century* (1904); F. W. Taussig, *Tariff History of the U.S.* (1914); E. R. Johnson, *History of Domestic and Foreign Commerce of the U.S.,* (1915); S. E. Morison, *The Maritime History of Massachusetts* (1921). *Population.*—U.S. and Massachusetts State Census *Reports;* publications of the State bureaux of labour and health. *Government.*—G. H. Haynes, *Representation and Suffrage in Massachusetts, 1620–1691,* Johns Hopkins Studies, xii; H. A. Cushing, *History of the Transition from Provincial to Commonwealth Government in Massachusetts* (1896); R. H. Whitten, *Public Administration in Massachusetts* (1898); A. E. McKinley, *The Suffrage Franchise in the 13 English Colonies in America* (1905); L. A. Frothingham, *Brief History of the Constitution and Government of Massachusetts* (1916); S. E. Morison, "The Struggle over the Adoption of the Constitution of Massachusetts, 1780," Mass. Hist. Soc., *Proceedings,* (1917); *Public Documents of Massachusetts,* annual. *Finance.*—J. B. Felt, *An Historical Account of Massachusetts Currency* (1839); A. M. Davis, *Currency and Banking in Massachusetts Bay* (1900); C. J. Bullock, *Historical Sketch of the Finances and Financial Policy of Massachusetts* (1907); Reports of the Commissioners of Banking: *Education.*—Annual *Reports* of the U.S. Commissioner of Education and of the Massachusetts Board of Education; J. Quincy, *History of Harvard* (1840); G. G. Bush, *History of Higher Education in Massachusetts* (1891).

History.—Lengthy and important bibliographies are to be found in Winsor's *Memorial History of Boston* (1880–81), and in his *Narrative and Critical History of the United States* (1887–89), both now

somewhat antiquated as to date but not in scholarship. J. T. Adams, *History of New England* (1927) (originally published separately with distinct titles), contains footnote references to several thousand works on New England, largely Massachusetts. J. G. Palfrey, *History of New England* (1858–90) is now out of date and belongs to the old "filio-pietistic" school. Other works are: Wm. Bradford, *History of Plymouth Plantation* (var. edits.); J. Winthrop, *History of New England, 1630–1649* (in journal form); S. E. Sewall, *Diary* (Mass. Hist. Soc.), gives an intimate picture of Boston life from 1674 to 1729; T. Hutchinson, *History of Massachusetts* (1764–1828), the publications of the Prince society, notably the *Hutchinson Papers* (1865), the *Andros Tracts* (1868–74), and the *Randolph Papers* (1898–1909); Young, *Chronicles of the Pilgrim Fathers* (1844); Young, *Chronicles of Massachusetts* (1846); C. W. Upham, *Witchcraft in Salem;* Henry Adams, *Documents relating to New England Federalism* (1877); R. P. Hallowell, *The Quaker Invasion of Massachusetts* (1887); W. B. Weeden, *Economic and Social History of New England* (1890); C. F. Adams, *Three Episodes in Massachusetts History* (1892); *ibid., Massachusetts: its Historians and its History* (1893); W. Walker, *Creeds and Platforms of Congregationalism* (1893); Ellis and Morris, *King Philip's War* (1906); F. H. Foster, *A Genetic History of the New England Theology* (1907); L. K. Mathews, *Expansion of New England* (1909); A. E. Morse, *The Federalist Party in Massachusetts* (1909); W. A. Robinson, *Jeffersonian Democracy in New England* (1916); A. M. Schlesinger, *The Colonial Merchants and the American Revolution* (1918); R. G. Usher, *The Pilgrims and their Story* (1918); A. B. Darling, *Political Changes in Massachusetts 1824–1848* (1925); *Diary of Cotton Mather,* Mass. Hist. Soc., *Collections,* Ser. vii, vol. vii.–viii.; the publications of the various learned societies are particularly important, notably the *Proceedings* and *Collections* of the Mass. Hist. Soc.; the *Proceedings* of the American Antiquarian Society; the *Publications* of the Col. Soc. of Mass.; and the *Register* of the N. E. Gen. and Hist. Society. Many of the town histories are excellent. The biographies and collected writings of many of the State's leaders, such as Samuel and John Adams, Daniel Webster, Elbridge Gerry, Charles Sumner, and later ones, are of importance for general history.

(J. T. A.)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, THE, an institution of higher education in Cambridge, Mass., was incorporated in 1861. It owes its origin to William Barton Rogers, its first president, a scientist of high rank and president of the National Academy of Science. He urged the establishment of an institute in which scientific pursuits should predominate. Owing to the outbreak of the Civil War it was not until 1865 that it was possible to make an actual beginning. The courses were especially designed to prepare men for mechanical and civil engineering and for the professions of the architect and chemist. In 1866, the institute moved into its first building on Boylston street, Boston, provided chemical laboratories and three years later physical laboratories. During 1870–76 the mining and metallurgy, mechanical engineering and mechanic arts laboratories and three new courses, mining, physics and biology were established. By 1900 the number of students had increased to 1,200 and the number of the instructing staff to 153. Three more large buildings had been erected and four new courses established—in electrical, chemical and sanitary engineering and naval architecture. The magnificent new buildings of the Massachusetts Institute of Technology built some ten years later in Cambridge on the banks of the Charles river gave the institute unexcelled facilities for engineering education and research.



BY COURTESY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY. PHOTOGRAPH, COPR. FAIRCHILDS

AERIAL VIEW OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The institute is one of the land grant colleges. The government is vested in a corporation consisting of five ex-officio members, 35 life members and 15 members elected for terms of five years from a group of candidates nominated by the alumni. The instructing staff in 1928 consisted of 487 members of whom 215 were of professorial grade. These professors constitute the faculty, which has the immediate supervision of all matters relating to the courses of instruction and to the admission and conduct of students. Exclusive of the summer school, the number of students in 1928 was 2,868. There were only 60 women, although women are admitted to any of the courses. The regular course of undergraduate study leads to the degree of B.Sc. in any one of the following 17 branches: civil engineering (including railroad operation), mechanical engineering, mining engineering and metallurgy, architecture, chemistry, electrical engineering, biology and public health, physics, general science, general engineering and mathematics, chemical engineering, sanitary and municipal engineering, geology and geological engineering, naval architecture and marine engineering, electrochemical engineering, engineering administration, aeronautical engineering, building construction. In each of these courses a large proportion of work of a literary and scientific character is insisted upon, and a serious effort is made to break down the barriers between professional and cultural studies. Opportunities are also afforded for study and research leading to the advanced degrees of master of science, master in architecture, doctor of philosophy, doctor of science, doctor of public health.

(S. W. S.)

MASSACRE, a wholesale indiscriminate killing of persons. The meaning and the old form *macecle* seem to point to a corruption of the Lat. *macellum,* butcher's shop or shambles, though it may be derived from Old Low Ger. *matsken,* to cut in pieces.

MASS ACTION, LAW OF: *see* CHEMICAL ACTION.

MASSAGE, a method of treating stiffness or other physical conditions by manipulating the muscles and joints, practised from time immemorial in all parts of the world and employed extensively for medical purposes at the present time.

Massage, as now practised, includes several processes, some passive, others active. The former are carried out by an operator, and consist of rubbing and kneading the skin and deeper tissues with the hands and exercising the joints by bending the patient's limbs. The active movements consist of a special form of gymnastics, designed to exercise particular muscles or groups of muscles. In "Swedish massage" the operator moves the limbs while the patient resists, thus bringing the opposing muscles into play. Sometimes the word "massage" is restricted to the rubbing processes, "manipulation" being used to cover all the movements mentioned.

Rubbing has been subdivided into several processes, namely (1) stroking, (2) kneading, (3) rubbing and (4) tapping, and great importance is attached to the application of a particular process in a particular way. Oils and other lubricants may or may not be used. But, however applied, the treatment acts essentially by increasing circulation and improving nutrition. It was shown by Lauder Brunton that more blood actually flows through the tissues during and after rubbing. The number of red corpuscles, and, to some extent, their haemoglobin value, are said to be increased (Mitchell). At the same time the movement of the lymph stream is accelerated. In order to assist the flow of blood and lymph, stroking is applied centripetally, *i.e.,* upwards along the limbs and the lower part of the body, downwards from the head. The effects of the increased physiological activity set up are numerous. Functional ability is restored to exhausted muscles by the removal of fatigue products and the induction of a fresh blood supply; congestion is relieved; collections of serous fluid are dispersed; secretion and excretion are stimulated; local and general nutrition are improved. These effects indicate the conditions in which massage may be usefully applied. Such are various forms of paralysis and muscular wasting, chronic and subacute affections of the joints, muscular rheumatism, sciatica and other neuralgias, local venous congestions, convalescent fractures of bones, sprains, contractions, obesity and chronic constipation. In certain other conditions massage gives relief, probably in large measure by suggestion

(*q.v.*). Such are insomnia, some forms of headache, hysteria and neurasthenia, disorders of the female organs, melancholia and other forms of insanity and morphinism.

The therapeutic value of massage when judiciously used is undoubted, but it is not appropriate for fevers, pregnancy, collections of pus, acute inflammation of the joints, inflamed veins, fragile arteries, wounds of the skin, and generally speaking, those conditions in which it is not desirable to increase the circulation, or the patient cannot bear handling.

Massage of the face and neck forms the basis of most systems of modern beauty culture. By stimulating circulation and the flow of lymph, by clearing the tissues of accumulated wastes and increasing their nutrition, massage has the effect of clearing and refining the skin and making the contours of the face and neck smooth and firm.

The revival of massage in Europe and America has called into existence a considerable number of professional operators, both male and female, who may be regarded as forming a branch of the nursing profession. Several things are required for a good operator. One is physical strength. Deep massage is very laborious work and cannot be carried on for even half an hour without unusual muscular power. A second important requirement is tactile and muscular sensibility. A person not endowed with a fine sense of touch and resistance is liable to exert too great or too little pressure; the one hurts the patient, the other is ineffective. Then skill and knowledge, which can only be acquired by a course of instruction, are necessary. Finally, the standard of personal character necessary is that required for the nursing profession in general. Massage should always be carried out under medical direction and in proper surroundings.

Bibliography.—J. Arvedoon, *Medical Gymnastics and Massage in General Practice* (London, 1926); I. C. Shires and D. Wood, *Advanced Methods of Massage and Medical Gymnastics* (London, 1927); J. B. Mennell, *Massage, its Principles and Practice* (London, 1920); B. M. Goodall-Copestake, *The Theory and Practice of Massage* (London, 1927; bibl.); E. A. G. Kleen, *Massage and Medical Gymnastics* (London, 1918).

MASSAGETAE (măs-săg′ĕ-tī), people described by Herodotus (i. 204–16; iv. 11, 172) as dwelling beyond the Araxes (Oxus) in what is now Balkh and Bokhara. It was against their queen Tomyris that Cyrus undertook the expedition in which according to one story he met his end. In their usages some tribes were nomads like the people of Scythia (*q.v.*), others with their community of wives and habit of killing and eating their parents recalled the Issedones (*q.v.*); while the dwellers in the islands of the river were fish-eating savages. Probably the name included all the barbarous north-eastern neighbours of the Persians. Herodotus says they only used gold and copper (or bronze), not silver or iron.

MASSA MARITTIMA, a town and episcopal see of the province of Grosseto, Tuscany, Italy, 24 m. N.N.W. of Grosseto direct and 16 m. by rail N.E. of Follonica (28 m. N.W. of Grosseto on the main coast railway), 1,444 ft. above sea-level. Pop. (1921) (town) 9,410; (commune) 15,484. The Romanesque cathedral (13th century) has a fine font (1267, with a cover of 1447) and a Gothic reliquary (1324) of the patron saint Cerbone. The battlemented municipal palace and other buildings of the 13th century are picturesque. Above the old town is a fortress built by the Sienese in 1337.

MASSASOIT (1580–1661), chief of the Wampanoag Indians, was born in the present limits of Massachusetts about 1580. His tribe of several thousand had been almost destroyed by an epidemic, supposed to be yellow fever, just before the arrival of the Mayflower. In March 1621, an Indian, Samoset, appeared at Plymouth and to the surprise of the Pilgrims spoke to them in English. He arranged for a meeting between his chief, Massasoit, and Governor Bradford. Massasoit appeared a week later, and signed a treaty of peace with the white men which remained inviolate for 54 years. In 1623, when he had been very ill, Edward Winslow visited him and effected a cure. In return for this kindness Massasoit revealed the plot of a neighbouring tribe to destroy the white men. *See* A. G. Weeks, *Massasoit of the Wampanoags* (1919).

MASSAWA or Massowah, a town on the African coast of the Red sea, chief port of the Italian colony of Eritrea, in 15° 36′ N. and 39° 28′ E. Pop. (1923) 12,275 including 137 Europeans. The town stands at the north end of the bay of Massawa and is built partly on a small coral island of the same name—where was the original settlement—and partly on the islets of Tautlub and Sheik Said, and the neighbouring mainland. The harbour is formed by the channel between the island and the mainland. It affords good anchorage in from 5 to 9 fathoms. The town possesses several good public buildings, chiefly built of coral, as are the houses of the principal European and Arab merchants. Since 1912 a railway has connected Massawa with Asmara, the capital of the colony. Massawa is the port for northern Abyssinia (of which Eritrea was formerly a part) but commerce is hampered by the lack of rapid means of communication. The trade consists mainly in exporting hides, butter, cotton, coffee and civet, and importing European and Indian cotton goods and silks. Fully 80% of the oversea trade of the colony passes through the port (*see* Eritrea).

The island of Massawa appears to have formed part of the Abyssinian dominions for many centuries. It was at Massawa (Matzua, as it is called by the Portuguese chroniclers) that Christopher da Gama and his comrades landed in July 1541 on their way to aid the Abyssinians against the Mohammedan invaders. Captured by the Turks in 1557, the island remained a Turkish possession over two hundred years, although James Bruce found in 1769 that the governor was paying half the customs receipts to the negus of Abyssinia in return for the protection of that monarch. At the close of the 18th century Massawa was held by the sherif of Mecca, and it afterwards passed to Mohammed Ali of Egypt. The Turks were reinstated about 1850, but in 1865 they handed the island back to Egypt for an annual tribute of 2½ million piastres. In Feb. 1885 Massawa was occupied by an Italian force, the Egyptian garrison stationed there being withdrawn in the November following. The port was the capital of the Italian colony until 1900 when the seat of administration was removed to Asmara.

MASSÉNA, ANDRÉ, duke of Rivoli, prince of Essling (1756–1817), the greatest of Napoleon's marshals, son of a small wine merchant, it is said of Jewish origin, was born at Nice on May 6, 1756. He began life as a cabin boy, but in 1775 enlisted in the Royal-Italien regiment. He quickly rose to be under-officer-adjutant; but he left the army in 1789, retired to his native city, and married. He left Italy, and joined the 3rd battalion of the volunteers of the Var in 1791, and by February 1792 was a lieutenant-colonel. He served in the army which occupied Nice, and in the advance to the Apennines which followed, his knowledge of the country and of the people was so useful that in December 1793 he was already a general of division. He won the battle of Saorgio in August 1794, and after many successes, on Nov. 23, 1795, he had the greatest share in the victory of Loano, won by Schérer over the Austrians and Sardinians. In Bonaparte's great campaign of 1796–97 Masséna was his most trusted general of division and won the crowning victory of Rivoli. During this campaign Bonaparte gave him the title of *enfant gâté de la victoire,* which he was to justify till he met the English in 1810. In 1798 he commanded the army of Rome for a short time, but was displaced by the intrigues of Berthier. Masséna's next important service was in command of the army in Switzerland, which united the army in Germany under Moreau, and that in Italy under Joubert. The archduke Charles and Suvórov, who had each been successful in Germany and in Italy, now turned upon him. He held his ground well against the archduke, and then suddenly, leaving Soult to face the Austrians, he transported his army to Zürich, where, on Sept. 26, 1799, he entirely defeated Korsakov. This campaign and battle placed his reputation on a level with that of his compatriot Bonaparte, and he might have made the revolution of Brumaire, but he was sincerely attached to the republic, and had no ambition. Bonaparte, now First Consul, sent him to command the débris of the army of Italy, and he defended Genoa from February to June to the very last extremity, giving time for Bonaparte to strike his great blow at Marengo. He now went to Paris, where he sat in the Corps Législatif in 1803, and

actually defended Moreau without drawing upon himself the ill-will of Napoleon, who well knew his honesty.

Marshal of France.—In 1804 he was made one of the first marshals of France of the new régime, and in 1805 was decorated with the Grand Eagle of the Legion of Honour. In that year Napoleon chose Masséna to keep in check the archduke Charles in Italy, while he advanced through Germany with the grand army. Masséna kept the archduke occupied till he received news of the surrender of Ulm, and then on Oct. 30, defeated him in the battle of Caldiero. After the peace of Pressburg, Masséna was ordered to take possession of the kingdom of Naples, and to place Joseph Bonaparte on the throne. He then distinguished himself in Poland. In 1808 he was made duke of Rivoli. In the campaign in 1809 at the battle of Aspern-Essling his magnificent leadership made what might have been an appalling disaster into a mere reverse of which the enemy could make no use. At Wagram Masséna, too ill to ride, directed from his carriage the movements of the right wing. He was created prince of Essling, and given the castle of Thouars.

Campaign in Spain.—Masséna was then ordered to Spain to "drive the English into the sea." (For campaigns of 1810 and 1811, the advance to and the retreat from Torres Vedras *see* PENINSULAR WAR.) Masséna himself, with some justice, ascribed his failure to the frequent disobedience of his subordinates Ney, Reynier and Junot. Though unsuccessful Masséna kept his army for five weary months close up to Wellington's impregnable position before retiring. His retreat through a devastated country was terrible, but his force of character kept his men together, and Ney showed his best side in brilliant rear-guard actions, until dismissed for a new act of insubordination. Soon Masséna was again ready to try his fortune, and he nearly defeated Wellington at Fuentes d'Oñoro, though much hampered by Bessières. His recall soon followed this and he returned home to find his prestige gone. The old marshal felt he had a right to complain of Ney and of Napoleon himself, and, it is said, opened communications with Fouché and the remnant of the republican party. Napoleon gave his greatest marshal no more employment in the field, but made him a territorial commandant at Marseilles. Louis XVIII. confirmed him in this command. When Napoleon returned from Elba, Masséna, probably by the advice of Fouché, kept Marseilles quiet to await events, the greatest service he could do the royalists, but afterwards imputed to him as a fault. After the second restoration Masséna was summoned to sit on the court-martial which tried Marshal Ney, but refused. He died on April 4, 1817, and was buried in Père-la-Chaise, with only the word "Masséna" upon his tombstone.

See Thiébault's *Éloge funèbre*, and Koch's *Mémoires de Masséna* (4 vols., 1849), a valuable work, carefully compiled. In more modern times E. Gachot has produced several important works dealing with Masséna's campaigns.

MASSENA, a village of St. Lawrence county, New York, U.S.A., on the Grass river, 3 m. from the St. Lawrence. It is served by the Grand Trunk and the New York Central railways. The population was 5,993 in 1920; 10,637 in 1930. It is surrounded by a farming and dairying region and has various manufacturing industries. Flour, paper and paper products, mica and aluminum ware are some of the leading products. The village was incorporated in 1886.

MASSENBACH, CHRISTIAN KARL AUGUST LUDWIG VON (1758–1827), Prussian soldier, was born at Schmalkalden (1758), and educated at Heilbronn and Stuttgart, devoting himself chiefly to mathematics. He became an officer of the Württemberg army in 1778, and left this for the service of Frederick the Great in 1782. After serving through the campaigns of 1793 and 1794 as a staff officer he published a number of memoirs on the military history of these years. He was chiefly occupied however with schemes for the reorganization of the then neglected general staff of the Prussian army, and many of his proposals were accepted. Bronsart von Schellendorf in his *Duties of the General Staff* says that "the organization which he proposed and in the main carried out survived even the catastrophes of 1806–1807, and exists even at the present moment in its original outline."

In 1805 came threats of the war with Napoleon, which Massenbach had strongly opposed. He was made quartermaster-general (chief of staff) to Prince Hohenlohe, over whom he soon obtained a fatal ascendancy. War was averted for a moment by the result of the battle of Austerlitz, but it broke out in earnest in October 1806. Massenbach's influence clouded all the Prussian operations. The battles of Jena and Auerstädt were lost, and the capitulation of Prince Hohenlohe's army was negotiated. Even suggestions of disloyalty were not wanting. He retired to his estate in the Posen province, and occupied himself in writing pamphlets, memoirs, etc. When his estates passed into the grand duchy of Warsaw, he chose to remain a Prussian subject, and on the outbreak of the war of liberation he asked in vain for a post on the Prussian staff. After the fall of Napoleon he took part in Württemberg politics, was expelled from Stuttgart and Heidelberg, and soon afterwards arrested at Frankfurt, delivered over to the Prussian authorities and condemned to fourteen years' fortress imprisonment for his alleged publication of state secrets in his memoirs. He was released in 1826. He died on Nov. 21, 1827, at his estate of Bialokoscz, Posen.

See a life by L. G. von Knesebeck (1924).

MASSENET, JULES EMILE FREDERIC (1842–1912), French composer, was born at Montaud, on May 12, 1842. He studied at the Paris Conservatoire, where he obtained the Grand Prix de Rome in 1863 with the cantata *David Rizzio*. Massenet's operas include *Hérodiade*, five acts (Brussels, 1881); *Manon*, five acts, opéra comique (1884); *Le Cid*, four acts, opéra (1885); *Esclarmonde*, four acts, opéra comique (1889); *Le Mage*, five acts, opéra (1891); *Werther*, four acts (Vienna, 1892); *Thaïs*, three acts, opéra (1894); *Le Portrait de Manon*, one act, opéra comique (1894); *La Navarraise*, two acts (Covent Garden, 1894); *Sapho*, opéra comique (1897); *Le Jongleur de Notre Dame* (Mentone, 1902). Massenet also wrote oratorios, orchestral suites, and songs. He was professor of composition at the Conservatoire from 1878 to 1896. His opera *Panurge* was written just before his death in Paris on Aug. 13, 1912.

A full bibliography of his works is given in Séré, *Musiciens français d'aujourd'hui* (2nd ed. 1921). *See* also, J. E. F. Massenet, *My Recollections* (Boston, 1919); R. Brancour, *Massenet* (1922); L. Schneider, *Massenet 1842–1912* (1926).

MASSEY, SIR EDWARD (*c.* 1619–74/5) English soldier, was born at Coddington, Cheshire. In 1639 he was a captain of pioneers in the army of Charles I., but soon after the outbreak of Civil War he went over to the parliamentarians. As lieutenant-colonel under the earl of Stamford he became, in 1643, governor of Gloucester, which he defended against the Royalists. In 1644 he was made general of the forces of the Western Association, and until 1645 played an important part in the war in the surrounding district. He became M.P. for Gloucester in 1646 and was one of the generals impeached by the army on the ground that they were attempting to revive the Civil War in the Presbyterian interests. Massey fled from England in June 1647, and though he resumed his seat in the house in 1648 he was again excluded by Pride's Purge, and after a short imprisonment escaped to Holland. Thence, openly taking the side of the king, he accompanied Charles II. to Scotland. He fought at the bridge of Stirling and Inverkeithing, and commanded the advanced guard of the Royalists in the invasion of England in 1651. Near Worcester he fell into the hands of his former comrades and was lodged in the Tower. He again escaped to Holland, and on Charles's return, was knighted and given a grant of £3,000. He is said to have died in Ireland.

MASSEY, GERALD (1828–1907), English poet, was born near Tring, Hertfordshire, on May 29, 1828. As a child he was sent to work in a silk factory, and afterwards at straw-plaiting. He struggled manfully against the distress and deprivations of his early years, and educated himself in his spare time. He threw himself into the movement known as Christian Socialism (*q.v.*), becoming associated with Maurice and Kingsley. He first became known as editor of the *Spirit of Freedom*, and at the age of 22 published his first volume of poems, *Voices of Freedom and*

Lyrics of Love. Massey's poetry has a certain rough and vigorous eelement of sincerity and strength which accounts for its popularity at that time. He also wrote several popular books on Egypt including *The Book of the Beginnings*, followed by *The Natural Genesis;* but his most important work is *Ancient Egypt: The Light of the World*, published shortly before his death. He died on Oct. 29, 1907. The best of his poems were collected by him in *My Lyrical Life* (2 vols., 1889); he also published works dealing with spiritualism, the study of Shakespeare's sonnets, and theological speculation.

See J. Churton Collins' article, *Contemporary Review* (May 1904).

MASSEY, WILLIAM FERGUSON (1856–1925), New Zealand statesman, was born at Limavady, Co. Derry, Ireland, on March 26, 1856. His parents emigrated to New Zealand when he was six, and eight years later he joined them at Tamaki. After an elementary education, he went on the land, and 20 years later, as president of the Auckland Agricultural and Pastoral Society, began to play a prominent part in public life. He entered parliament in 1894 as member for Waitemata, and in 1903 became leader of the Conservative opposition to Seddon and Sir Joseph Ward. In 1912 he defeated the ministry and formed a cabinet. Thereafter he played a dominating part in the Dominion's affairs. His strong personality, sterling honesty of purpose and administrative ability commanded universal respect, and during the World War, at the head of a strong Coalition ministry, which included his lifelong opponent, Ward, Massey led New Zealand with conspicuous ability and foresight. And, just as he had not hesitated to introduce conscription without reference to the people, so he had the courage, when peace came, to enforce unpopular economies. He was a member of the Imperial War cabinet in 1917–18 and in 1919 was the representative of New Zealand at the Peace Conference in Paris. Shortly after the Imperial Conference of 1923 his health gave way, and he died on May 10, 1925.

MASSICUS, MONS, a mountain ridge of ancient Italy, in the territory of the Aurunci. It projects in a south-westerly direction from the volcanic system of Rocca Monfina as far as the sea, and separates the lower course of the Liris from the plain of Campania. It consists of limestone, with a superstratum of pliocenic and volcanic masses, and was once an island; its highest point is 2,661 ft. above sea-level. It is now traversed by a long tunnel of the new direct railway to Naples.

It was very famous for its wine in ancient times. There was just room along the coast for the road to pass through; the pass was guarded by the Auruncan town of Vescia, which ceased to exist in 314 B.C. after the defeat of the Ausones. Its successor, Sinuessa, on the coast, a station on the Via Appia, was constructed in 312 B.C. Domitian considerably increased its importance by the construction of the Via Domitiana, which left the Via Appia here and ran to Cumae and Puteoli. The town was destroyed by the Saracens, but ruins are still visible two miles north-west of the modern Mondragone.

MASSIF, a French term, adopted in geomorphology for a mountainous mass of connected heights, whether isolated or forming part of a larger system. A "massif" is usually clearly marked off by valleys.

MASSILLON, JEAN BAPTISTE (1663–1742), French bishop and preacher, was born at Hyères on June 24, 1663, his father being a royal notary of that town. At the age of eighteen he joined the Congregation of the Oratory and taught for a time in the colleges of his order at Pézenas, and Montbrison and at the Seminary of Vienne. In 1693 he was placed at the head of the famous seminary of Saint Magloire. He soon gained a wide reputation as a preacher and was selected to be the Advent preacher at the court of Versailles in 1699. He was made bishop of Clermont in 1717, and two years later was elected a member of the French Academy. The last years of his life were spent in the faithful discharge of his episcopal duties; his death took place at Clermont on Sept. 18, 1742. Massillon enjoyed in the 18th century a reputation equal to that of Bossuet and of Bourdaloue, and has been much praised by Voltaire, D'Alembert and kindred spirits among the *Encyclopaedists*. He has usually been contrasted with his predecessor Bourdaloue, the latter having the credit of vigorous denunciation, Massillon that of gentle persuasiveness. Besides the *Petit Carême,* a sermon which he delivered before the young king Louis XV. in 1718, his sermons on the Prodigal Son, on the small number of the elect, on death, for Christmas Day, and for the Fourth Sunday in Advent, may be perhaps cited as his masterpieces. His funeral oration on Louis XIV. is remembered for the opening sentence: "Dieu seul est grand."

The first edition of Massillon's complete works was published by his nephew, also an Oratorian (Paris, 1745–48), and upon this, in the absence of mss., succeeding reprints were based. The best modern edition is that of the Abbé Blampignon (Paris, 1865–68, 4 vols.; new ed. 1886).

See Abbé Blampignon, *Massillon, d'après des documents inédits* (Paris, 1879); and *L'Épiscopat de Massillon d'après des documents inédits, suivi de sa correspondance* (Paris, 1884); F. Brunetière "L'Éloquence de Massillon" in *Études critiques* (Paris, 1882); Père Ingold, *L'Oratoire et le jansénisme au temps de Massillon* (Paris, 1880); Pauthe, *Massillon, sa prédication sous Louis XIV. et Louis XV.* (1908).

MASSILLON, a city of Stark county, Ohio, U.S.A., on the Tuscarawas river, at an altitude of 1,000 ft., 8 m. W. of Canton. It is on Federal highways 21 and 30 (the Lincoln) and is served by the Baltimore and Ohio, the Pennsylvania and the Wheeling and Lake Erie railways, inter-urban trolleys, and motor-bus lines. Pop. 17,428 in 1920 (86% native white); in 1930 (after annexations of territory) it had grown to 26,400. It is a manufacturing centre with diversified industries, and a distributing point for bituminous coal from Ohio and West Virginia. The manufactures include alloy and cold-drawn steels, aluminum and enamelled ware, marine engineering and shipping equipment. A State hospital for the insane is located here. Massillon was founded in 1826, incorporated as a village in 1853 and as a city in 1868. It was named after Jean Baptiste Massillon.

MASSIMO or **MASSIMI,** a Roman princely family of great antiquity, said to be descended from the ancient Maximi of republican Rome. The name is first mentioned in 1012 in the person of Leo de Maximis, and the family played a considerable part in the history of the city in the middle ages. The brothers Pietro and Francesco Massimi protected the German printer Ulrich Hahn, who came to Rome in 1467. In the 16th century the Massimi were the richest of the Roman nobles. A marquisate was conferred on them in 1544, and the lordship of Arsoli in 1574. To-day there are two branches of the Massimi, viz., the Principi Massimo, descended from Camillo Massimiliano (1770–1840), and the dukes of Rignano, descended from Francesco Massimo (1773–1844). The Palazzo Massimo, one of the finest Renaissance buildings in Rome, was built by Baldassare Peruzzi by order of Pietro Massimo, on the ruins of an earlier palace destroyed in the sack of Rome in 1527.

See F. Gregorovius, *Geschichte der Stadt Rom* (1880); A. von Reumont, *Geschichte der Stadt Rom* (1868); *Almanach de Gotha;* J. H. Douglas, *The Principal Noble Families of Rome* (1905).

MASSINGER, PHILIP (1583–1640), English dramatist, son of Arthur Massinger or Messanger, was baptized at St. Thomas's, Salisbury, on Nov. 24, 1583. He entered St. Alban hall, Oxford, in 1602. His father was attached to the household of the 2nd Earl of Pembroke, but on the succession of William Herbert in 1601 it has been suggested that the patronage ceased. On the other hand, à Wood says that he went to Oxford at Lord Pembroke's expense. Massinger left Oxford without a degree in 1606. His father had died in 1603, and he was perhaps dependent on his own exertions. He went to London to work as a dramatist, but his name cannot be definitely affixed to any play until fifteen years later, when *The Virgin Martyr* (ent. at Stationers' hall, Dec. 7, 1621) appeared as the work of Massinger and Dekker. During these years he worked in collaboration with other dramatists. From 1613 Massinger apparently worked regularly with John Fletcher, although in editions of Beaumont and Fletcher's works his co-operation is usually unrecognized.

Sir Aston Cokayne, Massinger's constant friend and patron, refers in explicit terms to this collaboration in a sonnet addressed to Humphrey Moseley on the publication of his folio edition of Beaumont and Fletcher (*Small Poems of Divers Sorts,* 1658), and in an epitaph on the two poets he says:—

Plays they did write together, were great friends,
And now one grave includes them in their ends.

After Philip Henslowe's death in 1616 Massinger and Fletcher began to write for the King's Men. Between 1623 and 1626 Massinger produced unaided for the Lady Elizabeth's Men then playing at the Cockpit three pieces, *The Parliament of Love, The Bondman* and *The Renegado.* With the exception of these plays and *The Great Duke of Florence,* produced in 1627 by the Queen's servants, Massinger continued to write regularly for the King's Men until his death. S. R. Gardiner, in an essay on "The Political Element in Massinger" (*Contemp. Review,* Aug. 1876), maintained that Massinger's dramas are before all else political.

In 1631 Sir Henry Herbert, the master of the revels, refused to license an unnamed play by Massinger because of "dangerous matter as the deposing of Sebastian, King of Portugal," calculated presumably to endanger good relations between England and Spain. There is little doubt that this was the same piece as *Believe as You List,* in which time and place are changed, Antiochus being substituted for Sebastian, and Rome for Spain.

Massinger seems to have supported the democratic views of his patron, the Earl of Montgomery, who was an enemy of Buckingham. In *The Bondman,* dealing with the history of Timoleon, Buckingham is satirized as Gisco. The servility towards the Crown displayed in Beaumont and Fletcher's plays reflected the temper of the court of James I. The attitude of Massinger's heroes and heroines towards kings is very different. Camiola's remarks on the limitations of the royal prerogative (*Maid of Honour,* act IV., sc. V.) could hardly be acceptable at court.

Massinger died suddenly at his house near the Globe theatre, and was buried in the churchyard of St. Saviour's, Southwark, on March 18, 1640.

The supposition that Massinger was a Roman Catholic rests upon three of his plays, *The Virgin Martyr* (licensed 1620), *The Renegado* (licensed 1624) and *The Maid of Honour* (*c.* 1621). *The Virgin Martyr,* which deals with the martyrdom of Dorothea in the time of Diocletian, cannot be relied on. It is not entirely his work, and the story is early Christian, not Roman Catholic. In *The Renegado,* however, the action is dominated by the beneficent influence of a Jesuit priest, Francisco, and the doctrine of baptismal regeneration is enforced. In *The Maid of Honour* a complicated situation is solved by the decision of the heroine, Camiola, to take the veil.

His plays have generally an obvious moral intention. He sets himself to work out a series of ethical problems through a succession of ingenious and effective plots. In the art of construction he has, indeed, few rivals. But the virtue of his heroes and heroines is rather morbid than natural, and often singularly divorced from common-sense. His *dramatis personae* are in general types rather than living persons, and their actions do not appear to spring inevitably from their characters, but rather from the exigencies of the plot. The heroes are too good, and the villains too wicked to be quite convincing. Moreover their respective goodness and villainy are too often represented as extraneous to themselves. This defect of characterization shows that English drama had already begun to decline. He contributed, however, at least one great and popular character to the English stage. Sir Giles Overreach, in *A New Way to Pay Old Debts,* is a sort of commercial Richard III., a compound of the lion and the fox, and the part provides many opportunities for a great actor. He made another considerable contribution to the comedy of manners in *The City Madam.* In Massinger's own judgment *The Roman Actor* was "the most perfect birth of his Minerva." It is a study of the tyrant Domitian, and of the results of despotic rule on the despot himself and his court.

Massinger was a student and follower of Shakespeare. The form of his verse, especially in the number of run-on lines, approximates in some respects to Shakespeare's later manner. He is rhetorical and picturesque, but rarely rises to extraordinary felicity. His verse is never mean, but it sometimes comes perilously near to prose, and in dealing with passionate situations it lacks fire and directness.

The plays attributed to Massinger alone are: *The Duke of Milan, a Tragedy* (*c.* 1618, pr. 1623 and 1638); *The Unnatural Combat, a Tragedy* (*c.* 1619, pr. 1639); *The Bondman, an Antient Storie* (licensed 1623, pr. 1624); *The Renegado, a Tragaecomedie* (lic. 1624, pr. 1630); *The Parliament of Love* (lic. 1624; ascribed, no doubt erroneously, in the Stationers' Register, 1660, to W. Rowley; first printed by Gifford from an imperfect ms. in 1805); *A New Way to Pay Old Debts, a Comoedie* (*c.* 1625, pr. 1632); *The Roman Actor, A Tragaedie* (lic. 1626, pr. 1629); *The Maid of Honour* (dating perhaps from 1621, pr. 1632); *The Picture, a Tragecomedie* (lic. 1629, pr. 1630); *The Great Duke of Florence, a Comicall Historie* (lic. 1627, pr. 1635); *The Emperor of the East, a Tragaecomoedie* (lic. and pr. 1631), founded on the story of Theodosius the Younger; *Believe as You List* (rejected by the censor in January, but licensed in May, 1631; pr. 1848–49 for the Percy Society); *The City Madam, a Comedie* (lic. 1632, pr. 1658), which Mr. Fleay (*Biog. Chron. of the Eng. Drama,* i. 226), however, considers to be a *rifaciamento* of an older play, probably by Jonson; *The Guardian* (lic. 1633, pr. 1655); and *The Bashful Lover* (lic. 1636, pr. 1655). *A Very Woman, or The Prince of Tarent,* licensed in 1634 as the work of Massinger alone, is generally referred to his collaboration with Fletcher.

Twelve plays of Massinger are said to be lost, but the titles of some of these may be duplicates of those of existing plays. Five of these lost plays were mss. used by John Warburton's cook for pie-covers. The numerous plays in which Massinger's co-operation with John Fletcher is generally assumed are dealt with under BEAUMONT and FLETCHER. But it may be here noted that Mr. R. Boyle has constructed an ingenious case for the joint authorship by Fletcher and Massinger of the two "Shakespearian" plays, *Henry VIII.* and *Two Noble Kinsmen.* (*See* the New Shakspere Society's *Transactions,* 1884 and 1882.)

Massinger's independent works were collected by Coxeter (4 vols., 1759, revised edition with introduction by Thomas Davies, 1779), by J. Monck Mason (4 vols., 1779), by William Gifford (4 vols., 1805, 1813), by Hartley Coleridge (1840), by Lieut.-Colonel Cunningham (1867), and selections by Mr. Arthur Symons in the *Mermaid Series* (1887–89). Gifford's remains the standard edition, and formed the basis of Cunningham's text. It contains "An Essay on the Dramatic Writings of Massinger" by Dr. John Ferriar.

Massinger has been the object of a good deal of criticism. A metrical examination of the plays in which Massinger was concerned is given in *Englische Studien* (Halle, v. 74, vii. 66, viii. 39, ix. 209 and x. 383), by Mr. R. Boyle, who also contributed the life of the poet in the *Dictionary of National Biography.* The sources of his plays are dealt with by E. Koeppel in *Quellen Studien zu den Dramen Chapman's, Massinger's und Ford's* (Strassburg, 1897). For detailed criticism, beside the introductions to the editions quoted, *see* A. W. Ward, *Hist. of Eng. Dram. Lit.* (1899), iii. 1–47; F. G. Fleay, *Biog. Chron. of the Eng. Drama* (1891), under *Fletcher;* and Koeppel in *Cambridge History of English Literature,* vol. vi.; a general estimate of Massinger, dealing especially with his moral standpoint, is given in Sir Leslie Stephen's *Hours in a Library* (3rd series, 1879); Swinburne, in the *Fortnightly Review* (July 1889), while acknowledging the justice of Sir L. Stephen's main strictures, found much to say in praise of the poet. Full discussion of the disputed plays will be found in A. H. Cruickshank, *Philip Massinger* (Oxford, 1928); *see* also the list which will be found at the end of ch. 5, *Cambridge History of English Literature,* vol. vi. (1910).

MASSINGHAM, HENRY WILLIAM (1860–1924), British journalist, was born at Old Catton, Norfolk. He commenced journalism at the age of 17, and, after serving on various newspapers, he began, in 1907, a long association with *The Nation,* which he edited till the end of 1923. He was a severe critic of the World War and the Peace Treaty of 1919 and advocated co-operation between the Liberal and Labour parties. An early member of the Fabian Society, Massingham ultimately joined the Labour party, though on ethical, rather than economic, grounds, and his last journalistic work was done for *The New Statesman.* He died at Tintagel, Cornwall, on Aug. 28, 1924. One of the best all-round journalists of his day, he was a trenchant writer on politics and a discerning critic of literature and the drama. He published in 1892 *The London Daily Press,* and contributed an introduction to the memorial edition of the works of Mark Rutherford (1923).

H. W. M. A Selection from the Writings of H. W. Massingham, ed. by H. J. Massingham (1925), contains highly appreciative estimates by G. Bernard Shaw and various eminent associates.

MASSINISSA (*c.* 238–149 B.C.), king of Massylian or eastern Numidia, was educated at Carthage. His kingdom, though nominally independent of Carthage, was imbued to a very considerable extent with Carthaginian civilization; Massinissa, though a barbarian at heart, had a varnish of culture, and the craft and cunning in which Carthaginian statesmen were supposed to

excel. While yet a young man (212) he forced his neighbour Syphax, prince of western Numidia, who had recently entered into an alliance with Rome, to fly to the Moors in the extreme west of Africa. Soon afterwards he appeared in Spain, fighting for Carthage with a large force of Numidian cavalry against the Romans under the two Scipios. The defeat of the Carthaginian army in 206 led him to cast in his lot with Rome. Scipio Africanus is said to have cultivated his friendship. Massinissa now quitted Spain for a while for Africa, and was again engaged in a war with Syphax in which he was decidedly worsted, but after Scipio's arrival in Africa in 204 Massinissa crushed his old enemy Syphax, and captured his capital Cirta (Constantine).

Here occurs the romantic story of Sophonisba, daughter of the Carthaginian Hasdrubal, who had been promised in marriage to Massinissa, but had subsequently become the wife of Syphax. Massinissa, according to the story, married Sophonisba immediately after his victory, but was required by Scipio to dismiss her as a Carthaginian, and consequently an enemy to Rome. To save her from such humiliation he sent her poison, with which she destroyed herself. Massinissa was now confirmed by Scipio in the possession of his kingdom. In the battle of Zama (202) (*see* PUNIC WARS), he commanded the cavalry on Scipio's right wing. For his services he received the kingdom of Syphax, and thus under Roman protection he became master of the whole of Numidia, and his dominions completely enclosed the Carthaginian territories. It would seem that he had thoughts of annexing Carthage itself with the connivance of Rome. In a war which soon followed he was successful; the remonstrances of Carthage with Rome on the behaviour of her ally were answered by the appointment of Scipio as arbitrator; but, as though intentionally on the part of Rome, no definite settlement was arrived at. Rome, it is certain, deliberately favoured her ally's unjust claims with the view of keeping Carthage weak, and it was Massinissa's policy, as soon as Carthage seemed to be recovering herself, to excite the fears of Rome, till at last the Third Punic War (149) ended in the final overthrow of Carthage. The king died soon after its commencement.

Massinissa converted a plundering tribe into a settled and civilized population. To his sons he bequeathed a well-stored treasury, a formidable army, and even a fleet. Cirta (*q.v.*), his capital, became a famous centre of Phoenician civilization. In fact Massinissa changed for the better the whole aspect of a great part of northern Africa. His fidelity to Rome was merely that of temporary expediency.

See Livy xxiv. 49, xxviii. 11, 35, 42, xxix. 27, xxx. 3, 12, 28, 37, xlii. 23, 29, xliii. 3; Polybius iii. 5 ix. 42, xiv. 1, xxxii. 2, xxxvii. 3; Appian, *Hisp.* 37, *Punica,* 11, 27, 105; Justin xxxiii. 1; A. H. J. Greenidge, *Hist. of Rome* (1904).

MASSON, DAVID (1822–1907), Scottish man of letters, was born at Aberdeen on Dec. 2, 1822, and educated at the grammar school there and at Marischal College. He studied theology at Edinburgh university, under Dr. Chalmers. He gave up his intention to enter the ministry, and became editor of the *Banner,* a weekly paper which advocated Free Church principles. After two years he returned to Edinburgh, where he became a frequent contributor to *Fraser's Magazine, Dublin University Magazine* (in which appeared his essays on Chatterton), and other periodicals. In 1847 he went to London, where he became secretary (1851–2) of the "Society of the Friends of Italy." In 1852 he was appointed professor of English literature at University college, London, and from 1858 to 1865 he edited the newly established *Macmillan's Magazine.* From 1865–93 he occupied the chair of rhetoric and English literature at Edinburgh, and promoted the movement for the university education of women. In 1879 he became editor of the Register of the Scottish Privy Council, and in 1893 was appointed Historiographer Royal for Scotland. His *magnum opus* is his *Life of Milton in Connexion with the History of His Own Time* (6 vols. 1858–80). He also edited the library edition of Milton's *Poetical Works* (3 vols., 1874), and De Quincey's *Collected Works* (14 vols., 1889–90). He died on Oct. 6, 1907. Professor Masson had married Rosaline Orme. His son Orme Masson became professor of chemistry in the university of Melbourne.

Among his other publications are *Essays, Biographical and Critical* (1856, reprinted with additions, 3 vols., 1874), *British Novelists and their Styles* (1859), *Drummond of Hawthornden* (1873), *Chatterton* (1873) and *Edinburgh Sketches* (1892).

MASSON, FRÉDÉRIC (1847–1923), French historian and academician was born in Paris on March 8, 1847. His father, Francis Masson, a solicitor, was killed on June 23, 1848, while serving as an officer in the *garde nationale.* Young Masson was educated at the college of Sainte Barbe, and at the lycée Louis-le-Grand, and then travelled in Germany and in England; from 1869 to 1880 he was librarian at the Foreign Office. He is best known for his books connected with Napoleon. In *Napoléon inconnu* (1895), Masson, with M. Guido Biagi, brought out the unpublished writings (1786–1793) of the future emperor. These were notes, extracts from historical, philosophical and literary books, and personal reflections. His other works include several books on Josephine; *Napoléon et sa famille* (9 vols., 1897–1907); *Napoléon et son fils* (1904); and *Autour de l'Île d'Elbe* (1908). Masson died in Paris on Feb. 19, 1923.

A bibliography of his works, including anonymous ones and those under an assumed name, has been published by G. Vicaire (*Manuel de l'amateur des livres du XIXe siècle,* tome, v., 1904).

MASS PRODUCTION. The term mass production is used to describe the modern method by which great quantities of a single standardized commodity are manufactured. As commonly employed it is made to refer to the quantity produced, but its primary reference is to method. In several particulars the term is unsatisfactory. Mass production is not merely quantity production, for this may be had with none of the requisites of mass production. Nor is it merely machine production, which also may exist without any resemblance to mass production. Mass production is the focussing upon a manufacturing project of the principles of power, accuracy, economy, system, continuity and speed. The interpretation of these principles, through studies of operation and machine development and their co-ordination, is the conspicuous task of management. And the normal result is a productive organisation that delivers in quantities a useful commodity of standard material, workmanship and design at minimum cost. The necessary, precedent condition of mass production is a capacity, latent or developed, of *mass consumption,* the ability to absorb large production. The two go together, and in the latter may be traced the reasons for the former.

I. THE ORIGINS OF MASS PRODUCTION

In origin mass production is American and recent; its earliest notable appearance falls within the first decade of the 20th century. The mere massing of men and materials is a procedure as old as the pyramids. Basic industries, like weaving, domestic baking, house construction and wooden ship building, are carried on, with only superficial changes, much as they were in ancient Egypt. Cottage manufactures and handicrafts moulded the practices of industry until the invention of the steam-engine. With the coming of power machines the seat of industry was removed from the homes of the people and a new work centre, the factory, was established. Much harsh criticism has been uttered against "the factory system," but it is perhaps fair to say that its first effect was to emancipate the home from being a mere adjunct to the loom or bench, and its later effect was to provide the home with means to develop the dignified status which it has now attained.

The Factory System Giving Way.—The early factory system was uneconomical. Its beginning brought greater risk and loss of capital than had been known before, lower wages and more precarious outlook for the workers, and a decrease in quality of goods. More hours, more workers, more machines did not improve conditions; every increase did but enlarge the scale of fallacies built into business. Mere massing of men and tools was not enough; the profit motive, which dominated enterprise, was not enough. There remained the scientific motive which grew eventually into what is called mass production.

The new method came after the failure of the mercantile and

financial emphasis in manufacture. The advent and progress of financial control of industry were marked by two developments, the corporation and the labour revolt. Artificial combination of industrial plants into vast corporations for financial purposes was the first movement toward *mass* in industry. It proceeded on the theory that complete financial control would automatically bring complete profit advantage. The theory ignored many vital principles of business and its fallacy became apparent, but not before serious social hostility had been incurred.

However, it was out of the social strife thus engendered that the idea began to emerge that possibly the difficulty lay in the neglect of scientific manufacturing principles. Industry was conceded to be necessary and useful; the service it rendered was regarded as of sufficient value to afford fair compensation for all engaged in it; it was therefore urged that the attention of management should be more directly focussed on the actual labour processes that were employed. This led to what was known early in the 20th century as the "efficiency movement" with its accompaniments of time-study and similar methods, although its roots were laid in the experiences of sound industrial observers as early as 1878. It cannot be said, however, that the efficiency experts did more than direct attention to the problem, by showing, in selected instances, how the then current methods were wasteful of men's earning power, and how their correction and improvement could lead to greater production, hence higher wages, and therefore a general betterment of labour relations. They emphasized a more intelligent management of methods than was then in use; they did not see that a wholly new method was possible which would simply abolish the problems of which the old method, under the most intelligent management, was inevitably prolific. For example they dealt with methods which enabled labourers whose task was to load 12½ tons of pig-iron a day, to load 47½ long tons a day for an increase in the day's pay from $1.15 to $1.85. They did not see that another and better method might be devised which would make it unnecessary for a working-man to carry 106,400 lb. of pig-iron to earn $1.85. Mass production was not in their view, but only the alleviation of the worst errors of competitive factory practice.

The Motor Industry Leads the Way.—To the motor industry is given the credit of bringing mass production to experimental success, and by general consent the Ford Motor Company is regarded as having pioneered in the largest development of the method under a single management and for a single purpose. It may, therefore, simplify the history of mass production and the description of its principles if the experience of this company is taken as a basis. It has been already suggested that mass production is possible only through the ability of the public to absorb large quantities of the commodity thus produced. These commodities are necessarily limited to necessities and conveniences. The greatest development of mass production methods has occurred in the production of conveniences. The motor vehicle represents a basic and continuous convenience-transportation.

Mass production begins, then, in the conception of a public need of which the public may not as yet be conscious and proceeds on the principle that use-convenience must be matched by price-convenience. Under this principle the element of service remains uppermost; profit and expansion are trusted to emerge as consequences. As to which precedes the other, consumption or production, experiences will differ. But granted that the vision of the public need is correct, and the commodity adapted to meet it, the impulse to increased production may come in anticipation of demand, or in response to demand, but the resulting consumption is always utilized to obtain such increase of quality, or such decrease of cost, or both, as shall secure still greater use-convenience and price-convenience. As these increase, consumption increases, making possible still greater production advantages, and so on to a fulfilment that is not yet in view.

The commodities that conduce to civilized living are thus far enjoyed by only a small fraction of the world's inhabitants. The experience of the Ford Motor Company has been that mass production precedes mass consumption and makes it possible, by reducing costs and thus permitting both greater use-convenience and price-convenience. If the production is increased, costs can be reduced. If production is increased 500% costs may be cut 50%, and this decrease in cost, with its accompanying decrease in selling price, will probably multiply by 10 the number of people who can conveniently buy the product.

II. THE PRINCIPLES OF MASS PRODUCTION

As to shop detail, the keyword to mass production is simplicity. Three plain principles underlie it: (*a*) the planned orderly progression of the commodity through the shop; (*b*) the delivery of work instead of leaving it to the workman's initiative to find it; (*c*) an analysis of operations into their constituent parts. These are distinct but not separate steps; all are involved in the first one. To plan the progress of material from the initial manufacturing operation until its emergence as a finished product involves shop planning on a large scale and the manufacture and delivery of material, tools and parts at various points along the line. To do this successfully with a progressing piece of work means a careful breaking up of the work into its "operations" in sequence. All three fundamentals are involved in the original act of planning a moving line of production.

This system is practised, not only on the final assembly line, but throughout the various arts and trades involved in the completed product. The motor car assembly line offers an impressive spectacle of hundreds of parts being quickly put together into a going vehicle, but flowing into that are other assembly lines on which each of the hundreds of parts have been fashioned. It may be far down the final assembly line that the springs, for example, appear, and they may seem to be a negligible part of the whole operation. Formerly one artisan would cut, harden, bend and build a spring. In 1928 the making of one leaf of a spring is an operation of apparent complexity, yet is really the ultimate reduction to simplicity of operation.

A Typical Operation Described.—For its illustrative value let us trace the course of a spring leaf after it has progressed from iron ore through ingot, bloom and billet stages, and is rolled into strips. (1) Beginning as a strip of steel prepared by the steelmill, it is placed in a punch press for cutting and piercing. The workman puts the strip into press until it hits a stop, then trips the press. The cut-off and pierced piece falls on a belt conveyor which runs along the loading end of a series of heat-treating ovens. (2) A second workman takes the pieces from belt conveyor and places them on conveyor which passes through the furnace (in which temperature is automatically controlled); thence they are deposited at a certain temperature by this conveyor at the unloading end of the furnace. (3) The heated piece is lifted with tongs by a third operator and placed in a bending machine which gives the leaf its proper curve and plunges it in oil, the temperature of which is maintained at a definite degree by apparatus beyond the operator's control. (4) As the bending machine emerges from the oil bath, the same operator takes out the leaf and sets it aside to air-cool. (5) The leaf is then drawn by a fourth operator through molten nitrate kept at a regulated temperature. (6) A fifth workman inspects it.

As a set of springs on the Ford car requires on an average 17 leaves, and 25,000 springs are an average day's output, this operation must be visualised as employing a great battery of lines similar to the one briefly described. As all the leaves in a spring are of different length and curve, from the bottom or master leaf to the top leaf, this operation must be visualised as one of many carried on simultaneously by different batteries of machines, each battery working on its own special size. All of these lines, with their various machines and operations, are converging on the point where the leaves are assembled into springs. The leaf whose progress has been described is the simplest one.

The operation proceeds as follows: (7) A sixth workman removes the leaf from the conveyor which carries it from the molten nitrate, and inserts a bolt through this and the other leaves required in the spring. (8) A seventh workman puts the nut on the bolt and tightens it. (9) An eighth workman puts on the right and left hand clips and grinds off the burrs. (10) A ninth workman inspects it. (11) He hangs the spring on a conveyor. (12) The

spring passes the tenth workman, who sprays it with paint, and the conveyor carries the spring above the ovens where it was originally heated, and the radiated heat "force dries" the paint. (13) The conveyor continues to the loading dock, where the eleventh workman removes it.

One workman under the old system could attend the leaf through all these phases, or even make a complete spring, but his production would be limited. Where large quantities of the same article are to be made, the simplest operation may involve the whole time of one man. A one-minute operation will require one man a full day of eight hours to accomplish it on 480 pieces. Now this simple part, a spring leaf, must be identical in strength, finish and curve with millions of others designed to fulfil the same purpose, and this becomes a complicated and delicate procedure requiring automatic machinery, the most accurate of measuring devices, pyrometer controls, "go" and "no go" gauges—in fact, the best facilities that can be provided by modern management. The leaf described, which is a minor matter when compared with the whole great process, becomes a major matter when considered by itself; it must have its own supply of material delivered in sufficient quantities at indicated places—for example, steel at 1; heat at 2; power and oil at 3; molten nitrate at 5; bolts at 7; nuts at 8; clips at 9; paint at 12. In this process the secrets of many arts and trades are employed.

The story of this minor part illustrates what is meant by orderly progression of the article through the shop. It goes to meet other parts of the motor-car which have come from other parts of the plant by similar processes. The story illustrates also what is meant by delivering the work to the workman: every workman's task is prepared for him by some other workman, and delivered to his hand. The third principle also is illustrated—the analysis of a single job into its constituent operations. The simplicity of the part here described should not be permitted to exclude from view the multitude of other operations, ranging from the heaviest forgings to the lightest manipulations in bench assembly of delicate electrical instruments. Some gauge inspections involve measurements to the ten-millionth part of an inch.

The economies arising from this method are obvious. The machinery is constantly in use. It would be economically impossible to maintain all this equipment for the service of men occupied in the entire operation of making springs. Presses, furnaces, bending machines, oil baths would be idle while the workman progressed from operation to operation. Under mass production it is the work that progresses from operation to operation. Use-convenience in the commodity would be lessened, while price-convenience would be destroyed. Economy in machine hours is, however, only one element; there is also economy in time and material and labour. Mass production justifies itself only by an economy whose benefits may be transmitted to the purchaser.

III. THE EFFECTS OF MASS PRODUCTION

But it is not the history and principle of mass production which provoke the widest discussions; the *effects* of it have been placed under scrutiny. What have been the effects of mass production on society?

(1) Beginning with management, where unquestionably mass production methods take their rise, there is a notable increase in industrial control, as distinguished from financial control. The engineer's point of view has gained the ascendancy and this trend will undoubtedly continue until finance becomes the handmaid instead of the mistress of productive industry. Industrial control has been marked by a continuous refinement of standardization, which means the instant adoption of the better method to the exclusion of the old, in the interests of production. Financial control was not, in its heyday, marked by a tendency to make costly changes in the interests of the product. The economy of scrapping the old equipment immediately upon the invention of the better equipment was not so well understood. It was engineering control, entrenched in mass production methods, that brought in this new readiness to advance. In this way management has been kept close to the shop and has reduced the office to a clearing house for the shop. Managers and men have been brought into closer contact and understanding. Manufacturing has been reduced to greater singleness of purpose.

(2) The effect of mass production on the product has been to give it the highest standard of quality ever attained in output of great quantities. Conditions of mass production require material of the best quality to pass successfully through the operations. The utmost accuracy must control all these operations. Every part must be produced to fit at once into the design for which it is made. In mass production there are no fitters. The presence of fitters indicates that the parts have been produced unfit for immediate placement in the design. In works of art and luxury this accuracy is achieved at the cost of careful handiwork. To introduce hand methods of obtaining accuracy into mass production would render mass production impossible with any reference to price-convenience. The standard quality of the product is guaranteed by the fact that machines are so constructed that a piece of work cannot go through them unless it exactly accords with specifications. If the work goes through the tools, it must be right. It will thus be seen that the burden of creation is on management in designing and selecting the material which is to be produced by the multiple processes utilised in mass production.

(3) The effect of mass production on mechanical science has been to create a wide variety of single-purpose machines which not only group similar operations and perform them in quantity, but also reproduce skill of hand to a marvellous degree. It is not so much the discovery of new principles as the new combination and application of old ones that mark this development. Under mass production the industry of machine making has increased out of all comparison with its previous history, and the constant designing of new machines is a part of the productive work of every great manufacturing institution.

(4) The effect of mass production on employees has been variously appraised. Whether the modern corporation is the destruction or salvation of arts and crafts, whether it narrows or broadens opportunity, whether it assists or retards the personal development of the worker, must be determined by observable facts. A cardinal principle of mass production is that hard work, in the old physical sense of laborious burden-bearing, is wasteful. The physical load is lifted off men and placed on machines. The recurrent mental load is shifted from men in production to men in designing. As to the contention that machines thus become the masters of men, it may be said the machines have increased men's mastery of their environment, and that a generation which is ceaselessly scrapping its machines exhibits few indications of mechanical subjection.

The need for skilled artisans and creative genius is greater under mass production than without it. In entering the shops of the Ford Motor Company, for example, one passes through great departments of skilled mechanics who are not engaged in production, but in the construction and maintenance of the machinery of production. Details of from 5,000 to 10,000 highly skilled artisans at strategic points throughout the shops were not commonly witnessed in the days preceding mass production. It has been debated whether there is less or more skill as a consequence of mass production. The present writer's opinion is that there is more. The common work of the world has always been done by unskilled labour, but the common work of the world in modern times is not as common as it was formerly. In almost every field of labour more knowledge and responsibility are required than a generation or two ago.

Some Criticisms Answered.—Mass production has also been studied with reference to what has been called the monotony of repetitive work. This monotony does not exist as much in the shops as in the minds of theorists and bookish reformers. There is no form of work without its hardness; but needless hardship has no place in the modern industrial scheme. Mass production lightens work, but increases its repetitive quality. In this it is the opposite of the mediaeval ideal of craftsmanship where the artisan performed every operation, from the preparation of the material to its final form. It is doubtful, however, if the mass of mediaeval toil was as devoid of monotony as has sometimes been pictured, but it is absolutely certain that it was less satisfactory in its re-

sults to the worker. In well-managed modern factories the tendency to monotony is combated by frequent changes of task.

The criticism of mass production as a means of reducing employment has long since been out of court. The experience of the Ford Motor Company is that wherever the number of men has been reduced on manufacturing operations, more jobs have been created. A continuous programme of labour reduction has been paralleled by a continuous increase in employment. As to the effect of mass production on wages and the relations between managers and men, there is little need to speak. It is perhaps the most widely understood fact about mass production that it has resulted in higher wages than any other method of industry. The reason is at hand. The methods of mass production enable the worker to earn more and thus to have more. Moreover, the methods of mass production have thrown so much responsibility on the craftsmanship of management, that the old method of financial adjustment by reduction of wages has been abandoned by scientific manufacturers. A business that must finance by drafts out of the wage envelopes of its employees is not scientifically based. It is the problem of management so to organise production that it will pay the public, the workmen and the concern itself. Management that fails in any of these is poor management. Disturbed labour conditions, poor wages, uncertain profits indicate lapses in management. The craftsmanship of management absorbs the energies of many thousands of men who, without mass production methods, would have no creative opportunity. Here the modern method broadens instead of narrows individual opportunity.

(5) As to the effects of mass production on society, the increasing supply of human needs and the development of new standards of living are the elements to be estimated. The enlargement of leisure, the increase of human contacts, the extension of individual range, are all the result of mass production. (H. Fo.)

See H. Ford, *My Life and Work* (1924), and *To-day and Tomorrow* (1926); E. G. Filene, *The Way Out* (1924); and Articles in the American *Economic Review*.

MASTABA, in Egyptian architecture, a rectangular cut stone tomb, with raking sides and a flat roof, usually containing three chambers. In the first the walls were sometimes richly decorated with paintings and had a low bench of stone on which incense was burnt. The second, containing the *serdab,* or image of the deceased, was either closed, with holes pierced in the wall separating it from the first chamber, or entered through a narrow passage through which the fumes of the incense passed. A vertical well-hole descended to the third in which the mummy was laid.

MASTER, one holding a position of authority, disposition or control over persons or things. As a title of the holder of an office, the use of the Lat. *magister* is very ancient. *Magister equitum,* master of the horse, goes back to the early history of the Roman Republic (*see* DICTATOR). The British office is termed MASTER OF THE HORSE. In mediaeval times the title was of great frequency. In the British royal household most of the offices bearing this title are now obsolete. Of the greater offices, that of master of the buckhounds was abolished by the Civil List Act 1901. The master of the household, master of the ceremonies, master of the king's music still survive. Since 1870 the office of master of the mint has been held by the chancellor of the exchequer. A deputy performs administrative and other duties.

At sea, a "master" is more properly styled "master mariner." In the merchant service he is the commander of a ship, and is by courtesy known as the captain. In the British navy he was the officer entrusted with the navigation under the captain. He had no royal commission, but a warrant from the Navy Board. Very often he had been a merchant captain. His duties are now performed by the staff commander or navigating lieutenant. The master-at-arms is the head of the internal police of a ship; the same title is born by a senior gymnastic instructor in the army. In the United States navy, the master is a commissioned officer below the rank of lieutenant.

"Master" appears as the title of many legal functionaries (for the masters of the supreme court *see* CHANCERY; and KING'S BENCH, COURT OF; for masters in lunacy *see* INSANITY: *Law; see* also MASTER OF THE ROLLS, p. 43). The "master of the faculties" is the chief officer of the archbishop of Canterbury in his court of faculties. His duties are concerned with the appointment of notaries and the granting of special licences of marriage. The duties are performed *ex officio* by the judge of the provincial courts of Canterbury and York, who is also dean of Arches, in accordance with s. 7 of the Public Worship Regulation Act 1874. The "master of the Temple" is the title of the priest-in-charge of the Temple church in London. It was formerly the title of the grand master of the Knights Templars. The priest-in-charge of the Templars' church was properly styled the *custos,* and this was preserved by the Knights Hospitallers when they were granted the property of the Templars at the dissolution of that order. The Act of 1540 (32 Henry VIII.), which dissolved the order of the Hospitallers, wrongly styled the *custos* master of the Temple, and the mistake has been continued. The proper title of a bencher of the Inns of Court is "master of the Bench" (*see* INNS OF COURT). The title of "Master-General of the Ordnance" was revived in 1904 for the head of the Ordnance Department in the British military administration.

"Master" is the ordinary word for a teacher, very generally used in the compound "schoolmaster." The word also is used in a sense transferred from this to express the relation between the founder of a school of religion, philosophy, science, art, etc., and his disciples. It is partly in this sense and partly in that of one whose work serves as a model or type of superlative excellence that such terms as "old masters" are used. In mediaeval universities *magister* was particularly applied to one who had been granted a degree carrying with it the *licentia docendi,* the licence to teach. In English usage this survives in the faculty of arts. The degree is that of *artium magister,* master of arts, abbreviated M.A. In the other faculties the corresponding degree is doctor. Some British universities give a master's degree in surgery, *magister chirurgiae,* C.M. or M.Ch., and also in science, *magister scientiae,* M.Sc.

Master was the usual prefix of address to a man's name, though originally confined to people of some social standing. Probably under the influence of "mistress," it was corrupted in sound to "mister," and was abbreviated to "Mr." In the case of the puisne judges of the High Court "Mr. Justice" is still used as the proper official form of written address. The Speaker of the House of Commons and the Speaker of the House of Representatives at Washington and also the Speakers in the State Legislatures are formally addressed as Mr. Speaker. The President of the United States is always addressed as Mr. President.

MASTER AND SERVANT. This comprehensive term includes all forms of occupation in which a person for valuable consideration hires out his services in a subordinate capacity to another for the purpose of helping that other in the performance of some duty or object for which assistance is either necessary or desirable. The contract need not be reduced into writing unless by the terms of the bargain the employment is to extend beyond a year, in which case, a written agreement is necessary, under s. 4 of the Statute of Frauds (*Dollar* v. *Parkington,* 1901, 84 L.J. 470). Consequently, a contract of service for a period of more than one year, terminable at any time by six months' notice, is unenforceable unless there be a memorandum in writing (*Hanau* v. *Erlich,* 1912, A.C. 39). Nor will part performance take the case out of the statute. It seems, however, that a contract of hiring for a year certain need not be evidenced by writing unless it is to commence at a future date which would extend the term of employment beyond the year. Where the agreement is in writing, the consideration for the servant's promise to remain in the master's employ should appear on the face of the document and also the period during which the hiring is to continue and the length of notice necessary for its termination. But in a general hiring by parol the nature of the employment is a factor to be considered in determining alike the duration of the engagement and the length of notice. In the case of a domestic or menial servant a general hiring will be construed as a hiring for a year terminable by a month's notice or by payment of a month's wages (with nothing additional for board and lodging) on the part of the master, and by a month's notice on the part of the servant. There is, how-

ever, no right of set off by a master for accidental breakage of domestic utensils by a servant. A custom in domestic service that either party may determine it at the end of the first month by notice given at any time during the first fortnight has been held reasonable (*George* v. *Davis,* 1911, 2 K.B. 445). Judicial decisions show that the rule as to a month's notice is not applicable in the case of an editor, a governess, a farm bailiff, a steward, the house-keeper of a large hotel or a servant in husbandry. But it has been held to apply to a gardener and a huntsman.

Where the relation of master and servant clearly exists, the employer is responsible for injury occasioned by the negligent conduct of the servant in carrying out his orders. And this rule is so extensive as to make the master liable for the careless, reckless and wanton conduct of his servant, provided it be within the scope of his employment. But this responsibility does not prevent the servant from also being liable. A master is not, however, responsible for a wilful fraud outside the course of the servant's employment, or for an act inconsistent with the nature of his duties.

If a servant wilfully disobey any lawful order of his master or unlawfully absent himself from his work, or if he be guilty of moral misconduct, or take a concealed commission, or prove grossly incompetent in some particular service for which he was engaged, he may be discharged without notice before the expiration of the period for which he was hired. Nor, in such case, is he entitled to any wages from the date of his discharge, if they had not then accrued due. There is no legal obligation on the part of the master to give a "character" to a domestic or menial servant, but it is common law misdemeanour for any one to give a false character either verbally or in writing. A master need not, when dismissing a servant, allege any particular act on the part of the latter as the ground for his discharge, it being sufficient for such cause actually to exist.

The obligations entailed upon a master towards his servant are further enhanced by the provisions of the National Health Insurance Act 1924. The consideration for the benefits under this Act, in the cases to which it applies, being a compulsory weekly payment by the master and the servant of the amounts set out in the second schedule to the act. *See* EMPLOYER'S LIABILITY; LABOUR LAW. (W. W.ᵉ P.)

MASTER OF THE ROLLS, in England, originally chief of the 12 clerks or masters in chancery and as such keeper of the rolls, especially of the register of original writs, and of all patents and grants under the great seal. He was first called master of the rolls in the statute 11 Hen. VIII. ch. 18. Before and after this date he is sometimes called vice-chancellor, since with the development of the chancery as a court, he was called upon to sit at first with the justices or with two or more masters; later, in the absence of the chancellor, by himself for judicial business. In fact he became the deputy of the chancellor. Meanwhile he had long ceased to be keeper of the records, but by the Public Record Office Act, 1838, their custody was restored to him, and he is now also chairman of the State Papers and Historical Manuscripts Commissions. Under the Judicature Act, 1875, and the Appellate Jurisdiction Act, 1876, he now always sits with the lords justices in the court of appeal (which usually sits in two divisions of three judges, the master of the rolls presiding over one division), whose decisions can be questioned only in the House of Lords. The master of the rolls was formerly eligible to a seat in the House of Commons. Sir John Romilly, appointed in 1851, was the last to enjoy this privilege, which was abolished by the Judicature Act, 1873. The salary is £6,000; the holder is sworn to the Privy Council.

See Holdsworth, *Hist. Eng. Law,* vol. i., ch. v. (H. H. L. B.)

MASTER OSCILLATOR, as applied to radio, is an oscillator of comparatively low power so arranged as to control the frequency of the output of an amplifier.

MASTERS, EDGAR LEE (1869–), American poet and novelist, was born at Garnett, Kan., on Aug. 23, 1869. He entered Knox college in Galesburg, Ill., and was admitted to the bar in 1891. A small book of verses appeared in 1898; followed by *Maximilian,* a drama in blank verse (1902); *The New Star Chamber and Other Essays* (1904); *Blood of the Prophets* (1905); *Althea,* a play (1907); and *The Trifler,* a play (1908).

It was William Marion Reedy, of St. Louis, who, in 1914, advised Masters to deal with the people of his own day, with human nature as he had seen it revealed in the court-room and the attorney's office. Masters produced a series of post-mortems spoken by the erstwhile inhabitants of a Middle-Western village from beyond the grave. He entitled his work *The Spoon River Anthology.* It remains Masters's greatest effort.

Two of Masters's best short poems are to be found in *Songs and Satires* (1916); other volumes of his poetry are: *The Great Valley* (1916); *Toward the Gulf* (1918); *Starved Rock* (1919); *Domesday Book* (1920); and *The New Spoon River* (1924). But the content of these books is most uneven in quality. Masters has also essayed the novel. His novels of boyhood, as *Mitch Miller* (1920), are his best. His novels of maturity, such as *The Nuptial Flight* (1923), *Mirage* (1924), are uneven in workmanship, though they contain some striking ideas. *Lee* (1926) is a long dramatic poem; *Jack Kelso* (1928), in which the central figure is a poet, a wanderer and a friend of Lincoln, is a poem having the proportions of an epic. Masters has been the opponent of hypocrisy and is often an ironist of great power.

See "Edgar Lee Masters: Critic of Life" in Llewellyn Jones's *First Impressions* (1925); "Robert Herrick and Edgar Lee Masters, Interpreters of our Modern World," in Harry Hansen's *Mid-West Portraits* (1923); Amy Lowell on Masters in *Tendencies in Modern American Poetry* (1917) and Louis Untermeyer's comments in *American Poetry since 1900* (1923). (W. R. BE.)

MASTIC or MASTICH, a resinous exudation obtained from the lentisk, *Pistacia Lentiscus,* an evergreen shrub of the family Anacardiaceae. The lentisk or mastic plant is indigenous to the Mediterranean coast region from Syria to Spain, but grows also in Portugal, Morocco and the Canaries. The production of the substance has been, since the time of Dioscorides, almost exclusively confined to the island of Chios. The shrubs are about 6 ft. high. The resin is contained in the bark and not in the wood, and in order to collect it numerous vertical incisions are made, during June, July and August, in the stem and chief branches. The resin speedily exudes and hardens into oval tears, which are collected every fifteen days. The collection is repeated several times between June and September, a fine tree being found to yield about 8 or 10 lb. of mastic during the season. Mastic occurs in commerce in the form of roundish tears about the size of peas. They are transparent, with a glassy fracture, of a pale yellow or faint greenish tinge, which darkens slowly with age. Its use in medicine is obsolete, and it is employed for making varnish.

Pistacia Khinjuk and *P. cabulica,* trees growing throughout Sindh, Baluchistan and Cabul, yield a kind of mastic. In Algeria *P. atlantica* yields a solid resin. Cape mastic is the produce of *Euryops multifidus,* the resin bush, or *harpuis bosch* of the Boers —a plant of the Compositae family. Dammar resin is sometimes sold under the name of mastic. The West Indian mastic tree is the *Bursera gummifera* and the Peruvian mastic is *Schinus Molle.* The name mastic tree is also applied to a timber tree, *Sideroxylon Mastichodendron,* family Sapotaceae, which grows in the West Indies and on the coast of Florida.

MASTIGOPHORA, an alternative name for the group *Flagellata* (q.v.) of the Protozoa.

MASTODON, a name given by Cuvier to those early forerunners of the elephants (*q.v.*) which have nipple-like prominences on the molar teeth. The generic term is now restricted by H. F. Osborn to a single species, *Mastodon americanus,* the American mastodon, but it is used familiarly to include a very large number of forms chiefly of Miocene and Pliocene age. For general account of these animals *see* the article PROBOSCIDEA.

The American mastodon is a large elephant which lived during Pleistocene times in the forests of eastern North America. It possesses molar teeth in which the ridges are placed transversely and are almost straight, the valleys between them not being blocked by intermediate cusps. The anterior molar possesses only three ridges. The upper tusks are large, devoid of enamel and upwardly directed, whilst the lower tusks are present only in the young animal as short, straight and forwardly directed spikes.

The ancestry of the American mastodon is unknown, but forms which are apparently closely allied have been discovered in China,

whilst a series of European animals, culminating in *Mastodon borsoni* are usually regarded as related. This association is, however, denied by H. F. Osborn. Skeletons of the mastodon have been found in Ohio and in the Hudson valley; all over the United States, its remains have been recorded, but it is rare in the Middle West and South. It is usually found in the deposits laid down in a swamp or small pool, and it seems certain that the animal was a forest form, living upon trees. (*See* also ELEPHANT, MAMMOTH.)

(D. M. S. W.)

MASTOID: *see* EAR, ANATOMY OF; EAR, NOSE AND THROAT, DISEASES OF.

MAS'ŪDĪ (ABŪ-L ḤASAN 'ALĪ IBN ḤUSAIN IBN 'ALĪ UL-MAS'ŪDĪ) (d. *c.* 956), Arabian historian, was born at Baghdad towards the close of the 9th century. After he had been in Persia and Kerman, he visited Istakhr in 915, and went in the following year to Mūltān and Manṣūra, thence to Cambay, Saimur and Ceylon, to Madagascar and back to Oman. He visited Tiberias in Palestine, and described the relics of the Christian church there. In 943 he was in Antioch, and two years later in Damascus. The last ten years of his life he spent in Syria and Egypt. Himself a Mo'tazilite (*see* MOHAMMEDAN INSTITUTIONS), he took his information, when necessary, from Persians, Jews, Indians, and even the chronicle of a Christian bishop.

His most extensive work was the *Kitāb akhbār uz-Zamān* or *Annals*, in 30 volumes with a supplement, the *Kitāb ul-Ausaṭ*, a chronological sketch of general history. The substance of the two parts was united by him in the *Murūj udh-Dhahab wa Ma'ādin ul-Jawāhir* ("Meadows of Gold and Mines of Precious Stones"), completed in 947 (French translation 9 vols. Paris 1861–77). In 956 he finished a second edition of this. Another work of Mas'ūdī, written in the last year of his life, is the *Kitāb ut-Tanbīh wal Ishrāf* (the "Book of Indication and Revision"), in which he summarizes the work of his life and corrects and completes his former writings. It has been edited by M. J. de Goeje (Leiden, 1894).

An account of Mas'ūdī's works is to be found in de Sacy's memoir and in Goeje's preface to his edition of the *Tanbīh*, and of the works extant in C. Brockelmann's *Gesch. der Arabischen Litteratur*, i. 144–145 (Weimar, 1898). C. Field's *Tales of the Caliphs* (1909) is based on Mas'ūdī.

MASULIPATAM or BANDAR, a seaport of British India, administrative headquarters of the Kistna district of Madras, on one of the mouths of the river Kistna, 215 m. N. of Madras city. Pop. (1921), 43,940. Masulipatam was the earliest English settlement on the Coromandel coast, its importance being due to the fact that it was the *bandar* or port of Golconda. An agency was established there in 1611. During the wars of the Carnatic, the English were temporarily expelled the town, which was held by the French for some years. In 1759 the town and fort were carried by storm by Colonel Forde, an achievement followed by the acquisition of the Northern Circars (*q.v.*). In 1864 a great stormwave swept over the entire town and is said to have destroyed 30,000 lives. In former days the chintzes of Masulipatam had a great reputation, but the weaving industry has declined. There are cotton ginning and pressing factories and rice mills, and Masulipatam has a college and training schools. The port is only a roadstead, where vessels anchor 5 m. out. There is a branch line from Bezwada on the Madras and Southern Mahratta railway. The chief educational institution is the Noble college of the Church Missionary Society.

MASURIAN LAKES, BATTLES OF THE, 1914 AND 1915. (*See* TANNENBERG.) It was the lake barrier which had proved the undoing of the Russians in their advance into East Prussia, and twice again was it to bring about their defeat when the Germans in their turn assumed the offensive. Jilinsky had failed to combine the action of his two armies, urging one forward to intercept what he thought to be a beaten enemy and dispatching the other on a subsidiary objective. The disaster to the II. Army had come to him as a crushing surprise, and in his fear that Rennenkampf would share the fate of Samsonov, he ordered the I. Army to halt and act on the defensive until fresh troops could be brought up from the centre of Russia. All chance of catching the Germans at a disadvantage during their temporary disorganization after the fighting at Tannenberg was thus lost.

I. THE SUMMER BATTLE

Ludendorff was not long in deciding what was to be done after the destruction of Samsonov. Even before the fighting at Tannenberg was over, on Aug. 29, 1914, he had commenced moving troops northwards to meet Rennenkampf. He was strongly urged to move southwards to the support of the sorely tried Austrians, but this would have meant leaving a strong and undefeated enemy directly in his rear, whilst attempting to traverse the self-same desert area which had tried Samsonov so greatly. From the German point of view it was more important to free East Prussia from the invader at once, and the Austrians must therefore wait their turn.

Position Before the Action.—All the German divisions had received their first reinforcements and were flushed with victory and full confidence in their leaders. Two fresh corps had arrived from the west. Rennenkampf did not appear to be on the move and was evidently commencing the blockade of Königsberg. Lötzen, the little fortress holding the main gap in the centre of the line of lakes, was still in German hands. Everything therefore seemed favourable for a German offensive.

Ludendorff's plan for his advance was in outline as follows: (1) Goltz with 2½ divisions was to check any advance on the part of the Russian II. Army from Poland; (2) François with three divisions and a cavalry brigade was to move round the southern end of the lakes at Johannisburg with the primary object of turning Rennenkampf's left, and at the same time dealing with any Russian forces assembling to the south of the lakes; (3) Mackensen with two divisions and two cavalry divisions was to cross the Lötzen gap and join with François in the attack against Rennenkampf's left; (4) the main body of eight divisions was to move direct on the Insterburg gap; (5) the Königsberg garrison was to make a demonstration against the blockading troops.

Rennenkampf had commenced withdrawing on Aug. 30, and on Sept. 2 he issued orders for a position to be taken up for defensive action from the sea near Libau to Angerburg at the northern end of the lakes. This position offered many advantages from a defensive point of view, running as it did behind the rivers Deime, Alle and Omet, but it was too extensive for the force of 12 divisions which Rennenkampf had at his disposal, the distance from flank to flank being 60 miles. Moreover, the left flank was exposed to attacks coming from the Lötzen gap and the southern end of the lakes. But it was chiefly in the manner in which he proceeded to occupy this position that he erred. He had no idea where the Germans were or what they had been doing in the interval since Tannenberg. He only had persistent rumours that the Germans were sending billeting parties to Königsberg. Instead of maintaining strong forces in front of his chosen position, in order to discover the enemy's intentions, Rennenkampf committed his troops at once to a linear defence of the line. He placed four of his divisions along the Deime on a front of 18 m., while keeping seven divisions to hold the remainder of his line of 42 miles. A single division was placed opposite the Lötzen gap to the east of the lakes.

It will thus be seen that from the very start of their manoeuvre the Germans had succeeded in out-generalling Rennenkampf. On the left of their line they were containing four Russian divisions with garrison troops, equivalent to about a division. In the centre they were opposing eight divisions to seven Russian divisions. On the right they were advancing with no less than five divisions and two cavalry divisions against a single Russian division.

German Attack.—Goltz attacked and took Mława on Sept. 4, and thereafter kept in check any of the units of the Russian II. Army which attempted to advance. By the night of Sept. 5 François was approaching the southern end of the lakes. By the 6th he had taken Johannisburg and Nikolaiken, driving back the few Russian troops opposing him. By the 7th he was through the lakes and had captured Bialla and Arys. The Russian troops opposing him had been hurried up without proper artillery support and were dispersed in disorder. Eleven Russian battalions were thus dissipated without result. On the 8th François turned northwards against the Russian flank. Sept. 9 was to be a fateful day for the Germans. Mackensen had commenced his crossing at Lötzen during the 8th, but he could not enlarge the bridge-head.

His troops attacked at 5 A.M., 12 noon and 8 P.M. on this day without success and that evening he reported no progress to François.

François' attack against Soltmahnen on the morning of the 9th came as a complete surprise to the left flank of the Russians opposing Mackensen. By noon the Russians were in hopeless rout, leaving 5,000 prisoners and 60 guns in the hands of François. The German enveloping movement had met with complete success. Rennenkampf's left flank division had been destroyed and about 8,000 men of the Russian X. Army concentrating about Augustówo and Osowiec had been placed out of action. The left flank of Rennenkampf's army now lay open to the attack of five German divisions. A second Tannenberg seemed more than probable.

Ludendorff had employed the 5th, 6th and 7th in bringing his eight divisions in line facing the Insterburg gap and, on the 8th, contact was gained with Rennenkampf's outposts. On the 9th, coinciding with François' attack, the Germans moved forward along the whole front. Little progress was made anywhere, and on the right the Russians made a determined counter-attack which completely held up the German advance. This check seems to have paralyzed Ludendorff temporarily, for he ordered his right under François and Mackensen to hold fast and even to close in to the centre for fear of disaster. But Rennenkampf had taken fright at the menace to his left and had decided to withdraw. That night he ordered a general retreat. He had been just too quick for the Germans. When Ludendorff allowed his right to move forward again, nothing further than cutting off the streams of disorganized transport and breaking up the Russian rear-guards was possible. Rennenkampf had pushed his retreat with desperation. Two of his corps had covered 58 m. in 60 hours. By the 13th he was safe from annihilation, and by the 14th his exhausted troops had crossed the East Prussian frontier between the forest of Rominten and the river Niemen.

Although the Russian I. Army had not been surrounded, it had suffered almost as much as the II. Army. Casualties since Sept. 6 had amounted to 125,000 men and 150 guns. Two corps had been destroyed and the whole army was out of action as a mobile force through lack of transport. The chief credit for this success must lie with François. In his march round the southern end of the lakes his men had covered 77 m. in the four critical days Sept. 6–9, and there had been severe fighting on two of those days. Had Ludendorff been quicker to realise that Rennenkampf's counter-attack on the 9th was made in order to disengage himself, and had his orders to François for the 10th and 11th not been so cautious, there can be no doubt that Rennenkampf's army would have been all but destroyed.

II. THE WINTER BATTLE

During their 28 days' invasion of East Prussia the Russians had lost some 310,000 men from the flower of their army and 650 guns. Their offensive had been completely defeated and they had been thrown on the defensive. It was not till late in the winter of 1914–15 that they began to show signs of activity once more. From the German point of view it was important to prevent another Russian invasion of East Prussia and it was therefore decided to upset the Russian plans by a strong offensive.

German Dispositions.—In Jan. 1915 the German VIII. Army, under Below, was holding a line from the frontier south of Lake Spirding, to the river Memel. Some 100,000 Germans were facing 200,000 men of the Russian X. Army under Siewers. To the south there were signs of a Russian XII. Army being assembled between Modlin and Thorn. Four fresh corps had been allotted for the offensive, making a total of some 250,000 men. In outline the German plan was as follows: (1) The X. Army (eight divisions and one cavalry division), under Eichhorn, was to envelop the Russian right, moving southwards from the Insterburg gap. (2) The right wing of the VIII. Army (three divisions), under Litzmann, was to envelop the Russian left by moving round the southern end of the lakes. (3) The remainder of the VIII. Army (four divisions) was to hold the centre.

Orders for the advance were issued on Jan. 28. The attack in the south was to commence on Feb. 7, with a view to drawing the attention of the Russians to this quarter. The main attack was then to come from the north on the 8th. Conditions were very different from those of the advance in Sept. of the year before. The weather was bitterly cold and the whole country was deep in snow. Large numbers of sleighs had been collected and the scale of clothing and food greatly increased. The German administration left nothing undone which could be thought out beforehand.

German Line Advanced.—Litzmann's advance found the marshy country in front of Johannisburg almost impassable, and the attack of the 7th came to little. Many of the units had to force their way through blinding snow storms, and it was not till the 8th that the Russian positions on the Pisseck were reached and taken, and by the 9th the end of the lakes was passed. This diversion served its purpose well, for the attack of the German X. Army in the north came as a complete surprise to the Russians in their winter quarters, leisurely thinking of an advance in the spring. They were given no time in which to readjust their line, and reserves had to be thrown in piece-meal to save the situation. On the 10th, a determined stand was made by four Russian divisions on either side of Eydtkuhnen, but by evening their resistance had been broken. Everywhere the effect of the German heavy artillery was decisive. Despite the difficulty of bringing forward the heavy wheeled vehicles, which broke through the frozen crust of the ground, the Germans never failed to support their infantry at the decisive point. By the 12th, Below's army had reached a line stretching from the forest of Rominten to Ludwinow.

Meanwhile, the German centre had moved forward to keep in touch with the southern wing. Russian resistance in the south seemed to centre round the town of Lyck, and Litzmann was reinforced by a fourth division for its capture. From the 10th to the 13th the fighting round Lyck was desperate. Often the opposing sides could not distinguish each other in the blizzards which swept over them, and owing to the difficulty of ammunition supply the infantry were unsupported by artillery fire of any sort, and fierce hand to hand fighting ensued. Casualties on both sides were therefore heavy and the Russians also lost over 8,000 prisoners and 14 guns. By the night of the 13th the Russians had been forced back and the town was in German hands.

Position After the Battle.—By the 14th, the German line ran from Rajgród in the south, through Suwalki, to Sztabinki in the north, in a semi-circle round Augustówo, at a distance of from 9 to 10 m., from the town. The wooded and close nature of the country made concerted attacks very difficult, but everywhere the superior individual training of the German soldier triumphed over the more ignorant Russian. The Russians fought with desperation to maintain their positions and it was not till the 17th that Siewers finally gave the order to abandon Augustówo. He succeeded in escaping envelopment by abandoning most of his transport and ammunition columns and retiring in disorder on Grodno. By the 20th the Germans were no longer in touch with the retreating Russians.

In the winter battle the Russians lost 110,000 prisoners and 300 guns, and the X. Army, like the I. and II. Armies, was placed *hors de combat*. They had been caught unawares in winter quarters, without proper protection and with an inferior intelligence service. Had the Germans been able to bring up the whole of their guns and ammunition on Feb. 14 they might have succeeded in surrounding Augustów, but the weather prevented this.

BIBLIOGRAPHY.—H. von Redern, *Winterschlacht in Masuren* (1918); P. von Hindenburg, *Out of My Life* (1920); E. Ludendorff, *My War Memories* (1922); Hoffmann, *The War of Lost Opportunities*, London, 1924. Camon, *Ludendorff sur le Front Russe, 1914–15*, Paris, 1926. (*See* also WORLD WAR: *Bibliography*.) (W. E. I.)

MASURIUM or **EKA-MANGANESE,** a chemical element, atomic number 43, the existence of which has only been demonstrated spectroscopically (*see* [Frl.] J. Tacke, *Zeit. angew. Chemie*, 1925).

MATABELE ("vanishing" or "hidden" people, so called from their appearance in battle, hidden behind enormous oxhide shields), a people of Zulu origin, who under the chief Mosilikatze were driven out of the Transvaal by the Boers in 1837. In their new territories the Matabele absorbed many members of the conquered Mashona tribes. The Matabele are now herdsmen and

agriculturists. The sororate is practised and a man may marry all his wife's sisters. (See *Africa*, vol. i., no. 4 [1928].)

MATACAN, an independent linguistic stock of South American Indians, so called from the Matacos, its best-known tribe. The Matacan tribes occupied a considerable area in the Bolivian and Argentine Chaco, along the Pilcomayo and Vermejo rivers, from the foothills of the Andes eastward to the Paraguay. Many of the tribes belonging to the stock are now extinct. The Matacos to-day are found south of the Vermejo in the western Chaco. The Chorotes (*q.v.*), one of the tribes of this stock, have recently been carefully studied by Nordenskiold. As described by the older writers, the Matacos (Mataguayes) and their affiliated tribes were an ugly, dark-skinned people, living mainly by hunting and fishing. They wore a kilt of skins, and lived in temporary small grass-thatched huts with very small, low doorways like those of the Chiquitos (*q.v.*). Their weapons were the bow, spear and club. They appear to have had no chiefs or leaders of authority. Monogamy was the rule. They performed elaborately costumed dances, but had no religious structures or images.

See D. G. Brinton, "Linguistic Cartography of the Chaco Region" (*Proc. Amer. Philos. Soc.*, vol. xxxvii.); J. Cardus, *Las Missiones Franciscanas en el territorio de la Republica de Bolivia* (Barcelona, 1886).

MATACHINES, bands of mummers or itinerant players in Mexico, especially popular around the Río Grande, who wander from village to village during Lent, playing in rough-and-ready style a set drama based on the history of Montezuma. Dressed in fantastic Indian costumes and carrying rattles as their orchestra, and with the help of a chorus of dancers they portray the desertion of his people by Montezuma, the luring of him back by the wiles and smiles of Malinche, the final reunion of king and people, and the killing of *El Toro* (the bull), the author of all the mischief.

MATADOR: *see* Bull-Fighting.

MATAGALPA, the metropolis of the coffee region of Nicaragua, a highland town with a number of foreign residents. The town lies about 3,000 ft. above the sea, has a population (1928) of about 12,000, and during the dry season is reached in a few hours from Managua by motor car (distance, 103 m.) and in the wet season, from Managua and León (120 m.) by mule or horseback, a two-day journey at its best. The coffee is shipped via Corinto. Matagalpa is a base for the mining and timber-cutting areas.

MATAMOROS, a town and port of the State of Tamaulipas, Mexico, on the south bank of the Río Grande, 28 m. from its mouth, opposite Brownsville, Texas. Pop. (1910) 7,390. Matamoros stands in an open plain, the commercial centre for a large district, but its import trade is prejudiced by the bar at the mouth of the Río Grande, which permits the entrance of small vessels only. The exports include hides, wool and live stock. The importance of the town is due to Brownsville, Texas, across the border, and its rail connection southward into Mexico. Matamoros was founded early in the 19th century, and was named in honour of the Mexican patriot Mariano Matamoros (*c.* 1770–1814). In the war between the United States and Mexico, Matamoros was easily taken by the Americans on May 18, 1846, following Gen. Zachary Taylor's victories at Palo Alto and Resaca de la Palma. Matamoros was occupied by the Mexican imperialists under Mejía in 1864, and by the French in 1866.

MATANZAS, an important city, port and centre of the sugar industry of Cuba, located on the northern coast of the island, 58 m. E. of Havana. Pop. (1925) 63,412. It is reached by rail, electric line, and by the new Central highway, from Havana and is connected by rail and highway with Santiago (481 m. S.E.). The harbour is in an open bay, 2 m. wide. Three rivers flow into the bay. Of these rivers the Yumuri is famous for the beauty of its valley, back of the city. Matanzas is divided into three sections by the Yumuri and the San Juan rivers. Wooded hills rise above the sloping plain on which the city is built, and above them the conical Pan (or loaf) de Matanzas (1,277 ft. high) which is a notable landmark. The Paseo de Martí, skirting the harbour, is a famous drive, marked at one end by a statue of Ferdinand VII. of Spain and on the other by a monument to the heroes of Cuban independence executed here by the Spaniards. A drive leads also to the ancient Castillo de San Severino (built in 1694 and rebuilt in 1773), to two more modern forts and to the Yumuri valley and the Caves of Bellamar, famous resorts. In the Yumuri valley is the Hermitage of Monteserrata, on La Cumbre, a hill crowning the valley. The history of Matanzas antedates the founding of the city, which took place in 1693, for prior to that its harbour was the resort of pirates. The town received the right to local government in 1694, and in 1815 was made capital of its department. Gabriel de la Concepción Valdés, a mulatto poet known as El Plácido (1809–1844), was born in Matanzas and executed there for participation in the negro conspiracy of 1844.

MATARÓ (anc. *Iluro*), a seaport of north-eastern Spain, in the province of Barcelona, on the Mediterranean Sea and the Barcelona-Perpignan railway. Pop. (1920), 24,125. The wine of the neighbourhood, which resembles port, is shipped in large quantities from Barcelona; and the district furnishes fine roses and strawberries for the Barcelona market. The industries include the manufacture of linen and cotton goods, especially canvas and tarpaulin, and of soap, paper, and chemicals. The railway opened in 1848 was the first constructed in Spain. Outside the town is the much-frequented carbonated mineral spring of Argentona.

MATCH. A piece of inflammable material, such as wood, cardboard or waxed thread, provided with a tip which ignites by friction. From the very earliest ages some means of bringing fire into existence has been of primary importance. During the evolution of fire-producers, other methods than that of friction—both chemical and mechanical—have been employed but the most successful agency for obtaining fire has been the friction match.

Discovery of Phosphorus.—In 1670 the alchemist Brand, of Hamburg, discovered phosphorus, which is present in urine in the form of alkaline and organic phosphates. Brand was preparing a liquid from urine which was supposed to possess the power of transmuting silver into gold, and hit upon phosphorus by accident. Phosphorus unites with oxygen with such facility that spontaneous ignition ensues on exposure to air; and the enigma, to which early efforts to utilize this material in a practical form were directed, was the control of this property. The earliest known method consisted in the rubbing of a small particle of phosphorus between two pieces of brown paper, and in the igniting of a *"Spunk"* or splinter of wood, previously tipped with sulphur. The risk of injury from burns by this process is apparent, and probably for this reason the employment of phosphorus for the purpose of ignition remained dormant for more than 100 years afterwards. Then the use of the phosphoric taper was suggested. This device consisted of a sealed glass tube containing a small portion of phosphorus, and a small length of waxed thread; ignition occurring upon contact with the atmosphere.

The Phosphorus Bottle of Cagniard de Latour (1810) contained partially oxidized phosphorus used in conjunction with a sulphur tipped splint and ignited by friction. In 1816 François Derosne is stated to have manufactured friction matches containing phosphorus.

Lucifers.—The year 1827 saw the first really useful friction match, made by an Englishman—John Walker, a druggist of Stockton-on-Tees. Walker's matches contained no phosphorus, but were made of chlorate-of-potash, sugar and gum arabic. The method of striking to obtain fire was to draw the splinter of wood, tipped with this composition, rapidly and under considerable pressure, through a piece of folded sandpaper. Imitations of Walker's match were sold by Samuel Jones of London, and also by G. F. Watts under the name of *"Lucifers."* None of these so-called *"Lucifers"* were easy of ignition. Attempts were made to provide special striking surfaces on the box; one of the first being composed of chlorate-of-potash, antimony sulphide, oxide of lead, sulphur and gum arabic, sold under the name of *"Congreves."*

Sauria's Invention.—Notwithstanding these experiments, an easily inflammable friction match was not achieved until a satisfactory method of embodying phosphorus in a suitable mixture was invented. This seems to have been successfully accomplished by Dr. Charles Sauria of St. Lothair in 1831. Sauria neglected

to acquire a patent, and as a consequence matches were manufactured according to his formula in many places, notably in Vienna and Darmstadt.

The Early Dangerous Trade.—The early strike-anywhere matches consisted mostly of a mixture of glue and the inflammable element in large quantities, but as manufacture progressed it was found that a very much smaller quantity of phosphorus was required to arrive at a satisfactory result, and that about 5% in a mixture with chlorate-of-potash and certain inert diluents was sufficient. Unfortunately the use of yellow phosphorus was accompanied by an insidious disease, known as *Phosphorus Necrosis,* or caries of the upper or lower jaw, which attacked workers in the industry, particularly those who were unhealthy. Sesquisulphide of phosphorus can be used without any deleterious effects and has now supplanted the poisonous phosphorus throughout the civilized world; an international convention at Berne in 1906 agreed to prohibit the use of yellow phosphorus.

The Safety Match.—A history of the evolution of the friction match would not be complete without some reference to the safety match, which is manufactured on a somewhat different principle. In this match the oxidizing agent, chlorate-of-potash, is separated from the inflammable portions of the composition, the former being on the head of the match, while the latter, consisting chiefly of amorphous phosphorus, is affixed to the box side.

Match Manufacture.—Since about 1900, the methods of match manufacture have undergone a complete change. From an industry in which practically every operation was conducted and completed by manual labour, it has become one of the most highly mechanized forms of industry. At the time of the introduction of Walker's Match, "*Spunks*" or splinters of wood were chopped off the wood-block in single units, and were dipped in the same manner. This procedure has now given place to specialized machinery adapted to each and every stage of the manufacture. Modern matches are prepared from two species of wood: viz.:—American pine and aspen.

Probably the earliest effort to provide a speedier means of dipping the matches consisted in assembling the splints in serried rows in a frame, in which each unit was separated. After dipping the matches were then dried, assembled from the frame, and put into the boxes by female labour. The boxes were prepared by cutting a thin shaving from a piece of timber, previously sawn to the correct size and stamped by means of a die folding; then finally fastened down with flour paste, and paper.

Match Machines.—In the modern match factory, ingenious mechanical devices are adapted to each process; in many instances the operations are combined on a single machine, notably on the so-called continuous match machine. There are two preparatory and essential requisites in the manufacture of matches, viz.:—(a) The preparation of the match splint. (b) The putting together of the boxes. In order to prepare the splint, a log with the bark still attached, about 8 ft. or more in length by about 10″ or more in diameter, is crosscut to obtain convenient lengths for subsequent handling. A machine of a simple type is next brought into operation for the purpose of debarking the log. A vertically rotating disc, furnished on its face with several knives set slightly in advance, serves to expose the wood and leaves it free for further treatment, which consists in slitting the log into a thin veneer about $\frac{1}{10}$″ diameter. In this process in England the log is fixed between two dogs, or clutches, of the machine, which seize it at each end and hold it firmly enough to prevent its slipping, while the shaving or veneer is being discharged. A revolving motion is then imparted to it, during which the log is incessantly pressed against a stationary knife. By this means the veneer is formed in one long shaving, suitable for further treatment in a crosscutter, which descends upon the assembled veneer. The output of this splint cutting contrivance approaches 2 millions per hour.

Impregnation of the splints in a chemical solution to prevent a glowing ember comes next, and for this purpose boric acid can be used. Splints are then dried and finally cleaned and straightened for presentation to the continuous match machine.

Box-making.—The making of the boxes follows up to a point the same route as the preparation of the splints, but with certain differences. The shaving is cut thinner, being only about 1/30″ thick, and the veneering machine for this purpose is fitted with scoring knives, which serve to mark the shaving in the exact place for the convenience of subsequent folding. The assembled veneer is then submitted to the chopper and sliced into its necessary widths. A complete box is composed of three distinct pieces of wood: (a) The rim of the inside, (b) The bottom of the inside, (c) The outer case. There are two machines for the preparation of the box, the inner machine and the outer; both are automatic. A machine for making the outsides can turn out 8,000 to 10,000 boxes per hour, while the inside machine can make 6,000 to 7,000 per hour.

The Continuous Match Machine.—On being assembled, the boxes are then carried forward to the continuous match machine. There are types, with varying capacity, but in round figures 7½ millions of matches can be paraffined, dipped, dried and put into their final resting-place in the space of 10 hours by one of these wonderful machines, with the assistance of about four attendants. In area, one type occupies a space of about 53 ft. long by 10 ft. wide by 9 ft. high. It weighs over 20 tons. For the purpose of obtaining a good mental picture of one of these machines, an endless perforated steel plate of considerable length can be readily imagined, at the beginning of which the splints contained in a suitable hopper are inserted by a joggling mechanism and a plunger into the plate, are carried forward over and dipped into the heated paraffin, and thence forward to a container with the striking composition, where they receive the ignitive head. A further advance carries them over and under a series of planes, during which the drying is completed, which process occupies about one hour of time, until they arrive almost at the point from which they started, when they are ejected into the boxes, the inner of which has been previously placed into the outer by an apparatus specially designed for this purpose. The continuous machine then opens the empty box by a self-acting plunger, and closing it again in a similar manner, delivers it ready for the wrapping operation.

(W. H. Di.)

UNITED STATES

The process of matchmaking in the United States differs radically from that common in England. The planks for the matches are sawed 2 in. thick, seasoned for two years, and then sawed into match blocks, of which those free from knots and with a straight grain are selected to be cured and fed into the match machine. At the head of the match machine, which is about 50 or 60 ft. long and 20 ft. high, is a frame which holds rows of hollow dies, which descend vertically and cut out splints from the match blocks. Some machines cut 50 splints at each revolution, and, with a speed of over 300 revolutions a minute, have produced 10,000,000 matches in a working day. Square stick matches are not popular in America and their manufacture is virtually discontinued. Of all wood matches made in the United States 97½% are of round grooved splint type—both strike-anywhere safety and strike-on-box safety types. These splints are automatically forced out of the dies into the perforations of a cast-iron plate. This forms part of an endless chain on which the splints are passed through a chemical solution, containing monoammonium phosphate, which impregnates the wood and prevents an afterglow when the match is burned. After drying to evaporate the water from this chemical bath, the machine carries the splints through a bath of paraffin wax, or similar material, so that they will catch fire readily when the match is lighted, the wax taking the place of the sulphur formerly used.

The machine then carries the splints through two dips to put the head on the match. The first dip gives the match the bulb, which is inert to ordinary friction and protects the tip of the match. The second dip forms the eye of the match, which is much smaller than the bulb and ignites when the match is struck. The modern match head contains a large number of chemicals and other ingredients, such as phosphorus, chlorate, potash, zinc oxide, glue and forms of gums, ground glass, quartz, whiting, etc., which must be thoroughly compounded for several hours in large mills

by means of special machines and under expert supervision. After being tipped the matches travel through blasts of air where they are dried. On their return to the head of the machine, punches drive the sticks out of the plates into a mechanism that packs the matches in cardboard boxes in two layers, with the heads in the opposite direction. Strips of cardboard are put over the matches and the covers sealed on the boxes—all by machinery. The book matches, which are supplied to smokers to be carried in the pocket, are safety matches, and are also made automatically by a machine which slits and dips the cardboard, puts the composition on the cover, and binds and cuts apart the books.

MATCH-LOCK: *see* Gun.

MATÉ or Paraguay Tea, the dried leaves of *Ilex paraguariensis* (and some other species), an evergreen shrub or small tree belonging to the same genus as the common holly. The leaves are from 6 to 8 in. long, shortly stalked, with a somewhat acute tip and finely toothed at the margin. The small white flowers grow in forked clusters in the axils of the leaves; the sepals, petals and stamens are four in number, or occasionally five; and the berry is 4-seeded. The plant grows abundantly in Paraguay, and the south of Brazil, forming woods called *yerbales.*

Although maté appears to have been used from time immemorial by the Indians, the Jesuits were the first to attempt its cultivation. This was begun at their branch missions in Paraguay and the province of Rio Grande de San Pedro, where some plantations still exist, and yield the best tea that is made. From this circumstance the names Jesuits' tea, tea of the Missions, St. Bartholomew's tea, etc., are sometimes applied to maté. Under cultivation the quality of the tea improves, but the plant remains a small shrub with numerous stems, instead of forming, as in the wild state, a tree with a rounded head. From cultivated plants the leaves are gathered every two or three years, that interval being necessary for restoration to vigorous growth.

The collection of maté is chiefly effected by Indians employed for that purpose by merchants, who pay a money consideration to the government for the privilege. The Indians usually travel in companies of about twenty-five in number, build wigwams and settle down to the work for about six months. Their first operation is to prepare an open space, called a *tatacua,* about 6 ft. square, in which the surface of the soil is beaten hard and smooth with mallets. The leafy branches of the maté are then cut down and placed on the tatacua, where they undergo a preliminary roasting from a fire kindled around it. An arch of poles, or of hurdles, is then erected above it, on which the maté is placed, a fire being lighted underneath. After drying, the leaves are reduced to coarse powder in mortars formed of pits in the earth well rammed. Maté so prepared is called *caa gazu* or *yèrva do polos,* and is chiefly used in Brazil. In Paraguay and the vicinity of Parana in the Argentine Republic, the leaves are deprived of the midrib before roasting; this is called *caa-miri.* A very superior quality, or *caa-cuys,* is also prepared in Paraguay from the scarcely expanded buds. Another method of drying maté has been adopted, the leaves being heated in large cast-iron pans set in brickwork, in the same way that tea is dried in China.

The tea is prepared in a small silver-mounted calabash, the tapering end of which serves for a handle. In the top, there is a hole and the tea is sucked by means of a bombilla. This instrument consists of a small tube 6 or 7 in. long, formed either of metal or a reed, which has at one end a bulb made either of extremely fine basketwork or of metal perforated with minute holes, so as to prevent the particles of the tea-leaves from being drawn up into the mouth. Some sugar and a little hot water are first placed in the gourd, the yerba is then added, and finally the vessel is filled to the brim with boiling water, or milk previously heated by a spirit lamp. A little burnt sugar or lemon juice is sometimes added instead of milk. Maté, like tea and coffee, contains caffeine, but in less quantity. It is also less astringent. Maté retains its flavour against exposure to the air and damp.

See *Kew Bulletin* (1892), p. 132.

MATERA, a city of Basilicata, Italy, capital of the province of Matera, 17 m. S. of Altamura (which is 30 m. W. of Bari) by rail; the line goes on to Miglionico, 18 m. S.W., 1,312 ft. above sea-level. Pop. (1921) 17,906. Part of it is built on a level plateau and part in deep valleys adjoining. The western façade of the cathedral is plain and the south front facing the piazza richly decorated. The campanile is 175 ft. high. In the vicinity are caves with 13th-century frescoes. The district was well populated in the palaeolithic and neolithic periods, and important discoveries have been made by Domenico Ridola.

MATERIAL CULTURE. Even under civilized conditions a great part of man's material culture is directly associated with his primary need, that of procuring food, and his progress in many other directions depends upon the measure of his success in this. The old classification of peoples or communities as hunters, herders or tillers of the soil, is therefore not without value, though it lays undue stress upon this aspect of human life, and more than one question is begged when it is assumed that the higher cultures must have passed through the lower stages to reach their present level. It is quite probable that the first men to begin the cultivation of plants were neither hunters nor herders in a specialized sense, but food-gatherers who, from depending upon such plant and animal produce as they could collect, were led to discover that roots and shoots and seeds could be made productive under control. Apart from those existing backward peoples who live by collecting, hunting and fishing alone, hunting may be a more or less essential activity in higher grades of culture, its importance decreasing with the extension of plant and animal cultivation, until in the higher civilizations it degenerates into a sport. The domestication of animals is, as is well known, often associated with agriculture, though in its intensive form it may have had its first big developments amongst nomadic peoples. The three categories may be regarded as specializations which arose out of the food-gathering that was in the beginning the compulsory occupation of the human stock, as it is of the existing apes. Specialization in, and dependence upon, hunting or the rearing of animal stock, involved a mode of life less likely to lead to and foster plant-growing than would a more settled existence in an area where vegetable food was plentiful, and where the phenomena of growth could be observed under similar conditions year after year. As is generally recognized, a settled life would also provide favourable conditions and incentives for the initiation of other peaceful arts, such as basket- and pottery-making, spinning and weaving; but it was only when plant cultivation established itself as cereal culture—the growing of grain such as barley and wheat, which could be stored for winter consumption—that the first civilizations became possible.

If food is the primary need of man, clothing and shelter, however they first arose, assumed the form of needs partly under stress of climate. Means of travel and transportation, especially over water, were accessory to the more immediate material aims, since they played an important part in opening up new food-areas, and provided new natural products and new environmental stimuli.

Arts and Crafts.—A close study of the means of procuring food leads to the consideration of the innumerable weapons and devices for hunting and fishing; of methods and appliances used in plant cultivation and the tending of domesticated animals; and of the great variety of methods, implements and utensils for carrying, storing and preparing food. With clothing are associated skin-dressing, bark-cloth making, spinning and weaving, whilst in shelter and in travel and transport are involved the building of wind-screens and dwellings, and the construction of carrying devices and water-craft. To the implements and appliances needed for the carrying out of operations connected with all these activities there must be added—with considerable overlap—the tools and mechanisms used in the treatment of materials, and in the construction of artefacts of all kinds.

Many artefacts have their main significance outside the limits of material culture, as, for example, in the case of personal ornaments, instruments for measuring time and weight, musical instruments, religious buildings and images of gods; but as artefacts or inventions these claim consideration from the same point of view as others serving more material ends. Their nature is, indeed, determined by the state of culture with which they are associated, and in their development they may react conspicuously upon the

technique or constructional principles upon which they depend. It is clear that man, even savage man, has aspirations besides those of preserving his life and making himself comfortable, and these carry him far beyond the limits to which he is pushed by necessity.

The ethnologist, in his studies of the culture of an alien people, finds the investigation of the material side of their life less difficult, and more reliable in its results, than is that of the social and religious aspects. There is less risk of error in describing a canoe or a method of making pottery, than in giving an account of a social or religious custom or belief. In the material object or the method the greater part of the truth is on the surface, and is easily grasped. The custom or belief may present features which are utterly foreign to the mode of thought of the investigator, and its real significance exists in the minds of men who may be incapable of explaining it clearly, or who may not desire to do so. Material culture is in fact a study of greater certainty because the evidences are stable and material, and can often be collected for detailed and leisured study. The fact that many artefacts are capable of preservation for hundreds or thousands of years adds to the scope of a study which thus ranges not only wide in space but deep in time.

Upon our accumulated knowledge of the material activities of peoples of all grades of culture a science of comparative technology has been built up which deals in detailed fashion with the technique of arts and crafts. Basket-work (*see* BASKET), pottery (*q.v.*), dwellings, weapons, weaving (*q.v.*) and other subjects are treated from this point of view elsewhere in this section, and only a few general considerations need be touched upon here.

Implements.—Even with some knowledge of natural materials, processes and forces, man can do little with his hands alone; but very much more can be achieved with the aid of a smooth pebble, a pointed stick and a sharp flint (*see* FLINTS). It was in the working of hard materials such as stone, wood and bone, that the hands had to admit their primary incapacity, though there were other things they could not do unaided. In some cases, however, an elaboration of tools and appliances can only increase speed and precision, though even a simple appliance like the primitive plough may produce results which are out of all proportion to its own structural complexity. In the development of most arts and crafts there has necessarily been constant interaction between materials, methods and appliances, but there is no common formula to express the degree of interdependence. Seeds may be sown, and clay may be shaped with little or no assistance from artefacts, but for breaking and crushing hard materials, for cutting, piercing, abrading and similar operations, tools are essential. Simple devices involving the application of leverage, the elasticity of wood and especially rotary motion—as in the drill, the wheel and the rotary quern—pointed the way to the development of machinery as we know it; progress in this direction was, however, dependent not only upon increased knowledge of natural forces and mechanical principles, but upon the production of iron in large quantities, and upon the evolution of methods of working and shaping the metal.

That there are conspicuous differences in the parts played by methods and appliances, respectively, in various arts and crafts, needs little demonstration, and in some cases there has been a great development in appliances without an equivalent improvement in the products. Basket-work, which reaches its highest level amongst uncivilized peoples, requires the simplest of tools, or even none at all, and the forms and fabrics are such as to preclude the use of mechanisms or machines; development has resulted from change and improvement in technique, and not from the invention of artificial aids for the craftsman. Similarly, though not equally, pottery-making was for long an art in which the hand was the only important tool employed in shaping the clay, and the early potter's wheel did not bring about a fundamental change in this respect—discoveries of new kinds of clay, and of better methods of preparing them, and of firing the pots, have been the most important factors in the evolution of pottery. Appliances have, however, played a greater part in the advances that have been made, than in the case of basket-making. In plant cultivation, again, much could be done with the hoe, or even with the simple digging-stick, but the evolution of the plough and of other accessory appliances, was essential to the growth of agriculture to its full usefulness. In modern spinning and weaving complex machinery does rapidly and surely what for some thousands of years was done slowly but adequately—as it is still done in some parts of the world—by means of spindles and simple looms made of a few sticks and wooden slats.

Theories of Development.—Since evolution became a dominant motive in scientific studies, the descriptive and comparative methods of treatment have been extended for reconstructive purposes. In anthropology this tendency has been encouraged by the stimulus afforded by the discoveries of the archaeologist, which give us clues not only as to the general course of evolution of material culture, and of individual appliances, but as to the relationships between ancient peoples. That there have been since early days in the history of man, innumerable instances of contact, migration and conquest, and that such relationships have led to transmissions of culture, or of cultural elements, from place to place and from people to people, is generally agreed. The attempts to ascertain how far an existing culture in any part of the world can be resolved into its historical elements—how far stratification can be detected, and transmissions be traced to their sources—have necessarily been based on analyses which take into account not material culture alone, but linguistic, religious, social and physical characters. Reconstructive work of this kind, though sometimes one sided, is the only approach to a scientific history of mankind, as distinct from literary histories of nations and peoples.

The attempted reconstructions are based on views which in their most definite form are regarded as characterizing the historical or diffusionist school of anthropologists. In controversial opposition are those to whom the term "evolutionists" has unaccountably become attached. Whilst the extreme diffusionist regards the independent origin and development of similar or identical methods, artefacts, beliefs and customs, as having been so infrequent as to be of negligible significance, the extreme evolutionist is supposed to postulate independent evolution as an ever-ready explanation of such similarities. It is not probable, however, that there is any evolutionist who denies the occurrence of diffusion, and there is certainly no diffusionist who denies the occurrence of evolution. There is, too, the belief that the whole controversy is futile.

The test question is that of the cultures of the Indians of America. There are some anthropologists who are prepared to regard diffusion as an acceptable and far-reaching explanation within the limits of the Old World and the New, respectively, but who look upon the culture of the American Indians as to all intents and purposes indigenous. This view involves the acceptance of a great number of difficult cases of independent origin and parallel or converging development.

Directional Invention.—In this enquiry much depends on whether we regard man's inventive powers as originative in character, based upon a far-seeing anticipation of ways and means as well as ends, or as an opportunism which ranges from the casual to the persistent according to circumstances. Under modern civilized conditions there is a constant striving, on the part of a small number of individuals, after discovery and invention. Even when the unexpected happens and is seized upon, there is some end in view, though it may be different from that eventually achieved. The world-wide literature of science, modern knowledge of the properties of materials, and of chemical and physical forces, combined with the possession of a great variety of tools and machines, are apt to lead us to conceive of the inventor as a creator rather than an adapter and improviser. Giant strides are apparently made, but they are in reality due to the summation of a number of much smaller steps; judgment is often confused, also, by the fact that a simple discovery may have important results, the discovery being judged by its consequences, and not by its own intrinsic simplicity. The fact that, as is the case with most modern advances, it could not have been made without elaborate apparatus or refined technique, may be of historical

interest, but this does not take it out of the category of the discoveries that man has been making since his career began. In short, the existing social and material conditions enable the civilized inventor to place himself in the way of receiving suggestions that can only reach him by way of methods and appliances that are themselves the end-results of a prolonged process of gradual evolution. Civilized man has, moreover, become convinced that nearly all things are possible, and that the unknown is not only a territory to be explored without fear, but with hope of great reward. He is an opportunist, pursuing discovery and invention by way of experiment to the furthering of directional aims, and his advantages over his early predecessors are due to his social and material heritage, and not to intellectual superiority. We can scarcely doubt that under conditions that favoured the accumulation of knowledge, and that provided opportunities and incentives to the discoverer and inventor, there have been in all the higher human cultures, individuals, relatively few in number, who have adopted such directional methods as their knowledge and material equipment allowed. But the ancient civilizations were themselves based upon the prior evolution of a grade of culture that rendered their foundation possible, and only when these had become well established were the conditions for the emergence of directional invention fulfilled. Even then the limitations of knowledge and the inhibitions of habit, prejudice and superstition, made progress incomparably slower than it is in our own times. Amongst uncivilized peoples, perceptible advance has probably been made only when racial contacts and impacts, great changes in environment, or discoveries which opened up new possibilities—such as those which led to agriculture and metal-working respectively—raised men out of the stagnation due to unchanging environment and a static condition of knowledge. There was new material to work upon, and attempts to apply the old methods were met by unexpected reactions on the part of the material or appliances used.

Chance Discoveries.—If we regard directional invention as characteristic of peoples living under civilized conditions, it is necessary to enquire how progress was made before civilization was established. If it could be said in 1927 that "most discoveries in physics arise from some experimental fact discovered more or less accidentally" (Presidential address [by Sir James B. Henderson] to the engineering section of the British Association for the Advancement of Science, 1927), it is not unreasonable to ascribe to chance the discoveries of early man. It can hardly be supposed that he experimented with stones in order to produce fire, before he had observed the production of sparks by a chance percussion; or that he took to testing the germinating power of seeds, because he felt the need of a more reliable food-supply; nor did he invent the blow-tube because he wanted something with which to shoot pellets or darts. He discovered accidentally that certain results followed certain actions, and in many cases the means came to hand and the end was achieved before the need was realized. There must have been innumerable instances of failure to recognize that a useful discovery was within reach, and the means and the end and the need alike remained unknown. Clay may have hardened in the fire, and copper melted, many times in vain.

It may be said that a manner of progress such as this, may account for the primary discoveries of man, and for their application in simple methods and appliances, but that he must have soon got beyond this dependence upon environmental suggestion; and indeed there was a gradually increasing change in the conditions determining the nature of his discoveries and inventions. But the change was one of scope rather than of character, and was due to the extension of his environment by the addition to it of his own accumulating knowledge and equipment. Thus, the ore of a metal was at first merely one kind of rock or stone amongst many others, but with increasing discoveries of its potentialities, man's environment was enlarged no less than it would have been if the ore had fallen from the skies, with instructions for use. Similarly, when he discovered that he could make a new kind of weapon or tool by thrusting a blade of stone into a bend or a cleft or a hole in a stick, he opened up a new field of invention, which had previously been outside his environment. Certain discoveries and inventions contained great possibilities, others had their chief value in their immediate utility, and were destined to advance but little. The pestle and mortar are much as they have always been, except in diversity of material, but the pick or the hoe led to the modern plough, and the canoe now figures as a battle-ship. In all the developments, each step has depended upon its predecessors, except in cases in which an appliance or method has reached its highest level only to be superseded by a rival which had evolved along different lines, and which contained greater potentialities. Thus, the spear-thrower gave place to the bow, and this to the gun, the push-quern to the rotary quern, stone-working to metal-working, though where the newer knowledge never penetrated, or met with opposition, the older ways survived.

Method of Variation.—If we take a closer view of the manner in which inventions develop, we find that two chief factors can be distinguished. In the one case, there is the method of variation, in which the individual changes are small in amount and unimportant in their effects, or, if not so small, they are such as could have been produced by the summation of a number of such changes. It is obvious that form and size may easily change as the result of the selection of variations, whether the selection is made with a clear consciousness of possibilities or not. By variation the bronze dagger was lengthened to become a sword, the flanged celt became a palstave, and such artefacts as wooden clubs, stone celts and arrow-heads, pots and a multitude of others developed into a variety of forms without the intervention of what is often called the inventive faculty, though not necessarily without imitation coming into play.

Mutations.—In addition to these variational changes, there are others which can only occur each as a single step of a decisive character. There can be no true intermediate stages, no summation of series, for example, between the worked stone held in the hand, and one fixed in a wooden haft; between the spear with a fixed point, and a harpoon with a detaching point; between a plain bow and a crossbow; between a simple wooden drill and a bow-drill. In all these cases the second appliance arose by an abrupt change, of an inventive character, and we may borrow a biological term and speak of such steps as mutations.

Two kinds of mutations may be distinguished. On the one hand there are improvements made as a result of discoveries arising during the manufacture or utilization of the artefact itself. These we may call free-mutations, and they are strictly comparable with the applied discoveries of the potentialities of natural objects. If we assume that the harpoon arose from a spear which had a bone point or blade tied to the shaft, we may regard the occasional breaking away of the point as the determining accident in the evolution of the new appliance. The tying cord might easily retain its connection with the shaft and become entangled with the point, in such a way that the essential feature of the harpoon presented itself ready-made. The observation that there were certain advantages in this looser mode of attachment might lead to its permanent adoption for spearing fish or aquatic mammals, and the free-mutation established itself. It is not possible to do more than speculate as to the mode of origin of most ancient inventions. In this case, as no doubt in many others, accident may well have played the predominant part.

It is in the second kind of mutations, which may be called cross-mutations, that the inventive faculty has its main opportunity. Here not only is the end pre-conceived, but a possible means is foreseen. Most modern inventions (the single steps, not complexes such as aeroplanes and loud-speakers) are cross-mutations, and they involve the adaptational transfer of a device or feature from one appliance to another, or the application of a device or feature that has become well-known through its utilization in other artefacts. The more highly developed the state of material culture, the more numerous are the opportunities for cross-mutation, though progress is still made step by step. Early man, and even early civilized man, had relatively few such opportunities, but occasionally he hit upon a new method or device that contained extensive possibilities of transfer and adaptation. The

idea of hafting, and the several methods of hafting (by means of lashings, tangs, sockets, etc.) were in origin based on free-mutation and variation; but they could be transferred as cross-mutations. Similarly, devices for utilizing and controlling rotary motion were capable of transfer. We must suppose that such transfer only took place to an artefact which had reached a stage of development at which the application of the mutation was a more or less obvious step to take; nevertheless it is clear that in cross-mutation there was a greater foresight and awareness than in the case of free-mutation, which only involved an appreciation of the immediate possibilities of a chance discovery. A free-mutation is a new discovery directly applied to the construction or improvement of an artefact, whilst a cross-mutation is the result of the extension of the utility of a known device. Any true inventive step is a mutation, and the term may be restricted in its use to the evolution of artefacts.

This "opportunist" view of the manner in which man's methods and artefacts have been evolved, emphasizes the extreme gradualness of the process. The simplest tool and method that are based on the most superficial phenomena, may have been arrived at over and over again. Such knowledge was probably part of the equipment of *Homo sapiens* at the time of his first dispersal. It is evident that the greater the number of determining variations and mutations involved, the less probable is it that the same result will have been reached independently in different parts of the world. The fact that in modern times two investigators occasionally make the same discovery or invent a similar device, has no bearing upon the question, since they work in reality in collaboration, starting from the same point, using similar apparatus, and drawing upon the records of the same predecessors. A consideration of modern inventive progress, in spite of its directional aims, strongly supports the opportunist view of the development of material culture.

BIBLIOGRAPHY.—O. T. Mason, *The Origins of Invention* (London, 1895); G. Elliot Smith, *The Migrations of Culture* (1917); R. H. Lowie, *Culture and Ethnology* (New York, 1917); Erland Nordenskiöld, *An Ethno-Geographical Analysis of the Material Culture of Two Indian Tribes of the Gran Chaco* (Göteborg, 1920); Clark Wissler, *Man and Culture* (1923); L. H. Dudley Buxton, *Primitive Labour* (London, 1924); Roland B. Dixon, *The Building of Culture* (New York and London, 1928). (H. S. H.)

MATERIALISM in philosophy, the theory which regards all the facts of the universe as explainable in terms of matter and motion, and in particular explains all psychical processes by physical and chemical changes in the nervous system (from Lat. *materia*, matter). It is thus opposed both to natural realism and to idealism. For the natural realist stands upon the common-sense position that minds and material objects have equally effective existence; while the idealist explains matter by mind and denies that mind can be explained by matter. The various forms into which materialism may be classified correspond to the various causes which induce men to take up materialistic views. *Naïve materialism* is due to a cause which still, perhaps, has no small power, the natural difficulty which persons who have had no philosophic training experience in observing and appreciating the importance of the immaterial facts of consciousness. The pre-Socratics may be classed as naïve materialists in this sense; though, as at that early period the contrast between matter and spirit had not been fully realized and matter was credited with properties that belong to life, it is usual to apply the term hylozoism (*q.v.*) to the earliest stage of Greek metaphysical theory. *Cosmological materialism* is that form of the doctrine in which the dominant motive is the formation of a comprehensive world-scheme: the Stoics and Epicureans were cosmological materialists. In *anti-religious materialism* the motive is hostility to established dogmas which are connected, in the Christian system especially, with certain forms of spiritual doctrine. Such a motive weighed much with Hobbes and with the French materialists of the 18th century, such as La Mettrie and d'Holbach. The cause of *medical materialism* is the natural bias of physicians towards explaining the health and disease of mind by the health and disease of body. It has received its greatest support from the study of insanity, which is now fully recognized as conditioned by disease of the brain. To this school belong Drs. Maudsley and Mercier. The highest form of the doctrine is *scientific materialism*, meaning the doctrine commonly adopted by the physicist, zoologist and biologist.

It may perhaps be fairly said that materialism is at present a necessary methodological postulate of natural-scientific inquiry. The business of the scientist is to explain everything by the physical causes which are comparatively well understood and to exclude the interference of spiritual causes. It was the great work of Descartes to exclude rigorously from science all explanations which were not scientifically verifiable; and the prevalence of materialism at certain epochs, as in the enlightenment of the 18th century and in the German philosophy of the middle 19th, were occasioned by special need to vindicate the scientific position, in the former case against the Church, in the latter case against the pseudo-science of the Hegelian dialectic. The chief definite periods of materialism are the pre-Socratic and the post-Aristotelian in Greece, the 18th century in France, and in Germany the 19th century from about 1850 to 1880. In England materialism has been endemic, so to speak, from Hobbes to the present time, and English materialism is more important perhaps than that of any other country. But, from the national distrust of system, it has not been elaborated into a consistent metaphysic, but is rather traceable as a tendency harmonizing with the spirit of natural science. Hobbes, Locke, Hume, Mill and Herbert Spencer are not systematic materialists, but show tendencies towards materialism.

Largely through the influence of Bergson, Alexander and Lloyd Morgan contemporary science is tending away from materialism and mechanism towards the recognition of other than mechanical factors in the phenomena, even the physical phenomena, of Nature.

See EMERGENCE, IDEALISM; and F. A. Lange's *History of Materialism* (Eng. Tr. 1926).

MATERIALS, STRENGTH OF, is a branch of applied mechanics which deals with the effects produced by forces in the materials of architectural and engineering construction. Its aims (in so far as these are practical) are to discover rules whereby the strength of a given part may be assessed, and on these to base general principles of design, whereby each member of a structure or machine may be given the material and proportions best suited to its function.

Thus, to take a fairly simple example, the choice of suitable material and proportions for a locomotive coupling rod is a problem which falls within the province of our subject. The rod is required to transmit from one wheel to the next a force which will depend upon the speed and on the tractive effort of the locomotive, and which will fluctuate during each revolution of the wheels. In addition, it will be subjected to bending actions, due to its own up-and-down motion, which will depend not only upon the speed of the locomotive but also upon the mass of the rod itself. When the material and proportions have been (provisionally) determined, the magnitudes of these different forces can be estimated: the question then presents itself, whether the strength of the rod will be adequate to its task.

At the outset it is evident that two factors are involved. Whatever be the material, a member will break or bend if its cross-section is too small: whatever be its size, certain properties (such as hardness or rigidity) are required of the material. So, following our subject, two investigations must be pursued. First, we must be able to predict the state of stress (that is, of internal action) which results when specified forces are applied to a body of specified form; secondly, we must be able to decide whether these internal actions can be brought into existence without detriment to a specified material. The first line of investigation is the province of the theory of elasticity; the second, that of metallurgy and the testing of materials: our problem is to combine, for the guidance of the architect or engineer, the knowledge which these different sciences afford.

THEORY OF ELASTICITY

2. For a full account of the methods and results of mathematical enquiry the special article ELASTICITY should be consulted. Much of the theory is concerned with problems of physical rather

than engineering interest, and methods of more restricted range can be employed to obtain those few and relatively simple solutions which form the basis of practical design. The essentials of the theory are: (1) a quantitative analysis of *stress*, or internal action; (2) a quantitative analysis of *strain*, or distortion; (3) postulates (based on experiment) regarding the relation of stress to strain. These, in conjunction with the accepted principles of mechanics, it employs to derive equations which govern the *displacement* at every part of a loaded body. The solution of those equations is a purely mathematical problem, which may present considerable difficulties.

Continuity.—3. The whole theory, as at present developed, rests on a fundamental assumption regarding the nature of materials. These are treated as "continuous," in the sense that they can (in imagination) be subdivided to any extent without losing any property which they exhibit in bulk. In other words, the theory contemplates a material having the nature of a structureless jelly, which would have exactly the same appearance when viewed through a microscope of any imaginable magnification.

The assumption must be recognized and its implications weighed, for it does not accord with our knowledge of real materials. These in all cases exhibit a definite structure, even when examined under low magnifications: brass, for example, is revealed as a conglomerate of small crystals of copper and of zinc. Small pieces cut from different parts would therefore *not* exhibit similar properties; and if we were to subdivide them further, down to molecular or atomic dimensions, we should ultimately reach a stage at which all resemblance to a continuous substance had disappeared.

We shall have to consider later how far it is permissible to apply to real materials results which are based on the assumption of continuity. For the moment we are concerned to develop, in accordance with this assumption, precise notions of stress and strain.

ANALYSIS OF STRESS

The Notion of Stress.—4. Let us imagine, in the first place, that a heavy cube (A) of the structureless material rests with its bottom face horizontal and in contact with a similar cube (B). To maintain equilibrium, an action must be exerted at the surface of contact, whereby B pushes upwards against the weight of A, whilst A pushes down on B with equal force. Mutual action of this kind is termed a *stress:* when, as in this example, its direction is at right angles to the surface at which it acts, it is termed *"normal stress."*

Action of the same kind (although different in amount) must evidently be exerted at any horizontal surface which divides either cube into two parts: the material below the surface must push upwards on that above, and the material above the surface must push downwards on that below. So the idea of stress can be extended from mutual actions between two bodies to mutual actions between different parts of the same body; the reality of the surface across which a stress is transmitted is a matter of indifference.

Again, we may conceive the total action across a surface to be made up of contributions from every part of that surface. In this way we arrive at the notion of *superficial intensity of stress.* If a portion of area S makes a contribution P to the total action, then the ratio P/S measures the average intensity of stress on that area. If S (and therefore P) is indefinitely small, so that the area is effectively concentrated at a point, the average intensity of stress may be identified with the actual local intensity at that point.

We employ the symbol p to denote this local intensity of stress. If equal contributions to the total action are made by equal areas, p will have a constant value over the surface considered; in such cases we say that the intensity of stress is uniform, or that the stress is "uniformly distributed." More generally, p will vary from point to point.

Normal and Tangential Stress.—The action at a given surface will not necessarily be directed at right angles to that surface. Let us imagine that the cube A, in the case already considered, is subjected to a horizontal force F which tends to slide it off B, and that sliding is resisted by friction at the surface of contact. Evidently there is a mutual action between A and B, at this surface, of a kind to which we have given the term stress; and further, action of the same sense and total amount must be exerted across any imaginary horizontal surface, lying below the point of application of F, which divides A into two parts. It would not be legitimate to say that this last action has its origin in friction; but we see the necessity for the concept of stresses, which may or may not be "uniformly distributed," having directions parallel to the surfaces at which they act. Such stresses are termed *tangential*, or *"shearing" stresses.*

Resolution of Stress.—5. In the general case, the action at a surface may have any inclination to that surface. Thus a stress, like a force, may be resolved into components having any three specified directions; and conversely normal and tangential stresses may be superposed, or "compounded."

Simple Longitudinal Stress.—Normal stress of the type already considered will be brought into existence when uniform pressures (that is, distributed normal forces of uniform intensity, acting inwards) are applied to the top and bottom faces of a cube. If the directions of the applied forces are reversed (fig. 1A), the stress across a horizontal surface will have the same direction and magnitude as before, but it will now be opposite in sense. We term it a *tensile stress,* because the applied forces tend to stretch the cube: stress of the former type is termed *compressive.*

Thus we see that normal stress may be of two kinds,—viz., tensile or compressive,—which differ only in respect of sense; compressive stress may be regarded as tensile stress of negative intensity. This convention will be adopted in what follows: we shall use the symbol p to denote tensile stress, and we shall represent compressive stresses by giving a negative sign to p. Tangential stress will frequently be represented by the symbol q.

When a long rod of uniform cross-section is stretched by means of a suspended weight, a practically uniform tensile stress will act on horizontal surfaces, and vertical surfaces will be free from stress. The material is then said to be subjected to "simple longitudinal stress." When a short pillar or block is compressed by opposite forces applied at its ends, we have, to a somewhat less close approximation, a state of simple longitudinal compressive stress.

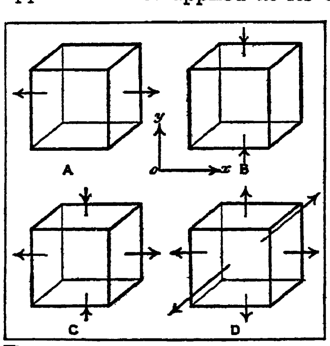


FIG. 1.—SIMPLE AND COMPOUND STRESSES

Compound Stress.—If the rod or block is subjected in addition to forces acting on its sides, a more complex state of stress is presented. We may regard it as a combination of two or more simple longitudinal stresses, and we describe it as a *compound stress.* In fig. 1, the first block (A) is subjected to simple longitudinal stress (tensile) in the direction *ox;* block B is subjected to simple longitudinal compressive stress in the perpendicular direction *oy*. When the two systems of applied force are combined, as in block C, we have a state of compound stress made up of two simple longitudinal components. In block D, three simple longitudinal components go to make up the state of stress.

Principal Stresses.—6. That part of the theory of elasticity which is called analysis of stress deals with the combination of simple stresses and, conversely, with the resolution of compound stresses into their "simple" components. The most important theorem in the subject may be stated as follows:—*At any point in a material, however complicated may be the state of stress at that point, three planes can be found, each perpendicular to the other two, which have the property that the stresses transmitted across them are purely normal.* These planes are termed *principal planes of stress* for the point considered, and the corresponding stresses are termed *principal stresses.*

We may imagine that a very small rectangular block of material, containing the point in question, has its faces parallel to the

three principal planes. The theorem states that only normal stresses will act upon those faces, as shown in case D of fig. 1, which accordingly represents the most general state of compound stress that can occur. The three normal stresses p_1, p_2, p_3 will in general all be different, and one or more may assume negative values (representing compressive stresses, as explained on p. 51).

Stress Equations of Motion or Equilibrium.—7. The directions of the principal stresses will in general vary from point to point, and cannot be determined until we have calculated the state of stress. For this purpose we form, in the first place, the equations of motion or of equilibrium for a small rectangular block of the material having edges parallel to three fixed axes Ox, Oy, Oz: hence, imagining the dimensions of the block to be made indefinitely small, we derive three equations of which the following is typical:

$$\frac{\partial X_x}{\partial x}+\frac{\partial X_y}{\partial y}+\frac{\partial X_z}{\partial z}+\rho X=\rho f_x. \tag{1}$$

In this equation, x, y and z are the components of a point referred to the fixed axes; X_x is the normal component of the stress on a plane through (x,y,z) which is perpendicular to Ox; and X_y, X_z are the tangential components, parallel to Ox, of the stresses on planes through (x,y,z) which are perpendicular to Oy and Oz respectively. X is the "body force" per unit mass (due, *e.g.*, to gravitation or electrical attractions), ρ the density of the material, and f_x the acceleration in the direction Ox, at the point (x, y, z).

Two-Dimensional Stress-Systems.—8. The derivation of these equations, and a proof of the theorem stated in § 6, will be found in the article ELASTICITY. We shall here confine attention to the special case in which there is no stress on planes perpendicular to Oz.

Fig. 2 shows a rectangular block of dimensions δx, δy, 1, in the directions of Ox, Oy, Oz respectively. The point A has co-ordinates x, y, and the stress on the face AD has a normal component which we denote (as above) by X_x; similarly, the stress on the face AB has a normal component which we denote by Y_y. The tangential stress on AB has a component in the direction of Ox which we denote (as above) by X_x; and similarly, the tangential stress on

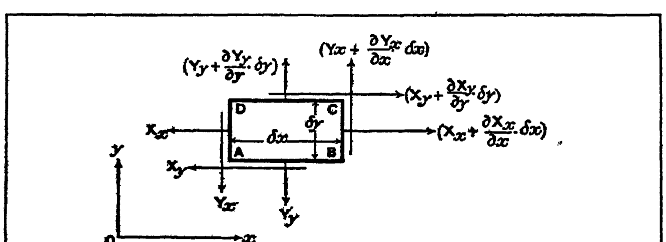


FIG. 2.—DERIVATION OF THE STRESS EQUATIONS OF MOTION: TWO-DIMENSIONAL CASE

AD has a component in the direction of Oy which we represent by Y_x.

On the face BC, as on AD, there will be component stresses X_x, Y_x; but their values will in general be different, because the state of stress will vary from point to point. We may represent them, as in the diagram, by $\left(X_x+\frac{\partial X_x}{\partial x}\cdot\delta x\right)$ and $\left(Y_x+\frac{\partial Y_x}{\partial x}\cdot\delta x\right)$ respectively, and the stresses on DC may be represented similarly.

Remembering that the total action on any face is given by the stress on that face multiplied by its area, we see that the resultant force tending to accelerate the block in the direction Ox is

$$\left(\frac{\partial X_x}{\partial x}\ \delta x\right)\ \delta y+\left(\frac{\partial X_y}{\partial y}\ \delta y\right)\ \delta x+\rho X\ \delta x\ \delta y,$$

where X is the body-force. This resultant may be equated to the product of mass and acceleration—that is, to $(\rho\ \delta x\ \delta y)\ f_x$. Then, if we cancel out the common factor $(\delta x\ \ \delta y)$, we obtain the equation

$$\frac{\partial X_x}{\partial x}+\frac{\partial X_y}{\partial y}+CX=\rho\ f_x,$$

which (since we have assumed that X_z is zero) is the same as (1).

9. A second equation may be obtained by considering motion in the direction Oy, and a third by considering the tendency of the block to turn about an axis parallel to Oz. The resultant moment on the block is given by

$$(Y_x\ \delta y)\ \delta x-(X_y\ \delta x)\ \delta y,$$

plus terms which become relatively negligible when δx and δy are indefinitely reduced. So we have, ultimately, the condition

$$Y_x=X_y, \tag{2}$$

which is typical of three that can be obtained in the general case. Thus in general six (not nine) components are required to specify the state of stress at a point, namely,

$$X_x,\ Y_y,\ Z_z,\ Y_z,\ Z_x,\ X_y; \tag{3}$$

and these six components are related by three equations of the type (1).

10. To illustrate the theorem of § 6, we shall again assume that planes perpendicular to Oz are free from stress. We shall consider the triangular block shown in fig. 3, and we shall imagine that the sides of this block are indefinitely small; then the effects of body-force and of acceleration may be neglected in comparison with those of stress. In accordance with (2), we denote by X_y the tangential stress on both of the faces AC, CB.

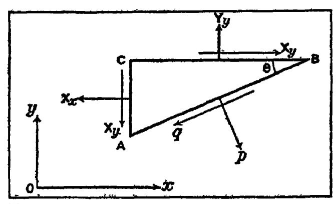


FIG. 3.—TRANSFORMATION OF STRESS COMPONENTS: TWO-DIMENSIONAL CASE

Let p and q be the (unknown) normal and tangential components of stress on the inclined face AB. Then for equilibrium in the direction of p we have the condition

$$p\ AB=(X_x\ AC)\sin\theta+(Y_y\ CB)\cos\theta \\ -X_y(AC\ \cos\theta+CB\ \sin\theta),$$

and for equilibrium in the direction of q we have similarly

$$q\times AB=(Y_y\times CB)\sin\theta-(X_x\times AC)\cos\theta \\ +X_y(CB\cdot\cos\theta-AC\cdot\sin\theta).$$

But $AC=AB\sin\theta$ and $CB=AC\cos\theta$. Hence, dividing out both equations by AB, we obtain the expressions

$$\left.\begin{aligned} p&=X_x\sin^2\theta+Y_z\cos^2\theta-X_y\sin 2\theta,\\ q&=\frac{Y_y-X_x}{2}\sin 2\theta+X_y\cos 2\theta, \end{aligned}\right\} \tag{4}$$

whence p and q can be found when X_x, Y_y, X_z are known.

The stress on AB will be purely normal if q is zero, and the second of (4) shows that this will happen if

$$\tan 2\theta=\frac{2X_y}{X_x-Y_y}, \tag{5}$$

—an equation which gives two values of θ, differing by a right angle. Thus, in our simplified case, the theorem is proved.

The first of (4) may be written in the form

$$p=\frac{X_x+Y_y}{2}+\frac{Y_y-X_x}{2}\cos 2\theta-X_y\sin 2\theta,$$

and hence p will have a stationary value if

$$0=\frac{\partial p}{\partial\theta}=(X_x-Y_y)\sin 2\theta-2X_y\cos 2\theta.$$

Comparing this condition with (5), we see that the normal stress will have stationary (*i.e.*, maximum or minimum) values on those planes for which the tangential stress is zero. This theorem holds in the general case.

Mohr's Circle Diagram for Compound Stress.—11. If, in fig. 3, the rectangular faces are principal planes of stress, X_y will be zero. Writing p_1 and p_2, in (4), for Y_y and X_x respectively, we have for this case:

$$\left.\begin{aligned} p &= \tfrac{1}{2}(p_1+p_2)+\tfrac{1}{2}(p_1-p_2)\cos 2\theta, \\ q &= \tfrac{1}{2}(p_1-p_2)\sin 2\theta. \end{aligned}\right\} \qquad (6)$$

It is clear that p and q will be given, in terms of p_1, p_2, by a circular diagram constructed as shown in fig. 4. If CA is drawn, at an angle 2θ to OCN, to meet the circle at A, the co-ordinates ON, AN of A will represent p and q respectively.

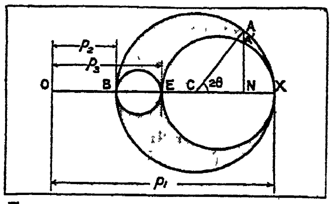


FIG. 4.—MOHR'S CIRCLE DIAGRAM FOR COMPOUND STRESS

Again, it is clear that the stress on AB (fig. 3) will not be affected by the addition of a third principal stress p_3, acting on the triangular faces of the prism; so, in the general case, the circle BAX still gives the stresses on planes which are parallel to the direction of p_3. In the same way, if OE (fig. 4) represents p_3, points on a circle having EB as diameter will relate the normal and tangential components of stress for all planes parallel to p_1, and points on a circle having EX as diameter will relate these components for all planes parallel to p_2.

On planes which are inclined to all three of the principal planes, the stresses, in the general case, will depend upon all three of p_1, p_2, p_3. But it may be proved that points taken, in fig. 4, to relate the normal and tangential components of stress on such planes will in all cases lie within the shaded area of the diagram. Thus, if the normal stress on a plane is specified by ON, the intensity of the tangential stress lies between limits given by AN and $A'N$.

Case of Two Equal and Opposite Principal Stresses.—12. If, in equations (6), we make p_2 equal and opposite to p_1, the stress on planes which are equally inclined to the principal planes of stress ($2\theta = 90°$) will be given by

$$p = 0, \qquad q = p_1. \qquad (7)$$

Hence we see that a state of stress represented by equal and opposite principal stresses of intensity p and $-p$ is equivalent to a state of simple shearing stress, of intensity p, on planes inclined at 45° to the principal planes of stress.

ANALYSIS OF STRAIN

Displacements.—13. In the analysis of strain, or distortion, the assumption of continuity is again fundamental. Disregarding all questions of molecular structure, we imagine our ideal material to occupy every point within a certain continuous surface (or within a volume contained by continuous surfaces, when the body considered is hollow)—the "boundary" of the solid body considered. When the material is distorted by the application of force, this boundary surface will assume a different form; but so long as the material is unbroken, it will remain a continuous surface.

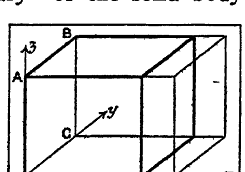


FIG. 5.—DIAGRAM ILLUSTRATING SIMPLE EXTENSION

In the unstrained body there will be, at any point defined by co-ordinates x, y, z, a certain "particle" of material. When the body is distorted, this particular particle will in general occupy a different position, which we may define by co-ordinates $x+u$, $y+v$, $z+w$; u, v, w are termed the component *displacements* of the particle in question. It is clear that, if we know the component displacements of any two particles P and Q, we can calculate the increase, due to strain, in the distance PQ; and further that, if we know the component displacements of a third point R, we can calculate the change, due to strain, in the angle PQR.

Simple Extension.—14. Let us imagine, for example, that a cube of the material is distorted in the manner which is indicated by fig. 5, so that four of its edges are lengthened by the same amount, whilst the other eight edges retain their original lengths and all the faces remain rectangular. If we choose axes Ox, Oy, Oz coinciding with three edges of the cube, as shown, it is clear that this state of strain will occur when every particle undergoes a displacement confined to the direction of Ox and of magnitude proportional to its original distance from the face $OABC$; then we shall have

$$u = ex, \quad v = 0, \quad w = 0,$$

where e is constant, and the fractional extension of any line PQ having the direction Ox will be given by

$$\begin{aligned} \frac{(\text{Strained length}) - (\text{Original length})}{(\text{Original length})} &= \frac{u_Q - u_P}{x_Q - x_P}, \\ &= \frac{e(x_Q - x_P)}{x_Q - x_P}, \\ &= e. \end{aligned}$$

We say that the material undergoes a simple extension, of amount e, in the direction Ox: any line in the material, initially parallel to this direction, is extended by the same fractional amount.

Simple Shearing Strain.—15. Another simple type of distortion can be imagined in which the shape of two faces is changed. Its nature is illustrated in fig. 6, and it will evidently occur when every particle undergoes a displacement confined to the direction Ox and of magnitude proportional to its distance from the face $OCEF$, for then we shall have

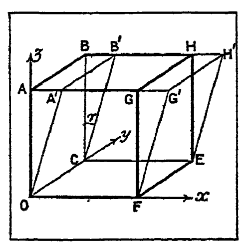


FIG. 6.—DIAGRAM ILLUSTRATING SIMPLE STRESS

$$u = \gamma z, \quad v = 0, \quad w = 0,$$

and all lines originally parallel to OZ will rotate through the same angle (the angle BCB' of the figure). If BB' is small, this angle will be represented sufficiently closely (in circular measure) by the ratio

$$\frac{BB'}{BC} = \frac{\gamma \cdot BC}{BC} = \gamma.$$

We say that the material undergoes "simple shearing strain" (or, more briefly, "simple shear") in the (z, x) plane; the magnitude of the strain is γ, the reduction in the angle between lines which were originally parallel to Oz and Ox.

Composition of Simple Strains: Principle of Superposition.—16. Suppose that the top face $ABHG$, after moving to the position $A'B'H'G'$, undergoes a further displacement in its own plane, this time in the direction Oy. We may imagine that the edges OA, CB, EH, FG, and any line of particles which was originally parallel to them, again remain straight and parallel; they now rotate through another angle γ; which is the reduction (in circular measure) in the (originally right) angle AOC. We say that a second simple shearing strain has been superposed on the first.

Evidently, only the top and bottom faces of the cube will remain rectangular after this second strain is imposed, and these can have their angles changed by the imposition of a third simple shear. In its final state, the body will be bounded by six parallelograms, and opposite faces will be similar; that is to say, the cube has distorted into a parallelopiped. Since the lengths of its edges are unaltered by the distortion, three quantities (namely, three angles of shear γ_1, γ_2, γ_3) are required to specify its final shape.

Lastly, we may imagine that the material undergoes three successive simple extensions in the three perpendicular directions Ox, Oy, Oz. Denoting these extensions by e_1, e_2, e_3, defined as above, we see that the three sets of parallel edges of the parallelopiped will be increased in the ratios $(1+e_1)$, $(1+e_2)$ and $(1+e_3)$. These expressions are not strictly correct, but they are sufficiently accurate if e_1, e_2, e_3 are small; for on this understanding the final shape would have been the same if the extensions had been imposed first and the shearing strains last. This is the *principle of superposition* for small strains.

Homogeneous Strain.—17. In these examples of simple

strain, the same description and diagrams would evidently apply to any cubical portion of the material, however small. In such circumstances the strain is said to be *"homogeneous,"* or uniform.

It is a fundamental principle in the analysis of strain that *in the immediate neighbourhood of any point, whatever may be the nature of the distortion, the strain is sensibly homogeneous;* in other words, whilst we can imagine types of distortion in which the faces and edges of a cube become curved, and in which opposite faces are unequally strained, it is permissible, when the dimensions of the cube are indefinitely diminished, to neglect these effects and to assume that the strained cube is a parallelopiped. This implies, according to the preceding investigation, that the most general type of strain at any point in a material may be described by specifying values of three extensions and three angles of shear. These six quantities are termed the "components of strain."

Strains Expressed in Terms of Displacement.—18. On the assumption that the displacements u, v, w are everywhere small, it may be shown (*see* article ELASTICITY) that the extension in the direction Ox will be given by

$$e_{xx}=\frac{\partial u}{\partial x},$$

and the "shear" in the (z, x) plane by

$$e_{zx}=\frac{\partial u}{\partial z}+\frac{\partial w}{\partial x}. \qquad (8)$$

Similar expressions hold for the other four components of strain. Thus the six components of strain are not really independent: they can all be expressed in terms of three component displacements u, v, w, when these are given as functions of x, y, z, the co-ordinates of a particle in the unstrained material.

Transformation of the Components of Strain.—19. Given the values of u, v, w, we can evidently calculate the component displacements, u', v', w', in any other three perpendicular directions Ox', Oy', Oz', and hence we can deduce expressions, *e.g.*, for the extension in the direction Ox' and for the shear in the (z', x') plane. This is the problem of "transformation of strain-components": the general formulae will be found in the article ELASTICITY, and it will suffice here to give a relatively simple example.

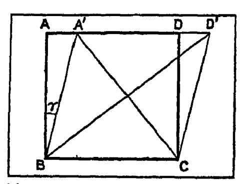


FIG. 7.—DIAGRAM ILLUSTRATING TRANSFORMATION OF STRAIN COMPONENTS

Consider a square block $ABCD$ which undergoes a simple shearing strain of magnitude γ, as shown in fig. 7. The diagonals AC, BD will evidently remain perpendicular to one another, and the angle $A'BD'$ will be $\left(45^\circ-\frac{\gamma}{2}\right)$; to the first order of small quantities, the sides AB, BC, CD, DA will retain their original length l. Hence, the strained length BD' will be given by

$$2l\cos\left(45^\circ-\frac{\gamma}{2}\right)=\sqrt{2}\cdot l\left(1+\frac{\gamma}{2}\right);\text{ very nearly, since }\gamma\text{ is small.}$$

That is to say, the fractional extension of BD is

$$\sin\frac{\gamma}{2}=\frac{1}{2}\gamma. \qquad (9)$$

The fractional extension of AC may be shown in the same way to be $-\frac{1}{2}\gamma$. So we see that a state of strain represented by equal and opposite extensions of amounts e and $-e$ in two directions at right angles implies a simple shearing strain of amount $2e$ in an element whose sides are equally inclined to these directions.

Principal Strains.—20. The fundamental theorem in the analysis of strain may now be stated:—*Through any point in the material, however complicated may be the state of strain at that point, three lines can be found, each perpendicular to the other two, which were also perpendicular to one another initially, when the material was unstrained.* In other words, a very small rectangular block of material, whose edges were originally parallel to these lines, will remain rectangular after strain. The most general type of distortion may be specified by fixing these three directions, and the extension which corresponds to each[1]: the extensions are called *"principal extensions,"* and the directions *"principal axes of strain."*

In the two-dimensional example just considered, the diagonals AC, BD are the principal axes of strain.

THE RELATION OF STRESS TO STRAIN

21. We have seen (§ 9) that *six* independent quantities (the "stress-components") are required, in general, to specify a state of stress; and further (§ 7), that *three* relations between them (the "stress equations" of motion or equilibrium) can be obtained by an application of dynamical principles. These relations are not sufficient to determine the stress-distribution produced by specified loads; to take a simple example, we cannot, by statical considerations alone, determine the load on each leg of a table, when all four are in contact with the ground. We need additional relations, and an obvious solution of the difficulty is to relate, by any arbitrary assumption, the six components of stress with the six components of strain. For we have seen (§ 18) that the latter can all be expressed in terms of *three* independent quantities—the components of displacement; so, by this procedure, we shall be left with three equations relating only three unknown quantities—that is, with information sufficient (*i.e.*, in theory) for a solution.

Hooke's Law.—22. The simplest relation that we can assume is direct proportionality—in other words, a "linear" law. The most general state of stress is defined by six independent components of stress, and the most general state of strain is defined by six independent components of strain: we assume that each one of the components of stress may be expressed in terms of the six components of strain by a formula of the type

$$p=a_1e_1+a_2e_2+a_3e_3+a_4e_4+a_5e_5+a_6e_6, \qquad (10)$$

where p stands for the stress-component, $e_1, \ldots e_6$ for the components of strain, and $a_1, \ldots a_6$ are constants. On this assumption, the stress equations remain linear when transformed, first into relations between the coefficients of strain, and thence into relations between u, v and w, the three components of displacement. Hence, if we obtain a solution—that is to say, expressions for u, v, w, at any point in a specified body, in terms of the applied forces—these relations will still be satisfied when we multiply u, v, w, together with the applied forces, by any constant factor. So we deduce from our assumption, that the displacements at every point, and hence the strains, will be proportional to the "load."

Robert Hooke, in 1660, discovered by experiment that this is in fact a property of real materials. He published his discovery (1676) under the form of an anagram, *ceiiinosssttuu* and did not until two years later disclose the solution—*"ut tensio sic vis* (*vis*)"; that is, "the Power of any spring is in the same proportion with the Tension thereof." (*De Potentia restitutiva,* London, 1678.) A more accurate statement of the experimental evidence is that, within certain definite limits of strain (*see* § 38):

(1) when the load is increased, the measured strain increases in the same ratio,

(2) when the load is diminished, the measured strain diminishes in the same ratio.

(3) when the load is reduced to zero, no measurable strain persists.

It will be realized that the assumption represented by (10), whilst it is consistent with these results, is more precise and of wider scope than any experiments that can be made. No method has been devised for measuring either the strain or the stress in the *interior* of an elastic body: all that can be done is to relate particular displacements with the resultant applied load. Thus the six expressions of type (10) are to be regarded as *postulates* of the mathematical theory, and the justification for applying this theory to real materials must be found in an increasing accumulation of observations in which its predictions are verified.

Aeolotropic and Isotropic Materials.—23. Since six coefficients (of type a_1, a_2, . . . etc.) are involved in each of the six expressions of type (10), our generalized statement of Hooke's

[1]It will be noticed that six quantities are still involved in the description.

law involves altogether 36 coefficients—the "elastic constants" of the material. An argument based on thermodynamical considerations indicates that only 21 of the elastic constants are to be regarded as independent; and on a certain hypothesis concerning the structure of real materials it may be shown that their elastic behaviour will be reproduced in an ideal material for which the number is further reduced to 15[1]. But a much more drastic reduction can be effected if we assume that our ideal material has the same elastic properties in all directions: this property is termed *isotropy*.

Isotropy is not a property of wood, which is well known to have its greatest strength "along the grain"; nor is it found, in experiment, to be a property of crystals: to represent such materials, we must assume this ideal material to be *aeolotropic*—that is, to have elastic constants which vary with direction. Wrought metals, on the other hand, behave as isotropic substances, in the sense that specimens cut from the same material, but in different directions, behave similarly under tests. Thus the assumption of isotropy, which greatly simplifies our calculations, is legitimate for most practical applications of the theory. We shall not discuss aeolotropic materials further in this article.

Stress-strain Relations in Isotropic Material.—24. For isotropic materials we may show that the number of independent constants cannot exceed *two*. For we have seen, in the analysis of stress (§ 6), that a small rectangular block can be found, at any point in the material, whose faces are subjected to purely normal stresses; and in the analysis of strain (§ 20), that a small rectangular block can be found whose faces remain rectangular after strain. The stresses on the faces, in the first case, are termed "principal stresses," and the extensions of the edges, in the second case, are termed "principal extensions, or strains." Now it is clear that, in material which has no directional property, the directions of the principal stresses and of the principal strains must coincide; for there is no reason why a symmetrical system of purely normal stresses should produce asymmetrical distortion, as would be the case if the block ceased to be rectangular. Therefore, in the most general statement of Hooke's law for isotropic materials, we have to relate three principal stresses with three principal strains; and our formulae will thus be three of the type

$$p_1 = ae_1 + be_2 + ce_3, \qquad (11)$$

where a, b, c are elastic constants.

But considerations of symmetry demand further, in the absence of directional properties, that the coefficients b and c shall be equal; for it is evident that e_2 and e_3, which both have directions perpendicular to p_1, can be interchanged without altering the magnitude of p_1. So the formula (11) becomes

$$p_1 = ae_1 + b(e_2 + e_3),$$

and this may conveniently be written in the equivalent form

$$p_1 = \lambda\Delta + 2\mu e_1, \qquad (12)$$

where Δ denotes the quantity $(e_1+e_2+e_3)$, and λ and μ are two elastic constants of the material which, unless related by some additional hypothesis, will be independent.

Modulus of Compression.—25. Adding the three equations of type (12), we see that

$$p_1 + p_2 + p_3 = (3\lambda + 2\mu)\Delta,$$

so that, if $p_1 = p_2 = p_3 = p$ (say), we have

$$3p = (3\lambda + 2\mu)\Delta \qquad (13)$$

Now Δ may be interpreted as the fractional increase in volume which results from the distortion considered. For if the sides of our rectangular block were l_1, l_2, l_3 before strain, they will be $(1+e_1)l_1$, $(1+e_2)l_2$, $(1+e_3)l_3$ after strain, and hence the strained volume will be given by

$$l_1 \cdot l_2 \cdot l_3(1+e_1)(1+e_2)(1+e_3), =$$
$$l_1 \cdot l_2 \cdot l_3 \cdot (1+e_1+e_2+e_3),$$

very nearly, if e_1, e_2 and e_3 are small quantities. Therefore the increase in volume due to strain is

$$l_1 \cdot l_2 \cdot l_3 \cdot \Delta,$$

and the fractional increase is Δ, very nearly.

Let us now suppose that our material is strained by hydrostatic pressure. Then the relation (13) will hold, both p and Δ being negative. If we write k for the ratio

$$\frac{\text{Intensity of Pressure}}{\text{Consequent reduction in volume}},$$

we have

$$k = \frac{-p}{-\Delta} = \frac{3\lambda + 2\mu}{3}, \text{ by (13).} \qquad (14)$$

The quantity k is termed the *modulus of compression* or *bulk modulus* of the material.

Modulus of Rigidity.—26. Let us next suppose that e_1 and e_2 are equal in magnitude and opposite in sign, and that e_3 is zero. Then Δ will be zero, and we have as relations of the type (12):

$$\left.\begin{array}{l} p_1 = 2\mu e_1, \\ p_2 = 2\mu e_2, \end{array}\right\} \text{so that } p_1 = -p_2,$$
$$p_3 = 0.$$

The state of stress is that considered in § 12, and the state of strain is that considered in § 19. It will be seen that the stress may be regarded as a simple shearing stress of intensity p_1, and the strain as a simple shear of amount $2e_1$. Therefore

$$\mu = \frac{p_1}{2e_1} = \frac{\text{Intensity of shearing stress}}{\text{Consequent shear}}. \qquad (15)$$

The quantity μ is termed the "modulus of rigidity," or "shear modulus" of the material. From the physical standpoint, k and μ are to be regarded as the fundamental elastic constants: k measures the resistance to change of volume unaccompanied by change of form, whilst μ measures the resistance to change of form unaccompanied by change of volume.

Young's Modulus and Poisson's Ratio.—27. The conditions in a simple tensile test are such that, very approximately,

$$p_2 = p_3 = 0,$$

so that e_1, e_2, e_3 will all be proportional to p_1, the longitudinal tension.

Considerations of symmetry require that e_2 and e_3 shall be equal, but we may not assert that they are zero: in tests on actual materials it is found that e_2 and e_3 are finite and opposite in sign to e_1. If then we write

$$e_2 = e_3 = -\sigma e_1,$$

the relations of type (12) become

$$p_1 = \{\lambda(1-2\sigma) + 2\mu\}e_1,$$
$$0 = \lambda(1-2\sigma) - 2\mu\sigma,$$

and we deduce that

$$\left.\begin{array}{l} \sigma = \dfrac{1}{2}\,\dfrac{\lambda}{\lambda+\mu}, \\ p_1 = 2\mu(1+\sigma)e_1. \end{array}\right\} \qquad (16)$$

The ratio

$$\frac{p_1}{e_1} = \frac{\text{Longitudinal stress}}{\text{Consequent longitudinal extension}}$$

is termed *Young's Modulus* for the material, and is generally denoted by the symbol E. We see from (16) that

$$E = 2(1+\sigma)\mu = \frac{\mu(3\lambda + 2\mu)}{\lambda + \mu}. \qquad (17)$$

The ratio

$$\sigma = \frac{\text{Lateral contraction}}{\text{Longitudinal extension}} = \frac{1}{2}\,\frac{\lambda}{\lambda+\mu}$$

is termed *Poisson's Ratio*.

[1] *cf.* A. E. H. Love, *Mathematical Theory of Elasticity* (1927), § 66. The relations which effect this reduction in the number of the elastic constants are known as "Cauchy's relations."

We observe that the three equations of type (12) are equivalent to three of the type

$$e_1 = \frac{1}{E}\left[p_1 - \sigma(p_2 + p_3)\right]. \qquad (18)$$

Relations Between the Elastic Constants. Conditions for Stability.—28. However we express the stress-strain relations, only two independent constants (namely λ and μ) are really involved: therefore any three of the foregoing elastic constants can be related. Thus we have expressed E, in (17), in terms of λ and μ; similarly, from (14) and the first of (16) we have

$$k = \mu\left(\frac{2}{3} + \frac{\lambda}{\mu}\right) = \frac{2}{3}\mu\frac{1+\sigma}{1-2\sigma} = \frac{E}{3(1-2\sigma)}, \qquad (19)$$

whence
$$\left.\begin{aligned} \sigma &= \frac{1}{2}\,\frac{3k-2\mu}{3k+\mu}, \\ E &= \frac{9\mu k}{3k+\mu}. \end{aligned}\right\} \qquad (20)$$
and

Now it is an observed property of real materials (and an evident condition of their persistence) that the elastic constants E, μ, k, shall all be positive. It follows from (17) that σ cannot be negative and numerically greater than 1; for otherwise the ratio E/μ would be negative. And since $(1+\sigma)$ is thus shown to be positive, it follows from (19) that σ cannot be positive and greater than $\frac{1}{2}$; for otherwise the ratio k/μ would be negative. Thus we have as the condition for a stable material,

$$-1 < \sigma < \tfrac{1}{2}. \qquad (21)$$

In ordinary materials σ has a value between 0·25 and 0·33.

SOME SIMPLE STRESS-DISTRIBUTIONS

Tension.—29. Turning from the methods to the results of mathematical enquiry, we remark that some of its simplest solutions are those which have proved most useful to the practical engineer. Thus the "tie," or member subjected to tensile load, is one of the commonest of structural units: theory states that the stress in a straight tie of uniform cross-section will be a simple tensile stress of uniform intensity, provided that the line of the resultant pull passes through the centroid, or centre of area, of each cross-section. At the ends this simple stress-distribution will be modified according to the manner in which the load is applied; but theory shows that the modification is unimportant, except in the immediate neighbourhood of the ends. Thus, when we subject a straight rod of material to a tensile test, it does not matter how the load is applied, provided that the line of the pull is accurately central, and that the resulting strain is measured over a limited part of the length, remote from the loaded ends.

Bending.—30. Another structural unit of very common occurrence is the beam or girder, a member whose function is to resist *bending*. B. de St. Venant (1856) first put the theory of bending on a satisfactory basis (J. de Math. [Liouville], Ser. 2, vol. 1). He showed that a state of stress can be maintained in a straight beam of uniform section, such that there is at every point a purely longitudinal stress (either tensile or compressive). The intensity of this stress depends upon the position of the point: in any cross-section of the beam (fig. 8) there will be a line NN such that at points on this line the stress is zero; at any other point P, the intensity of stress will be proportional to y, the distance of P from NN. NN will always pass through the centroid of the cross-section: if this has a plane of symmetry (QQ in the figure) which is also the plane of bending, then NN will be perpendicular to that plane.

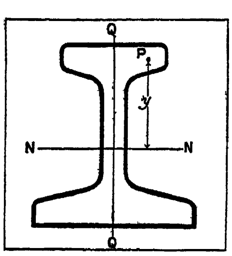


FIG. 8.—STRESSES DUE TO BENDING

Let R be the radius of the (very large) circle into which the beam is bent; let I be the "geometrical moment of inertia" of the cross-section about the line NN; and let E be Young's modulus for the material. Then the longitudinal stress p at P (acting at right angles to the cross-section) will be given by

$$p = \frac{Ey}{R}, \qquad (22)$$

and the total bending action M (which is resisted by this distribution of stress) will be given by

$$M = \frac{EI}{R}. \qquad (23)$$

Hence we have also

$$p = \frac{My}{I}. \qquad (24)$$

These results apply, strictly, to a beam which is bent by forces applied in a particular way (*i.e.*, so as to produce the foregoing distribution of stress on the terminal sections); but theory indicates reasons why the results may, with an accuracy sufficient for practical purposes, be extended to beams bent in any manner, and even to beams of varying cross-section. The results (22)–(24) thus form the basis of a very general theory of bending.

Torsion.—31. Much use is made in mechanical engineering of circular shafts which transmit couples from one end to the other: for example, the propeller shaft of a steamship transmits a couple from the engine or turbine to the propeller, where this couple is opposed by the reaction of the water. Such couples tend to twist the shaft, and in this problem again the state of stress is, fortunately, simple. Let AB (fig. 9) be a uniform circular shaft held at the end A and twisted by a couple applied in the plane B. In consequence of the strain due to twisting (this is very much magnified in the diagram) a radius CD in the plane B remains straight but turns round to CD', and a line AD, originally parallel to the axis of the shaft and at a distance r from it, distorts into a helix AD'—that is, into a curve which makes a constant angle θ with lines parallel to the axis. Cross-sections of the shaft remain plane when the shaft is twisted and hence θ is the angle of shear: so, at a distance r from the axis, we have a shearing stress, of intensity

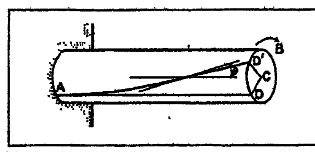


FIG. 9.—STRESSES DUE TO TWISTING

$$q = \mu\theta, \qquad (25)$$

acting on each cross-section in a direction perpendicular to the radius.

Now let i denote the angle of twist DCD', and let l be the length of the shaft. Then i and θ (both being assumed very small) are related by the equation

$$l\theta = ri,$$

whence, by (25),

$$q = \mu\frac{i}{l}r = \mu\tau r, \qquad (26)$$

where τ is the "angle of twist per unit length." That is to say, the intensity of shear stress at any point in the cross-section is proportional to r, the distance of that point from the axis.

The total twisting couple T (which is resisted by this distribution of shear stress) is given by

$$T = \int 2\pi r^2 q\,dr = 2\pi\mu\tau\int r^3 dr = \mu\tau J, \qquad (27)$$

where J is the "geometrical polar moment of inertia" of the cross-section (either solid of hollow) about the axis. So we have, from (26) and (27),

$$q = \frac{Tr}{J}. \qquad (28)$$

It should be emphasized that these formulae apply only to shafts of circular cross-section.

Principle of Superposition. Bending Combined with Twist.—32. A consequence follows from the fact that the elastic equations are linear in form. If we can calculate the stresses, strains or displacements which result when any two systems of load act separately on a given body, then we know that these two systems, acting simultaneously, will produce stresses, strains or

displacements which may be found by adding their separate effects. We say that stresses, strains or displacements may be *superposed.*

33. As an example of the use of this principle, we may consider the important problem of a crank (fig. 10). Let a force P be applied to the crank pin A at right angles to the plane of the crank. Then the stresses exerted at any section C of the shaft have to resist, first, a twisting moment of magnitude

$$T=P{\cdot}AB,$$

and secondly, a bending moment of magnitude

$$M=P{\cdot}BC.$$

There will also be shear stresses required to resist the direct force P; but these may be neglected as unimportant for practical purposes. The principle of superposition asserts that the stress at C is made up of a normal stress p, due to bending, which may be calculated by means of (24), and of a shearing stress q, due to torsion, which may be calculated by means of (28). We have, in fact, at the surface,

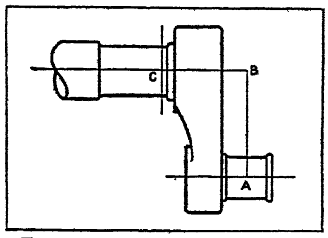


FIG. 10.—STRESSES IN A CRANK

$$p=\frac{4M}{\pi a^3},\qquad q=\frac{2T}{\pi a^3},\tag{29}$$

where a is the radius of the shaft (assumed solid).

Stresses Due to Internal Pressure, in Thin Circular Tubes or Spherical Shells.—34. When a long circular tube of uniform thickness is subjected to uniform internal pressure, considerations of symmetry show that the stresses exerted across any plane which contains the axis will be purely normal; moreover, if the thickness is small, this normal stress must be practically uniform. Let t be the thickness of the tube, r the inner radius, P the internal pressure, and p the stress; then, considering any length l of the tube, we see that a total force due to pressure, of amount

$$l\times 2r\times P,$$

is balanced by a total resistance due to stress, of amount

$$2(l\times t\times p).$$

Hence we deduce that

$$p=P\frac{r}{t}.\tag{30}$$

35. A similar argument may be employed to find the stress imposed by uniform pressure on a thin spherical shell. Using the same notation, we see that a total force due to pressure, of amount

$$\pi r^2\times P,$$

is balanced by a total resistance due to stress, of amount which is given approximately by

$$2\pi r\times t\times p.$$

Hence, in the spherical shell, the stress is given by

$$p=\tfrac{1}{2}P\frac{r}{t}.\tag{31}$$

36. If the ends of a circular tube are closed, the pressure on the ends will impose a stress, on planes which are perpendicular to the axis, of intensity given by (31). The stress on axial planes is given by (30), and the radial stress (which varies from $-P$ at the inner face to zero at the outer face) is relatively negligible. So the tube will undergo circumferential and axial extensions which, by the formulae (18) of § 27, are

$$\left.\begin{aligned} e_1&=\frac{1}{E}\left[P\frac{r}{t}-\sigma\left(\tfrac{1}{2}P\frac{r}{t}\right)\right]=\frac{2-\sigma}{2E}P\frac{r}{t},\\ e_2&=\frac{1}{E}\left[\tfrac{1}{2}P\frac{r}{t}-\sigma\left(P\frac{r}{t}\right)\right]=\frac{1-2\sigma}{2E}P\frac{r}{t}.\end{aligned}\right\}\tag{32}$$

We see from the second of (32) that the longitudinal extension is related with the dimensions of the tube by an elastic constant $E/(1-2\sigma)$ which we have shown (§ 28) to be equal to $3k$. We have in fact

$$e_2=\frac{1}{6k}P\cdot\frac{r}{t}.\tag{33}$$

This result has been utilized in the experimental determination of k (*see* § 48).

APPLICATION OF THE THEORY TO REAL MATERIALS

Scope of the Theory.—37. The theory of elasticity, and hence the solutions which it provides, are based upon three main assumptions, namely:

(a) that the material, and therefore the displacement, are "continuous";
(b) that "Hooke's law" is satisfied;
(c) that the strains and displacements are everywhere small.

Only when these assumptions are justified will the foregoing solutions be strictly valid.

Now real materials, as we have seen, are not continuous at all: timber, for example, has a "grain" which can be seen with the naked eye, and metals, examined under the microscope, are found to be conglomerates of small crystals, in general arranged at random. But their structure is invariably fine in relation to the sizes of members used in engineering construction, or of the pieces in which they are tested for strength and rigidity; hence its exact nature is a question of minor importance to the practical designer, who (with certain exceptions which will be stated later) is concerned to know the general nature, rather than the finer details, of the stress-distributions which occur. We may legitimately employ "statistical" rather than exact methods, carrying over to real problems the concepts and notation which our theory has developed in relation to ideal continuous materials.

This is the standpoint adopted in the second branch of our subject, the science of testing of materials. When we stretch a rod of steel in a testing machine, and measure the resulting extension, we interpret our results as giving relations between stress and

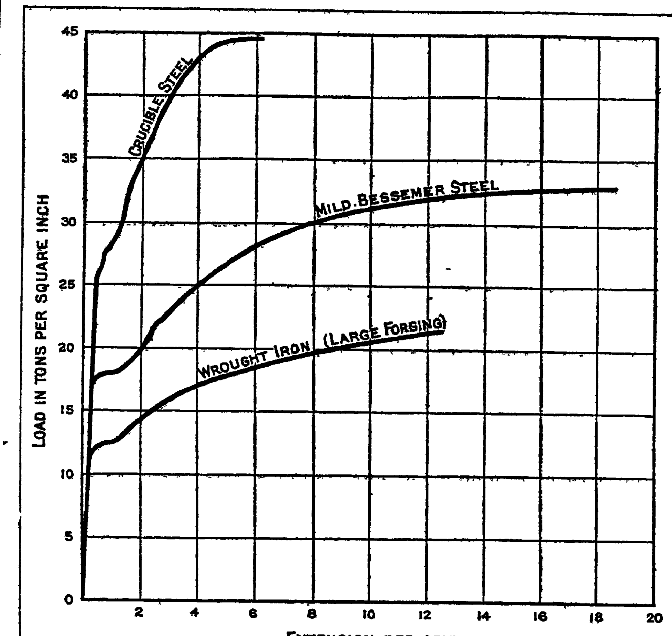


FIG. 11.—STRESS-STRAIN DIAGRAMS

strain. We calculate the stress, in accordance with our theoretical definition (§ 4), as the quotient of the total load divided by the cross-sectional area of the rod; we measure the extension of some definite length of the rod, and calculate the strain, again in accordance with theory (§ 14), as the corresponding fractional extension; and we assume, on grounds which are afforded by the theory (§ 29), that the stress and strain are uniform. That is to say, we treat the material as continuous, disregarding all effects which depend upon its detailed structure. Further, in dealing with steel

or other wrought metal, we treat the material as *isotropic,* although we know that the crystals composing it have properties which depend on direction. This is legitimate from the practical standpoint, because the random orientation of the crystals renders the material *"statistically isotropic"* (*cf.* R. V. Southwell and H. J. Gough, *Phil. Mag.,* Jan. 1926, § 1): it would evidently not be permissible in relation to wood or other materials which exhibit a definite "grain."

38. Fig. 11 gives some results, due to Kirkaldy (Experiments on the Mechanical Properties of Steel by a Committee of Civil Engineers, London, 1868 and 1870), which have been interpreted in this manner; they relate to tests made on long rods in tension. It will be seen that the stress and strain are very closely proportional—*i.e.,* that Hooke's law is satisfied—up to a definite limit for each material which represents a considerable stress but a very small extension (less than ½%). This limit is termed the "limit of proportionality" for stress of the type considered. After it has been passed, the strain increases at a much greater rate in relation to the stress; moreover, as we shall see later, the strain does not disappear when the load is removed, so that the elasticity of the material, as well as the proportionality of stress to strain, has broken down. Therefore, in real materials, the second assumption (*b*) of the mathematical theory is satisfied only within the limits of proportionality: if these are exceeded, we may no longer assume that the stresses are distributed in accordance with our calculations.

39. A restriction is thus imposed upon the application of mathematical theory. But its practical utility is not seriously affected, for the reason that *stresses which would produce elastic failure should be avoided in design:* they would evidently involve permanent distortion of the member concerned, and in most cases they would be liable to cause actual rupture of the material. It is a general rule of design that stresses must not be allowed to exceed the "limits of proportionality" for the material concerned; so we may say that *assumption (b) will be satisfied by actual materials, within the permissible range of stress.*

It follows that assumption (*c*) will also be satisfied, since, as we have just seen, the permissible range of stress corresponds to a very small permissible range of strain. To sum up:—Unless we are concerned to know the distribution of stress in such detail that the actual structure of our material is a contributory factor, we may rely on the mathematical theory to predict either (1) the distortion or (2) the stresses which will be produced by specified loads, up to that point at which the strains first cease to be purely elastic. After this point is reached, we are less concerned to know the precise distribution of stress, because we know in advance that the stresses will be unsafe.

But a problem of fundamental importance still remains to be examined, in that the mathematical theory, of itself, affords no answer to the general question, whether specified forces will involve stresses that are safe. Curves of the type of fig. 11, derived from tensile tests, will of course give the required information in relation to members which have to withstand pure tension; but they will not supply adequate data for the design, *e.g.,* of a crank subjected to combined twist and bending, since this, as we have seen (§ 33), involves a state of *compound stress.*

The Question of Elastic Failure.—40. The circumstances which determine failure of elasticity in real materials, when the state of stress predicted by theory is of the most general type (involving three unequal principal stresses) have been a subject of much controversy. At the outset we observe that this is one of the exceptional cases, mentioned earlier, in which mathematical theory, with its fundamental assumption of continuity, ceases to give an adequate account of the real state of affairs. For whatever may be the factors affecting strength, they must depend upon the structure of the material, which is not in fact uniform or continuous. Failure will commence at some point of greatest weakness, and will be determined, not by the general distribution of stress, considered statistically, but by the actual state of stress at that point.

Thus our mathematical concept of stress, and the calculations which are based upon it, break down as applied to the "problem of elastic failure," which strictly falls within the province of the physicist rather than the engineer. On the other hand, we have no alternative method of calculation, and some basis for design must be laid down, even though it may not be strictly logical. What is attempted is to find rules whereby, when the stress-distribution has been calculated by the mathematical theory, it may be examined to determine whether the stresses fall within the elastic limit. We suppose that our material has been tested under simple conditions (*e.g.,* in tension, where the state of stress is as illustrated in diagram *A* of fig. 1), and that its limits of proportionality have been ascertained. We are confronted, in the general problem, with the state of stress which is illustrated by diagram *D* of the same figure; and we seek a criterion which shall determine limits of proportionality for this state. The evidence for the criterion will be experimental, but it must be interpreted in accordance with "statistical" ideas, which have no strict validity; so it is not surprising that general agreement on a definite criterion has not in fact been attained.

Alternative Theories.—41. Lamé, followed by Rankine, adopted a *Maximum Stress Theory,* according to which the criterion of elastic failure is p_1, the (numerically) greatest of the principal stresses. Let f be the limit of proportionality as measured in a simple tensile test: then, according to the theory, failure occurs if

$$p_1 \geqq f,$$

and p_2 and p_3 have no effect. In particular, f is the limiting value of the hydrostatic pressure which can be sustained without permanent distortion of the material.

Experiment contradicts this conclusion, for it is found that much greater pressures can be sustained[1]: moreover, the theory is at variance with results obtained in torsion tests, where the material is subjected to simple shear (§ 31). The criterion is no longer accepted, except as a working rule for design in brittle materials, such as cast iron.

42. The *Maximum Stress Theory,* proposed by Poncelet and St. Venant, asserts that extension, rather than stress, is the deciding factor. If e_1 is the (numerically) greatest of the three principal strains, it asserts that failure will occur if

$$e_1 \geqq e,$$

where e is the limiting strain in a simple tensile test. This criterion, in virtue of (18), may be written in the equivalent form

$$p_1 - \sigma(p_2 + p_3) \geqq f,$$

which shows that all three of the principal stresses are involved.

This theory, too, is discredited by the evidence which has been cited. Wehage, in 1888, found the criterion to be at variance with results for wrought iron subjected to equal tensions in two directions at right angles.

43. The *Maximum Shear Theory* was first proposed by Coulomb. It asserts that the greatest shearing stress, or (what is the same thing) the algebraic difference between the greatest and least of the principal stresses, is the deciding factor. Thus, if p_1, p_2, p_3 are the principal stresses, and if

$$p_1 > p_2 > p_3,$$

the theory asserts that failure will occur if

$$p_1 - p_3 \geqq f,$$

where f has the same meaning as before.

Tests made on ductile materials (low-carbon steel, copper, brass) lend considerable support to this theory. In the experiments of J. J. Guest (Phil. Mag., July, 1900), somewhat inconclusive evidence was obtained from non-ferrous materials, but the results for steel were in close accord with the "stress-difference" criterion, which is generally accepted to-day as a basis for design in ductile materials. It is commonly known as "Guest's law."

From a theoretical standpoint, however, Guest's law is open to the objection that it indicates no limit to the strength of a

[1]Extension of the theory by the assumption of different limits for tension and compression (the latter determined by means of a compression test) only partially removes this difficulty.

material when the state of stress is that known as "hydrostatic tension,"—*i.e.*, when the principal stresses are all equal and positive. Practical difficulties have so far prevented the imposition of this stress in an actual experiment, but it is impossible to believe that elastic failure could never occur. Moreover, it is known that the limits of proportionality for tension and compression are not always equal, as the law would suggest. In relation to materials like cast iron, the criterion certainly requires modification: we shall consider that modification which has been proposed by O. Mohr. (*Zeitschr. des Vereines Deutscher Ingenieure*, Bd. 44, 1900.)

44. *Mohr's theory* rests on an hypothesis regarding the nature, or inner mechanism, of elastic failure. Just as two bodies having rough surfaces in contact will slip over one another if a force is applied which is sufficient to overcome the resistance of friction, so two parts of the same body, separated by an imaginary surface, are imagined to slip when the tangential stress at this surface attains a certain limiting value. Irreversible or "non-elastic" strain is regarded as the resultant effect of such slips occurring on a large number of planes in the material. And just as the resistance of friction, in the first case, depends on the pressure between the two bodies at their surface of contact, so it is contemplated that the limiting intensity of the tangential stress may depend upon the normal stress with which it is compounded. Mohr's theory seeks to determine, by means of simple tests, the general nature of this dependence.

According to the view just stated, if two planes in the material are subjected to the same normal stress, slipping will occur first on that plane which is subjected, in addition, to the greater tangential stress. Therefore, in Mohr's circle diagram (fig. 4), the state of stress on that plane at which elastic failure originates will be given by some point on the outer circle *BAX*, which is determined by the greatest and least of the principal stresses.

Let f_t denote the limit of proportionality for the material, as determined by a simple tensile test. Then it is known that elastic failure can occur under a state of stress defined by principal stresses f_t, O, O, and the normal and tangential components of stress for that surface at which failure originates will be given, for this state, by some point on the circle *OAB* in fig. 12. Similarly, if f_c is the limit of proportionality as determined by a test of the material in simple compression (where the principal stresses are $-f_c$, O, O), we know that the component stresses on the surface at which failure originates will be given by some point on the circle *OCD* of the same diagram. It is not necessary to draw more than one half of each circle, because the sign of the tangential stress, on the hypothesis stated, will not affect the question of failure.

Now a circle could be drawn in the diagram to represent any other state of stress for which the limit of proportionality had been determined: all that is needed is a knowledge of the greatest and least of the principal stresses, to fix the ends of its horizontal diameter. According to Mohr's hypothesis, circles drawn in this

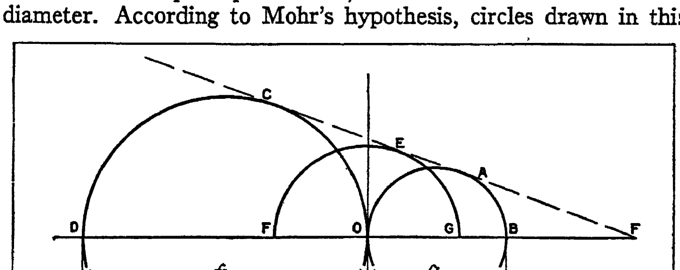


FIG. 12.—MOHR'S THEORY OF ELASTIC FAILURE

way for all conceivable tests would be touched by an enveloping curve, such as the dotted curve *CEA* in fig. 12; and this curve will represent the relation of tangential to normal stress which is the real criterion of elastic failure. For practical purposes the form of *CEA* may be determined by drawing only a few circles: for example, in addition to the tensile and compressive tests which have been considered already, we might carry out a test of the material in torsion (*i.e.*, in simple shear), and so obtain a circle centred at the origin, as illustrated by *FEG* in fig. 12. If the stress-difference criterion were correct, we should find that all three circles had the same diameter, so that the form of *CEA* would became a straight line parallel to *DOB*.

Mohr's theory is a logical development of assumptions which are certainly reasonable. Moreover, it offers a way of escape from the difficulties, mentioned above, in regard to the permissible limits for "hydrostatic" tension and compression; for there is no reason why the enveloping curve should not meet the horizontal axis at some point *F* which (regarded as a circle of zero diameter) represents a limiting hydrostatic tension of finite intensity, whereas on the compression side it may very well cut the axis at infinity. These questions are left to be settled by experiment.

Strain-energy Theories.—45. A criterion of quite another type was suggested by Beltrami in 1885 (Roma. Acc. Lincei Rend. 1885; Math. Annalen, 1903), and more recently by B. P. Haigh (Brit. Ass. *Reports*, 1919 and 1921): it is based on the assumption that any definite volume of material has only a limited capacity for absorbing and storing energy in the form of elastic strain. In isotropic material, the energy stored per unit volume in a state of stress defined by p_1, p_2, p_3 is

$$W=\frac{1}{2E}\left[p_1^2+p_2^2+p_3^2-2\sigma(p_2p_3+p_3p_1+p_1p_2)\right], \qquad (34)$$

and according to Beltrami's theory, failure will occur if

$$W \geqq C^2,$$

where C is a physical constant of the material.

On this basis, the limits for "hydrostatic" tension and compression will evidently be identical, and this fact constitutes an objection which has been urged already, in relation to other theories.

46. Hüber, followed by Hencky (*Zeitschr. f. Ang. Math. u. Mech.*, 1924), has proposed a modified energy criterion, in which that part of W which corresponds to change of volume (as opposed to change of form) is neglected. This procedure is equivalent to the assumption of an infinite bulk-modulus,—that is (§ 28) to the assumption that σ has the value $\frac{1}{2}$: inserting this value in (34), we have the modified criterion, that elastic failure will occur if

$$\frac{1}{4E}\left[(p_1-p_2)^2+(p_2-p_3)^2+(p_3-p_1)^2\right] \geqq C^2, \qquad (35)$$

where C has the same value as before.

No limit is now imposed on the resistance of the material either to hydrostatic tension or compression, and hence one difficulty (in theory) still remains. The criterion is found to accord closely with the results of experiment, within the ranges of stress which have been imposed.

TESTING OF MATERIALS

47. The second branch of our subject—that known as "testing of materials"—is concerned with those properties of real materials which determine their value to the engineer. His most important requirements are rigidity, which demands a knowledge of the elastic constants, and strength, which requires that the criterion of elastic failure shall be expressed in exact numerical form; but he desires in addition that his materials shall possess qualities, such as hardness and tenacity (or "toughness"), which are more difficult to define with precision, because they relate to behaviour in that range of stress and strain wherein Hooke's Law, and hence the mathematical theory of elasticity, do not apply.

Stress-strain Diagrams.—48. The customary procedure for determining elastic constants is to plot diagrams of the type exemplified by fig. 11, showing the relation of stress to strain. Young's modulus (E) is generally obtained by subjecting a long rod to tension, and measuring the consequent increase in the distance between two definite marks. The stress is calculated, in accordance with § 29, as the ratio (total load)/(area of cross-section), and the extension as the ratio (increase of length between marks)/(original length between marks). To find the modulus of rigidity (μ), it is usual to subject a circular rod to torsion, and to interpret the results in accordance with the mathematical solution of this problem (§ 31), whereby the shear stress

(q) at the outer surface can be calculated in terms of the twisting couple, and the shear strain (θ) in terms of the rotation, relative to one another, of two cross-sections separated by a known length. Knowing E and μ, we can, theoretically, deduce any other of the elastic constants by the formulae of § 28. But special methods are often employed to determine particular constants directly: thus, Poisson's Ratio 6, or the "bulk modulus" k, can be found by tests which depend upon the mathematical solution for uniform bending, or for a closed tube subjected to internal pressure (§ 36).

In all cases, when the diagram has been constructed, the relevent elastic constant can be deduced as the ratio of stress to strain within the range for which these quantities are proportional. The extent of this range is also determined by the test, and it provides a part of the information required to fix the criterion of elastic failure (*see* §§ 41–46). But, for reasons which we have indicated, the whole diagram (up to the point of ultimate fracture) is important: thus it is essential that we should be able, in these tests, to apply a measured load through a considerable distance.

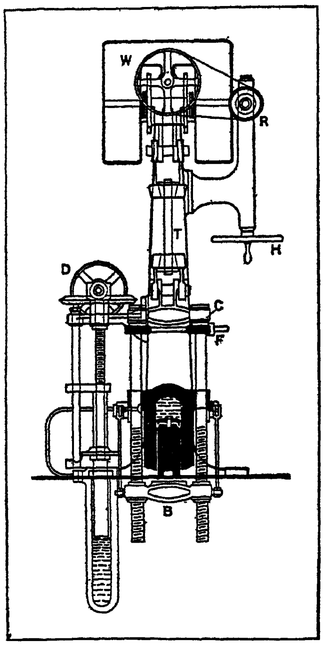


FIG. 13.—SINGLE-LEVER TESTING MACHINE

Testing Machines.[1]—49. When a material is to be tested in simple tension, and when samples are available in the form of thin wires, the stress may be applied directly by means of suspended weights: for pieces of larger section some mechanical means for multiplying force is required. In large testing machines, the load is usually applied by hydraulic pressure acting on a plunger to which one end of the specimen is secured, and it is measured by connecting to the other end a lever, or system of levers, provided with adjustable weights. Provision is generally made for subjecting a specimen either to simple tension, simple compression, bending or torsion.

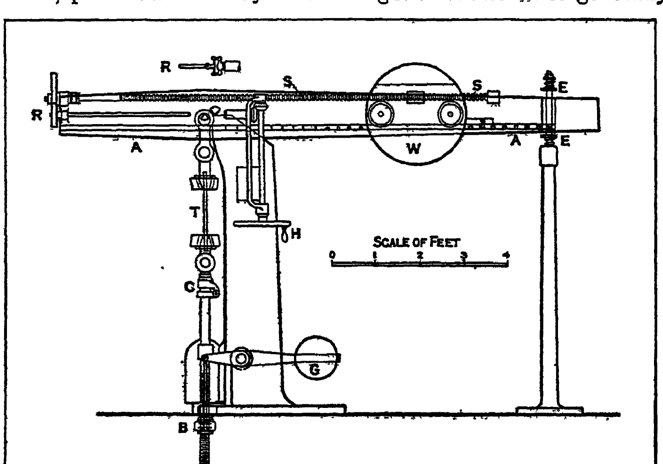


FIG. 14.—SINGLE-LEVER TESTING MACHINE

Figs. 13 and 14 show a form of single-lever testing machine designed by J. H. Wicksteed (*Proc. Inst. Mech. Eng.*, 1882); the machine shown exerts a maximum force of 30 tons, but 100 tons or more are exerted by similar machines in common use. AA is the lever, on which there is a graduated scale. The stress on the Test-piece is measured by a weight W which can be moved through a measured distance along AA by a handwheel H connected with gearing SS. The Hooke shaft R is shown in a separate sketch in fig. 14. The upper end of the sample is gripped in a holder which hangs from a knife edge 3 inches from the fulcrum of the lever; the lower end is gripped in a similar holder which is jointed to a cross-head C, connected by adjustable screws (to provide for specimens of different lengths) to a lower cross-head B, on which the hydraulic plunger exerts its thrust. G is a counterpoise which pushes up the plunger when the water is allowed to escape. In this machine the hydraulic pressure is applied by means of an auxiliary plunger Q of small diameter. Q is driven by a belt on pulley D.

Pressure being admitted to the main plunger, a load is imposed upon the specimen, and the weight W is then run out along the lever until this just "floats" between the stops EE. The load (and hence the stress) can thus be determined, and it remains to measure the accompanying strain.

Extensometers.—50. It will be appreciated that this last requirement calls for very precise apparatus. In iron or steel, the extension produced by a stress of 1 ton per sq.in. is about $\frac{1}{13,000}$, and elastic failure occurs at an extension of perhaps $\frac{1}{1,000}$: thus, if the extension of an 8 inch "gauge length" is to be measured, it is desirable that this shall be read to about $\frac{1}{50,000}$ inch when Young's modulus or the extent of the elastic range are under examination. Measurements made on one side of the specimen only are liable to be in error on account of bending caused by slight eccentricity of loading: accordingly, it is best to measure the relative displacement of two pieces attached in such a manner as to share equally in the strain on both sides.

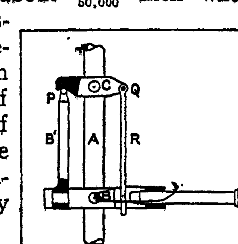
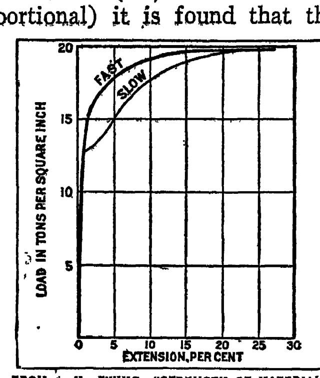


FIG. 15.—EWING EXTENSOMETER

The extensometer of J. A. Ewing is illustrated (diagrammatically) by fig. 15. Two clips B and C are attached to the specimen, each by means of a pair of opposed screws. Between B and C is a rod B', hinged to B and fitting into a spherical recess in C. A bar R hangs from C by a hinge Q, and carries a mark which is read by a microscope attached to B. Thus, as the specimen stretches (B' remaining of constant length), the bar R is pulled up relatively to the microscope, and the amount of the movement is measured by a micrometer scale in the eye-piece. Calibration is effected by means of a micrometer screw attached as indicated at B.

Strain Beyond the Elastic Limit; Influence of Time.—51. Within the region of "plastic" distortion (*i.e.*, where the stress and strain are not directly proportional) it is found that the behaviour of a metal is largely influenced by the *rate* at which the load is increased; the full strain corresponding to a given load is reached only after a perceptible time. Fig. 16 gives some results obtained by Ewing (J. A. Ewing, *Strength of Materials*, p. 42, 1914), from tensile tests of soft iron wire. The "fast" loading caused rupture in 4 minutes: the "slow" loading took 5,000 times as long. When a tensile load, of amount exceeding the elastic limit, is applied and then kept constant, the specimen is observed to extend at first rapidly and then more slowly. In general it appears that the slow extension comes ultimately to an end; but when the applied load is nearly equal to that which would immediately break the specimen, the extension, after slowing down, quickens again and continues until rupture occurs. If, on the other hand, the specimen is subjected to an *extension* which is maintained constant, it is found that the load required to maintain that extension gradually diminishes.

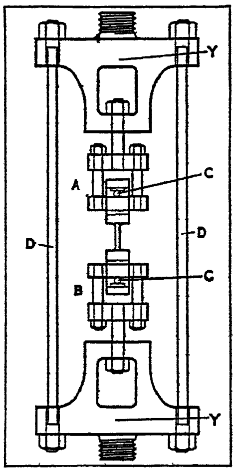


FROM J. H. EWING, "STRENGTH OF MATERIALS" (UNIVERSITY PRESS, CAMBRIDGE)
FIG. 16.—INFLUENCE OF RATE OF LOADING

"Yield."—52. Special interest attaches, for materials such as wrought iron and mild steel, to that part of the stress-strain dia-

[1] §§49–56 have been based, by permission, on the article written by Sir J. A. Ewing for the 11th edition of this *Encyclopædia*.

gram which lies just outside the elastic range. Reference to Kirkaldy's diagrams (fig. 11) shows that a point (called by A. B. W. Kennedy the "yield-point") is reached, soon after the material has ceased to be elastic, at which the extension increases without any corresponding increase of stress. Somewhat later, the extension becomes less rapid and the stress rises at a fairly regular but gradually decreasing rate. If a lever type of machine is employed, the beam drops when the yield point is reached. Meanwhile the specimen is seen to undergo a considerable change: if scale previously adhered to its surface, this is observed to flake off, in lines inclined at roughly 45° to the direction of pull; if the surface is polished, lines appear on it, having the same direction, which can be recognized by touch as steps or ridges. These lines are known as *Lüders' lines* (W. Lüders, *Dingler's Polytech. Journ.*, vol. 155 [1860], p. 18): their occurrence may be used to determine, without the use of an extensometer, the yield point of a material.



FROM "PROCEEDINGS OF THE ROYAL SOCIETY"

FIG. 17.—APPARATUS EMPLOYED BY ROBERTSON AND COOK

Researches by A. Robertson and G. Cook (*Proc. R.S.* [A], vol. 88, 1913) have shown that the phenomenon of "yield," thus revealed by early diagrams, is much more complex than those diagrams would suggest, and of the first importance from the practical standpoint. Realizing that its effects would be masked by the inertia of the testing machine as ordinarily employed, these investigators employed the device which is illustrated by fig. 17. Two long rods *DD* were arranged in parallel with the specimen, so as to share in taking any load applied to the end yokes, *YY*. The loads taken by these rods could be deduced (from a previous calibration) by measuring the elastic strains to which they were subjected: thus, when the total load applied to the yokes was known, the load in the specimen could be deduced. Yield of the specimen merely shifted a greater part of the total load on to the rods; and since these, on account of their length, remained elastic, there was no sudden increase in their total extension, and consequently no drop of the beam. Accurately central loading of the specimen was ensured by applying the load through hard steel balls, *CC*, with the aid of special shackles *A*, *B*.

The specimens were of ordinary mild steel, annealed (*see* § 54) to remove any stresses which might have been induced in course of manufacture. The results showed that the stress, on the occurrence of "yield," does not merely remain constant, but actually *drops*, by an amount which may be as high as 36%. The practical importance of this effect is evident, for it means that the material, within the region of "plastic" strain, can adjust itself in such a manner as to relieve any intense concentration of stress which may have occurred within the elastic range. This property, which is of great value in constructional work, is known as *ductility*.

Intermittent Loading: Hardening Effect of Permanent Set.—53. Time has another effect of a different and remarkable kind. If, at some point *a* (fig. 18) in the region of plastic strain, the load is removed, a part of the strain disappears. This part is accordingly termed the "elastic strain": to a close approximation, it is related with the stress by a linear law, the ratio of stress to elastic strain being, so far as can be ascertained, the ordinary elastic constant of the material. If the load is immediately replaced and then increased in the ordinary way, a new yield-point *b* is found at or near the stress previously reached. The full line *bc* in fig. 18 shows the subsequent behaviour of the specimen. If on the other hand, some hours are allowed to elapse before the load is replaced, the new yield point appears, not at *b*, but at a higher stress *d*. Fracture occurs (at *e*, fig. 18) under a higher load than before, and at a smaller total extension: we say that a process of *hardening* has been going on during the interval of rest.

A similar and even more marked hardening is found to occur when the load, instead of being removed and replaced, is maintained constant for some hours. When loading is resumed, the yield-point is found to be raised very considerably. Fig. 19 exhibits experiments of this kind, made by J. A. Ewing on specimens of annealed iron wire: *ab* shows the result of continuing to load after an interval of 5 minutes, and *acd* after an interval of 45½ hours. (J. A. Ewing, *Proc. R.S.*, 1880.)

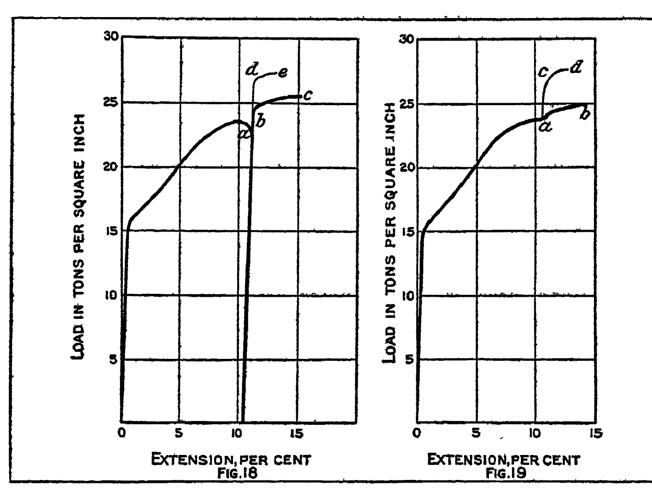
Annealing.—54. This hardening effect of plastic strain is of great practical importance. When a hole is punched in a plate, the material round its edge is severely distorted by shear, and the consequent hardening of this material is accompanied by a serious decrease in ductility. Consequently, if the plate is strained by tension, concentration of stress, resulting in the formation of cracks, may occur at the edge of the hole. This bad effect of punching disappears when a narrow ring of material, immediately surrounding the hole, is removed by a cutting tool.

The hardening effect can also be removed by the process of *annealing*, that is, by heating to redness and cooling slowly. This process is very generally employed in practice, for relieving internal stresses caused by the processes of manufacture.

Recovery of Elasticity.—55. Although the yield point may be raised by overstrain, as described above, the elasticity of the material is found to be impaired. Only within narrow limits, if at all, is stress proportional to strain during the process of reloading. But a sufficiently long rest will restore the elasticity, and after weeks or months the metal is found to be elastic up to a point which may be much higher than the original elastic limit.

Experiments by J. Muir (*Phil. Trans. R.S.*, vol. 193, 1900) have shown that temperature has an important influence on the rate of this "recovery of elasticity." In iron and steel, complete recovery can be produced in a few minutes by dipping the overstrained specimen into boiling water.

When a piece of iron or steel, after being overstrained in tension, is subjected to a compressive load, the strain is not found to be proportional to stress unless recovery has been effected by rest or heating. After recovery, the elastic limit for compression is lower than it would be in the normal state; but Muir's experiments show that the reduction is less than the amount by which the elastic limit for tension has been raised. That is to say, the general effect of strain-hardening followed by recovery is to widen the total range of stress within which stress and strain are proportional.



FIGS. 18 AND 19.—HARDENING EFFECT OF PERMANENT SET

Hysteresis.—56. We may summarize this account of the behaviour of metals within the range of "plastic" strain by saying that the strain in this range is no longer (as in Hooke's law) uniquely determined by the stress, but depends upon the previous "stress-history." This phenomenon is termed *"hysteresis."* When the stress on a specimen fluctuates in a regular manner between two fixed limits, the stress-strain diagram assumes the form of a closed figure, which is called a "hysteresis loop."

Fig. 20 shows hysteresis loops for a steel specimen exposed to three different cycles of stress; the sequence of operations is

Material	Results from tensile test								Fatigue properties
	Young's Modulus (tons per sq. in.)	Poisson's ratio	Limit of proportionality (tons per sq. in.)	Stress at "yield" (tons per sq. in.)	Stress at fracture (tons per sq. in.)	Elongation, %	Reduction of area, %	Brinell hardness number	Endurance limit (tons per sq. in.)
Mild steel (0·02% carbon)	13,400	0·3	7·2	8·5	19	48·3	76	69	±11·6
Medium carbon steel (0·37% carbon), annealed	do	do	16·3	16·9	31·3	32	49	131	±13·0
Ditto., quenched and tempered	do	do	29	30·8	47	22	56	205	±22·8
Nickel-chrome steel, quenched and tempered	do	do	97·8	—	125·5	7·5	31·5	510	±48·7
Steel casting (0·32% carbon)	do	do	8·9	15	34	26	34	141	±13·5
Drawn copper	—	0·35	—	—	18·3	26	48	—	Less than ± 7·75
Hard-drawn brass	about 5,000	0·33	—	—	26·8	40	73	—	Less than ± 8·9
Duralumin, heat-treated	4,900	—	—	—	22·8	29	47	100	± 5·4
Ditto, annealed	4,800	—	—	—	11·2	25	61	50	± 4·8

indicated by the arrows. It will be seen that the area of the loop increases with the range of stress. This area may be interpreted as measuring the work done in performing the cycle of operations: if the strain had been wholly elastic, the area of the loop would have been *nil,* because the work done in stretching would have been recovered during the process of unloading, but in the plastic range more work is done in stretching than is subsequently recovered. The difference, of course, is absorbed by the specimen or transformed into heat.

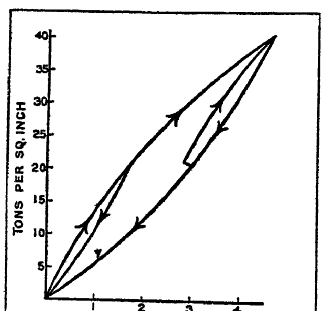


FIG. 20.—HYSTERESIS LOOPS

Elongation and Reduction of Area.—57. Useful information in regard to ductility is afforded by the *elongation* of a specimen tested in tension—that is, the total extension of the specimen at the instant of fracture. Barba (*Mem. Soc. des Ing. Civ.,* 1880) has shown that this quantity depends upon the form of the specimen, so that geometrical similarity must be maintained if strictly comparable results are to be obtained from specimens of different sizes. Unfortunately, the practice of different countries as regards the standardization of test pieces does not yet satisfy this condition.

Another quantity which serves as a convenient measure of ductility is the *reduction of area*—that is, the decrease in the cross-sectional area of the specimen after fracture, expressed as a percentage of the original area. This quantity is less dependent than elongation on the geometrical form of the specimen but it is difficult to measure accurately.

Fracture by Tension.—58. The ultimate stages of a tension test—that is, the circumstances which determine the elongation and reduction of area—are evidently governed by the stress-strain relations in plastic material, of which little is understood. When a bar of uniform section is pulled, the extension is at first distributed fairly uniformly over the whole gauge length. But just before the bar breaks, a large additional extension occurs near the place of rupture, and the section is much more contracted there than in other parts, so that the specimen forms a "waist." Fig. 21 illustrates this point; it is taken from a photograph of a broken specimen of mild steel, which had a uniform diameter before the test.

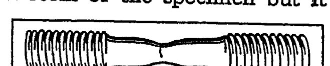
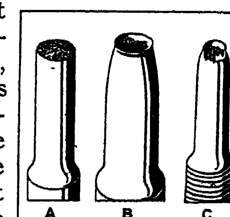


FIG. 21.—MILD STEEL SPECIMEN FRACTURES BY TENSION

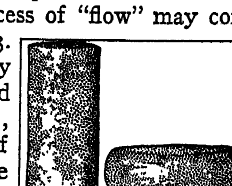
It appears that the material, just before fracture, is in an unstable state of stress. Any local contraction of area will cause an increase of stress in that region, and this in turn will cause further plastic distortion, or "flow." On the other hand, the hardening effect of plastic strain operates in the reverse direction, tending to increase the resistance to flow. It is probable that this second effect predominates in the earlier stages of the test, and so maintains stability; for it seems clear that the first effect, once it predominates, must result in final rupture. The notion of instability seems to explain the observed fact, that the ultimate stress (at fracture) is largely dependent upon the form of the test specimen.



FROM H. J. GOUGH, "THE FATIGUE OF METALS" (BENN)
FIG. 22.—STATIC TENSILE

Rupture may occur by direct separation over a surface which is nearly plane and perpendicular to the direction of the pull: such fractures are characteristic of hard steels and other non-ductile materials. But in ductile materials, which break at a "waist," the fractured specimen generally reveals a ring-shaped crater on one side of the break and a truncated cone on the other (fig. 22): rupture has occurred by shearing on the outer (inclined) surface and by direct separation in the central region, where the fracture is approximately plane.

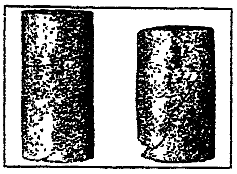
Fracture by Compression.—59. In compression tests of ductile material, such as mild steel, the process of "flow" may continue indefinitely, as indicated by fig. 23. There is here no possibility of instability (if the specimen is made short, to avoid buckling in the manner of long columns), since the flow results in an increase of cross-section, which tends to reduce the stress. Brittle materials fail by shearing on inclined planes, after the manner of fig. 24. These planes are nearly, but not exactly, coincident with the planes of maximum shear. It appears that a normal component of stress on a plane may increase the resistance to shear on that plane, in the manner contemplated by Mohr (§ 44).


FROM TIMOSHENKO AND LESSELS, "APPLIED ELASTICITY"
FIG. 23.—COMPRESSION FAILURE OF LOW-CARBON STEEL

FATIGUE

60. A question of great interest, both scientific and practical, is the effect of stresses which fluctuate repeatedly between definite limits. Hodgkinson, in 1837, first drew attention to this problem. At that time, bridges of masonry were being replaced on an extensive scale by bridges of wrought iron, and engineers who

appreciated the significance of Hodgkinson's experiments realized that the properties of the new material were very imperfectly understood. A commission was appointed to consider the application of iron to railway structures, its report (1849) described experiments which indicated clearly (1) that failure can result from repetitions of a load less than the ultimate static load, and (2) that such failure is *not* caused by deterioration of the material with time, if the ultimate static load may be taken as an indication of quality.



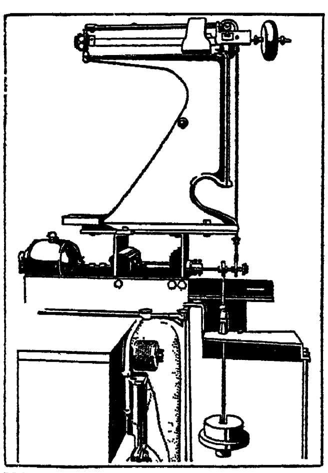
FROM TIMOSHENKO AND LESSELS, "APPLIED ELASTICITY"

FIG. 24.—COMPRESSION FAILURE OF CAST IRON

Fracture produced by a large number of repetitions of stress is generally described as "fracture by fatigue." The classical researches on the subject are those of A. Wöhler, who tested iron and steel under direct tension, torsion and bending, and who paid, for the first time, strict attention to the magnitudes of the *local stresses* involved. Wöhler's experiments showed that a stress well below the ultimate strength of a material (as measured in an ordinary tension test) will suffice to produce fracture if it be often enough removed and restored, or even alternated with a smaller load of the same kind; the smaller the range through which the stress is varied, the greater is the number of repetitions (or stress-cycles) which a specimen can endure.[1]

These investigations have been continued by many other workers, and the literature bearing on the subject of fatigue is now very extensive. Only the merest outline can be given here: the reader is referred to a very clear and complete account by H. J. Gough, *The Fatigue of Metals* (1924).

Testing Machines.—61. Many distinct types of machine have been devised for applying fluctuating stresses. Perhaps the most important is Wöhler's "rotating bar" machine, which (in the modified form employed at the National Physical Laboratory, England) is illustrated in fig. 25. The specimen, a solid or tubular rod, is rotated by an electric motor (as in a lathe) at speeds up to 2,400 r.p.m. It is subjected to equal up-and-down forces, applied through ball bearings, at two points in its length, by a small single-lever testing machine and by dead weights. Thus it is exposed, over the greater part of its length, to a uniform bending moment; and since the plane of this bending moment rotates in relation to the specimen, the stress at any point in a cross-section fluctuates between positive and negative values during each revolution. Within the elastic limit, the stresses can be calculated in accordance with § 30.



FROM H. J. GOUGH, "THE FATIGUE OF METALS" (BENN)

FIG. 25.—WOHLER MACHINE

A modified form of this machine, employed by T. E. Stanton and R. Batson (*Brit. Ass. Report*, 1916) enables torsional stresses to be superposed.

"Specific Stress" and "Specific Strain."—62. It is important to distinguish between the conditions imposed by different machines, because these largely influence the behaviour of the material. Thus the machine just described applies a definite bending-moment (that is, practically speaking, a definite stress), independent of the strains which the material may undergo; we describe such conditions as *specific stress*. In other machines a definite strain is imposed, independent of the stress-distribution which may result through plastic distortion of the specimen; we describe such conditions as *specific strain*. In other machines, again, the conditions are such that the stress either increases or diminishes as the strain increases.

This variation in the conditions of test has its counterpart in actual practice: thus a connecting-rod is exposed to conditions of specific stress, and the valve springs of an internal combustion engine to conditions of "specific strain."

The Variable Factors in Fatigue. Nomenclature.—63. Even when the stress imposed is the simplest possible,—namely, simple tension,—it is evident that many variable factors are involved. First, the stress may vary between any two limits. Using positive and negative signs to denote tension and compression, we write $p_{max.}$ and $p_{min.}$ for the highest and lowest tensions which are imposed; we term $p_{max.}$ the "upper" or "superior" limit of stress, and $p_{min.}$ the "lower" or "inferior" limit. The "total range of stress" (R), and the "average" or "mean stress" of the cycle (M), are then defined by the relations

$$R = p_{max.} - p_{min}\ ,$$
$$M = \tfrac{1}{2}(p_{max.} + p_{min.}),$$

and the stress-cycle may be concisely described as the cycle

$$(M \pm \frac{R}{2}).$$

In an "alternating stress" test, M is zero and the stress fluctuates between equal and opposite limits.

Again, the stress may fluctuate between specified limits at different speeds If T is the time (in secs.) taken by one complete stress cycle, the number of cycles per second is given by

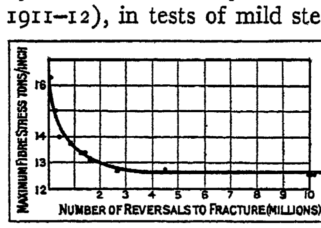
$$n = \frac{1}{T},$$

and is termed the "frequency" of the test.

Further, the stress may fluctuate with time, *during one stress-cycle*, according to any imposed relation. This relation ought always to be specified in describing the results of tests, in order to make the conditions precise; but little information is available at present regarding its importance.

Endurance Tests, and the "S-N Curve."—64. The aim of fatigue tests is to determine, for a definite stress-cycle applied at a definite frequency, the number of cycles which a material can sustain without fracture. This number (N) is termed the "*endurance.*"

In a test under alternating stress, the cycles may (subject to the remark at the end of the last paragraph) be taken to be defined by $\frac{R}{2}$, the greatest (numerical) value of the stress S. We seek by experiment to relate S with the endurance N, and the curve which gives this relation is termed an "*S-N* curve." Fig. 26, by T. E. Stanton and J. R. Pannell (*Proc. Inst. Civ. Eng.*, vol. 188, 1911–12), in tests of mild steel, shows typical results. It will be seen that the plotted points lie more or less evenly on a curve which appears to become parallel with the N axis when the number of reversals to fracture is large. The last point on the diagram relates to a specimen which was still unbroken after 10 million reversals of stress. We say that the test has been carried out "on a 10 million reversals basis"; and on this basis we may express the results by saying, either



FROM H. J GOUGH, "THE FATIGUE OF METALS" (BENN)

FIG. 26.—ENDURANCE TESTS

(a) that the endurance limits of stress are ±12·75 tons/sq.in. or
(b) that the limiting range, *for reversed stresses*, is 25.5 tons/sq.in.

65. Evidently, *if the true curve does in fact become horizontal, there is a limiting range of stress below which fracture will not occur for any number of reversals, however large.* It is not possible to decide this question positively, since we can, in practice, impose only a limited number of stress-cycles. (The greatest numbers imposed in any recorded test would appear to be 202 millions: the specimen, tested by J. E. Howard under reversed bending—*Proc. Inter. Assoc. Test. Mat.*, 1909 Congress.—was not broken.) But the weight of evidence appears to show that limiting ranges of stress do exist, and that they can be found, with all the accuracy required for practical purposes, by endurance tests on a 10^7 reversals basis. Gough, who has done much to

[1]A. Wöhler, *Zeitschr. f. Bauwesen*, vols. 8–20 (1860–70). An account is given in *Engineering*, vol. 11 (1871).

elucidate this question, emphasizes that tests on a one million reversals basis are practically worthless.

Relation Between Safe Range and Mean Stress.—66. Assuming that a limiting range exists for reversed stresses, the question arises, how is it affected by the imposition of a mean stress M? In other words, what is the relation between R and M, for safe ranges of stress?

Before this question can be answered, it is evident that a very large amount of data must be accumulated; Gough, who has analysed carefully such results as are available, regards the problem as still unsolved. Two forms of "law" have been proposed which seem fairly satisfactory, namely, the "modified Goodman law" and "Gerber's parabolic law." According to the modified Goodman law,

$$R = R_0\left(1 - \frac{M}{f}\right),$$

where R is the safe range corresponding to a mean stress M, R_0 is the safe range when $M = O$ and f is the ultimate strength of the material. According to Gerber's law,

$$R = R_0\left(1 - \frac{M}{f}\right)^2.$$

Gerber's law is closely satisfied by the experiments of Wöhler and Bauschinger and, less closely, by Haigh's results for mild steel. Goodman's law applies to Haigh's experiments on naval brass, in cases where the mean stress was tensile. (*Cf.* Gough, op. cit., Chap. IV.)

Influence of Frequency.—67. This again is a question demanding a great accumulation of experimental results. Tests by B. Hopkinson (*Proc. Roy. Soc.*, vol. 86, 1911) and Stanton indicate that a slight increase in endurance accompanies a rise in frequency. Under reversed stresses, the limiting ranges of stress for a certain mild steel were found to be:

$\pm 12 \cdot 5$ tons/sq.in. (Stanton machine: 1,000/1,300 r.p.m.)
$\pm 13 \cdot 0$ tons/sq.in. (Wöhler machine: 2,200 r.p.m.)
$\pm 14 \cdot 5$ tons/sq.in. (Hopkinson machine: 7,000 r.p.m.)

C. F. Jenkin (*Proc. Roy. Soc.*, vols. 103, 1923 and 109, 1925) has developed apparatus by which fatigue tests can be conducted at speeds up to 20,000 cycles per second. His work is still in progress, but so far his results confirm the conclusion that increased speed has at all events no deleterious influence.

Summary.—68. Much information is now available regarding the behaviour of engineering materials under imposed stresses of various kinds.

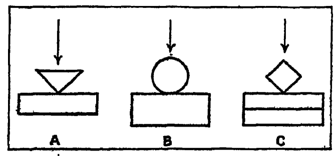
But much still remains to be done:

(1) in developing rules for design which shall be applicable to "compound" fatigue stresses;
(2) in correlating the fatigue properties of a material with "static" properties such as its elastic limit, yield stress or ultimate strength, or with the results of "impact" or "hardness" tests;
(3) in explaining the inner mechanism of fatigue.

The last of these problems comes within the scope of the third section of this article. All three are discussed at considerable length (although, necessarily, without very conclusive results) in the treatise by Gough to which reference has been made above.

Impact Tests.—69. Fatigue tests are concerned with the slow cumulative effect of stress-cycles which could be imposed thousands or even millions of times without producing rupture. At the other end of the scale of practical conditions, we have to consider the possibility that a material may be broken by *shock* —that is, by intense stresses maintained for an infinitesimal period of time.

To investigate "toughness," or resistance to shock, is the purpose of *impact tests.* They usually involve the breaking of a specimen of standardized form (it is commonly notched, in order to secure a concentration of stress at one section) by means of a falling weight: the energy absorbed in this process is taken as a figure of merit for the material. Unfortunately, they have been developed largely by empirical methods—mainly because little is known of the stresses which obtain during impact. The shape of the notch, the velocity of striking, even the shape of the striker, appear to affect the results, which are not easy to interpret by a dimensional law, even when specimens of the same material and geometrical form are employed, differing only in respect of size (*cf.* R. V. Southwell, Aeronautical Research Committee, R. and M. 732, 1921). Thus it is difficult to compare results obtained by different methods or on different machines, and the subject cannot be briefly summarized. The reader is referred to Batson and Hyde, *Mechanical Testing*, vol. 1 (1922), or to Timoshenko and Lessels, *Applied Elasticity*, Chap. XIV.



FROM TIMOSHENKO AND LESSELS, "APPLIED ELASTICITY"

FIG. 27.—FORMS OF INDENTATION TEST

Hardness Tests.—70. In using the term "hardness," we may be thinking of resistance to indentation, of resistance to abrasion, or of ability to retain a cutting edge. These properties are not identical, and each calls for a separate test. We shall here confine attention to various forms of *indentation test.* (*Cf.* Timoshenko and Lessels, op.cit., Chap. XV.)

A measure of resistance to indentation may be obtained by applying a standard pressure to two crossed specimens of the same material and measuring the indentation thus produced. Reaumur (1722) used right-angled prisms and measured the *depth* of the indentation; Foppl used circular cylinders (figure 27b) and measured the *superficial area;* Haigh used square prisms (fig. 27c).

Brinell (*Proc. Inter. Ass. Test. Math.*, 1901) proposed a test which has since come into very general use. A hard steel ball is forced into the material under a standard pressure, and the dimensions of the indentation are measured. This test is practically convenient, in that it can be imposed without damage on a finished engineering component; moreover it appears to determine, with some accuracy, the ultimate strength which may be expected of the material when exposed to an ordinary tensile test. Subsequent work by Meyer (*Zeitsch. d. Ver. deutsch. Ing.*, p. 645, 1908), Batson (*Proc. Inst. Mech. Eng.*, 1923) and Devries (*Proc. Am. Soc. Test. Math.*, vol. XI.) has shown that standardization of the test conditions is important: Brinell suggested a ball of 10 mm. diameter, and a standard pressure of 3,000 kg. for hard and of 500 kg. for soft materials.

71. Dynamic tests of a similar nature have been proposed. In the *scleroscope* test, hardness is measured by the height of rebound of a small diamond-pointed hammer which is allowed to fall through a standard distance: an advantage is offered in that there is no permanent indentation.

Reaumur also tested hardness by using the material to scratch a standard bar of increasing hardness from one end to the other. Turner (*Proc. Birm. Phil. Soc.*, vol. V. 1887) reversed the process, employing a standardized diamond point to scratch the material under test, and measuring the load which this point must carry in order to produce a visible scratch. Martens, Hadfield and Hankins have contributed to the development of this test, and have investigated the correlation of "scratch hardness" with "Brinell hardness" (*cf.* Timoshenko and Lessels, *loc. cit.*).

INNER STRUCTURE OF METALS: PROBLEMS OF ELASTIC FAILURE AND OF FATIGUE

72. Advances in experimental technique have made great changes in our outlook on the problems of elastic failure and of fatigue. In tests made for engineering purposes, we have seen that *resultant* effects, observed in a specimen of considerable size, are analysed as though due to *continuous* strains in a structureless material: even in the work of Bauschinger and others, on "yield," "recovery" and allied phenomena, no mental picture is suggested of the inner mechanism by which those effects are produced. That the older ideas suffice to explain the behaviour of materials from an engineering standpoint is shown by C. F. Jenkin's successful derivation of all the ordinary phenomena of low-speed tests from a conceptual "model" characterized merely by a resistance to distortion which is due in part to elasticity and in part to "solid" friction (*Engineering*, Nov. 17, 1922). But to

explain the first occurrence of elastic failure, or the processes which result in fatigue and ultimate fracture, it has become clear that attention must be concentrated upon the inner structure of the crystalline aggregate.

Microscopical Examination.[1]—73. The microscopical study of metals was initiated by H. C. Sorby in 1864 (*Brit. Ass. Report,* 1864). After a period of neglect, it was taken up and pursued energetically by many workers; at the hands of Ewing, Rosenhain, Humphrey, Beilby, Osmond and Arnold it has yielded results which are of fundamental importance in relation to the strength of materials. The technique employed may be studied in the article on METALLOGRAPHY: here it is sufficient to state that a polished surface, etched and examined in a microscope under oblique illumination, is seen to be made up of irregular areas having well-defined boundaries. These areas are the sections of crystalline grains which constitute the mass of the metal; the irregular boundaries are the chance surfaces in which one grain has met another during the process of its crystalline growth. The size of the grains depends very largely upon the heat treatment to which the metal has been subjected: sudden cooling from a high temperature tends to make the grains small, slow cooling to keep them large; and protracted exposure to moderate temperatures has been observed in some cases to favour the growth of very large grains.

Changes in Structure Produced by Strain.—74. When a metal is stretched beyond its limit of elasticity, the grains are found to have lengthened in the direction of that stretch. Subsequent exposure to fairly high temperature results in a reconstruction of the grains: the original pattern is not reproduced, but the new pattern reveals no direction of predominating length. Researches by J. A. Ewing and W. Rosenhain (*Phil. Trans. R.S.,* 1900) showed that "plastic" strain is the result of slips which occur in the cleavage or "gliding" planes of the individual crystals. These slips are observed, under the microscope, as sharply defined lines which appear on the surface of each grain. Seen under normal illumination the lines are dark; seen under oblique illumination they may be made to appear as bright lines on a dark ground: thus they may be recognized as narrow steps produced by the slipping of one part of the crystalline grain over another. Fig. 28 represents a section of two contiguous surface grains, having "gliding" planes as indicated by the dotted lines; *AB* is a part of the polished surface. Under stress which exceeds the elastic limit (such as a pull in the direction of the arrows), yielding occurs by slip at a limited number of places, such as *a, b, c, d, e.*

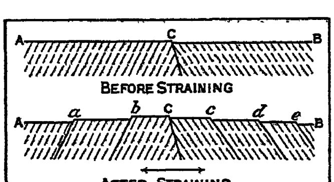


FIG. 28.—PLASTIC SLIPPING IN A CRYSTAL

Many such lines appear as the process of straining goes on: in general three intersecting systems, and in many cases four, are seen. In this way severe deformations may occur, which will not destroy the crystalline structure of any grain, although they will largely change its shape.

"Amorphous" Theory.—75. The "amorphous theory of metals," first propounded by G. T. Beilby and developed by W. Rosenhain (Beilby, *Aggregation and Flow of Solids,* 1921, p. 123), seeks to explain, in conformity with these observations, the phenomena of "strain hardening" (§ 53). It can be shown that the process of polishing develops on the surface of metals a thin layer of "amorphous" (or structureless) material; and it is assumed that slipping at the internal surfaces of a crystal has a similar effect. The amount of amorphous material will increase with the intensity of the stress applied: it is assumed that this material is at first mobile (that is, offers little resistance to further distortion), but afterwards sets like cement, and is then hard and elastic.

Effects of Fatigue.—76. Ewing and Humphrey (see *Phil. Trans. R.S.,* 1903) employed the microscope to examine the process by which metals break through "fatigue" when subjected to repeated reversals of stress. The first sign of fatigue was the appearance of slip lines on one or more crystals in the region of greatest stress: these become more distinct and tend to broaden, developing finally into cracks which can be identified as such because they do not disappear when the surface is repolished. Once a crack has formed it quickly spreads, and finally the specimen breaks with a sharp fracture.[1]

X-Ray Examination of Crystals.—77. For the microscope, as we have seen, the crystal grain is the ultimate unit. But the methods of X-ray analysis, developed by W. H. and W. L. Bragg (*see* CRYSTALLOGRAPHY), have enabled the study of inner structure to be carried much further, since they reveal the structure of the individual crystal; and a further stimulus to research in this field has resulted from the discovery, by H. C. Carpenter, C. F. Elam and others (*see* METALLURGY), of methods whereby single crystals of aluminium and other metals can be produced in sizes such that they can be subjected to ordinary engineering tests. At the hands of G. I. Taylor, C. F. Elam (*Proc. R.S.* [A], vol. 102, pp. 643–67, 1923) and others, these tests have provided a satisfactory explanation of the manner in which crystals distort under steady or fluctuating loads.

78. The stress which a single crystal can withstand without suffering permanent distortion is markedly low as compared with the strength of the crystalline aggregate. It thus appears that we must look to the crystal boundaries (where the atoms presumably have a more random distribution, owing to conflict between requirements of adjoining crystal "lattices") for an explanation of the relatively high resistance which the aggregate can oppose. This view is supported by the fact that increased strength accompanies a reduction in the size of the crystal grains, under the influences of hardening processes such as heat treatment or "cold work." It remains for further investigation, using the more powerful methods which are now available, to give precision to ideas which have helped, in the past, to correlate the phenomena of plastic distortion and fatigue.

Current Views on Elastic Failure and Fatigue.—79. A. A. Griffith (*Phil. Trans. R.S.* [A], vol. 221, pp. 163–198, 1920) has been led, by discrepancies between theory and experiment in regard to concentration of stress in the neighbourhood of scratches or flaws, to propound a theory of rupture (for brittle materials) which takes account of the surface-energy generated in the formation of cavities. He has verified the consequences of his theory by producing fibres of fused silica which exhibit strength of a quite abnormal order.

This work is quoted as exemplifying the new outlook which has been made possible by recent advances in physics: it is to microscopical, chemical and X-ray investigations that engineers are looking for a solution of the ultimate problems of elastic failure and fatigue. But understanding of the properties of materials contributes only to one side of the general problem of engineering design; and the practical rule, that working stresses must be kept within the elastic limits, is not likely to lose its validity. The other side of the problem is the calculation of stress, and stresses, in a crystalline aggregate, can only be determined in statistical fashion. So tests of the older type, on specimens large in comparison with the crystalline structure, have not ceased to be useful, nor reached the limits of their development.

(R. V. S.)

MATER MATUTA, an obscure Italian deity, variously stated to be a goddess of dawn (Lucretius, v. 656) or of ripening (*maturescentia*) corn (Augustine, *civit. Dei,* iv., 8, probably from Varro). In either case her name is connected with *mane, matutinus,* and either would account for the fact that she is connected with childbirth and the care of young children, and therefore identified with *Eileithuia;* but the agricultural explanation is perhaps more in keeping with the general character of Italian religion. She had temples at many places in central Italy, and at Rome her festival, the *Matralia,* was on June 11. Only free women living in a first marriage might take part; the offerings were of a simple and old-fashioned character; and the women prayed, not for their own children, but for those of their sisters, a rite as yet unexplained. Matuta was later identified with Ino-Leucothea.

[1]§§73–76 have been based, by permission, on the article written by Sir J. A. Ewing for the 11th edition.

[1]A theory of the propagation of fatigue fractures has been propounded by R. V. Southworth and St. S. Gough, Phil. Mag. Jour. 1926.

See Wissowa, *Religion und Kultus,* 2nd ed., p. 110; H. J. Rose, *Roman Questions of Plutarch* (1924), p. 175.

MATERNITY AND INFANT WELFARE. After the World War all civilized countries realized the importance of decreasing the high death-rate among women at childbirth and among infants under one year of age. In Great Britain there is a considerable body of new legislation intended to supplement welfare agencies and to provide State aid. The Maternity and Child Welfare Act 1918 gives comprehensive powers to local authorities. It consolidates the work commenced in 1906 by the St. Marylebone Health Society. Like nearly every other movement to fight disease, modest experiments by groups of social workers pointed the way to larger State and municipal action.

In 1910 there were 90 infant welfare centres in Great Britain, and by 1914 the number had risen to 400. Owing to the impetus of the War and the Child Welfare Act of 1918, there were in May 1928 no fewer than 1,561 infant welfare centres under the local authorities and 870 voluntary centres, as well as 153 maternity institutions recognized by the Ministry of Health.

The various enactments bearing on the subject are the Factory and Workshops Act of 1901, which endeavours directly to protect the woman who has recently given birth to a child; the Midwives Act of 1902, which laid the foundation of a safe and efficient system of practice by midwives; the Notification of Births Act of 1907 and the extension of the act in 1915, which Miss Margaret Llewelyn Davies described as "nothing less than a welcome by society to each of its newly-born citizens, and a signal of help and a message of hope to every mother in the land." Under this act the father or doctor or midwife must notify the public health authority within 36 hours of the birth of a child. Advice and help, free of charge, are then given by a woman health visitor. The National Health Insurance Act provides a maternity benefit of 40s. for an insured woman or the wife of an insured man.

The Ministry of Health, formerly the Local Government Board, encouraged local authorities to extend and develop their maternity and child welfare services. In a circular letter to local authorities issued in 1914 the board stated that an estimate had been laid before parliament for a grant to be distributed to local authorities and voluntary agencies in respect of institutions or other provision for maternity and child welfare, that more extended and systematic measures than had hitherto been generally adopted were necessary. Sir Arthur Newsholme, in a report on maternal mortality in connection with childbearing, published in 1915, stated that "the present report is intended to draw attention to this unnecessary mortality from childbearing, to stimulate further local inquiry on the subject and to encourage measures which will make the occurrence of illness and disability due to childbearing a much rarer event than at present." His successor, Sir George Newman, 10 years later (1924), in his preface to Dr. Janet Campbell's *Maternal Mortality,* referring to the fact that approximately 3,000 mothers had died each year at childbirth for the previous 10 years, stated: "That is a serious and largely an avoidable loss of life at the time of its highest capacity and in its most fruitful effort."

Administration.—The local authorities carrying out maternity and child welfare schemes are the county councils, county borough councils and the councils of certain of the larger county districts—as a general rule those having a population of more than 20,000. These are in the main the authorities which adopted the Notification of Births Act referred to above, under which some work for mothers and babies was already being done before the passing of the act of 1918. The regulations, under which a grant is payable by the Exchequer of 50% of the approved net expenditure of local authorities, set out the services which may and should be comprised in a maternity and child welfare scheme, and from them the scope and content of the services may readily be understood. 1. The salaries and expenses of inspectors of midwives and of health visitors and nurses engaged in maternity and child welfare work; 2. The provision of a midwife for necessitous women and for areas insufficiently supplied with this service; 3. The provision, for necessitous women, of a doctor for illness connected with pregnancy and for aid during the period of confinement; 4. The expenses of a centre, *i.e.*, an institution for providing medical supervision and advice for expectant and nursing mothers and for children under five years of age, and medical treatment at the centre for cases needing it; 5. Arrangements for instruction in the general hygiene of maternity and childhood; 6. Hospital treatment for complicated cases of confinement and for children under five years of age found to need in-patient treatment; 7. The cost of food certified as being necessary to expectant and nursing mothers and for children where the case is necessitous; 8. Expenses of crèches and day nurseries and of other arrangements for attending to the health of children under five years of age whose mothers go out to work; 9. Accommodation in convalescent homes for nursing mothers and for children; 10. The provision of homes and other arrangements for attending to the health of children under five years of age of widowed, deserted and unmarried mothers; 11. Experimental work in relation to maternity and child welfare work; 12. Contribution by a local authority to voluntary institutions. Exchequer grants on the same scale are also paid to voluntary agencies which carry out certain services to the satisfaction of the Minister of Health.

The expenditure on maternity and child welfare services provided by local authorities for the year 1927–28 was upwards of £1,500,000, in addition to which Exchequer grants amounting to over £217,000 were made to voluntary agencies. If to these figures is added nearly £2,000,000 paid in maternity benefit under the national health insurance scheme, a total of nearly £4,000,000 is spent each year on these services, without taking account of the expenditure out of local rates, or of the voluntary agencies, or of other benefits paid to women during pregnancy from health insurance funds or of the voluntary hospital services.

Infant and Maternal Mortality.—The services given at the centres by both lay and professional workers helped to secure the reduction of the infant mortality rate from 154 per 1,000 births in 1900 to about 70 per 1,000 births in 1927. This gratifying result means that (calculated on the average infant mortality of 1901–10) there was in 1927 a further saving of some 40,000 infant lives. "It also implies a better physical condition in children from one to five years of age, and a more enlightened understanding of personal and public hygiene" (Sir George Newman). While this saving of infant lives is all to the good, it is disturbing to find on an analysis of the statistics that the reduction in the infant mortality rate has occurred almost entirely subsequent to the first few weeks of life and that the death-rate of infants up to the age of four weeks has remained almost stationary, being 32 per 1,000 births in 1927 as against 40 births for 1906–10.

So, too, in the case of maternal mortality, notwithstanding that Sir Arthur Newsholme reported in 1915 that "800 mothers die each year in England and Wales as the result of childbearing whose lives would be saved if the experience of the rest of England and Wales were as favourable as London," and that there would be a further saving of 1,100 lives of mothers secured annually in England and Wales if puerperal fever were to be eliminated "as it has been substantially from the experience of many lying-in hospitals." Dr. Janet Campbell, 10 years later, writes that "avoidable maternal deaths are a matter of everyday occurrence," and that "puerperal infection leads to more deaths and more injury than any other complication of childbearing."

It has been shown that the mortality rate of very young babies is nearly as high as it was early in the century. On examining the statistical returns of maternal mortality as published by the registrar general it is seen that while the death-rate of mothers at childbirth was 5 per 1,000 births for the period 1906–10, it was 4·11 per 1,000 births in 1927.

Here then is the problem. Improvements in general sanitation and public health services, a better education in public and personal hygiene, the maternity and child welfare services, the services provided under the national health insurance scheme, have had no visible effect upon the vital statistics relating to childbearing. Comparing the period 1906–10 with the year 1927—*i.e.,* the period prior to the establishment and development of maternity and child welfare services by the local authorities with the latest complete figures available—it is seen that taking the 1906–10 period as 100, the relative mortality rates provisionally ascer-

tained for 1927 are:—

Maternal mortality	82·2 %
Infants under four weeks	80·0
Infants from four weeks to one year	49·35

According to Dr. Janet Campbell, the death of the mother is often followed by the death of the baby and "by the impaired health and nutrition of the remaining children."

Disability Among Married Women.—It has been pointed out that the mortality returns "reveal only a part of the total damage and disability, and that an incalculable amount of unreported and often untreated injury and ill-health results from pregnancy and labour." Statistics relating to the comparatively heavy incidence of sickness amongst married women were presented to the royal commission on national health insurance which reported in March 1926. The Government actuary reported that an urgent matter is the excess of the claims of married over unmarried women. At the important ages, 20–25, 25–30 and 30–35, the married woman's rates of sickness represent the following percentages of those of the unmarried class:

Ages	*1921* %	*1922* %	*1923* %
20–25	242	284	299
25–30	174	198	242
30–35	158	171	198

The majority report of the royal commission recommended the provision of improved maternity services "as and when funds are available to meet the cost." The minority report, however, declared that "the high maternal death-rate and the great amount of sickness amongst mothers clearly prove the need of reorganization and extension of maternity work," and recommended that medical benefit under the health insurance scheme should include medical attention at confinement and should be extended to include the wives and dependants of insured men. The provision of more adequate services for women at childbirth is a matter of urgent necessity. "If a woman can rely upon securing the services of a careful up-to-date practitioner, or upon the attendance of a well-trained midwife who is able to obtain prompt and competent medical assistance in case of need, nearly all other conditions become of minor importance" (Dr. Janet Campbell).

Effect of Environment.—The development of antenatal services appears to afford the most likely solution to the problem. Regional distribution of the mortality does not point to industrial factors as being the chief causes of deaths. At the same time, it is not without significance that nine of the 10 county boroughs having the highest rates of maternal mortality in the four years 1919–22 were in Lancashire and Yorkshire, and seven of those nine towns, viz., Halifax, Rochdale, Huddersfield, Bury, Oldham, Dewsbury and Blackburn, in the report of 1914–15 are among the county boroughs which exact "the heaviest toll of life from mothers in childbearing." Industrial areas can, however, be found with extremely low rates of mortality; the predominatingly working class district of West Ham actually had in 1919–22 the lowest rate of maternal mortality of all the county boroughs.

The same county borough had the lowest rate among the metropolitan boroughs in 1914. In the counties of Lancashire and Yorkshire it is the practice for a considerable proportion of married women to be employed in the textile mills, and it is difficult to resist the conclusion that the nature of their employment, together with the strain of managing the household and bearing large families, is in no small degree responsible for the unenviable position which the towns occupy and have occupied for so many years. The puerperal death-rate in Wales has always been higher than that in England, and, until recently, than in Scotland. That is probably due, not so much to any special cause peculiar to Wales, as to the fact that, broadly speaking, the whole country is either extremely rural or highly industrial. The services available in most rural areas leaving much to be desired, and the exceedingly hard life associated with the mining industry, must be factors contributing to the high maternal mortality rates disclosed.

An enlightened public opinion would encourage and, where necessary, compel the local authorities to provide the services considered by the experts to be essential. The medical profession has the knowledge; administrators, local and national, are capable of creating the administrative machinery; there is no lack of voluntary helpers; the provision of the necessary finance and the co-operation of mothers are the factors depending upon education.

It may be said, in summing up this vitally important subject, that there are few departments of human life in which greater and more beneficent progress has been made in recent years, as compared with the ignorant and haphazard practice of the past.

BIBLIOGRAPHY.—*The International Year Book of Child Care and Protection*, compiled by E. Fuller (1925); *Oeuvre Nationale de l'enfance—Rapport annuel* (Brussels, 1923); *Inter. Record of Child Welfare Work*, No. 1–2 (Brussels, 1921–23) continued as *Bulletin international de la protection de l'enfance* (No. 22) (Brussels, 1924); *Co-opération et prévoyance sociale en Tchécoslovaquie*, ed. A. Klimt (Prague); *The Declaration of Geneva* (in 36 languages) (London); J. M. Campbell, M.D., *Reports on Public Health and Medical Subjects, No. 5: Maternal Mortality;* No. 48: The Protection of Motherhood, Ministry of Health (H.M. Stationery Office, 1924); *Report of the Proceedings of the Third English-speaking Conference on Infant Welfare* (1924); *Annual Report of the Infant Welfare Societies of Chicago* (Chicago). (M. BON.)

UNITED STATES

In the United States public health work essentially educational in character did not begin until the present century. The great increase in scientific information as to the pathology of disease, together with the development of a public-nursing technique, made possible a preventive programme. Before 1900 public health activities were largely confined to the control of contagious disease and sanitation. Thus, while the first school inspection was begun in Boston in 1894, the first health teaching in connection with the schools was undertaken through the co-operation of the Henry Street Nursing Service in New York in 1902; and the present type of school health programme which seeks to interest the child in the formation of good health habits began to be included in school curricula only about 1918.

The establishment of the first bureau of child hygiene, in New York city in August, 1908, with Dr. S. Josephine Baker as its director, began a new era in the child health programme. In 1910 New York and Louisiana organized divisions of child hygiene in their State departments of health. The U.S. children's bureau created by act of Congress in the spring of 1912 was directed to "investigate and report upon . . . all matters pertaining to the welfare of children and child life among all classes of our people . . . and especially . . . the questions of infant mortality, the birthrate . . . and diseases of children," and under the leadership of Julia C. Lathrop began at once a series of studies of infant mortality, the publication of popular bulletins and co-operation in demonstrations of child health examinations, "baby weeks," etc. By 1920 child hygiene divisions had been established in most of the larger cities and towns and in the departments of health in 28 States. In 1921 the U.S. Maternity and Infancy Act, popularly known as the Sheppard-Towner Act, was passed.

In 1923 two private national organizations, the American Child Hygiene Association and the Child Health Organization of America, united under the presidency of the Hon. Herbert Hoover to form the American Child Health Association. This association has been active in promoting May Day as Child Health Day, and has published an important survey of child health in 86 cities with a population of from 40,000 to 70,000, and many popular bulletins.

The Federal Maternity and Infancy Act authorized for a five-year period, which was extended to a seven-year period in 1927, an annual appropriation of $1,240,000, of which a sum not to exceed $50,000 may be expended by the U.S. children's bureau for administrative purposes and for the investigation of maternal and infant mortality, the balance to be divided among the States accepting the act as follows: $5,000 unmatched to each State, and an additional $5,000 to each State if matched; the balance to be allotted among the several States on the basis of population and granted if matched. National administration of the act was lodged with the children's bureau of the U.S. department of labour; local administration in the States is in the child hygiene or child wel-

fare division of the State agency of health, or, where such a division does not exist, the agency designated by the State. In 1927, 45 States—all except Connecticut, Illinois and Massachusetts—had accepted the benefits of the act and approximately $1,000,000 was being expended by the National Government in subsidies to the States. In 1924 the benefits of the act were made available to the territory of Hawaii, which promptly accepted and matched the funds made available. The 1927 report of the activities undertaken by the States under the terms of this act showed continued progress as old activities spread over a greater territory and new activities were initiated. These had for their objects (1) better infant care through the teaching of mothers; (2) better care for mothers through education as to the need and value of skilled supervision during pregnancy, childbirth and the lying-in period; and (3) more widespread medical and nursing facilities so that adequate maternity and infant supervision would be available. Children's health centres or conferences and prenatal or maternity centres or conferences are everywhere recognized as the best agencies for teaching the hygiene of maternity and infancy. An objective in most of the States is the establishment of permanent, locally-supported centres. Demonstration conferences have been held and intensive pieces of work undertaken by the States when there was evidence of special need. In the main the activities promoted with maternity and infancy funds have been for the benefit of rural communities and smaller cities and towns. State reports of the work during the fiscal year 1926–27 show 21,347 child-health conferences held by 37 States, with 136,813 infants and children of pre-school age examined, and 235 permanent child health centres established through the efforts of the States. Since 1920 child hygiene or child welfare divisions or bureaux have been organized in the departments of health in 13 States and the territory of Hawaii. At present all the States except one have such a bureau or division promoting child health, almost all of them being in the State department of health; in that one State the department of public health administers the work directly.

Sixteen States have been admitted to the United States birth-registration area since the passage of the Maternity and Infancy Act, so that at present 42 States together with the district of Columbia (all except Colorado, Nevada, New Mexico, South Carolina, South Dakota and Texas) have been admitted to what is known as the birth-registration area of the United States. This area included on Jan. 1, 1928, approximately 92% of the total population of the United States. In 1915 the infant mortality rate for the birth-registration area was 100; in 1920, 86; and in 1927 (provisional), 64. In 1920 only four States in the area had a rate below 70, and none had a rate below 60 deaths per 1,000 live births. In 1927, 29 States and the district of Columbia had a rate below 70, and of these, 11 were below 60. (Four of these 29 States had been admitted to the area since 1920.) Figures for foreign countries are not available for 1927, but in 1926, as a result of the lowering of the American rate to 73 only Australia, the Irish Free State, the Netherlands, New Zealand and the Union of South Africa—of the countries for which figures are available—had a lower infant mortality rate than the United States. In 1915 eight countries had lower rates.

On the face of the figures, maternal mortality from all causes appears to have been increasing in the United States. Analysis of the statistics shows that the certification of the causes of deaths has improved during the last 20 years. If allowance is made for the probable effect of this improvement in certification, the mortality from puerperal septicaemia has fallen throughout the period instead of increasing up to 1911 and falling since that time, as the figures taken at their face value would indicate, and the mortality from other puerperal causes has been approximately stationary. After allowances are made for the margin of error in the statistics of the United States and of other countries, it seems probable that the rate in the United States is actually considerably higher than in most countries. The maternal death rate per 10,000 live births in the birth-registration area of the United States was 68·0 in 1921, with only four States having a rate below 60. In 1926 it was 65·6, with 13 States having a rate below 60. Of these only two were admitted to the area since 1921. Analysis of the death rate shows a reduction in deaths from puerperal septicaemia which is probably due to the education as to the importance of prenatal care being carried on by the State health departments in co-operation with the children's bureaux.

Great emphasis is being placed on prenatal supervision by the State bureaux of maternal and infant hygiene, and there is evidence of great interest in the programme of work which is slowly getting under way. Studies of maternal mortality along lines laid down by the children's bureau consulting obstetrical committee are being made at the request of the State medical societies in some 11 States. Reports of activities undertaken under the Maternity and Infancy Act for the fiscal year 1926–27 show 3,231 prenatal conferences with 17,762 mothers in attendance, and 14 permanent prenatal centres established. More than 650 midwife classes were held in 16 States with an enrolment of almost 11,000 midwives, 6,000 of whom completed a somewhat formal course of instruction. Most of these were negro midwives who had had little or no previous training. Women in isolated rural districts are being reached by "prenatal letters" and itinerant conferences. More generally accessible hospital care during confinement is also receiving consideration.

In 1928, 21 States (Colorado, Florida, Idaho, Iowa, Kansas, Kentucky, Louisiana, Massachusetts, Minnesota, Montana, Nebraska, Nevada, New Hampshire, New Jersey, North Carolina, Pennsylvania, Rhode Island, South Carolina, Utah, Vermont and Virginia) and the district of Columbia had laws or regulations making medical inspection of school children mandatory, although in some of these States the examination required was only for certain defects or for communicable diseases. In nine States (Alabama, Connecticut, Georgia, Indiana, Maine, New York, Washington, West Virginia and Wyoming) it was mandatory for certain districts. Two States (Kansas and South Dakota) had laws specifically requiring only examination of the teeth of school children, and in 12 other States and the district of Columbia this was included in the requirement of a complete examination. Thirty-five States—all except Arkansas, Colorado, Kansas, Louisiana, Montana, Nebraska, New Hampshire, New Mexico, South Dakota, Oklahoma, Texas, Vermont, Wyoming and the district of Columbia—have laws with reference to physical education (usually including health teaching) in elementary schools, which are either mandatory or mandatory in effect. The teaching of health and health habits as distinguished from either medical inspection or physical education has greatly increased.

Bibliography.—S. Josephine Baker, *Child Hygiene* (1925); *Reports of the Administration of the Maternity and Infancy Act*, children's bureau, U.S. dept. of labour (1923–26); *Birth Statistics*, bureau of the census, U.S. dept. of commerce (annual); *A Health Survey of 86 cities*, by the research division of the American Child Health Association of New York city (1925). (G. Ab.)

MATHEMATICAL ARTICLES. The field of mathematics is so extensive and its divisions are so numerous that it is impossible to treat of the subject under any one head or even, as was formerly attempted, by means of a small number of topics like Arithmetic, Algebra, the Calculus, and Geometry. Readers who wish a general survey should also consult the articles on Mathematics (Nature of), Mathematics (Foundations of), Mathematics (History of).

In the field of number, elementary discussions are given under Arithmetic, Numerals, Finger Numerals, and Fraction, while more advanced treatments will be found under Number, Number Theory, Number Sequences, Infinity, Continued Fractions, Complex Numbers, Quaternions, Magic Squares, and Tables, and under such special heads as Bernoulli, Euler, and Stirling Numbers.

Algebra is considered in an elementary way under this topic, and in its more advanced aspects under Determinants, Diophantine Equations, Equations, Fermat's Theorem, Forms (Algebraic), Series, Fourier's Series, Groups, Interpolation, Linear Algebra, Polynomial, Probability and Error, and Trigonometry, and under a number of minor heads.

As in the other general branches, Geometry is treated in an elementary way under this general title, with more advanced topics separately considered. These include such special fields as Affine

GEOMETRY, ANALYSIS SITUS, ANALYTIC GEOMETRY, CIRCLE, CONIC SECTIONS, CONFORMAL REPRESENTATION, CURVE, CURVES (SPECIAL), DESCRIPTIVE GEOMETRY, DIAGRAM, DIFFERENTIAL GEOMETRY, GEOMETRIES (FINITE), LINE GEOMETRY, MANIFOLDS, MENSURATION, NONEUCLIDEAN GEOMETRY, PERSPECTIVE, POINT SETS, PROJECTIVE GEOMETRY, RIEMANNIAN GEOMETRY, SOLIDS (GEOMETRIC), SURFACE, and TRIANGLE, with subjects like TRIGONOMETRY which are partly algebraic and partly geometric.

The "infinitesimal calculus" (differential and integral) is considered in a general way under CALCULUS, but various special branches are treated under DIFFERENTIAL EQUATIONS, DIFFERENTIAL FORMS, and MAXIMA and MINIMA. Certain branches to which the word "calculus" attaches will be found under such special heads as BARYCENTRIC CALCULUS, CALCULUS OF DIFFERENCES, and CALCULUS OF VARIATIONS.

The general function theory is considered under the head of FUNCTIONS, with special articles on ELLIPTIC FUNCTIONS, BESSEL FUNCTIONS, and such functions as are appropriately treated under topics like TRIGONOMETRY.

The important field of instruments and models is represented by the articles on CALCULATING MACHINES, MATHEMATICAL INSTRUMENTS, and MATHEMATICAL MODELS. The graphical features are discussed under GRAPHICAL METHODS, CHARTS, and NOMOGRAPHY.

In addition to the topics mentioned above, there are a large number on special subjects like KNOTS, BINOMIAL THEOREM, DUALITY, AXES, and ORDINATES.

MATHEMATICAL INDUCTION, one of various methods of proof of a mathematical statement. It can best be understood from an illustration. Suppose that it is desired to prove that the sum of the first n odd numbers is n^2; that is, that

$$1+3+5+\ldots+(2n-1)=n^2.$$

It is evidently true when $n=2$, for $1+3=4=2^2$.

Suppose that it is true for $n=k$. In that case we should have

$$1+3+5+\ldots+(2k-1)=k^2.$$

Adding the next odd number, which is $(2k-1)+2$, or $2k+1$, we have

$$1+3+5+\ldots+(2k+1)=k^2+2k+1=(k+1)^2.$$

But this is just what we would have in the formula if we replace n by $k+1$. That is, if the formula is true for $n=k$, it is true for $n=k+1$.

The mathematical induction now consists in reasoning:

(1) We have shown that if the formula is true for any particular value of k, it is true when k is increased by 1.

(2) But we know by actual computation that it is true for the particular value 2.

(3) Hence it must be true for $2+1$, or 3; hence for $3+1$, or 4, and so on for all positive integers.

The method is used in numerous cases in series. For example, it is easily shown by this reasoning that, in the geometric series: $1+ar+ar^2+\ldots+ar^{n-1}$, $S=a(1-r^n)/(1-r)$; that the sum of the cubes of the first n numbers is $\frac{1}{4}n^2(n+1)^2$; and that the sum of the squares of these numbers is $\frac{1}{6}n(n+1)(2n+1)$.

MATHEMATICAL INSTRUMENTS. The term "mathematical instruments" in its widest significance includes various instruments used in drawing, surveying, astronomy, etc. We will here consider certain instruments designed to perform operations involving computation and measurement. Instruments and machines concerned with the mechanical performance of addition, subtraction, multiplication, division, etc., are described under CALCULATING MACHINES.

Instruments for Solving Equations.—Many instruments have been designed for the mechanical solution of algebraical equations. These are in general more remarkable for the ingenuity displayed in their design than for the practical value of the results obtainable. No instrument of this type has been brought into extensive use, but a few of them have found a limited application in cases where a considerable number of roughly approximate results are required. (*See* the works of Jacob, Horsburgh and Baxandall given in the bibliography.)

Planimeters.—The invention in 1814 of the first instrument for directly measuring an area bounded by an irregular curve is attributed to the Bavarian engineer, J. H. Hermann. The instrument was improved by Lämmle in 1816, and actually constructed in 1817. Tito Gonella of Florence in 1824 invented independently a similar instrument. It embodied a recording wheel which rolled on the surface of a cone, the angular motion of the wheel relative to that of the cone varying with the distance of the wheel from the apex of the cone. The position of the wheel on the cone was made to vary according to the length of the ordinate of the curve, thus the total angular rotation of the recording wheel gave the measure of area. Gonella soon afterwards replaced the cone by a disc.

The Swiss engineer Oppikofer invented in 1826 a planimeter which was similar to Gonella's first type (wheel and cone). This was first made successfully by Ernst, who improved it and made it for general sale. In 1849, Wetli of Zürich independently invented the disc type of planimeter adapted for both positive and negative co-ordinates, and the instrument was made by Starke of Vienna. The example shown in Pl. I. fig. 1, which was constructed about 1860, is engraved:—"Patent von Wetli & Starke, No. 103." It consists of a rotatable horizontal circular disc with a specially prepared fine upper surface on which the registering roller rests. The disc is mounted on a frame supported by three grooved wheels, which can roll on three parallel rails. Beneath the disc and mounted on the frame is a horizontal rod held between two pairs of guide rollers so that it can move in a direction at right angles to the rails. By means of a thin wire wound round the axle of the disc and attached to the ends of the rod the disc is given an angular movement proportional to the longitudinal displacement of the rod.

An upright frame screwed to the other end of the base-plate carries one end of the axle and the two divided circles which record the rotation of the registering wheel. Pivoted to this upright is a light frame carrying the registering wheel at its other end, which can be raised or lowered by means of a milled-headed screw; when the frame is lowered the wheel rests with a constant pressure on the disc. As the tracing point attached to one end of the rod is guided along the curve whose area is to be measured, the distance between the centre of the disc and the plane of the registering wheel is always proportional to the ordinate of the curve. The number of revolutions of the registering wheel gives therefore a measure of the area.

Hansen of Seeberg suggested improvements, which were embodied in the instrument made by Ausfeld, known as the Wetli-Hansen planimeter. John Sang of Kirkcaldy invented and made in 1851 a "planometer" of the wheel and cone type, which resembled that made by Ernst. An example of Sang's instrument is shown in Pl. I., fig. 2.

It will be seen that the revolving motion of the index-wheel is in proportion to the motion of the tracer up or down the paper, multiplied by the right and left distance of the wheel from the apex of the cone; and therefore, when the tracer is made to describe any complete perimeter, the whole rotatory motion of the index wheel represents the algebraic sum of the products of ordinates to every point in that perimeter, multiplied by the increment of their co-ordinates; thus it is a measure of the included space.

Clerk Maxwell in 1855 designed a planimeter in which pure rolling was substituted for the undesirable partial sliding of the register wheel on the cone or disc which occurred in previous types, but the instrument was never constructed. James Thomson in 1876 investigated the same problem, and in attempting to simplify Maxwell's mechanism, evolved his disc, sphere, and cylinder combination which could be applied to the construction of a planimeter.

This combination is shown in Pl. I., fig. 4, which represents the original model of Kelvin's harmonic analyser, made in 1876. The plane of the circular disc is inclined at 45°, and the sphere (shown displaced from its proper position) rests against the disc and the cylinder. The points of contact of the sphere are on a generating line of the cylinder and the horizontal diameter of the disc, and the distance of the sphere from the centre of the disc is controlled by the movement of a rod carrying two

forks, between which the sphere fits when the instrument is in use. The sphere acts as an intermediate variable gear, which communicates the rotation of the disc to the cylinder at a rate directly proportional to the distance between the axis of the disc and the centre of the sphere. This rod carries near its other end a pointer. When used as a planimeter, the curve whose area is required is wrapped round the larger cylinder, and as this is made to rotate the pointer is guided so as to follow the point of the curve which is on the topmost generating line. If the instrument is adjusted so that the sphere is at the centre of the disc when the pointer is on the axis of x, then the distance of the sphere from its central position will be always equal to the ordinate y of the curve, and the measuring cylinder will give, by the amount of its rotation, the value of $\int y \cdot da$—*i.e.*, the area of the curve. Owing to the difficulties and cost of construction, this type of planimeter was never made commercially, but Kelvin adopted the mechanism in his harmonic analyser.

A planimeter of the polar type, in which the recording wheel, kept in the required position by means of a guiding curve, rolled on the paper, was designed about 1856 by Gierer of Fürth. Bouniakovsky of St. Petersburg and Decher of Augsburg in 1856 each proposed an instrument of this type, in which the guiding curve was replaced by linkwork. C. V. Boys in 1883 invented a polar planimeter in which there was no slipping, but it was never constructed commercially.

Jacob Amsler, about 1854, invented his polar planimeter, which from its simple construction and low price very soon came into extensive use; up to 1884 Amsler had made over 12,000 examples of this instrument. An example made by Stanley about 1875 is shown in Pl. I., fig. 3. In using the instrument, the weighted point F is fixed and the tracing pointer T is guided exactly once round the outline of the figure whose area is to be measured. The difference of the readings on the graduated roller R before and after this operation gives the area of the figure in units depending on the radius TP of the tracing arm. Accurate setting of the tracing arm is facilitated by means of a fine screw adjustment. The example shown is of the "proportional" type—*i.e.*, the unit can be changed by altering the radius of the tracing arm.

About 1893, Coradi introduced his "compensation" polar planimeter, adopting a suggestion made by O. Lang, a Neuweid surveyor. In this modification of Amsler's polar planimeter the tracing frame and the pole arm are made in separate parts so as to allow the pole arm to be placed on either side of the tracer arm. Any error due to non-parallelism of the axis of the roller and the tracer arm can be eliminated by taking the mean of two readings, one obtained with the pole to the left of the tracer arm, and the other with the pole symmetrically to the right.

Integrator.—Amsler in 1856 invented his "integrator," which will measure larger areas than can be measured by the polar planimeter. It will also measure the moment and the moment of inertia of an area about any axis lying in the plane of the area. The instrument (Pl. I., fig. 5) is carried by a pair of wheels moving in a straight groove in a long steel bar, and a counterbalance weight is provided. If the tracing point T be guided so as to describe the outline of a plane figure, the graduated roller A attached to the swinging arm will register the area of the figure. The outer roller M will register the moment of the areas about the straight line described by the point where the axis of rotation of the instrument intersects the paper. The moment of inertia about the same straight line is deduced from the readings on the first roller and the inner one. Two gauges are provided for indicating the exact position of the straight line to which the moments are referred.

The integrator shown in Pl. I., fig. 6, was designed by Professor Hele-Shaw for determining areas, moments of stability and inertia by a single tracing of the figure. The principle of the instrument is similar to that of Amsler's integrator, but the instrument is designed specially to avoid slipping of the measuring wheel upon the moving surface, which in this case is a sphere.

In 1876 F. Hohmann invented a "precision" planimeter, which since 1880 has been made with various modifications by Amsler, Coradi, Ott and others. In this type the recording wheel rests lightly on the specially prepared fine surface of a disc, so as to reduce friction due to slipping.

Important improvements due to Coradi are embodied in the instrument shown in Pl. I., fig. 7, which was made in 1915. The pivot end of the tracer arm is constrained to move in a circle whose centre is the same as that of the base plate, or pole disc. The edge of the pole disc is milled and engages with a small wheel on the axis of the revolving disc. This latter is made of aluminium and its upper surface is covered with smooth paper. As its axis, which is attached to the pole arm, revolves with the pole arm, the small wheel gears with the edge of the pole disc and the aluminium disc rotates through an angle proportional to the angle described by the pole arm. Upon this rotating disc rests the recording wheel, which is in turn rotated by its contact with the disc through an angle proportional to the area swept over by the tracer. The length of the tracer arm can be varied to suit the scale required, and the tracer point is provided with a support and a spring contact.

Ott (of Kempten, Bavaria) manufactures an "universal" planimeter which is made in three sections, and can be set up in different ways so as to form a compensation polar planimeter, a rolling planimeter, or a radial averaging instrument.

In 1887, Captain Prytz invented the simple knife-edge or "hatchet" planimeter, introduced and popularized in England by Professor Goodman. In its original form it consisted of a metal bar, bent at right angles at both ends, one of which (the tracer) was pointed, and the other in the form of a curved knife-edge. In using this instrument, a point is chosen at or near the centre of the area to be measured, and a radial line is drawn to the boundary. The point of the instrument is placed at the centre, and the hatchet pressed into the paper to form a dent. The point of the instrument is then made to follow the radial line and the boundary line, ultimately returning to the central point of the area, along the same radial line. The hatchet is again pressed into the paper to form a dent. If AB, AB^1 be the initial and final positions of the arm, the area described is equal to the length of the arm multiplied by the length of the arc BB^1. Within certain limits, the length of the chord BB^1—*i.e.*, the linear distance between the initial and final marks made by the knife edge—may be taken instead of the length of the arc. In 1890 Prof. Goodman added a scale on the back of the instrument, which when applied to the distance between the two dents gave a direct reading of area in square inches.

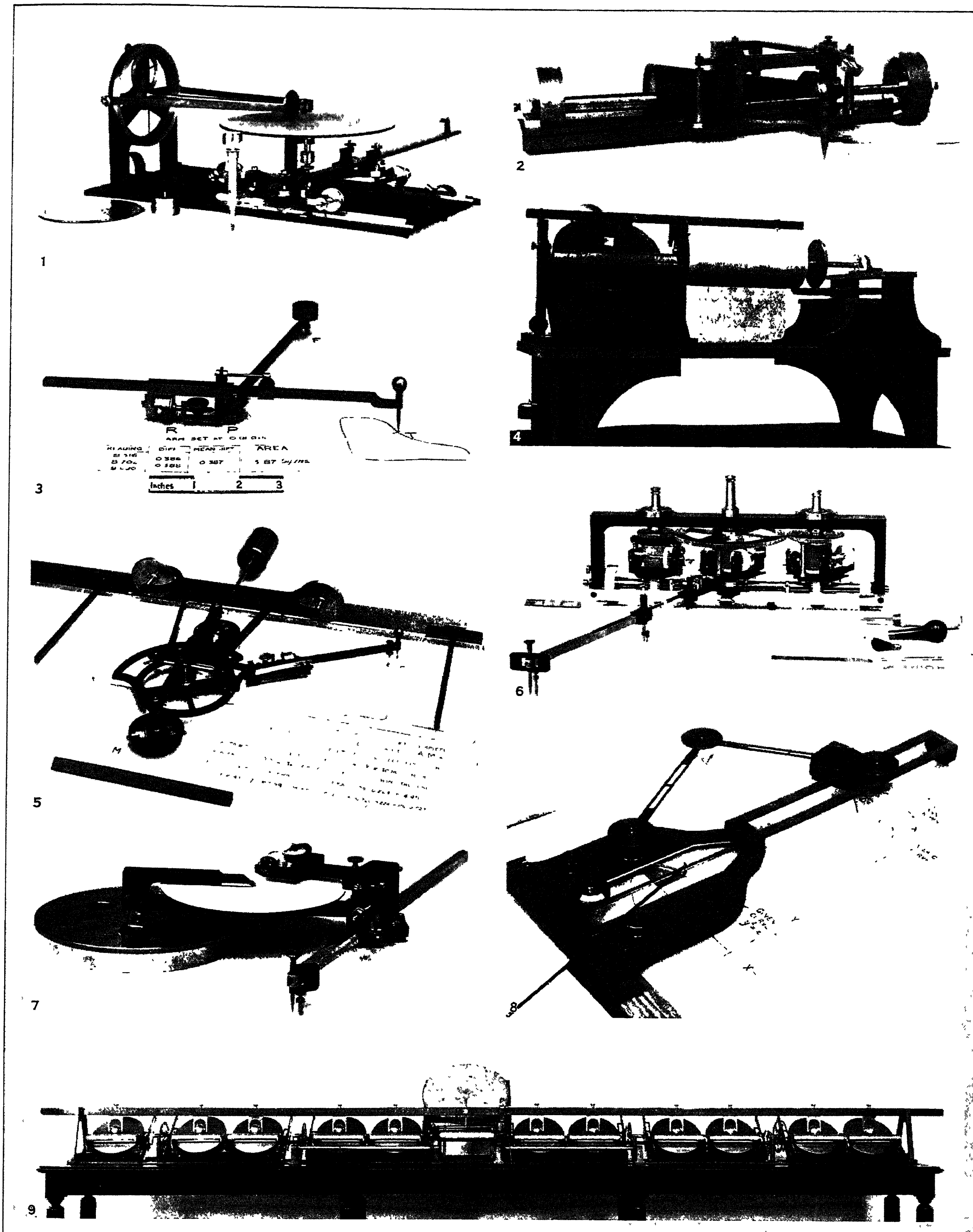
Integraphs.—This class of instrument is designed to draw the integral curve, corresponding to any given curve. The example shown in Pl. I., fig. 8 was invented by Professor C. V. Boys in 1881. It is an exact mechanical translation of the mathematical method of integrating $y \cdot dx$.

For any value of x the steepness of the curve drawn by the instrument is proportional to the ordinate of the given curve for the same value of x. The ascent then made by the new curve in passing from one ordinate to the other is a measure of the area between the given curve, the axis of x and the two ordinates.

The frame work is a kind of T-square (which can slide along a horizontal straight edge) carrying a fixed centre B, which moves along the axis of x of the given curve. A rod, passing always through B, carries a pointer A, which is constrained to move in the vertical line $e\ e$ of the T-square; A can then be made to follow any given curve. The distance from B to $e\ e$ is constant (k), therefore the inclination of the rod AB is such that its tangent is equal to the ordinate of the given curve $\div k$; so that AB has always the inclination of the required curve.

The curve is drawn by means of a three-wheeled cart of lead whose first wheel C is mounted like the steering wheel of a bicycle. By means of epicyclic gearing this wheel is kept parallel to AB, and can move only in the direction of its own plane. As C is always in $e\ e$ produced, the wheel draws the required curve if allowed to pass over a sheet of carbon paper.

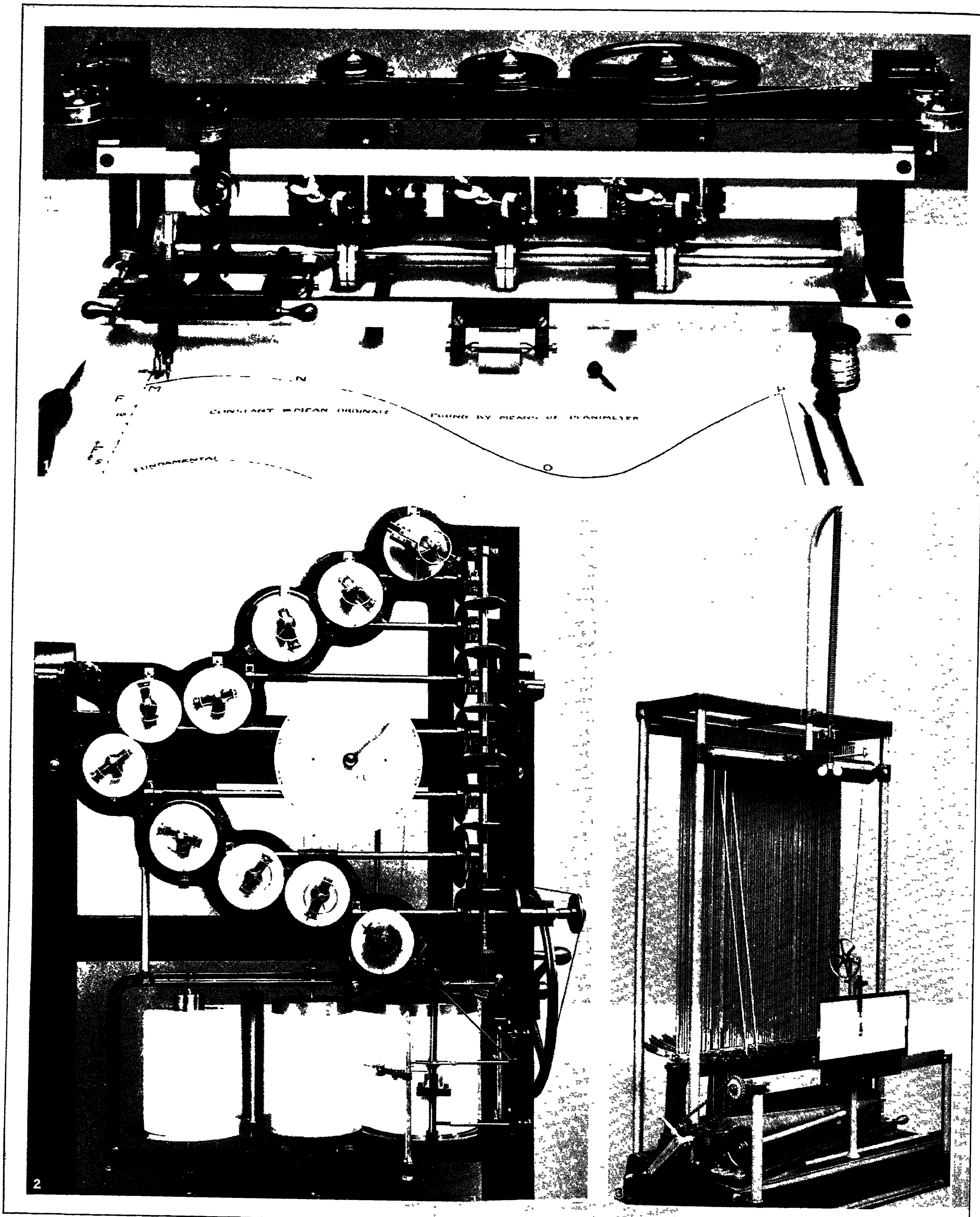
The first integraph made commercially was invented independently by Abdank-Abakanowicz about the same time as that of Boys. This instrument has been made in considerable numbers, with modifications and improvements in design and construction,



BY COURTESY OF THE BOARD OF EDUCATION, SCIENCE MUSEUM, LONDON

MATHEMATICAL INSTRUMENTS: PLANIMETERS, INTEGRATORS AND HARMONIC ANALYSERS

1. Wetli-Starke Planimeter. 2. Sang Planimeter. 3. Amsler Polar Planimeter. 4. Original Kelvin Harmonic Analyser. 5. Amsler Integrator. 6. Hele-Shaw Integrator. 7. Coradi precision-disc Planimeter. 8. Boys Integraph. 9. Kelvin Harmonic Analyser (All instruments described in text)



HARMONIC ANALYSER, HARMONIC INTEGRATOR AND TIDE PREDICTING MACHINE

1. Henrici's Harmonic Analyser for obtaining mechanically the simple harmonic components of a periodic curve. Model made by Coradi in 1894
2. Kelvin's Tide Predicting Machine, 1876, for predicting, a year or years in advance, the depth of water for any port at every instant
3. Michelson and Stratton's Harmonic Integrator for obtaining mechanically the resultant of a large number of simple harmonic motions. 1904 Model

by Coradi of Zürich. Several polar integraphs have also been designed by Prof. Pascal. (*See* his *I Miei Integrafi*, Naples, 1914.)

An integraph has been developed recently by V. Bush, F. D. Gage and H. R. Stewart which plots continuously a curve representing the product of two functions introduced into the machine in the form of curves. It evaluates $F(x)$ against (x) from the expression $F(x)=\int_a^x f_1(x)f_2xdx$, where f_1 and f_2 are known functions, formal or empirical. A full account of this machine is given by V. Bush and others in the *Journal of the Franklin Institute* (Jan. and Nov. 1927).

Harmonic Analysers.—In many scientific investigations the results of observations when plotted on paper take the form of an irregular curve which repeats itself at approximately regular intervals—*i.e.*, the curve, is periodic. Such a curve may be considered to be the sum of a series of simple harmonic curves, and it is the first object of harmonic analysis to find these simple component curves, which together build up a given periodic curve.

The various arithmetical or graphical methods which have been devised for this purpose are somewhat laborious, and Lord Kelvin in 1876 was the first to invent an instrument for performing the operation mechanically. This instrument was an adaptation of the disc-sphere-cylinder planimeter invented by his brother, James Thomson, in 1876.

The first completed instrument designed by Kelvin, and used for the harmonic analysis of tidal observations, is shown in Pl. I., fig. 9. It embodies 11 sets of the disc-sphere-cylinder combination, one for each harmonic. The curve to be analysed is wound on a central cylinder, and the simple harmonic angular motions of the proper periods are communicated to the disc by suitable gearing. The bar to which the tracer is attached has a series of pairs of projections which embrace the spheres. In actual use, the tracer is made to follow the curve, and the readings on the different integrating cylinders give the required coefficients.

Other harmonic analysers have been invented in 1894 by Henrici and Sharp, by Yule in 1895, Michelson and Stratton in 1898, Mader in 1909 and Boucherot in 1913. An example of Henrici's instrument, made by Coradi in 1894 is shown in Pl. II., fig. 1. A full description is given by Henrici in *Phil. Mag.* for July 1894; and in *Ency. Brit.*, 10th ed., art. "Mathematical Instruments."

A different type of harmonic analyser, in which the principle of action is based on Clifford's graphic method of harmonic analysis, was invented by O. Mader in 1909. An ordinary polar planimeter forms part of the instrument, and the tracer can be adjusted on its arm so as to suit any length of base from 20 mm. to 360 mm. Previous harmonic analysers could only be applied to curves of a fixed base; thus curves to any other base required redrawing to the given base before being analysed. In using the instrument, the guide ruler is placed parallel to the base line of the curve to be analysed, and the tracer of the planimeter is placed in one of the two holes of a toothed disc. These discs are easily interchanged.

For finding the coefficient A_n of the term $A_n \cos\left(n\,\frac{2\pi x}{a}\right)$ the toothed disc marked n is put in position and the tracer of the planimeter is put in the hole marked c. For the coefficient of the corresponding sine-term the tracer is put in the hole marked s. Toothed discs are provided for values of $n=1, 2, 3, \cdots 19$.

Harmonic Integrators.—When the component harmonic curves are known, or have been obtained by means of harmonic analysis the value of y for different values of θ in Fourier's formula can be found by computation. A great saving of labour is effected by performing this operation mechanically by means of "harmonic integrators," which are designed to draw a curve representing the value of y for all values of θ.

Tide-predicting Machine.—The method adopted by Kelvin is represented by the original model of his tide-predicting machine, made in 1872, and preserved in the Science Museum. In this model, eight pulleys are carried on axes at the ends of eight cranks of adjustable length, four on the upper side and four on the lower side of a rectangular wooden frame. A cord fixed at one end passes alternately under and over the lower and upper pulleys respectively, and at the other end carries a weight representing the marker. The centre of each pulley can thus describe a circle of adjustable radius, which circular motion is equivalent to the sum of two simple harmonic motions, one vertical and the other horizontal. The horizontal component of the circular motion leads to a slight motion of the cord out of its vertical position. If the radius of the circle described by the centre of each pulley is a small fraction of the distance between the upper and lower pulleys, Kelvin considered that the error introduced was practically negligible. The hanging weight will therefore perform a complex harmonic motion, which is the sum of the constituent vertical harmonic motions of the pulleys.

Pl. II., fig. 2 shows the first complete working machine made on the lines of the above model. There are ten wheels, one for each simple harmonic constituent obtained by means of the harmonic analyser, and the curve representing a year's tide for any port can be drawn in about four hours. The machine was constructed by A. Légé, under the superintendence of E. Roberts, who was also responsible for the design of later machines of larger capacity. In these machines the horizontal component was eliminated, the portions of the flexible wire between the upper and lower pulleys remaining always vertical. In the Liverpool machine made in 1924, there are 26 constituents; in the latest American machine (constructed 1896–1910) there are 37 constituents, and the tidal curves for 7 years can be run off in 12 hours.

A. E. Donkin in 1873 designed and constructed a harmonic integrator for compounding two simple harmonic motions. The curves are drawn by a pen on a paper secured round the surface of a cylinder. By means of two eccentrics simple harmonic motions are given to the pen and the cylinder respectively, the relative number of vibrations being variable by means of change wheels. Since both pen and cylinder move at once, the curve drawn shows the combination of the two motions.

The machine shown in Pl. II., fig. 3 was designed by Michelson and Stratton in 1898. The principle adopted is that of the addition of the elastic forces of spiral springs. In 1897 a machine of this type with 20 elements was made, and in the following year one with 80 elements, as in the example shown. An element consists of an eccentric (near the base of the machine) which, by means of an eccentric rod, communicates a simple harmonic motion to the end of a horizontal lever, curved to a radius equal to the length of a long rod, the foot of which may be clamped in any position along the lever. The top end of this rod actuates a lever whose end is attached to a small spring. Each of the 80 elements is similarly constructed, and the *amplitude* of the harmonic motion transmitted to the end of each spring is proportional to the distance of the foot of the corresponding long rod from the middle of the curved lever; for setting these distances accurately a special gauge is provided. The lower end of each of the small springs is attached to one end of a wide balance lever (made as a hollow cylinder on axial knife-edges), and the sum of their efforts is balanced by the action of a single powerful counter-spring. The motion of the lower end of the large spring is accordingly proportional to the algebraic sum of the motions of the upper ends of the small springs, and this resultant motion is magnified mechanically and conveyed to a pen, which registers the motion on a paper carried by a travelling plate driven by hand through the mechanism which rotates eccentrics.

By means of suitable toothed wheels forming a cone, the eccentrics are given periods increasing in regular succession; the eccentric nearest the hand wheel revolving 80 times while that at the opposite end revolves once. Turning the hand wheel produces at the upper ends of the small springs motions corresponding to $\cos\theta$, $\cos 2\theta$, $\cos 3\theta$, etc., up to $\cos 80\theta$, with amplitudes depending on the setting of the long rods.

The motions of the elements may be changed from those for *cosine* to those of *sine* by disengaging the cone and turning all the eccentrics through 90°, for which purpose a long pinion is provided. The machine is used as an *analyser* for finding the coefficients in a Fourier's series for a given periodic function.

Bibliography.—J. Amsler, "Über das Polar Planimeter," Dingler's *Polytechnisches Journal* (vol. cxl., 1856, pp. 321–327; vol. cxli.,

1856, pp. 326–329); H. S. Hele Shaw, "Mechanical Integrators," *Min. Proc. of Civil Engineers* (1885, p. 75) and "The Theory of Continuous Calculating Machines and of the Mechanism of this Class on a New Principle," *Phil. Trans. R.S.* (1885, vol. clxxvi., part ii., 367); W. Dyck, *Katalog mathematischer und mathematisch-physikalischen—Modelle* (Munich, 1893, pp. 180–224; also Supplement, 1893, and article "Mechanical Integration" in it by A. Amsler); O. Henrici, "Report on Planimeters," *Annual Report of the British Association* (1894); L. Jacob, *Le Calcul Mécanique* (1911, pp. 201–392); H. Morin, *Les Appareils d' Integration* (1913); E. M. Horsburgh (Editor), *Handbook of the Exhibition at the Napier Tercentenary Celebration* (Edinburgh, 1914), republished in London under the title *Modern Instruments of Calculation. See* articles by C. Tweedie on "Integraphs," by G. A. Carse and J. Urquhart on "Integrometers," "Planimeters" and "Harmonic Analysis," and by A. M. Robb on "The Use of Mechanical Integrating Machines in Naval Architecture"; H. Levy, "Mechanical Methods of Integration," in Glazebrook's *Dictionary of Applied Physics* (1923, vol. iii., pp. 450–457); D. Baxandall, *Mathematics. I.—Calculating Machines and Instruments* (1926. H.M. Stationery Office. A Catalogue of the calculating machines and instruments, exhibited in the Science Museum, South Kensington, with descriptive and historical notes and illustrations).

(D. B.)

MATHEMATICAL MODELS. The child's box of bricks is probably mankind's earliest acquaintance or contact with mathematical conceptions. The concrete forms of the cube which go to make up the puzzle pictures of the nursery, or the more complete selection of geometrical solids comprising cubes, prisms and cylinders which make up the "Building Sets" of the same period, must, however, in some measure, appeal to the latent mathematical faculty of the child mind, just as the abacus or "counting bead frame" may have stirred some little impulse in the arithmetical complex.

At an early stage in the child's career it is instructed that the cube, prism, etc., have many special properties which may, when used in right proportions, render them amongst the most pleasing forms of architecture. The simple doubled cube for example provides an exquisite form of pedestal and cross and the inherent beauties of the rectangular prism furnish a valuable architectural theme; also by means of models, it is possible to illustrate to the practical man a conception which may be perfectly clear to a gifted or trained mathematical mind.

A knowledge of plane geometry acquired without any reference to models may be said to flatten out the mind and to engender habits of thought which make it difficult at a later stage of mathematical education to explore space of three dimensions.

Plane Geometry.—Some early editions of Euclid had diagrams intended to be cut and folded, and a work by Cowley of 1752, *New and Methodical explanations of the Elements of Geometry*, included pieces of cardboard for the building up of various models. So talented a thinker and philosopher as Herbert Spencer appreciated the advantage of a model, for, writing to his father in January 1839, and speaking of his self-set task of regular, daily and systematic study of mathematics, he says "I have found out the grand principle of the projection of shadows and I feel almost certain of its correctness. To make myself still more satisfied I have made a model in pasteboard and I find that the real shadow is as exactly as possible what I had made it by projection."

Intuitive Geometry.—A valuable aid to the training of the young mathematical mind is to cut out, in cardboard, a number of equilateral triangles of the same size; the single triangle representing the plane figure; several piled one on top of the other with corresponding edges coplanar and corresponding corners collinear illustrate the solid figure of the triangular prism, while four of them placed together with pairs of edges coinciding, one of them being used as a base, gives the first of the regular solids, viz., the tetrahedron. The student may thus, by inductive process, quickly arrive at the historical selection of the five regular solids.

Simple models of this nature may be used to demonstrate common practical problems involving important principles relating to regularity and maximum and minimum values; as for example:—

1) Three straight lines of given total length enclose the greatest area when the lines form an equilateral triangle.

2) Four planes of a given total area enclose the greatest volume when the planes form a regular tetrahedron.

This statement could be varied by saying that for a given volume enclosed by four planes the surface is a minimum when the planes form a regular tetrahedron.

From these examples it will be remarked that regularity of shape is clearly connected with economy of bulk or volume, and where such regular forms occur in nature as in, say, crystal formations, we may naturally look for some explanation of maximum and minimum properties.

An important application of this style of model can be made by drawing out in the first place a regular hexagon of say, one inch edge. Set out upon each edge a further series of similar hexagons. Cut out with a sharp knife the first or inner hexagon and round the 18 lines of the outer edge of the figure, *i.e.*, the boundary lines. Next cut along and through one only of the radial lines; then cut halfway through, and fold back or crease the remaining radials common to each hexagon. The paper may now be folded and provides a medium for the illustration of some interesting problems. First fold over one hexagon upon another when the "space" becomes pentagonal. Folding two we get the square; three, the triangle; the four fold giving a mathematical "solid of no depth." If a number of such developed surfaces be cut out of different colours and made up permanently by gumming the folds, practically the whole series of semi-regular polyhedra may be worked up in effective manner. Of particular interest in its physical application is the "two-fold," *i.e.*, that giving a square and four hexagonal faces. Two of these units suitably connected at the joints by adhesive paper give the solid decatetrahedron of the Catalan Collection by Delagrave (1877); Pl. I. fig. 1 shows a polyhedron of 14 faces (6 square, 8 hexagon) which may be looked upon as a transition form between the cube and octahedron and which ten years or so later (1889) Lord Kelvin recognised as a shape providing minimum partitional area for cells of given volume, naming it the tetrakaidecahedron. (*See* SOLIDS: *Geometric.*) Pl. I. fig. 2 shows a somewhat similar construction of the "development" for the dodecahedron.

Mathematical models need not be accurate representations of a function in the same way, as, say, logarithmic tables or scales. They are not to be considered in the same category as graphs or nomograms. (*See* NOMOGRAPHY.) But they need to be constructed with reasonable care, and of suitable materials. It is sufficient if they enable the student to visualise the problem and follow the algebraic analysis involved. Mathematical models serve not to prove propositions but to demonstrate problems.

Materials for Models.—A mathematically plane surface has for example no counterpart in practice, but thin sheet metal or cardboard suffices for many purposes although in certain cases transparent celluloid or glass is to be preferred, whilst in others, strings, elastic, silk or cotton cords—which may be of different colours,—arranged closely together and parallel may be employed as where, for instance, it may be desired to demonstrate and variably warp or deform a surface; or to illustrate the continuously intersecting planes of descriptive geometry or the discriminant surfaces involved in algebraic equations of the 4th or 5th degree, etc.

Descriptive Geometry.—For the study of descriptive geometry (*q.v.*), perspective (*q.v.*), etc., a useful device is found in a pair of planes hinged together and possibly provided with a third plane of reference. Such folding planes if perforated allow of the setting up of problems in situ and the elucidation of the problems of orthogonal projection. The models introduced by Prof. Osborne Reynolds and G. Cussons of Manchester (1876) (Pl. 1 fig. 3) and the more recent developments by Mr. Andrew H. Miller of Glasgow University (Pl. I. fig. 4), are interesting examples of this class. In the former type the problems are permanently drawn out, in the latter they may be built up before the eyes of the student, precaution being taken in the design to avoid distracting the students' attention from the mathematics to the mechanism thus enabling the solution of the problems to be demonstrated in proper sequence step by step. In this class may be included the design (Pl. I., fig. 5), of Mr. H. G. Green of Nottingham University College and described in the *Mathematical Gazette* (London) No. 174, as *A Model for Figures in Three Dimensions*, which is partic-

ularly useful for three dimensional and trigonometrical studies. Posts may readily be fixed in the holes of the double base of the apparatus and cords as "Lines of vision," etc., serve to illustrate questions of the man and flagstaff type, subtended angles, etc.

Models of Wood.—Solid models of wood may be sectioned to elucidate many problems, an impressive example being shown in Plate I. fig. 6, a cube is cut into four different tetrahedra of equal volume, without making new corners. One face common to all four is that of half of the face of the cube; the sides being a face diagonal and two edges of the cube, the combination elucidating the problems relating to square root, etc.

A further example is the well known model of the *Binomial Cube, i.e.,* a cube built up of small cubes and prisms whose length of edge is represented by arbitrary value of a and b, and an entirely new and of course larger cube $(a+b)^3$ being formable by a combination of blocks equalling $a^3+3a^2b+3ab^2+b^3$.

The study of conic sections so frequently treated analytically, is much simplified by the use of a model, such as the right circular cone, in which plane sections are made

1) parallel to the base;
2) parallel to a generating line of the cone;
3) inclined to the axis at an angle greater than the semi-vertical angle of the cone;
4) inclined to the axis at an angle less than the semi-vertical angle of the cone,

giving respectively the *circle, parabola, ellipse,* and *hyperbola* (one branch), while a combination of solid, wire and plane model allows demonstration (as in fig. 1) of such solutions as the determination of the slope of a line by the method of inscribed spheres.

Problems concerned with the toroid (anchor ring) and cylinder, and interpenetration generally, can be most satisfactorily illustrated by wooden models since the common element is produced in the course of manufacture and its shape may be separately examined (Pl. I., fig. 7).

An interesting series of models is presented by the development of the higher species from the forms of the regular solids by cutting off corners and edges and/or producing the faces until they meet again. Kepler (1619) appears to have discussed the species and it is known that they received attention at the hands of Meister (1771) although definite records are lost; but they were rediscovered by Poinsot in 1809 and have since been widely treated in particular by Cauchy, Bertrand, Cayley and Wiener. Since in the tetrahedron the faces already cut one another, it will be evident that it cannot have any higher species. Producing the faces of the cube we get a group of three intersecting square prisms, the faces of which may intersect again at infinity.

The second species of the octahedron consists of two intersecting tetrahedra, whose surfaces when produced to the third species will be found to consist of six intersecting rhombic prisms having infinite volume.

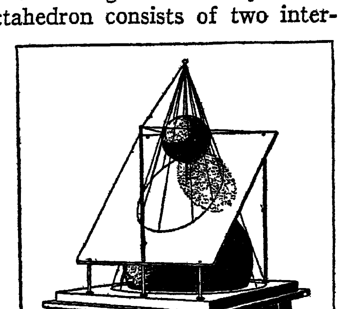


FIG. 1.—CONE WITH INSCRIBED SPHERES AND SECTION PLANE

Developing the solids in the systematic order thus defined, viz., the formation of succeeding solids by producing the faces of the first till they meet again, then producing the faces of the second to form the third, etc., etc., we arrive at four regular species for the dodecahedron and eight for the icosahedron. The four species of the dodecahedron are all regular-faced polygons, the first and third being ordinary pentagons, those of the second and fourth being pentagons of the second series or pentacles. Of the eight species of icosahedron, derived in systematic order, only the first and seventh are regular, their faces being equilateral triangles. (*See* SOLIDS: *Geometric.*)

In making up such models it is generally convenient to start with a model of the first species and build up or convert it into the second species by adding to each face the appropriate complement by dowelling it to the intersecting corner, the forms of the faces of the various complements being obtained from the complete plan of the face of the polyhedron.

Technical Construction.—*Symmetrical Solids* and surfaces of revolution can be turned in a lathe, a templet representing a plane section containing the axis being applied to the work from time to time until the whole solid of revolution is worked up.

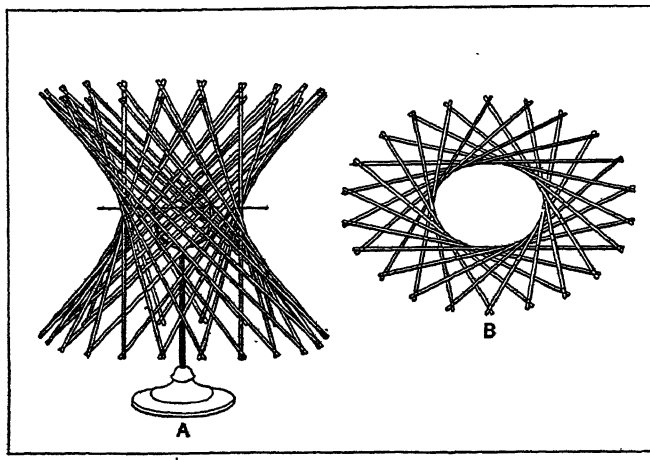


FIG. 2A.—MOVABLE ROD MODEL OF ONE SHEET; HYPERBOLOID SHOWING BOUNDARY ELLIPSE HYPERBOLE
FIG. 2B.—MODEL OF TYPE SIMILAR TO PLATE I. FIG. 12, BUT ARRANGED TO SHOW IT REVERSED

Surfaces which are non-symmetrical round the axis may also be turned or formed in a suitable lathe having a chuck capable of eccentric motion. Such models may attain a high order of accuracy since micrometer measurements may be applied to the work in the machine. It is of course easy to represent many of the surfaces by means of fixed wires shaped and assembled to represent their principal axes (Pl. I. figs. 8, 9, 10), but a more intriguing series of flexible models can be made up of rods or strips, pin jointed or hinged at their extremities since such provide a mechanism whereby ruled surfaces of the hyperboloids, etc., may be demonstrated and allow of conversion or "reversal" into their confocal surfaces. (*See* figs. 2a and 2b.)

Thread Models.—Ruled surfaces, *i.e.,* surfaces generated by the motion of a straight line, fall naturally into a class for easy modelling, since the generating line can be represented by successive stretched threads. (*See* SURFACE.) Thread models can, therefore, illustrate a wide variety of combinations as in Plate I. fig. 12, which consists of two circular discs drilled with equidistant holes closely together, supported as shown and threaded with weighted cords so that the cords may slide through the lower holes.

We have in this model a demonstration of

1) a cylinder—when the discs and cords hang freely,
2) a hyperboloid of revolution—when one or other disc is rotated slightly relatively to the other,
3) the limiting position of a pair of cones upon further rotation,

thus providing an interesting example of maximum and minimum values since the cylinder represents the maximum volume for a given perimeter and the cone the minimum, the circular ends being of constant value. Threads stretched as generators across the bars of a jointed quadrilateral of which the sides are movable in pairs may be used to illustrate the changes from a plane through all forms of paraboloid to double plane. Pl. I. fig. 11 shows an example; the hyperbolic paraboloid generated by a single system of right lines. It comprises two bars pierced with equidistant holes, one bar being fixed, the other capable of swinging round an axis which can also be inclined at different angles to the fixed bar.

With the bars placed parallel, the strings indicate a plane. When inclined to one another yet in the same plane they still illustrate a plane but when the bars are not in the same plane the strings assume the surface of a twisted plane; viz., the hyperbolic paraboloid, a natural surface for the maximum cleavage properties of

a ploughshare. It may be observed from the model that no two strings lie in the same plane and therefore no part of the surface is truly plane. Such a surface cannot be made by simply twisting a plane sheet of metal which would show malformation on opposite sides of the axis.

Space Curves.—There remain, however, still further types of example wherein space curves of the 3rd order are represented by the developable surfaces of their tangents.

Such a series would comprise models showing:—

1) the curves with their asymptotes,

2) the developable tangent surface,

3) the curves as partial sections of cones and cylinders,

4) the two dual generations of the curves, their developable surface, etc.

An example shown in Pl. I. fig. 13, illustrates the involute of the planes which touch two conic sections possessing a common tangent.

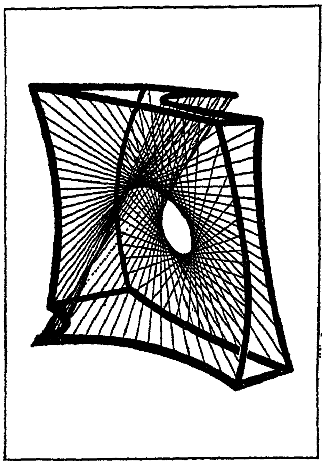


FIG. 3.—CUBIC SPACE CURVES
Tangent surface of cubic ellipse

These models would demonstrate the cases of singularity which can arise in a position of a space curve according as the point or flexion plane is a progressive or regressive element and also the relation of the position to infinite distance.

Examples of the problems connected with the theory of *cubic space curves—cubic ellipses, hyperbolas, parabolas,* etc.,—are shown in fig. 3, viz., the tangent surface of the cubic ellipse, the surface which separates the points of the first case from those of the third, and in fig. 4 the horopter,—a symmetrical cubic ellipse lying on a circular cylinder both of them of special application in physiological optics.

A physical-science application is given in fig. 5 which illustrates the form of equipotential lines and lines of force corresponding to two electric conductors charged to the same sign.

Helical Surfaces.—Helical surfaces may best be demonstrated by either shaped wires or small surfaces of tinplate hinged together, the former providing the cheaper but a less flexible medium. Typical examples are the helical surfaces of Pl. I. fig. 14, where generators and principal tangent curves are picked out in different colours to render them distinguishable, and in Pl. I. fig. 15, that of a model composed of small hinged sections, we have an illustration of the same problem solved by the application of the idea of polyhedra to the theory of the bending of surfaces.

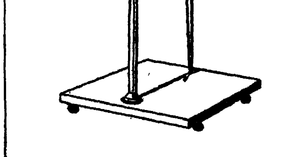


FIG. 4.—THE HOROPTER, A SYMMETRICAL CUBIC ELLIPSE LYING ON A CIRCULAR CYLINDER

The same model also exemplifies the Voss surface demonstrated by finite plane elements of surface hinged together to enable them to be bent in two conjugate systems of geodetic lines.

Cardboard Models.—In Pl. II. fig. 1 is illustrated an example of model made up of thin sheets, *e.g.,* cardboard circles of regularly varying diameters set equally apart in parallel vertical planes, whereby it is possible to evolve the whole series of surfaces of the second order (ellipsoid, hyperboloid, paraboloid, etc.).

A further advantage of this type of model is that the sections may be interlocked across an axis and thereby deformed at will, a feature which may be reached in another way as in the deformable circles of figs. 2 and 3 of Pl. II. In this type a number of different sized wire circles are loosely jointed together across a diameter by a special form of hinge—Wiener's limited joint—which allows at once an extraordinary freedom and restraint.

The figure shows the limiting positions of circle and sphere and the formation of prolate and oblate ellipsoids. Similar models may be readily made to illustrate the elliptic paraboloid, and paraboloids of one sheet or of two sheets, and of double cones, etc., the method of construction with its property of semi-transparency enabling a clear idea to be obtained of the constant relationship of the asymptotic cone and that the lengths of all segments of generating lines remain unaltered.

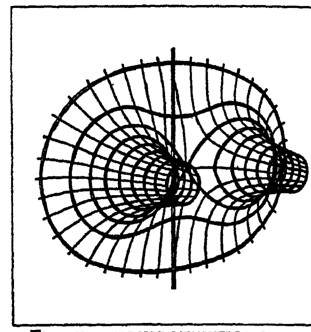


FIG. 5.—EQUIPOTENTIAL LINES

Surface Models.—The method of representing the surfaces of the 2nd order by thin sheet circles arranged in parallel planes suggests the means of producing what is probably the most generally useful of all types, viz., surface models of wood, clay or plaster. A model of a cubic surface for example may be considered as built up of a number of parallel horizontal sections each of which is a plane cubic curve.

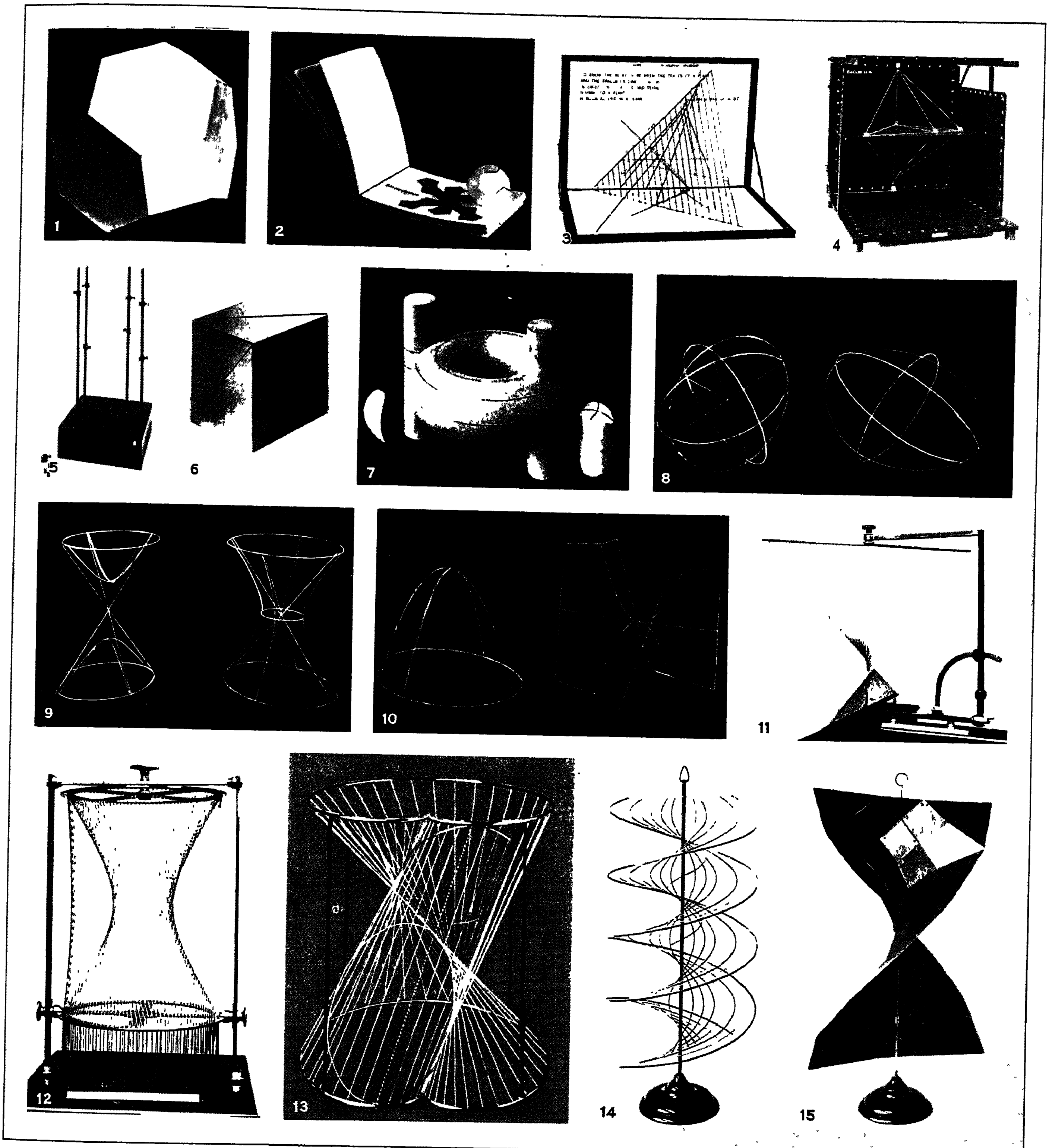
In order to produce such models it is in the first place essential to prepare templets, which embody the particular function to be illustrated. If then a series of such be erected in the appropriate coordinate planes, a surface will ultimately emerge which may be definitely outlined by narrow strips of thin muslin or fabric fixed into position by a plastic medium such as claywash, wax or plasticene, from which subsequently a plaster cast may be taken. On the permanent surface may be marked appropriate axial and geodetic lines and to it tangent planes of say transparent celluloid, etc., may readily be applied. Surface models may alternatively be made up of thin layers of wood suitably shaped, the smooth contour being filled in by wax, or they may be evolved by applying templets after the manner employed in shaping a model ship's hull. Such a model may of course represent a function of pure mathematics, *e.g.,* $f(x, y, z) = 0$ or some physical function say of the pressure volume and temperature of a gas, as in the case of Prof. James Thomson's model of 1871, made to illustrate the data obtained by Prof. Andrews in his classic experiments on the relation between temperature, pressure and volume of a constant mass of carbonic anhydride when the values were plotted, with temperature as the x, pressure as the y, and volume as the z coordinates respectively.

A somewhat later application of the method was made by Maxwell who as the outcome of a suggestion by Prof. Willard Gibbs used the quantities *volume, energy* and *entropy* in making his famous *thermodynamic surface model* in which the properties of a substance in its solid, liquid and gaseous or any conditions in which these states co-existed are indicated by the geometrical properties of the surface.

Maxwell showed how isothermal and isopiestic lines could be drawn upon it and that there is one position of the tangent plane in which it touches the surface in three points which represent the solid, liquid and gaseous states of the substance when the temperature and pressure are such that the three states can exist together.

Plaster Models.—Plaster casts can obviously be produced at less cost than the original mould, so that wherever feasible the method affords a convenient means of reproducing surface models of either constantly varying functions as in surfaces of revolution or of irregular or non-continuous form.

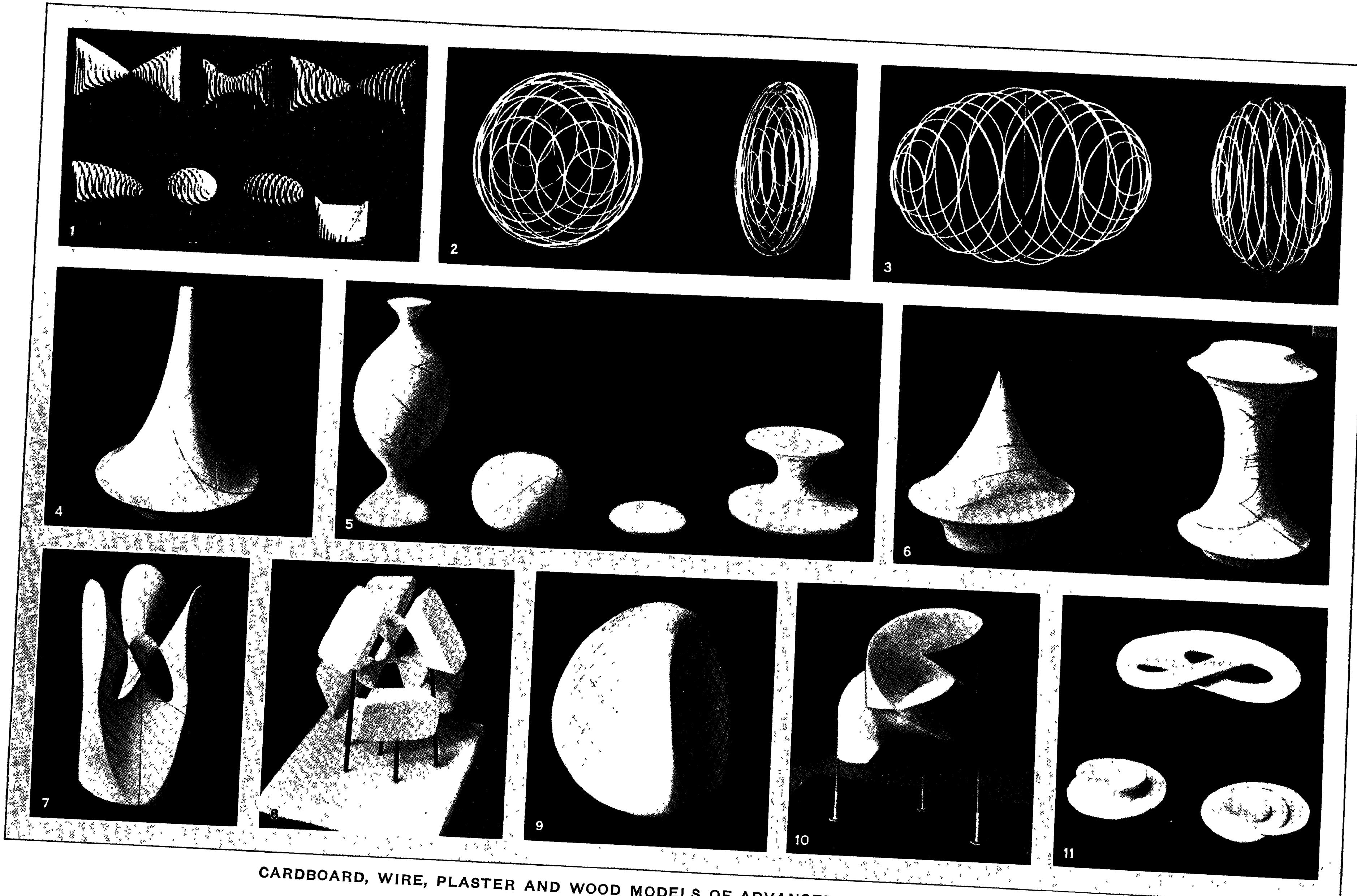
The former case is typically represented by Pl. II. fig. 4, the surface of rotation of the tractrix about its asymptote, upon which may easily be scribed after moulding the body, the geodetic lines and principal tangent curves, or such surfaces of constant mean curvature shown in Pl. II. fig. 5 which illustrates (left to right) (1) *onduloid,* (2) *nodoid,* (3) *ring of the nodoid* arising by rotation of the loop, and (4) the *catenoid,* a minimum surface whose constant mean curvature is null.



MODELS ILLUSTRATING PLANES, SOLIDS AND OTHER MATHEMATICAL FIGURES

1. Paper model of polyhedron having 14 faces (6 square, 8 hexagon)
2. Dodecahedron; with page showing shape in one plane of all surfaces of the model
3. Folding planes for use in the study of descriptive geometry
4. Model for geometrical study. Planes and solids may be built up in the classroom by changing adjustment of shelf and threads
5. A model for figures of three dimensions. A recent development, useful in three-dimensional and trigonometrical studies
6. Wood model: a cube of four different tetrahedra of equal volume
7. The torus (anchor ring) and cylinder, showing interpenetration
8. Wire models for the demonstration of ellipsoid figures
9. Wire models showing two sheet and one sheet hyperboloid
10. Wire figures of the elliptic and hyperbolic paraboloids
11. Bar and thread model; to illustrate changes from the plane through all forms of paraboloid to double plane, the threads acting as generators
12. Disc and thread model for demonstrating (a) cylinder, (b) hyperboloid of revolution; (c) limiting position of a pair of cones
13. Space curve model illustrating the involute of the planes which touch two conic sections possessing a common tangent. Curves and supports are of wire; threads serve to indicate sides of cones
14. Shaped wires on an upright support demonstrating helical surfaces; generators and principal tangent curves are of different colours
15. Helical surfaces: model made of small hinged sections with a vertical support; polyhedra applied to theory of the bending of surfaces

MATHEMATICAL MODELS



CARDBOARD, WIRE, PLASTER AND WOOD MODELS OF ADVANCED MATHEMATICAL CONCEPTS

1. Models illustrating the whole series of surfaces of the second order
2 and 3. Wire circles loosely jointed by special hinge (Wiener's joint) allowing an extraordinary degree of either freedom or restraint
4. Plaster model: surface of rotation of tractrix about asymptote
5. Plaster models: (left to right) onduloid; nodoid; ring of nodoid arising by rotation of the loop; catenoid, a minimal surface
6. Surface of constant negative curvature (1) cone type (2) hyperboloid type
7. Third order surface; four real conical nodes and tangent curves
8. Kummer surface: singularity surface of a complex of second degree
9. Roman surface (Steiner); three intersecting double straight lines
10. Model illustrating minimal surface; contains system of parabolas
11. Riemann surfaces

Surfaces of rotation having a constant negative measure of curvature as in Pl. II. fig. 6, that on the left being of the cone type and bearing geodetic and asymptotic lines, that on the right illustrating the hyperboloid type and being marked with parallel geodetic lines and geodetic circles.

Pl. II. fig. 7 illustrates a surface of the third order showing four real conical node points and the principal tangent curves.

A form of Kummer surface (singularity surface of a complex of the second degree) is shown in Pl. II. fig. 8. It is of the fourth order of the fourth class and has sixteen real node points and the same number of double tangential planes.

A further example of a surface of the fourth order, four planes making contact along circles, is the so-called *Roman surface* due to Steiner and shown in Pl. II. fig. 9. It has three intersecting double straight lines and is of the third class. The asymptote lines are indicated.

An interesting example of a model illustrating a minimum surface is shown in Pl. II. fig. 10. It contains a system of real parabolas the planes of which make a constant angle with a fixed plane of the space.

Fundamental examples in connection with the function theory are shown in Pl. II. fig. 11, where is shown: (1) (at top) Simply connected Riemann surface (two leaf) which contains in its interior one point of double inflexion of the first order. (2) (bottom left) A simply connected Riemann surface (three leaf) with an interior point of double inflexion of the second order. (3) (bottom right) A triply connected Riemann surface with a boundary line turning back upon itself. Fig. 6 illustrates the function $W^4=l-Z^4$, and the course of the elliptic functions $p(n)$ and $p'(n)$ in the Weierstrassian series is shown in fig. 7.

Linkages and Kinematical Models.—Linkages may be defined mathematically as systems of bars connected by pin joints or hinges, to allow deformability without sliding motion. All algebraic curves may be generated by such articulated linkages, Kempe, Darboux, etc., having analysed the position very fully, and numerous attempts have been made to solve by linkage systems the mathematically indeterminate trisection of an angle. These devices fall, however, into the classification of instruments rather than models, and space shortage forbids their treatment here, a qualification which applies also to a treatment of kinematical models dealing with related motion.

Stereoscopic and Optical Methods.—Another series of models has been developed to a limited extent by producing a solid effect from plane figures by means either of viewing bi-coloured

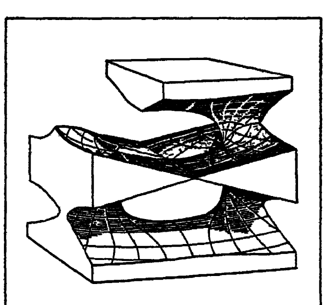


FIG. 6.—ILLUSTRATING THE FUNCTION $W^4=L-Z^4$

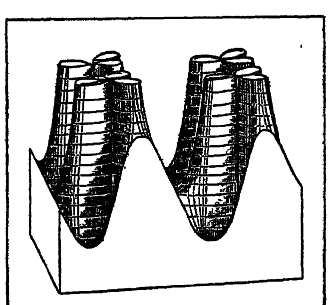


FIG. 7.—WEIERSTRASSIAN SURFACE

diagrams through absorption screens or the more common method of displaced image.

Examples of the first method are the *plastographs* or *anaglyps* by Mr. H. Richard of Chartres, and in England by Mr. G. F. Smith, who have produced examples illustrating the interpenetration of prisms, sections of a helicoid, etc.

The second method is represented by the series designed by Sir George Greenhill to illustrate gyroscopic movements, *e.g.*, the locus of the axis of a spinning top or Maxwell gyroscope.

Quite recently a series of lantern slides illustrating certain algebraic curves, viz., the dual singularities, etc., involved in the theory of cubics and the construction of hyperelliptic and quartic curves has been developed by Prof. Arnold Emch at the University of Illinois, who has also produced a cinematograph film of the Poncelet polygon, *i.e.*, showing the succeeding positions or continuous movement of a triangle remaining inscribed and circumscribed to two fixed circles respectively.

A novel method of treatment is that devised by Prof. Papperitz of Freiberg, viz., kinodiaphragmatic projection. The device consists essentially of a variable speed gear box capable of imparting rotatory motion to a transparent diaphragm placed parallel to and immediately in front of the condenser of an optical lantern. Upon the diaphragm may be fixed any combination of thin polished wires which will reflect narrow beams of light into the focussing lens. Beyond and in front of the lens is placed a second rotating axis which may be vertical or inclined, and carry a surface model—say, a sphere, cylinder, etc.,—built up of wires, spaced apart.

Shadowgraphs are thus projected on to a distant screen, the forms being continuously changed or dissolved into one another according to their relative axial speeds, and by the rotation of stereomatical bodies and simultaneous projection it is possible to produce three-dimensional images in space. (G. W. Cu.)

MATHEMATICAL SOCIETIES AND PERIODICALS.

The number of mathematical societies, clubs, and circles organized since the early one at Hamburg in 1690 is exceedingly large, but the number of mathematical periodicals since the seventeenth century is very much larger. Important mathematical work of a country is often given in publications of its academies or societies. Hence any listing of mathematical periodicals must take account of these. Space limitations require that a selection only be made from the vast amount of available material regarding societies and periodicals. That each country's contribution in this regard might be clearly set forth, the material has been arranged alphabetically according to countries.

The great national mathematical societies were established in their countries in the following order: Russia, Great Britain, France, Italy, United States and Germany.

ARGENTINA.—The Sociedad Matemática Argentina was organized at Buenos Aires in 1921 and in 1924 adopted *Revista de Matemáticas y Físicas Elementales* (1919–24), as its official organ, the name being then changed to *Revista Matemática* (1924+). These periodicals were continuations of *Revista de Matemáticas,* Buenos Aires (1916–18). Material of more importance has appeared in *Universidad Nacional de la Plata, Facultad de Ciencias Físicas, Matemáticas y Astronomicas* (1901+), and *Boletín del Seminario Matemático Argentino* (1928+).

AUSTRALASIA.—There are some mathematical papers in *Royal Society of New South Wales, Journal and Proceedings* (1867+), Sydney; and *Royal Society of Victoria, Proceedings* (1854+), Melbourne.

AUSTRIA.—*Monatshefte für Mathematik und Physik* (1890+) has been issued by the Mathematical Seminary of the University of Vienna. The *Anzeiger* and *Denkschriften* and *Sitzungsberichte, mathematisch-physikalische Klasse* (1848+), of the K. Akademie der Wissenschaften, are of importance for the mathematician.

BELGIUM.—The Société Mathématique de Belgique, founded at Brussels in 1921, adopted *Mathesis, recueil mathématique à l'usage des Écoles Spéciales,* Ghent (1881+, suspended 1916–20) as its official organ. But the chief sources for research material in mathematics are: *Académie Royale des Sciences, des Lettres et des Beaux-Arts,* Brussels, *Bulletin* (1832+), and *Mémoires* (1840+); and *Société Scientifique de Bruxelles, Annales* (1875+; suspended 1914–19), Louvain. Another publication of this Société, *Revue des Questions Scientifiques* (1877+), contains interesting material, especially for the history of mathematics. *Correspondance Mathématique et Physique* (Quetelet) published at Ghent and Brussels (1825–39) was of more importance than *Nouvelle Correspondance Mathématique,* Brussels (1875–80). A recent Flemish publication at Ghent is *Wis-en Natuurkundig Tijdschrift* (1921+). *Isis* (1913), a journal devoted to the history of science was founded, and is still conducted, by Sarton. After one and a half volumes had been issued the publication was continued in the United States (*see*

there).

CZECHOSLOVAKIA.—The Spolku pro Volné Přednášky z Mathematiky a Fysiky (society for free lectures on mathematics and physics) was founded in 1862 and flourished till the organization in 1869 of Jednota Českých Mathematiků, called Jednota Československých Mathematiků a Fysiků since 1921, with over 2,000 members. It is the most affluent mathematical society in the world, owning its own press and building where it does an extensive business in the publication of texts used in elementary schools throughout the country. Among its mathematical publications are: *Časopis pro Pěstování Mathematiky a Fysiky* (1872 +), *Archiv Mathematiky a Fysiky* (1875–79), *Rozhledy Mateematicko-Přírodovědecké* (1893–1921; as a separate publication 1922+), and a score of treatises on topics in the fields of mathematics and physics. *See* V. Posejpal, *Dějepis Jednoty Ceských Mathematiků*, Prague, 1912.

Publications de la Faculté des Sciences de l'Université Masaryk (1921+) Brünn, contain a number of mathematical monographs.

DENMARK.—The important mathematical work is published in *K. Danske Videnskabernes Selskab*, Copenhagen, *Mathematisk-Fysiske Meddelelser* (1917+); *Oversigt* (1814+); and *Selskabs Skrifter, Naturvidenskabelig og Mathematisk Afdeling* (1824+). For more elementary mathematics were *Tidsskrift for Mathematik* (1859–89) Copenhagen, and *Maanedsskrift for den Elementaere Mathematik* (1886–89), continued as *NytTidsskrift for Mathematik, A* [elementary], *B* [advanced] (1890–1919), which were continued by the Matematik Forening i København, founded in 1905, as *Matematisk Tidsskrift, A, B* (1919+). For at least a dozen years previously this society had published a *Medlemsblad.*

DOMINION OF CANADA.—Some mathematical papers are to be found in *Proceedings and Transactions of the Royal Society of Canada* (1882+).

FINLAND.—Mathematical papers of importance are to be found in: *Finska Vetenskaps-Societeten, Acta, Societatia Scientiarum Fennicae* (1842+) and *Commentationes Physico-Mathematicae* (1922+); and in *Suomen Tiedeakatemia, Toimituksia, A* (Finnish Academy of Sciences, Annales, A, 1909+). The papers of the latter are entirely in English, French and German.

FRANCE.—The Société Mathématique de France, founded at Paris in 1872, has about 415 members and publishes a *Bulletin* (1873+). The other most important periodicals for mathematics are: *Annales Scientifiques de l'École Normale Supérieure* (1864 +); *Journal de l'École Polytechnique* (1795+); *Journal de Mathématiques Pures et Appliquées* (1836+), continuation of *Annales de Mathématiques Pures et Appliquées* (1810–32); *Annales de la Faculté des Sciences de l'Université de Toulouse pour les Sciences Mathématiques et les Sciences Physiques* (1887+); *L'Institut de France, L'Académie des Sciences, Comptes Rendus* (1835+); *Société Philomathique de Paris, Bulletin* (1789+); and *Association Française pour l'Avancement des Sciences, Compte Rendu* (1872+). There is much of mathematical interest in *Revue du Mois* (1906–20) (Borel) and *Revue de Métaphysique et de Morale* (1893+), Paris.

Other periodicals are: *Nouvelles Annales de Mathématiques* (1842–1927); *L'Intermédiaire des Mathématiciens* (1894–1925) of value for bibliography and history; *Revue de Mathématiques Spéciales* (1890+) for secondary schools; and *Journal de Mathématiques Élémentaires et Spéciales* (1877–1901) (de Longchamps).

GERMANY.—The oldest mathematical society in existence is the Mathematische Gesellschaft in Hamburg, founded in 1690 as "Kunstrechnungsliebende Societät," and continued, 1790–1876, as "Gesellschaft zur Verbreitung der mathematischen Wissenschaften." It has about 100 members and has published *Mitteilungen* (1873–1880, mimeographed; 1881+, printed) and at least 80 issues of *Jahresbriefe* or *Jahres-Berichte* or *Berichte* (1723–1878). What constitutes a complete set is unknown. The national society, Deutsche Mathematiker Vereinigung, was founded in 1891 and has about 1,100 members. It has published *Jahresbericht* (1892+), with *Ergänzungsbände* (1906–14). The Berliner Mathematische Gesellschaft, founded in 1901, has about 300 members, and has published a *Sitzungsberichte* (1902+). The Gesellschaft für angewandte Mathematik und Mechanik, which was founded at Leipzig in 1922, has approximately 320 members.

Four of the most important periodicals in the world are: *Mathematische Annalen* (1869+), *Mathematische Zeitschrift* (1918+), and *Journal für die reine und angewandte Mathematik* (Crelle, 1826+), and *Jahrbuch über die Fortschritte der Mathematik* (1871+) an annual survey of mathematical literature since 1868. Other publications of special value for the mathematician are: *Nachrichten, mathematisch-physikalische Klasse,* of the Gesellschaft der Wissenschaften (1845+), Göttingen; *Preussische Akademie der Wissenschaften,* various publications (1710+); *Bayerische Akademie der Wissenschaften, Sitzungsberichte* (1860+) and *Abhandlungen* (1829+); *Sächsische Gesellschaft (Akademie) der Wissenschaften, Berichte* (1846+) and *Abhandlungen* (1849+); Heidelberg, *Akademie der Wissenschaften, Sitzungsberichte* (1910+). Among others are: *Archiv der Mathematik und Physik* (1841–1920); *Zeitschrift für Mathematik und Physik* (1856–1917) to which *Abhandlungen zur Geschichte der mathematischen Wissenschaften* (1877–1913) was a supplement (1877–1900); *Mathematisch-naturwissenschaftliche Mitteilungen,* Tübingen and Stuttgart (1884–1922; no numbers 1893–98; title extended, 1899+, by: *im Auftrag des mathematisch-naturwissenschaftlichen Vereins in Württemberg*), which in 1891–92 had the title *Mitteilungen des mathematisch-naturwissenschaftlichen Vereins in Württemberg;* University of Hamburg, *Abhandlungen aus dem mathematischen Seminar* (1922+); *Zeitschrift für angewandte Mathematik und Mechanik* (1921+); and *Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht* (1870+). Of historical interest are: *Acta Eruditorum* and *Supplementa* (1682–1734); *Nova Acta Eruditorum* and *Supplementa* (1732–76); *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* (1902+); and *Archiv für die Geschichte der Naturwissenschaften und der Technik* (1909–22), continued as *Archiv für Geschichte der Mathematik, der Naturwissenschaften und der Technik* (1927+).

GREAT BRITAIN.—Among various early mathematical organizations is The Mathematical Society, founded by mathematicians of Spitalfields in 1717. It continued in existence till its absorption in 1845 by the Astronomical Society. (See *History of the Royal Astronomical Society 1820–1920,* London, 1923, pp. 99–104; A. DeMorgan, *Budget of Paradoxes,* second ed., Chicago, 1915, vol. 1, pp. 374–383; *The Articles of the Mathematical Society meeting . . . in Brown's Lane, Spitalfields . . . (A Catalogue of the books belonging to the Society),* London, 1784 and 1821.) The London Mathematical Society, founded in 1865, has about 400 members. Its publications are *Proceedings* (1866 +) and *Journal* (1926+). The Edinburgh Mathematical Society (about 275 members) was founded in 1883, and has published *Proceedings* (1884+) and *Mathematical Notes* (1909+). The Mathematical Association (about 1,160 members) was founded in 1871 as The Association for the Improvement of Geometrical Teaching, and took its present name in 1897. It has published *Reports* (1871–93) and *Mathematical Gazette* (1894+).

Material of importance for the mathematician is to be found in *Royal Society of London, Transactions* (1665+); *Cambridge Philosophical Society, Proceedings* (1843+) and *Transactions* (1820+); *Royal Society of Edinburgh, Proceedings* (1832+) and *Transactions* (1783+); *Cambridge Mathematical Journal* and *Cambridge and Dublin Mathematical Journal* (1837–54), continued as *The Quarterly Journal of Pure and Applied Mathematics* (1857+); *Messenger of Mathematics* (1871+), continuation of *Oxford, Cambridge and Dublin Messenger of Mathematics* (1862–71); *London, Edinburgh and Dublin Philosophical Magazine* (1798+) and *British Association for the Advancement of Science, Reports* (1836+). In *Nature* (1869+) there is much of interest.

Among many minor serials are: *Mathematical Questions and Solutions from "The Educational Times" with many Papers and Solutions* (1864–1916), continued with a slight change in title till 1918; *The Mathematician* (1843–50) (Davies); *Mathematical Repository* (1795–1804, 1806–35) (Leybourn). If *The Lady's*

Diary continued as *The Lady's and Gentleman's Diary* be regarded as a mathematical serial, it is the longest lived of all such serials being published for 168 consecutive years, 1704–1871.

GREECE.—The 'Ελληνιγὴ Μαθηματικὴ 'Εταιρεια (Greek Mathematical Society), with about 160 members, was founded at Athens in 1918 and *Bulletin de la Société Mathématique de Grèce, Δελτιον 'Ελληνικῆs Μαθηματικησ 'Εταιρειαs,* in Greek, has been published at Athens since 1919.

HOLLAND.—The oldest existing national mathematical society, Wiskundig Genootschap (about 243 members), was founded at Amsterdam in 1778. Associated with its name on its various publications, and as a part of the title, is the motto: "Een onvermoeide arbeid komt alles te boven" ("Unwearying toil conquers everything"). The Society's chief recent publications are: *Wiskundige Opgaven met de Oplossingen* (1855+); *Nieuw Archief voor Wiskunde* (1875+) which was a continuation of *Archief* (1856–74), which continues the society's *Verslagen van het Verhandelde op de Wetenschappelijke Vergaderingen* (1844–1852); and *Revue Semestrielle des Publications Mathématiques* (1893+). Of at least eleven other earlier periodicals of the Society the earliest is *Kunst-Oeffeningen over verscheide nuttige Onderwerpen der Wiskunde* (1782–88). *See* M. Van Haeften, *Het Wiskundig Genootschap zijn oudste Geschiedenis, zijn Werkzaamheden en zijn Beteekenis voor het Vezekeringswezen* (Groningen, 1923).

There is important mathematical work in publications of the Amsterdam Academy of Sciences, *Afdeeling Natuurkunde:* (a) *Verhandelingen* (1854+); (b) *Verslagen* (1853+); and (c) *Proceedings* (1898+) mainly translated from the *Verslagen.*

Among elementary periodicals, which are very numerous, are: *Tijdschrift voor Wiskunde* (1874–77), Deventer; *Nieuw Tijdschrift voor Wiskunde* (1913+), Groningen; *Bijvoegsel van het Nieuw Tijdschrift voor Wiskunde* (1924–27) continued as *Euclides, Tijdschrift voor de Didactiek der Exacte Vakken* (1927+); *Christiaan Huygens* (1921+); and *Wiskundig Tijdschrift* (1904–21), Haarlem.

HUNGARY.—The chief older mathematical publications are of the Hungarian Academy of Sciences (Magyar Tudomanyos Akadémia) at Budapest. They are: *Mathematikai és Physikai Lapok* (1892+), *Mathematikai és Természettudomány Értesitö* (1882 +), and *Mathematische und naturwissenschaftliche Berichte aus Ungarn* (1882+). A series of mathematical memoirs, *Értekezések a Mathematikai Tudomanyok Köréböl,* (1867–1894), is another valuable publication of the Akadémia. A recent important publication of the University of Szeged is *Acta Litterarum ac Scientiarum, Sectio Scientiarum Mathematicarum* (1922+). Intended for the secondary schools the periodical *Középiskolai Mathematikai Lapok,* Budapest (1893–1914), has been continued as *Középeskolai Mathematikai és Fizikai Lapok* (1925+).

INDIA.—The Calcutta Mathematical Society, founded in 1908 for the promotion of mathematical research, publishes a *Bulletin* (1909+). Since 1919 the University of Calcutta has published an annual volume, *Journal of the Department of Science,* which is devoted to original contributions in mathematics, chemistry, physiology, and botany. The Indian Mathematical Club (formerly The Analytic Club) was founded at Madras in 1907 and the first printed *Progress Report,* no. 7, appeared in 1908. This publication was followed by *The Journal of the Indian Mathematical Club* (1909–10), continued as *The Journal of the Indian Mathematical Society* (1911+).

ITALY.—The Circolo Matematico di Palermo, founded in 1884, has been both a national and an international organization, and now has about 584 members. Its chief publication has been its *Rendiconti* (1887+). The Unione Matematica Italiana was established as a national organization in 1922 and now has about 373 members. Its official organ is a *Bollettino* (1922+). The Circolo Matematico di Catania, of the University of Catania, was founded in 1921, and published *Note e Memorie* (1921–22), *Esercitazioni Matematiche* (1921–26), continued as *Note ed Esercitazioni Matematiche* (1927+).

The most important periodicals for mathematics, and among the most important in the world, are: *Annali di Matematica Pura ed Applicata* (1858+) a continuation of *Annali di Scienze Matematiche* (1850–57) which may possibly be regarded as a development of *Raccolta di Lettere ed altri Scritti intorno alla Fisica ed alle Matematiche* (1845–49); *R. Accademia dei Lincei,* Rome, *Rendiconti* (1884+), *Memorie* (1876+); and Prince Boncompagni's *Bullettino di Bibliografia e di Storia delle Scienze Matematiche e Fisiche* (1868–87), Rome. Among many other periodicals are: *R. Accademia delle Scienze dell' Istituto di Bologna, Memorie* (1850+) and *Rendiconto* (1829+); *Giornale di Matematiche* (1863+) (Battaglini); *R. Accademia delle Scienze Fisiche e Matematiche,* Naples, *Rendiconti* (1862+) and *Atti* (1864); *R. Accademia della Scienze di Torino, Atti* (1865+) and *Memoire* (1759+); University of Rome, *Facoltà di Scienze, Seminario Matematico, Rendiconti* (1914+); *Archivio di Storia della Scienza* (1919+); *Bollettino di Bibliografia e Storia delle Scienze Matematiche* (1898–1922) (Loria) continued as a supplement to the secondary school journal *Il Bollettino di Matematica* (1902+); *Periodico di Matematiche,* various titles (1886+) organ of Societa Italiana "Mathesis"; Istituto G. Ferraris, *Rassegna di Matematica e Fisica* (1920+), Rome; and *Giornale di Matematica Finanziaria* (1922+). *Scientia* (1907+) contains popular articles of value.

JAPAN.—The Physico-Mathematical Society of Japan (*Nippon Sûgaku-Buturigakkwai*) founded in 1884, has published proceedings (*Kizi,* 1884+), the first two volumes (1884–1887) being in Japanese, and the rest mainly in English. *The Tôhoku Mathematical Journal* (1911+) is now published by the Imperial University at Sendai. Under the auspices of the National Research Council of Japan have already been published (1924–28) five volumes of *The Japanese Journal of Mathematics, Transactions and Abstracts.* Two other English periodicals containing some advanced mathematical work are: *Science Reports, First series, Mathematics, Physics, Chemistry* (1912+) also published by the Imperial University at Sendai; and *Journal of the Faculty of Science, Imperial University of Tokyo, Section 1, Mathematics, Astronomy, Physics, Chemistry* (1925+). The latter is the continuation of *Journal of the College of Science, Imperial University at Tokyo* (1887–1925).

There is also *Journal of The Mathematical Association of Japan for Secondary Education,* in Japanese (title excepted) (1919+).

NORWAY.—The Norsk Matematick Forening, founded at Oslo in 1918, has as its official organ, *Norsk Matematisk Tidsskrift* (1919+). The Society is publishing also *Norsk Matematisk Forenings Skrifter* (1921+), and *Sophus Lie Gesammelte Abhandlungen* (1922+). *Archiv för Mathematik og Naturvidenskab* (1876+), Oslo, and *Norske Videnskabs-akademie i Oslo, Mathematisk-naturvidenskabelig Klasse, Skrifter* (1894+) contain some valuable mathematical material.

POLAND.—The Polskie Towarzystwo Matematyczne (Société Polonaise de Mathématique) was founded at Cracow in 1919, and one volume of *Rozprawy* (1921), in Polish, was published. This was continued by annual volumes (1922+) of *Rocznik* (*Annales*) in French. A Polish supplement (*Dodatek*) is also issued (1922+). Among the older periodicals are two published in Warsaw: *Prace Matematycznofizyczne* (1888+) and *Wiadmości Matematyczne* (1897+). A new Warsaw periodical of much importance, devoted entirely to the theory of aggregates, is *Fundamenta Mathematicá* (1920+). Another publication valuable for its mathematical material is *Akademija umiejetności, Bulletin International,* Cracow (1889–1900), in French and German; *Bulletin International, Classe des Sciences Mathématiques et Naturelles, Série A* (1901+); and *Memoires, Classe des Sciences Mathématiques et Naturelles, Série A* (1928+).

PORTUGAL.—*Jornal de Sciencias Mathematicas e Astronomicas* (1877–1902), Coimbra, of the Academia Polytechnica do Porto, was continued as the Academia's *Annaes Scientificos* (1905–21), and then as *Anais da Faculdade de Sciências do Porto* (1927+). Under the auspices of the Accademia Real das Sciéncias de Lisboa, has been published *Jornal de Sciencias Mathematicas, Physicas e Naturaes* (1866+).

RUMANIA.—The Societatea "Gazeta Matematică," with about 110 members, was founded at Bucharest in 1909, and *Gazeta Matematica foae lunara de Matematici elementare si speciale pentru*

ugul Şçoalelor secundare, speciale şi superioare (1895+), became its official organ Among numerous minor mathematical serials of Rumania is the monthly *Revista Matematică din Timişoara* (1921+), published at Timişoara. Some advanced mathematical work has been published in *Bulletin Mathématique de la Société Roumaine des Sciences,* Bucharest (1892+); and *Académie Roumaine,* Bucharest, *Annales* (1867+), and *Section Scientifique, Bulletin* (1912+).

RUSSIA.—At Moscow in 1864 was organized a Circle of lovers of mathematics which in 1867 developed into the important Moscow Mathematical Society (Moskovskoe Matematicheskoe Obshchestvo). This organization founded and carried on *Matematicheskiĭ Sbornik* (1866+). Another important society is Khar'kovskoe Matematicheskoe Obshchestvo, founded in 1879. Its *Communications (Soobshcheniia)* (1879–1918) were continued as *Annales Scientifiques des Institutions Savants de l'Ukraine, section mathématique* (1924–28) which were continued as *Communications de la Société mathématique de Kharkow* (1927+). A third society is at the University of Kazan, Fiziko-Matematicheskoe Obshchestvo, about 106 members, whose Bulletin (*Izviestiia*) (1891+) was the continuation of the physics-mathematics section (1880–90) of the society of naturalists of the University. *Bibliographia Mathematica Rossica* (1896–1900) was a supplement to *Izviestiia*. A fourth society is Leningradskoe Fiziko-Matematiceskoe Obshchestvo, founded in 1892, and with about 80 members. The first volume of *Journal de la Société Physico-Mathématique de Léningrade* appeared in 1927. Much of mathematical importance appears in the various publications of the Academy of Sciences, Leningrad (1726+).

Fiziko-matematicheskiia nauki v ikh nastoiashchem i proshedshem (1885–1905), edited and conducted by Bobynin was important for its bibliographical and historical articles and supplements.

SOUTH AFRICA.—Some mathematical papers are to be found in *Royal Society of South Africa, Transactions* (1908+), Cape Town; and in *South African Journal of Science* (1903+) of the South African Association for the Advancement of Science.

SPAIN.—The Sociedad Matematica Española founded at Madrid in 1910 published a *Revista* (1911–1917). This was continued (1919+) as *Revista Matematica Hispano-Americana,* published under the auspices of the Sociedad and of the Laboratorio y Seminario Matematico of the University. This Seminario has also issued some *Publicaciones* (1916+). The *R. Academia Española, Memorias* (1870+), Madrid, contains mathematical material.

SWEDEN.—*Acta Mathematica* (1882+), founded by Mittag-Leffler, one of the most important mathematical periodicals in the world, is edited by mathematicians of Sweden, Norway, Denmark and Finland, and is published by the Mathematical Institute, at Djursholm, of the Royal Academy of Sciences (K. Svenska Vetenskabsakademien), Stockholm. The Academy's *Arkiv för Matematik, Astronomi och Fysik* (1903+) is also of importance to the mathematician, as well as considerable mathematical material in its *Handlingar, Bihang til Handlingar, Årsbok,* and *Öfversigt. Svenska Aktuarieföreningens Tidskrift,* Upsala (1914–17), and *Skandinavisk Aktuarietidskrift,* Upsala (1918+) contain mathematical material of value.

To Sweden must also be credited *Bibliotheca Mathematica* (1884–1915) founded and edited by Eneström and, from 1888 on, the outstanding journal of its time for the history of mathematics. (*See* below under United States.)

SWITZERLAND.—The Société Mathématique Suisse was founded in 1909 to promote mathematical research. The Société Suisse des Professeurs de Mathématiques, otherwise named earlier, and founded in 1900, is primarily for professors in the secondary schools. The activities of both organizations are set forth in the country's only separate mathematical periodical, *L'Enseignement Mathématique, méthodologie et organization de l'enseignement, philosophie et histoire des mathématiques, chronique scientifique, mélanges bibliographie* (1899+), Paris and Geneva. In addition to its serials the Schweizerische Naturforschende Gesellschaft (founded 1815) publishes Euler's *Opera Omnia* of which 22 volumes have already appeared (1911+). Other sources where material of interest, some of high order, may be found, are: *Vierteljahrschrift der naturforschenden Gesellschaft in Zürich* (1856+); *Mitteilungen der naturforschenden Gesellschaft in Bern* (1843+); *Verhandlungen der naturforschenden Gesellschaft in Basel* (1852+); and *Bulletin de la Société Vaudoise des Sciences Naturelles* (1842+), Lausanne.

UNITED STATES.—The New York Mathematical Society, founded in 1888, developed into the American Mathematical Society (1894) which now has about 1,800 members, and is dedicated to promoting mathematical research. The *Bulletin of the New York Mathematical Society* (1891–94) was continued as *Bulletin of the American Mathematical Society* (1894+). The *Transactions of the American Mathematical Society* was established in 1900, and in 1927 the Society acquired an important share in editorial control of the *American Journal of Mathematics* (1878+), established by The Johns Hopkins University under Sylvester's direction. The Society has also published volumes on important topics of modern mathematics. The Mathematical Association of America, founded in 1915, and now having over 2,000 members, aspires particularly to serve the colleges of the country by awakening and sustaining interest in mathematics and by fostering the beginnings of mathematical research. Its official organ (1916+) is *The American Mathematical Monthly* (1894+) founded and published for many years by B. F. Finkel. *Bibliotheca Mathematica* (*see* under Sweden) was revived by the Association in 1929.

Other important mathematical publications are: *Annals of Mathematics* (1884+), a continuation of *The Analyst* (1874–83), published by the University of Virginia 1884–99, by Harvard University till 1912, and since then by Princeton University; and *Journal of Mathematics and Physics* (1921+) published by the Massachusetts Institute of Technology. Brief announcements of new results are to be found in *National Academy of Sciences, Proceedings* (1915+). Some valuable mathematical work is to be found in *University of California, Publications in Mathematics* (1912+); *Rice Institute Pamphlets* (1915+), Houston, Texas; *American Academy of Arts and Sciences, Proceedings* (1846+), *National Academy of Science, Memoirs* (1866+), and in *Isis* (1913+; not published between 1914 and 1919) the official organ of the History of Science Society. (*See* under Belgium.)

Mathematics Teacher (1908+) is the official journal (1921+) of the National Council of Teachers of Mathematics, organized in 1920, and now having about 5,000 members. It publishes also a *Yearbook* (1926+).

BIBLIOGRAPHY.—Current journals grouped under countries of publication are listed in *International Catalogue of Scientific Literature, List of Journals,* 1903, and *Supplementary List of Journals,* 1904. But from the bibliographic point of view the great *Union List of Serials in Libraries of the United States and Canada,* New York, 1927, supersedes everything else of the kind. (R. C. A.)

MATHEMATICAL TABLES. The primary purpose of mathematical tables is to render the work of the professional computer in mathematics, engineering, astronomy, statistics, etc., less laborious than it would otherwise be. The arrangement and typography must be such that the minimum strain is imposed on the computer's eyes, for he may be called upon to use the table for hours at a stretch. The results tabulated are the "tabular results"; and the corresponding numbers, by which the table is entered, are the "arguments." A table is one of single or double entry, according as it has one or two arguments. A table of logarithms of numbers is a table of single entry, the numbers being the "arguments" and the logarithms the "tabular results"; a simple multiplication table is one of double entry, giving the product xy as the "tabular result" corresponding to the "arguments" x and y.

The invention of logarithms in 1614 came as a great boon to computers (astronomers particularly), for it made calculations involving multiplications comparatively easy work. Since that time the majority of tables of special functions were, until quite recently, published giving the logarithmic instead of the natural values, but owing to the increasing utility of calculating machines, there is now a tendency to publish the natural values.

Notation.—In the description of tables the following contraction for the interval of the argument will be used. Instead of writing, for example, that "the logarithmic sines are given for every 10 seconds up to 45°, or from 0° to 45° at intervals of 10 seconds," the writer will use the contraction "logarithmic sines are given for 0° (10″) 45°." In general *n-place* table means one, in which the tabular results are exhibited to *n* decimal places.

Common or Briggsian Logarithms of Numbers.—This system of logarithms is used for most practical purposes. The fundamental work which contains the results of the original calculations is that of Briggs's *Arithmetica Logarithmica* (London, 1624); it gives the logarithms of the integers 1 to 20,000 and 90,000 to 100,000 to 14 decimal places with interscript differences. Briggs intended to publish the logarithms of the numbers 20,000–90,000 to 14 places, but before he completed this part of the table he was forestalled by De Decker in his *Tweede Deel der Nieuwe Telkonst* (Gouda, 1627) and Vlacq in his so-called *Editio Secunda* of Briggs's *Arithmetica* (Gouda, 1628), who gave the 10-decimal logarithms of integers 1–100,000 with differences. The tables of De Decker and Vlacq are identical, for the men were really partners in the speculation. For the majority of succeeding tables of logarithms of numbers, either the tables of Briggs or De Decker-Vlacq have been the sources, directly or indirectly. Very few recalculations have been made and for nearly 300 years the De Decker-Vlacq table, with its errors corrected, was the best 10-place table of the logarithms of numbers. In 1794 Vega published a reprint of Vlacq's table; this 10-place table, of which the arrangement is not so good as Vlacq's, is very useful and is still in general use. Although Vega bestowed great care on the detection of errors, there are a number of last figure errors. The title is *Thesaurus Logarithmorum Completus* (Leipzig). Three photographic reprints have been published, two at Florence by the *Istituto Geografico Militare* in 1889, 1896, and the third by Stechert of New York in 1923. In the last one the reproduction is very poor and all the errors of the original appear. Duffield's 10-place table (Washington, 1897) cannot be trusted, for, although he claims to have made a recalculation, practically all Vega's last figure errors appear. Peters in *Zehnstellige Logarithmentafel: Erster Band.* (Berlin, 1922) gives the 10-place logarithms of all numbers to 100,000 with first differences and an auxiliary table, which shows corrections for second differences. The table is the result of a new calculation.

In many problems 10-figure accuracy is not required, but in the above such tables have been described for they are the fundamental tables. A large number of tables exhibiting 4, 5, 6-place logarithms have been published. A good 6-place table is Bremiker's *Logarithmorum VI. Decimalium Nova Tabula.* (Berlin, 1852.) Several editions appeared with title page in German and English (1875). 7-place logarithms are frequently required and there are a considerable number of accurate and well-arranged tables, including those of Bremiker, Bruhns, Dupuis, Lalande, Sang, Schrön and Shortrede. Schrön's table *Siebenstellige Gemeine Logarithmen*—(Braunschweig, 1860) is typical. There have been editions in German, English and French. The arrangement is the best for a 7-place table and the modern editions are accurate. The figures of the logarithms are grouped 3, 4, the first group being printed only once. When a change occurs in the final figure of this leading group in the course of a row it is shown by an asterisk prefixed to all the groups affected in the row. This method of attracting the attention of the computer is very successful. In 1871 Sang published *A New Table of Seven-place Logarithms of Numbers from 20,000 to 200,000* (London). There is a distinct advantage in choosing this range in place of 10,000 to 100,000. For the latter range the differences at the commencement of the table change so rapidly that the proportional parts are so numerous that they are either very crowded or some of them are omitted; by making the table start from 20,000 the differences are halved in magnitude and there are one-fourth as many on a page. This table, unlike most 7-figure tables, is mainly the result of a new calculation. There are very few 8-place tables; until quite recent times there was only one such table—John Newton's *Trigonometria Britannica* (London, 1658), where the logarithms of numbers to 100,000 are given. The usual arrangement of 7-place tables is due to this Newton, viz., the first four figures of the argument are shown in the left hand margin, while the fifth figure is shown at the head of successive columns. The only other 8-place tables have been published since 1890; the Service Géographique de l'Armée (France) published an abridgement of the *Tables du Cadastre* (the famous French manuscript tables) under the title *Tables des Logarithmes à hûit décimales des nombres de 1 à 120,000* (Paris, 1891), and in the same year Mendizábal Tamborrel published *Tables des Logarithmes à hûit décimales des nombres de 1 à 125,000* (Paris). Bauschinger and Peters, as a result of an entirely new calculation to 12 places, published *Logarithmisch-trigonometrische Tafeln mit acht Dezimalstellen* (Leipzig, 1910). It has appeared with English title and preface. The logarithms to 8 decimals of all numbers to 200,000 may be taken from this directly.

It is sometimes necessary to use logarithms to a greater number of figures than 10, but owing to the great expense of publishing extensive tables to a large number of figures, several methods have been devised by mathematicians which enable a computer, with the help of a comparatively small table, to calculate the logarithm to the required number of figures. For example, Gray in *Tables for the Formation of Logarithms and Anti-Logarithms to twenty-four or any less number of places* (London, 1876), explains a method by which the logarithm and antilogarithm can be found to any number of places not greater than 24. Similar tables and methods have been published by Börgen, Steinhauser, Guillemin, Mansion-Namur, Pineto, Andoyer and Ellis. At present there is in progress an extensive table to 20-decimals, the calculations being carried out by Thompson. The first part appeared in 1924 to commemorate the Tercentenary of Briggs's publication of *Arithmetica Logarithmica* under the title *Logarithmetica Britannica, being a Standard Table of Logarithms to Twenty Decimal Places* (Cambridge University Press, 1924). This part gives the logarithms of numbers 90,000 to 100,000; two more parts have been published since 1924.

Logarithmic Trigonometrical Functions.—The original and fundamental tables of the logarithmic trigonometrical functions are (1) Vlacq's *Trigonometria Artificialis* (Gouda, 1633), which exhibits log sines and tangents to every ten seconds of the quadrant to 10 decimal places with differences. (2) Briggs's *Trigonometria Britannica* (London, 1633), which gives the natural sines to 15 places, tangents and secants to 10 places, log sines to 14 places and tangents to 10 places at intervals of 0·001 degree from 0° to 45° with interscript differences. In Vlacq's earlier work of 1628 there are given, in addition to the logarithms of numbers, the log sines, tangents and secants for every minute of the quadrant to 10 places with differences. The majority of the logarithmic-trigonometrical tables published since 1633 have been calculated from, or are abridged forms of the tables of Briggs and Vlacq. It is to be noted that Vlacq used the sexagesimal division of the degree, while Briggs used the centesimal division. This step of Briggs was important and it is probable that, if Vlacq's table had not been published in the same year, tables published subsequently might have used the latter division, and thus ensured a saving of work in interpolations, multiplications, etc. The French mathematicians at the end of the 18th century divided the right angle centesimally, but there is no real advantage in doing this. Michael Taylor in *Tables of Logarithms* (London, 1792) made a big advance by giving log sines and tangents to *every second* of the quadrant to 7 places. This table was calculated by interpolation from Vlacq's *Trigonometria* to 10 places and then cut down to 7, so that the table should be accurate to the last figure. This table is in inconvenient arrangement. Bagay's *Nouvelles Tables Astronomiques et Hydrographiques* (Paris, 1829) has always been preferred. This also gives a complete logarithmic trigonometrical canon to every second.

Many collections of tables give the logarithmic trigonometrical canon to 7 places (*e.g.*, Schrön, Bruhns, etc.) for every sexagesimal minute, or for every 10 sexagesimal seconds, or for every centesimal minute, or for every 10 centesimal seconds. Bauschinger and Peters (Leipzig, 1911) in *Logarithmisch-trigonometrische Tafeln*

give the logarithmic trigonometrical functions for every sexagesimal second to 8 places, while Peters in another work (Leipzig, 1911) gives a similar table to 7 places. In 1911 Andoyer at Paris published a table as a result of an original calculation giving these functions to 14 decimals with differences for every 10 sexagesimal seconds; *Nouvelles Tables Trigonométriques Fondamentales.* In the second volume of his *Zehnstellige Logarithmentafel,* Peters gives an extended canon to 10 decimal places. For the centesimal division of the quadrant Hobert and Ideler, *Nouvelles Tables Trigonométriques* (Berlin, 1799) and Borda and Delambre, *Tables Trigonométriques Décimales* (Paris, 1801), give the canon to 7 places for every centesimal minute (10^{-4} quadrant). Mendizábal Tamborrel in his tables, already mentioned, gives an 8-place canon for every 10^{-6} gone (about 1·3 sexagesimal seconds) (A gone= 360°). Becker and Van Orstrand, *Smithsonian Mathematical Tables* (Washington, 1909) give these functions to 5 places for every 0·001 radian in the first quadrant.

Natural Trigonometrical Functions.—The greatest computer of pure trigonometrical tables was Rheticus, whose work has never really been superseded. His celebrated 10-decimal canon, the *Opus Palatinum* was published at Neustadt in 1596 and in 1613 his 15-decimal tables of sines by Pitiscus at Frankfort with title *Thesaurus Mathematicus.* This wonderful achievement was overshadowed by the invention of logarithms by Napier in 1614, for the natural trigonometrical functions gave way to the logarithmic. The *Opus Palatinum* contains the 10-decimal trigonometrical functions for every 10 seconds with differences. The *Thesaurus* gives the sines to 15 places with differences to the third. These tables are the fundamental tables for practically all natural trigonometrical tables up to the present day. The number of tables of natural trigonometrical functions published since Rheticus is not large. Natural sines and tangents to 8-places for every sexagesimal second have been published by Gifford, *Natural Sines* (Manchester, 1914) and *Natural Tangents* (Manchester, 1920). Briggs in his *Trigonometria* gives natural sines to 15 places, tangents and secants to 10 places for every 0·01 degree. Hobert Ideler in work already quoted gives a 7-decimal canon for every centesimal minute. Becker and Van Orstrand have published an interesting table with interval of argument 0·001 radian, while Burrau (Berlin, 1907) gives a 6-place table for interval 0·01 radian. Andoyer, *Nouvelles Tables, Trigonométriques Fondamentales contenant les valeurs naturelles* (Paris, Hermann, 1915–18) published tables of the natural functions to 15 places for every 10 seconds, which he had calculated *de novo* during the years 1910–14; the tables occupy three large volumes. He also gives tables for the centesimal division of the quadrant to 20 decimals.

Antilogarithms.—A table of antilogarithms gives as the tabular results the number whose logarithm is equal to the argument. By inverse entry and interpolation, tables of logarithms can be used as tables of antilogarithms, so that few antilogarithmic tables have been published. The methods mentioned above for the determination of logarithms to a large number of places can, in general, be applied inversely for antilogarithms. The largest and earliest usable table of antilogarithms is Dodson's *Antilogarithmic Canon* (London, 1742), giving 11-figure numbers corresponding to the logarithms 0·00000(0·00001)0·99999 with differences. In 1849 Filipowski in *A Table of Antilogarithms* (London) and Shortrede in *Logarithmic Tables* (Edinburgh) give 7-figure antilogarithms for 0·00000(0·00001)0·99999. Dietrichkeit (Berlin, 1906) gives a similar table. In 1908 Börgen published a table and method for calculating logarithms to 11 or 10 places in *Logarithmisch-trigonometrische Tafel* (Leipzig, Engelmann, 1908) and his main table gives 11-figure antilogarithms for logarithms 0·0000 (0·0001)0·9999. A similar table is given by Guillemin, *Tables de Logarithmes* (Paris, 1912) to 13 figures for 0·0000(0·0001)0·7000 and to 12 figures for 0·7001(0·0001)0·9999.

Napierian Logarithms in their original form have passed completely out of use and are only of historic interest. (*See* NAPIER.)

Hyperbolic Logarithms.—The first publication of a table which can be interpreted as a hyperbolic logarithm table in the modern sense is *New Logarithmes* (1619) by J. Speidell. The most extensive table was computed by Dase, *Tafel der natürlichen Logarithmen der Zahlen* (Vienna, 1850); it gives the 7-place logarithms of 1(1)1000 and 1000(0·1)10,500. Barlow in *New Mathematical Tables* (London, 1814) gives the 8-place logarithms of all integers to 10,000. Schulze in his *Neue und erweiterte Sammlung logarithmischer Tafeln* (Berlin, 1778) includes a table of hyperbolic logarithms to 48 places of all integers to 2,200 and of the primes and some other numbers to 10,000. This table was calculated by Wolfram, who was not able to complete the work. The incomplete table was given by Schulze, but Vega in the *Thesaurus* (1794) completed it. An 8-figure abridgment of it was included in Vega's collection of tables (1797) and later editions. Barlow used Wolfram's table in his calculations. Thiele in *Tafel der Wolframschen Hyperbolischen 48-stelligen Logarithmen* (Dessau, 1908) extended the table to all numbers to 5,000 and the primes to 10,000. Salomon, *Logarithmische Tafeln* (Vienna, 1827) gives 10-place logarithms to 1,000 and of primes to 10,333; Callet, 48-place logarithms to 100 and primes to 1,097; Hutton, 7-place to 1,200, also Willich (1852); Rees's *Cyclopaedia* (1819) art. "Hyperbolic Logarithms," 1(1)10,000 to 8-places. Vega in *Tabulae Logarithmico-trigonometricae* (Leipzig, 1797) and Köhler in *Logarithmisch-trigonometrisches Handbuch* (Leipzig, 1848) give 8-place logarithms to 1,000 and primes to 10,000.

Gaussian or Addition and Subtraction Logarithms.—In certain problems in astronomy and other subjects it is sometimes necessary to calculate the logarithm of $(a+b)$ and $(a-b)$ from log a and log b where a knowledge of the actual values of a and b is not required. Gaussian tables are intended to be used for this purpose. Leonelli in a very rare book, *Supplément Logarithmique* (Bordeaux, 1802–03), was the originator of a table which would simplify the calculations. A specimen table is given where, with log x as argument 0·00000(0·00001)0·00104, $\log\left(1+\frac{1}{x}\right)$ and $\log(1+x)$ are given to 14 places. Gauss, who took up the idea, constructed the first complete table of addition logarithms. It first appeared in Zach's *Monatliche Correspondenz* (vol. xxvi., 1812) and gives 5 places only in the tabular results. Three columns are headed A, B and C. The argument log x in column A is 0(0·001) 2·00(0·01)3·4(0·1)5·0; columns B and C give $\log\left(1+\frac{1}{x}\right)$ and $\log(1+x)$ respectively to 5 places. By this table $\log(a+b)$ can be obtained by direct or inverse use of the table. Gauss's table has been reprinted in several collections of tables. There are several good tables to 6 and 7 places, but there are variations of the arrangement. Gray, *Tables and Formulae* (London, 1870) gives 6-place values of $\log(1+x)$ for log x=0·0000(0·0001)2 and $\log(1-x)$ for log x=3·00(0·001)1·00(0·0001)1·899 with proportional parts; Cohn, *Tafeln der Additions- und Subtraktions-logarithmen* (Leipzig, 1909) gives a convenient table; $\log\left(1+\frac{1}{x}\right)$ is given to 6 places for log x=0·0000(0·0001)1·500 (0·001)3·00(0·01)5·0(0·1)6 with differences and $\log\left(1/1-\frac{1}{x}\right)$ for log x=0·3000(0·0001)1·500 (0·001)3·00(0·01)5·0. Similar tables are given by Bremiker, Gundelfinger and Jones. Seven-place tables are given by Matthiessen, Wittstein and Zech. The first of these is "nearly useless" (Gauss); the others tabulate in convenient form and for the greater part of the range the interval is 0·0001. Wittstein makes one table suffice for both addition and subtraction, while Zech has two. "Wittstein's table answers the purpose Gauss had in view the best of all" (Glaisher). By Zech's tables $\log\left(1+\frac{1}{x}\right)$ and $\log\left(1/1-\frac{1}{x}\right)$ are tabulated with log x as argument. In 1922 in the *Bulletin Astronomique, Deuxième Série* (Paris, 1922), pp. 5–32, Andoyer has published "Tables Fondamentales pour les logarithmes d'addition et de soustraction." These are to be regarded as basic tables for the future compilation of a table of Gaussian logarithms to n places when $n<16$. The chief table gives A and S to 16 decimal places corresponding to the argument D0·00(0·01) 9·00 where $A=\log(1+10^{-D})$, $S=-\log(1-10^{-D})$. [If D= log x,

$A=\log\left(1+\frac{1}{x}\right)$, $S=-\log\left(1-\frac{1}{x}\right)\Big]$. Two auxiliary tables are given with method.

Factor Tables.—The earliest extensive factor table is that of Chernac, *Cribrum Arithmeticum* (Deventer, 1811); it exhibits the factors of all numbers not divisible by 2, 3 or 5 up to 1,020,000 with the prime numbers indicated as they appear. Burckhardt published *Table des Diviseurs* (Paris, 1814–16–17), giving the lowest factor of all numbers indivisible by 2, 3 or 5 up to 3 millions (3,036,000). The accuracy of this table is high. Dase followed with a similar table for the range 6–9 millions, *Factoren-Tafeln für alle Zahlen der siebenten Million* (Hamburg, 1862), and two similar volumes. The Tables for the fourth, fifth and sixth millions were supplied by Glaisher and completed in 1883. Felkel (Vienna, 1776) probably aimed at 10 million, but the highest number is 408,000. In Lehmer's table (Carnegie Institution, Washington, 1909) the least factor of numbers up to 10 millions indivisible by 2, 3 and 5 is given.

Product Tables.—These are of two distinct types: (i.) the simplest exhibits the products (a) to 9×99,999, (b) to 99×999, (c) to 999×999. (ii.) The other consists of a table of quarter squares, the use of which depends on the formula $\frac{1}{4}\{(a+b)^2-(a-b)^2\}=ab$, viz., the product of two numbers is one-quarter of the difference of the squares of their sum and difference. Bretschneider in *Produktentafel* (Hamburg-Gotha, 1841) gives the first 9 multiples of all integers to 99,999, while Crelle gives a similar table *Erleichterungs-Tafel* (Berlin, 1836) showing the first 9 multiples of numbers to ten million. The earliest extensive table is that of Herwart ab Hohenburg, *Tabulae Arithmeticae* (Munich, 1610), and this is of the type (C). Crelle, *Rechentafeln* (Berlin, 1820) gives a table for the same range; this has passed through many editions in English, French and German. The range 99×999 has been chosen by Zimmermann, in *Rechen Tafeln* (Berlin, 1899) and Peters (Berlin, 1909).

Quarter-squares.—A number of tables of quarter-squares have been published, of which the most extensive is that of Blater, *Tables of Quarter-Squares up to 200,000* (London, 1887). This is an English edition of the work originally published in Vienna. Other tables include Laundy, *Table of Quarter-Squares* (London, 1856) up to 100,000; Voisin, *Tables de Multiplications* (Paris, 1817) up to 20,000. Centnerschwer, *Neu erfundene Multiplications- und Quadrat-Tafeln* (Berlin, 1825) also takes the upper limit 20,000. Several tables give quarter-squares for ranges below 10,000.

Tables of Squares, Cubes and Higher Powers.—A fairly large number of extended tables of squares of integers have been published but few tables of cubes. The earliest combined tables were those of Babington, *Pyrotechnic* (London, 1635), which exhibits the squares of integers to 25,000 and cubes to 10,000, and Guldinus, *De centro gravitatis. Appendix* (Vienna, 1635), which exhibits squares and cubes of all integers to 10,000. The most extensive table of this type is that of Kulik, *Tafeln der Quadrat- und Kubik-Zahlen* (Leipzig, 1848), giving squares and cubes of all integers to 100,000. As far as squares are concerned, the tables of quarter-squares of Blater and Laundy mentioned above may be used as tables of squares to 200,000 and 100,000 respectively. Squares and cubes are given in the various editions of Barlow's *Tables* (1814), to 10,000, in Buchner's *Tabula* (1701), to 12,000; Hutton, *Tables of the Products and Powers of Numbers* (London, 1781), gives squares to 25,400 and cubes to 10,000; Jahn, *Tafeln* (Leipzig, 1839) gives squares to 27,000 and cubes to 24,000. Tables of squares (without cubes) include the following:—Gossart (Paris, 1865) to 10,000, Maginus (Venice, 1592) to 10,100, and the most extensive table of squares is Ludolf's *Tetragonometria Tabularia* (1689), of which there were several editions giving squares to 100,000.

There are few tables of higher powers and those are, in general, of very limited extent. The 1814 edition of Barlow's *Tables* contains the first ten powers of numbers 1 to 100, fourth and fifth powers of numbers 100 to 1,000; Gélin, *Recueil de Tables* (Namur, 1881) gives fourth, fifth, sixth, seventh and eighth powers of numbers to 100; Hutton, *Tables* (1781) gives the first ten powers of numbers to 100; Moore's *Arithmetic* (London, 1660) the fourth powers of numbers to 300 and the fifth and sixth powers to 200.

Square and Cube Roots.—Barlow's *Tables* (1814) exhibit square and cube roots to 7 decimal places of all integers up to 10,000. Hülsse's edition of Vega's *Sammlung* (Leipzig, 1840) gives square and cube roots to 12 and 7 places respectively of all integers to 10,000. A most useful table of square roots has recently been published by Milne-Thomson, *Standard Table of Square Roots* (London, Bell & Sons, 1929). This gives the square roots of x and $10x$ for $x=100$ (0·1) 1000 to 8 significant figures, *i.e.* 6 decimal places with first differences for the $\sqrt{x}$ and $\sqrt{10x}$ columns. This table enables a computer to find the square root of any number with the minimum of interpolation.

Reciprocals.—Barlow's tables give the reciprocals to 7 places of numbers to 10,000. The most useful table of reciprocals is Oake's *Table of Reciprocals of Numbers from 1 to 100,000* (London, 1865), giving the reciprocals to 7 significant figures. First differences and proportional parts are shown, so that the reciprocals of all numbers to 10,000,000 can be immediately written down to 7 significant figures. A similar table is *Cotsworth's Direct Reciprocals* (M'Corquodale, Leeds). A few other tables give reciprocals, but for a very small range. Picarte, *La Division réduite a une addition* (Paris, 1861), in his table shows the reciprocals of 1000(1) 10,000 to 10 significant figures. The table actually gives the first nine multiples of these reciprocals to be used in a method for simplifying division; by this method the process of division is converted into a simple one of addition.

Gamma-function (Factorials).—The first table exhibiting the logarithms of the Γ-function was given by Gauss in 1813; he gives $\log \pi z$ to 20 decimal places for $z=0{\cdot}00(0{\cdot}01)1{\cdot}00$ $[\pi z=\Gamma(z+1)]$. The largest and best known table until recent times is that of Legendre, published in *Exercises de Calcul Intégral* (Paris, 1817), and in *Traité des fonctions elliptiques* (Paris, 1825). This gives $\log \Gamma z$ to 12 decimal places for $z=1{\cdot}000(0{\cdot}001)2{\cdot}000$ with first, second and third differences. This table was reproduced by Schlömilch in *Analytische Studien* (Leipzig, 1848), pp. 183–209. A 7-figure abridgement is given in *Smithsonian Physical Tables* (1920), and a 6-figure abridgement in *Integral Calculus* (1884) by Williamson. In *Brit. Assoc. Report*, 1916, pp. 123–4, Watson gives a small table showing $10+\log_e\Gamma(1+x)$ to 10 places for $x=0{\cdot}005(0{\cdot}005)1{\cdot}000$. A 7-figure table also appears in *Tables for Statisticians and Biometricians* (Cambridge University Press, 1914). A photographic reprint of Legendre's table was published in 1921, *Table of the Logarithms of the Complete Γ-function to 12 figures, Tracts for Computers, No. IV.* (Cambridge University Press). In the *Tracts for Computers* series, No. VIII. (1922) gives *Table of the Logarithms of the Complete Γ-function to 10 decimal places for argument 2 to 1,200 beyond Legendre's Range* (*Argument 1 to 2*) by E. S. Pearson, while No. IX. gives *Log Γ (x) from x= 1 to 50·9 by intervals of 0·01*, by Brownlee. A very extensive table of the Incomplete Gamma-Function has been published by the Biometric Laboratory, University of London, under the supervision of Professor Pearson. $\log_{10} n!$ is tabulated by Degen in *Tabularum Enneas* (Copenhagen, 1824) to 18 decimal places for $n=1(1)1200$.

Hyperbolic and Exponential Functions.—$\log_{10} \sinh x$, $\log_{10} \cosh x$.—Gudermann, *Theorie der potenzial- oder cyklisch-hyperbolischen Functionen* (Berlin, 1833), gave tables for the quadrant at intervals of 0·01 of a grade to 7-places and also a 9-place table for $x=2{\cdot}500(0{\cdot}001)5{\cdot}000$ and a 10-place table for $x=5{\cdot}00(0{\cdot}01)12{\cdot}00$. Ligowski, *Tafeln der Hyperbolfunctionen* (Berlin, 1890) supplies the gap $x=0{\cdot}000$ to $2{\cdot}000$ using 5 places and also $x=2{\cdot}00$ to $9{\cdot}00$. Becker and Van Orstrand, *Smithsonian Mathematical Tables* (Washington, 1909) give 5-place logarithms for $x=0{\cdot}0000(0{\cdot}0001)0{\cdot}100(0{\cdot}001)3{\cdot}00(0{\cdot}01)6{\cdot}00$.

Sinh *x* and Cosh *x*.—Ligowski gives these functions to 6 places for $x=0{\cdot}00(0{\cdot}01)8{\cdot}00$; Burrau (Berlin, 1907) to 5 places for $x=0{\cdot}00(0{\cdot}01)10{\cdot}00$; Dale, *Five-figure Tables (London, Arnold,* 1903), to 5 places for $x=0{\cdot}00(0{\cdot}01)2{\cdot}0(0{\cdot}1)6{\cdot}0$; and Becker and Van Orstrand for the same arguments and to the same accuracy as the logarithms.

Log e^x.—The most extensive table is that of Glaisher, *Camb. Phil. Trans.* XIII., 1883, which exhibits the values to 10 places for (i.) x=0·000(0·001)0·100, (ii.) 0·00(0·01)2·00, (iii.) 0·0(0·1) 10·0(1·0)500. Becker and Van Orstrand give 7-place values for x=0·000(0·001)3·00(0·01)6·00. e^{-x} is given in an extensive table by Newman, *Camb. Phil. Trans.* XIII. (1883) to 18 places for x=0·000(0·001)15·350; to 14 places for x=15·350(0·002)17·300 (0·005)27·635. It is given by Becker and Van Orstrand for the same range and accuracy as *log* e^x. In the *Camb. Phil. Trans.* (1883) Glaisher also gives e^x to 9 figures for the same arguments as *log* e^x. In the *Tables of the Exponential Functions* (Washington, 1913) Van Orstrand gives e^x and e^{-x} to 20 places for x=0·0(0·1)32·0.

Tables of Some of the Higher Mathematical Functions.—The majority of such tables are of limited range and have generally been calculated for some special purpose. They appear in a few collections of tables to 4 or 5 places, but more usually in the journals of scientific societies to a larger number of places.

Probability Integral.—There are a considerable number of small tables of this integral, particularly in collections of tables for statisticians; there is a certain amount of variation in the actual form of the integral tabulated. Burgess, *On the Definite Integral* $\frac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt$ (Edinburgh, 1898) gives a number of references to existing tables. His main table exhibits the 9-decimal values of the function for t=0·000 (0·001)1·250 with first and second differences and $\frac{2}{\sqrt{\pi}}e^{-t^2}$ to 9 decimals; also $\frac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt \frac{2}{\sqrt{\pi}}e^{-t^2}$ to 15 places with first four differences for t=1·000(0·001)1·500 (0·002)3·000(0·1)5(0·5)6·0. When great accuracy is not required, the 4-place tables of Jahnke and Emde, *Funktiontafeln* (Leipzig, 1909) may be used. Useful tables are given in *Tables for Statisticians* (Pearson). The first table of this integral is given in the form $\int_t^\infty e^{-t^2}dt$ by Kramp in his *Analyse des Réfractions* (Strassburg, 1798), to 8 places for t=0·00(0·01)2·00 and to 11 places for t=2·00(0·01)3·00. A similar table appears in De Morgan's *Theory of Probabilities,* where there is also a 7-place table for $\frac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt$ for t=0·00(0·01)2·00. Markoff in *Tables des valeurs de l'integrale* $\int_x^\infty e^{-t^2}dt$ (St. Petersburg, 1888), gives 11-place values with first four differences for x=0·00(0·01)4·80.

Legendre Coefficients or Zonal Harmonics.—The values of $P_n(x)$ for x=0(0·01)1·00, n=1(1)7 are given by Glaisher in *Brit. Assoc. Rep.* (1879). They are reproduced by Dale and Jahnke-Emde. $P_n(\cos\theta)$ for n=1(1)7 and θ=0°(1°)90° are given to 4 places by Perry, *Proc. Phys. Soc.* (1892) and *Phil. Mag.* (1891); also in Jahnke-Emde. Extensive tables have been published by Tallquist at Helsingfors, 1908.

Bessel Functions.—The work of Jahnke and Emde referred to above contains a list of all tables before 1909 connected with Bessel Functions, and also some 4-place tables. The majority of tables of these functions are scattered through the journals of mathematical and scientific societies. Hansen's extension of Bessel's tables is reproduced by Schlömileh in *Zeitschr. für Math.* (1868) and by Lommel in *Studien über die Bessel'schen Functionen* (1868). This is a 7-place table of $J_0(x)$ and $J_1(x)$ for x=0 to 20 at intervals of 0·01. These functions to 12 decimals are given by Gray and Mathews as a reprint of the table of Meissel, *Abh. d. Berlin Akademie* (1888). In 1889 the Committee of the British Association for the Calculation of Tables decided to commence work on the tables of Bessel Functions and the first extensive table appeared in 1893, giving $I_1(x)$ to 9 places with first differences for x=0·000(0.001)5·100; $I_0(x)$ followed in 1896. Further tables appeared in the Reports of this Committee in 1907, 1909 and 1911 [also Neumann Functions $G_n(x)$ and $Y_n(x)$], 1912 (*ber x* and *bei x*), 1913 and later. In *Proc. Roy. Soc.* (1899) Aldis, "On the numerical computation of the functions $G_0(x)$,$G_1(x)$ and $J_n(x)$" gives a number of tables to 21 places for x=0·0(0·1)6·0.

Elliptic and Other Functions.—The Committee of the British Association (Mathematical Tables) commenced work on the elliptic functions in 1911 and tables appeared in the Reports of 1911–12–13–19. In the Report of 1924, tables of the Lommel-Weber and Bessel-Clifford functions are given.

Legendre, *Traité des fonctions elliptiques* (1826), gives a number of tables of the elliptic functions of the first and second kind and 4-place tables appear in the Jahnke-Emde collection.

q-Tables.—$\text{Log}_{10}q$ from θ=0° to 90° has been tabulated by Glaisher in *Month. Not. R. A. Soc.* (1877) for every degree to 10 places; Jacobi, *Crelle's Journal,* XXVI., for every tenth of a degree to 5 places; Bertrand, *Calcul Intégral* (1870), for every 5 minutes to 5 places and Meissel, *Sammlung mathematischer Tafeln* (Iserlohn, 1860) for every minute to 8 places.

Tables of integrals such as $Si\,x=\int_0^x\frac{\sin x}{x}dx$, $Ci\,x=\int_0^x\frac{\cos x}{x}dx$, $Ei\,x=\int_0^x\frac{e^x}{x}dx$, $Li\,x=\int_0^x\frac{dx}{\log x}$, have also been published. The Jahnke-Emde collection contains tables of the first three integrals to 4 places; Glaisher *Phil. Trans.* (1870), p. 367, gives *Si x*, *Ci x*, *Ei x* to 18 places for x=0·00(0·01)1·0, and to 11 places for x=1(0·1) 5(1)15(5)20. *Ei x* is also given by Bretschneider in *Grunert's Archiv* III., p. 33 to 20 places for x=1(1)10 and for x=10(1)20 by Gram in *Publications of the Copenhagen Academy* (1884). The latter extends Glaisher's table in some places, giving *Ei x* for x=5·0(0·2)20·0 to 8, 9 or 10 places. *Li x* has been published by Glaisher in his *Factor Tables* (1883) to the nearest integer for 0(50,000)9,000,000. Tables of the integrals are of limited extent.

Fresnel Integrals.—In the *Brit. Assoc. Report* (1926) $C(x)$ and $S(x)$ were tabulated to 6 places for x=0·0(0·1)20·0. Lommel, *Abh. Münch. Akademie* (1880), gives the values for z=0(1)50, where the integral $C(x)=\int_0^x\cos\frac{1}{2}\pi x^2dx$ is written in the form $\frac{1}{\sqrt{(2\pi)}}\int_0^z\frac{\sin z}{\sqrt{z}}dz$, A 4-place table appears also in Jahnke-Emde.

Pearson Integral.—The integral $F(r,n)=e^{-\frac{1}{2}\pi n}\int_0^\pi \sin^r x\,e^{nx}dx$ which is required in certain statistical work has been tabulated in the form $\log F(r,\phi)$ where $n=r\tan\phi$, in *Brit. Assoc. Reports* (1896) and (1899), for successive integral values of r to 50, to 7 places. Tables of associated integrals appear in *Tables for Statisticians.*

References.—Glaisher, "Report on Mathematical Tables," *Brit. Assoc. Report* (1873); De Morgan, "Mathematical Tables," *English Cyclopaedia* (1861), vol. vii.; Mehnke, "Numerisches Rechnen," *Encyk. der Math. Wiss.* (Leipzig, 1900–04), vol. i., pt. ii., pp. 941–1079; Horsburgh, *Modern Instruments and Methods of Calculation* (Edinburgh, 1915), pp. 47–60; Henderson, *Bibliotheca Tabularum Mathematicarum, being a descriptive catalogue of mathematical tables, Part I. Logarithmic Tables* (Cambridge University Press, 1926) (in progress).

(JA. H.)

MATHEMATICS, FOUNDATIONS OF. No proposition of mathematics is considered to be established until it has been *proved*—that is to say, logically deduced from other propositions previously established. But obviously this process of proof must begin somewhere; we must make some assumptions in order to start at all; and the problem arises, "What are the fundamental assumptions or *axioms* from which all the propositions of this subject can be deduced?"

With regard, for instance, to Euclidean Geometry, this problem has been solved; it is found that all geometrical terms, such as circle or parallelogram, can be defined in terms of a few *indefinables,* such as "point" and "straight line," and all the propositions of geometry can be deduced from a relatively small number of axioms about these indefinables, such as that through any two points passes one and only one straight line. When this has been done, we naturally want to discover whether these axioms are true. The answer to this question lies with the physicist; all that the mathematician can say is that if the axioms are true, then all the rest of geometry will be true also.

It is therefore clear that the mathematician asserts the propo-

sitions of geometry, not as absolute truths, but merely as implied by the axioms; and that, regarded as a branch of mathematics, geometry has no essential reference to physical space. For we can say, not only of physical points and planes but also of any classes of things which we may call points and planes, that *if* they obey the axioms of geometry, they obey the conclusions also.

So the mathematician regards geometry as simply tracing the consequences of certain axioms dealing with undefined terms, which are really variables in the ordinary mathematical sense, like x and y. And he demands of his axioms, not that they should be true on some particular physical interpretation of the undefined terms, but merely that they should be *consistent* with one another. If they were inconsistent this would probably appear from contradictory consequences being deduced from them; but although we had not as yet deduced any contradictory consequences, we could not therefore be sure that the assumptions were compatible with one another; for the latent contradiction might only become manifest after more elaborate deductions. The only way to provide positive proof is to find an interpretation of the undefined terms which will make the axioms true, since, if there are actual things for which they are true, the axioms must certainly be consistent. The things used for this purpose must not be taken from the physical world, or our proof would be subject to all the doubts and reservations of the experimental method. In fact, if the proof of consistency is to be a mathematical one, the entities which our undefined terms are interpreted to mean can only be taken from some other branch of mathematics. In the case of geometry we use the *real numbers* of algebra and analysis; for, if "point" be taken to mean ordered triad of numbers (x, y, z) and "plane" to mean set of such ordered triads satisfying a linear equation, and so on, it follows from the theory of real numbers that on this interpretation the axioms of geometry will be true, provided the theory of real numbers can be assumed.

Numbers.—We are thus thrown back to the theory of real numbers, for which we can again lay down axioms, using "real numbers" as a variable or undefined term meaning any things for which the axioms are true. If we proceed in this way we shall not, of course, have definite things called real numbers to use, as explained above, in showing the axioms of geometry consistent; but we shall still be able to prove that if the axioms about real numbers are compatible, so are those of geometry; and our next step will be to investigate, for their own sake and for the sake of geometry, the consistency of the axioms about real numbers.

This, in turn, we can establish by giving them a particular interpretation in terms of the rational numbers or fractions (the real numbers include also surds and other irrationals), and so indirectly in terms of the natural numbers 0, 1, 2, 3 . . . etc. For the natural numbers, again, a system of axioms has been laid down by Peano, in which the undefined terms are "number," "zero" and "successor," and a proof may again be demanded of their compatibility. But now there is no simpler branch of mathematics in which to interpret them; for with natural numbers we seem to have reached the most primitive mathematical material.

But apart from this difficulty about the consistency of the axioms on which depends, as we have seen, the proof of the consistency of the axioms of all other branches of mathematics, there is a further reason for being dissatisfied with the axiomatic treatment of the natural numbers. For if we adopt it, we shall be meaning by "numbers" any things that satisfy these axioms; whereas, in fact, there seems to be one definite meaning of number which is of peculiar importance and of which we should expect the mathematician to give an account. For instance, if I say that I have 2 pennies in my pocket, I there use "2" in a definite sense which we all understand. I do not mean by it merely something satisfying certain axioms, because it is easy to see that any axioms satisfied by the series of natural numbers must also be satisfied by, for instance, the numbers from 100 onwards; so that a purely axiomatic treatment of number would not enable us to distinguish between having 2 pennies in our pocket and having 102. Nor is it open to the mathematician to put this distinction aside as belonging to physics or some other branch of science, because he himself needs it in his own mathematical work, since he not only deals with the numbers as things about which he is talking, *i.e.*, as substantives, but also uses them as adjectives in just the ordinary sense. When he says, for instance, that a quadratic equation has *two* roots, the two in "two roots" is the same two as that in "two pennies," and it is essential to realize the difference between it and 102, a difference which depends on the individual natures of the numbers and not merely on the axioms they satisfy. (*See* NUMBER.)

Mathematics and Logic.—We are therefore led to investigate *cardinal numbers*—the kind of numbers that answer the question "How many?"—and by discovering what these are, we shall be able to prove the consistency of Peano axioms. The cardinal numbers bring us to *logic;* they belong to the terms which we use in any sort of reasoning, such as "all," "some," "not," "or," "class" and "relation"; and Frege has shown that they could in fact be defined in terms of these simpler logical notions, so that to give a clear account of the cardinal numbers and provide a basis from which to deduce their properties, we must make an investigation of formal logic.

This is also indispensable for another reason; we have so far discussed the axioms from which geometry, for instance, can be deduced, but said nothing about the methods of deduction, such as the principle of *reductio ad absurdum,* which belong to formal logic, but are as much presupposed in the validity of geometry as are the axioms themselves. These principles of deduction can be set out as propositions, containing no notions except the purely logical ones referred to above; and they can then themselves be made the subject of logical deductions. The propositions of formal logic can, in fact, all be deduced from a small number of primitive propositions, using only two or three particularly simple principles of deduction, *e.g.*, if p is true and p implies q, then q is true.

This leads to a complete merging of mathematics in formal logic; all mathematical propositions can be stated in purely logical terms and deduced from the primitive propositions of logic (terms such as "point" and "plane" being, as explained above, simply replaced by variables). The cardinal numbers can also be defined in purely logical terms and their properties can be similarly established. It can incidentally be shown that they satisfy Peano's axioms (provided we assume what is called the Axiom of Infinity). But it is no longer necessary to give these axioms, or those for real numbers, a fundamental place in our system of analysis. It is simpler to define the real numbers as definite entities constructed from the cardinal numbers in a definite way, and not merely to regard them as any things satisfying certain axioms.

The Paradoxes.—This reduction of mathematics to formal logic was first projected by Frege and was actually carried out by Whitehead and Russell in their *Principia Mathematica* (1910). It was, however, faced with various difficulties which were not altogether overcome, so that no system has been provided which finds general acceptance. These difficulties arise from the so-called Paradoxes of the Theory of Aggregates, which are cases in which it seems possible to give logical or mathematical proofs leading to each of two contradictory conclusions, a result which is intolerable to the mathematician as it overthrows his science altogether. Many instances of this seem to be mere quibbles, but more complicated ones cannot easily be distinguished from ordinary mathematics. An easy illustration is provided by the following example, non-mathematical. The word "short" is a short word, but the word "long" is not a long word. This suggests a division of adjectives according as they do or do not have the property which they connote. Words like "short" which apply to themselves let us call autological; and words like "long" which do not apply to themselves let us call heterological. Now suppose we put the question, "Is the word 'heterological' a heterological word?" Then we at once obtain contradictory answers. For if it is heterological, that means that it does not apply to itself, *i.e.*, that it is not heterological; but if it is not heterological, then it does apply to itself, *i.e.*, it is heterological.

In order to escape these contradictions Whitehead and Russell invented the Theory of Types, of which the essential idea is that a sentence which is perfectly grammatical English may yet be literally nonsense. To say that a class, *e.g.*, the class of things

other than men, is a member of itself (*i.e.*, not a man) appears to be a truism, but on the Theory of Types it is really nonsense. To say that Socrates is a man is sense, but to say that a class whether of men or not-men is or is not a man is sheer nonsense, for the class is of a different logical type from Socrates and the same predicate cannot significantly be applied to more than one type of subject. The contradictions arise from sinning against the rules of logical grammar by confusing logical types.

Unfortunately, in order to escape some of the contradictions such as the one about "heterological" above, Whitehead and Russell were obliged to go further than this and introduce distinctions and restrictions which had the effect of invalidating some important types of mathematical argument, especially that known as Dedekindian section; to avoid this consequence they introduced an assumption, known as the Axiom of Reducibility, which is generally considered unplausible and unsatisfactory.

Intuitionists and Formalists.—This defect in the system of *Principia Mathematica* has prevented its obtaining any general acceptance, and several of the greatest mathematicians now approach the problem on entirely different lines. The *Intuitionist* school, led by Brouwer and Weyl, proposes to abandon many generally accepted parts of mathematics, and to retain only such propositions as they can prove without using the Law of Excluded Middle, which says that either all numbers have a certain property or at least one number does not have it. They think that it is wrong to say that there is a number with a certain property, *e.g.*, satisfying a given equation, unless we have a definite construction for finding one.

On the other hand, the *Formalist* school, who follow Hilbert, hope to put an end to this disastrous scepticism, by taking an altogether different view of what mathematics is. They regard it as merely the manipulation of meaningless symbols according to fixed rules. We start with certain rows of symbols, called axioms; from these we then derive others by substituting certain symbols called constants for others called variables, and by proceeding from the pair of formulae p, if p then q, to the formula q. Mathematics is thus regarded as a sort of game, played with meaningless marks on paper, rather like noughts and crosses; but besides mathematics there is, according to Hilbert, another subject called metamathematics which is not meaningless, but consists of real assertions about mathematics, telling us that this or that formula can or cannot be obtained from the axioms according to the rules of deduction. The most important theorem of metamathematics is that it is not possible to deduce a contradiction from the axioms, where by a contradiction is meant a formula with a certain kind of shape which can be taken to be $0 \neq 0$. Although no complete proof of this theorem has yet been published, it is supposed that it can be proved, and that scepticism arising from the fear of contradiction will then be finally disposed of.

Since, whatever else a mathematician is doing, he is certainly making marks on paper, it must be granted that the formalist view consists of nothing but the truth; but it is hard to suppose it the whole truth, as our interest in the symbolic game surely arises from the possibility of giving meaning to some, at least, of the marks we make, and the hope that with the meaning so given they will represent knowledge and not error.

Wittgenstein.—We see, then, that these eminent mathematicians, great as are the differences between them, are yet agreed that mathematical analysis as ordinarily taught cannot be regarded as a body of truth, but is either false or at best a meaningless game; and if classical mathematics is to be defended, some answer must be found to their criticisms. Such an answer might be based on the logical and important work of Wittgenstein.

If we take the view that mathematics can be reduced to formal logic, there is one problem of fundamental importance which Wittgenstein claims to have solved. He has clearly defined the peculiar characteristic of logical propositions. It was formerly supposed that any true proposition which mentioned no particular thing or relation, and so could be stated in purely logical terms, was a proposition of logic or mathematics. But such a view is evidently mistaken, as such a statement as "any two things differ in at least 30 ways" can be stated in purely logical terms and may well be true, but even so it would not be a logical o. mathematical truth. Logic and mathematics have a further char acteristic, which you can call either necessity or tautology accord ing to your philosophy, and which Wittgenstein has precisel analysed. Further, Ramsey claims to have shown that usin Wittgenstein's work the system of Principia Mathematica can b reconstructed so that the unsatisfactory Axiom of Reducibility i no longer required. Thus classical mathematics, interpreted a one with formal logic, may yet be rehabilitated.

BIBLIOGRAPHY.—A. N. Whitehead and B. Russell, *Principia Mathe matica* (3 vols. 1910–13; 2nd ed. 1925); B. Russell, *Introduction t Mathematical Philosophy* (1917) (for the general reader); L. Witt genstein, *Tractatus Logico-Philosophicus* (1922); A. Fraenkel, *Zeh Vorlesungen über die Grundlegung der Mengenlehre* (1927, Bibl.) *See* also papers by Brouwer in *Mathematische Annalen*, vols. xciii. xcv., xcvi. (1925–26); Hilbert in *Mathematische Annalen*, vols. lxxxviii and xcv. (1923–25); Ramsey in *Proceedings of the London Mathematical Society*, 2nd series vol. xxv. (1926), and Weyl in *Mathematische Zeitschrift*, vol. x. (1921). (F. P. R.)

MATHEMATICS, HISTORY OF. The science of mathematics had its origin in the practical needs of men for number names and simple measures, and in their mental thirst for knowledge. Intuitively the early man knew that a straight line is the shortest path between two points; he took pleasure in symmetric decorations; he developed the names of small groups of objects; in time he felt the need for counting within a very limited range, and he later came to be conscious of the mystery of numbers and to set aside the lower primes as having specially mysterious properties. It was the age of mathematical intuition. It extended throughout the long prehistoric era and characterized the science of the early Chinese, Hindus, Babylonians and Egyptians.

Mathematical Proof.—Simple observations, the induction which leads mankind to draw conclusions from a similarity of results, faith in one's vision and touch—these characterized the world's mathematics down to about the 7th century B.C. Some of the results in Egypt, of a thousand years earlier, have been thought to give evidence of the existence of logical proofs, but the assertion rests on too uncertain foundations to be generally accepted. Thales (*c.* 640–*c.* 546 B.C.) of Miletus, on the Ionian coast of Asia Minor, is credited with having proved five or six theorems in plane geometry. In themselves, they were of the simplest nature, but the fact that they were proved in some kind of a logical manner is so significant as to render the achievement epoch-making. The greatest disciple of Thales was Pythagoras (*c.* 572–*c.* 501 B.C.). He taught that mathematics was the basis of all sciences and gave to it a position which it has held substantially ever since. It was largely due to his influence that men like Oenopides, Hippocrates of Chios, Antiphon, Archytas, and Theodorus of Cyrene, all of the 5th century B.C., and Plato, Eudoxus, and Aristotle of the century following, were enabled to perfect Greek mathematics and to prepare the way for such later writers as Euclid (*c.* 300 B.C.), Archimedes (*c.* 240 B.C.), and Apollonius (*c.* 225 B.C.). It was the beginning of the epoch of deduction, and the position of mathematics in the scheme of knowledge is due almost entirely to Greek influence.

Number Symbolism.—No ancient civilization had a number symbolism that, for convenience and ability to secure results, approaches the one which we commonly use to-day. The Greeks came nearer to it than other peoples, but it was the Hindu-Arabic system which began to attract the attention of European scholars about A.D. 1000, that rendered possible the great advance of non-geometric mathematics. (*See* NUMERALS.)

Mediaeval Mathematics.—The Muslim civilization, particularly as represented at Baghdad, *c.* 800–*c.* 1000, developed a type of mathematics which combined the characteristic features of the Greek and Hindu treatments of the science. Eastern faith in astrology and skill in number met with Western faith in philosophy and skill in geometry, and the Baghdad scholars, absorbing each, produced text books in general algebra, elementary number, astronomy, and trigonometry which, through the efforts of Latin translators, gave new life to mathematics in Europe.

The Period of the Renaissance.—The 15th century found Europe ready to carry on the work of the Arab mathematicians, particularly in algebra and astronomy. The next two centuries

saw astronomy more distinctly placed among the exact sciences, largely through the efforts of men like Copernicus (*c.* 1520) and Kepler (*c.* 1610); saw algebra develop into something besides a set of number puzzles, largely as a result of the labours of such scholars as Tartaglia, Cardan, and Viète; and saw the first steps taken to give the world the disciplines of analytic geometry (Fermat and Descartes, *c.* 1630–40), logarithms (Napier and Briggs, *c.* 1615), and the calculus (Newton and Leibnitz, *c.* 1680).

Modern Mathematics.—The new geometry and the calculus, together with the work of such men as Fermat, Mersenne, and Pascal in the theory of numbers, prepared the way for the remarkable advance which has taken place in mathematics in the last two centuries. The applications of the calculus to mechanics and astronomy; the forming of such special branches as differential equations; the invention of elliptic functions, hyperbolic trigonometry, descriptive geometry, and modern projective geometry; the enlarging of the doctrine of probability to include the modern theory of statistics and the development of the theory of least squares; the advance in the theory of numbers since the time of Gauss (*c.* 1800); the development of the non-Euclidean geometries; the invention of new number systems; the creation of the theory of functions with its many ramifications; the enrichment of the theory of equations through the introduction of the Galois theory; the modern study of polynomials; the applications of much of this work to the study of electricity, the wave theory, optics, physics, and the nature of the universe; and the laying of more secure foundations of mathematics in its various branches, all this has led to a science of such extent as to make the work of the earlier centuries seem almost insignificant. Certain it is that the 19th and the first part of the 20th centuries have shown a development in pure mathematics and its applications that promises well for its continued growth.

Bibliography.—The history of such special topics as algebra, arithmetic, geometry, trigonometry, calculus, functions, and number will be found treated as extensively as the space permits under these several heads. In addition to these articles the reader will find it desirable to consult the following: M. Cantor, *Vorlesungen über Geschichte der Mathematik* (Leipzig, Teubner, 1880–1908), with various revisions. (The standard treatise for scholars. In consulting the work, *see* the numerous suggestions for change or correction in each number of the *Bibliotheca Mathematica*, 3rd series.) Sir T. L. Heath, *History of Greek Mathematics* (Cambridge, 1921). (The leading work on the subject.) J. C. Poggendorff, *Handwörterbuch zur Geschichte der exacten Wissenschaften* (Leipzig, 1858–1926). (The standard work on mathematical biography.) J. Tropfke, *Geschichte der Elementar-Mathematik* (2nd ed.). (The leading collection of facts on the subject.) F. Cajori, *History of Mathematics,* 2nd. ed. (New York, Macmillan, 1919). (A general survey of the subject.) D. E. Smith, *History of Mathematics* (Boston, U.S.A., Ginn, 1923, 1925). (Chiefly elementary mathematics. Many illustrations, including facsimiles.) S. Günther and H. Wieleitner, *Geschichte der Mathematik* (Leipzig, 1908, 1921). (A general summary for students.) W. W. R. Ball, *History of Mathematics,* various editions (London, Macmillan). (A well-written introduction to the subject). For an extensive bibliography consult Smith's history cited above, and the current volumes of the *Jahrbuch über die Fortschritte der Mathematik* (Berlin); *Isis* (Ghent and Brussels), and the *Revue Semestrielle* (Amsterdam). For the earlier bibliography of historical journals and source material *see* Smith, *op. cit. See* also Mathematical Periodicals and Societies.

(D. E. S.)

MATHEMATICS, NATURE OF, the general term for the various applications of mathematical thought, the traditional field of which is number and quantity. (The word mathematics is derived from the Greek *μαθηματική sc. τέχνη,* art.) It has been usual to define mathematics as "the science of discrete and continuous magnitude." Even Leibnitz,[1] who initiated a more modern point of view, follows the tradition in thus confining the scope of mathematics properly so called, while apparently conceiving it as a department of a yet wider science of reasoning. A short consideration of some leading topics of the science will exemplify both the plausibility and inadequacy of the above definition. Arithmetic, algebra, and the infinitesimal calculus, are sciences directly concerned with integral numbers, rational (or fractional) numbers, and real numbers generally, which include incommensurable numbers. It would seem that "the general theory of discrete and continuous quantity" is the exact description of the topics of these sciences. Furthermore, can we not complete the circle of the mathematical sciences by adding geometry? Now geometry deals with points, lines, planes and cubic contents. Of these all except points are quantities. Also, as the Cartesian geometry shows, all the relations between points are expressible in terms of geometric quantities. Accordingly, at first sight it seems reasonable to define geometry in some such way as "the science of dimensional quantity." Thus every subdivision of mathematical science would appear to deal with quantity, and the definition of mathematics as "the science of quantity" would appear to be justified. We have now to see why the definition is inadequate.

[1]Cf. *La Logique de Leibnitz,* ch. vii., by L. Couturat (Paris, 1901).

CRITICAL QUESTIONS

Types Relating to Numbers.—What are numbers? We can talk of five apples and ten pears. But what are "five" and "ten" apart from the apples and pears? Also in addition to the cardinal numbers there are the ordinal numbers: the fifth apple and the tenth pear claim thought. What is the relation of "the fifth" and "the tenth" to "five" and "ten"? "The first rose of summer" and "the last rose of summer" are parallel phrases, yet one explicitly introduces an ordinal number and the other does not. Again, "half a foot" and "half a pound" are easily defined. But in what sense is there "a half," which is the same for "half a foot" as "half a pound"? Furthermore, incommensurable numbers are defined as the limits arrived at as the result of certain procedures with rational numbers. But how do we know that there is anything to reach? We must know that $\sqrt{2}$ exists before we can prove that any procedure will reach it.

Types Relating to Geometry.—Also in geometry, what is a point? The straightness of a straight line and the planeness of a plane require consideration. Furthermore, "congruence" is a difficulty. For when a triangle "moves," the points do not move with it. So what is it that keeps unaltered in the moving triangle? Thus the whole method of measurement in geometry as described in the elementary textbooks and the older treatises is obscure to the last degree. Lastly, what are "dimensions"? All these topics require thorough discussion before we can rest content with the definition of mathematics as the general science of magnitude; and by the time they are discussed the definition has evaporated. An outline of the modern answers to questions such as the above will now be given. A critical defence of them would require a volume.[1]

Nature of Cardinal Numbers.—A one-one relation between the members of two classes α and β is any method of correlating all the members of α to all the members of β, so that any member of α has one and only one correlate in β, and any member of β has one and only one correlate in α. Two classes between which a one-one relation exists have the same cardinal number and are called cardinally similar; and the cardinal number of the class α is a certain class whose members are themselves classes—namely, it is the class composed of all those classes for which a one-one correlation with α exists. Thus the cardinal number of α is itself a class, and furthermore α is a member of it. For a one-one relation can be established between the members of α and α by the simple process of correlating each member of α with itself. Thus the cardinal number one is the class of unit classes, the cardinal number two is the class of doublets, and so on. Also a unit class is any class with the property that it possesses a member x such that, if y is any member of the class, then x and y are identical. A doublet is any class which possesses a member x such that the modified class formed by all the other members except x is a unit class. And so on for all the finite cardinals, which are thus defined successively. The cardinal number zero is the class of classes with no members; but there is only one such class, namely—the null class. Thus this cardinal number has only one member. The operations of addition and multiplication of two given cardinal numbers can be defined by taking two classes α and β, satisfying the conditions (1) that their cardinal numbers are respectively the given numbers, and (2) that they contain no member in common, and then by defining by reference to α and β two other suitable classes whose cardinal numbers are defined to be respectively the

[1]Cf. *The Principles of Mathematics,* by Bertrand Russell (Cambridge, 1903).

required sum and product of the cardinal numbers in question.

With these definitions it is now possible to *prove* the following six premises applying to finite cardinal numbers, from which Peano[1] has shown that all arithmetic can be deduced:—

i. Cardinal numbers form a class. ii. Zero is a cardinal number. iii. If a is a cardinal number, $a+1$ is a cardinal number. iv. If s is any class and zero is a member of it, also if when x is a cardinal number and a member of s, also $x+1$ is a member of s, then the whole class of cardinal numbers is contained in s. v. If a and b are cardinal numbers, and $a+1=b+1$, then $a=b$. vi. If a is a cardinal number, then $a+1=0$.

It may be noticed that (iv.) is the familiar principle of mathematical induction. Peano in an historical note refers its first explicit employment, although without a general enunciation, to Maurolycus in his work, *Arithmeticorum libri duo* (Venice, 1575).

But now the difficulty of confining mathematics to being the science of number and quantity is immediately apparent. For there is no self-contained science of cardinal numbers. The proof of the six premises requires an elaborate investigation into the general properties of classes and relations which can be deduced by the strictest reasoning from our ultimate logical principles. Also it is purely arbitrary to erect the consequences of these six principles into a separate science. They are excellent principles of the highest value, but they are in no sense the necessary premises which must be proved before any other propositions of cardinal numbers can be established. On the contrary, the premises of arithmetic can be put in other forms, and, furthermore, an indefinite number of propositions of arithmetic can be proved directly from logical principles without mentioning them. Thus, while arithmetic may be defined as that branch of deductive reasoning concerning classes and relations which is concerned with the establishment of propositions concerning cardinal numbers, the introduction of cardinal numbers makes no great break in this general science. It is merely a subdivision in a general theory.

Nature of Ordinal Numbers.—We must first understand what is meant by "order," that is, by "serial arrangement." An order of a set of things is to be sought in that relation holding between members of the set which constitutes that order. The set viewed as a class has many orders. Thus the telegraph posts along a certain road have a space-order very obvious to our senses; but they have also a time-order according to dates of erection, perhaps more important to the postal authorities who replace them after fixed intervals. A set of cardinal numbers has an order of magnitude, often called *the* order of the set because of its insistent obviousness to us; but, if they are the numbers drawn in a lottery, their time-order of occurrence in that drawing also ranges them in an order of some importance. Thus the order is defined by the "serial" relation. A relation (R) is serial[2] when (1) it implies diversity, so that, if x has the relation R to y, x is diverse from y; (2) it is transitive, so that if x has the relation R to y, and y to z, then x has the relation R to z; (3) it has the property of connexity, so that if x and y are things to which any things bear the relation R, or which bear the relation R to any things, then *either* x is identical with y, *or* x has the relation R to y, *or* y has the relation R to x. These conditions are necessary and sufficient to secure that our ordinary ideas of "preceding" and "succeeding" hold in respect to the relation R. The "field" of the relation R is the class of things ranged in order by it. Two relations R and R′ are said to be ordinally similar, if a one-one relation holds between the members of the two fields of R and R′, such that if x and y are any two members of the field of R, such that x has the relation R to y, and if x' and y' are the correlates in the field of R′ of x and y, then in all such cases x' has the relation R′ to y', and conversely, interchanging the dashes on the letters, *i.e.*, R and R′, x and x', etc. It is evident that the ordinal similarity of two relations implies the cardinal similarity of their fields, but not conversely. Also, two relations need not be serial in order to be ordinally similar; but if one is serial, so is the other. The relation-number of a relation is the class whose members are all those relations which are ordinally similar to it. This class will include the original relation itself. The relation-number of a relation should be compared with the cardinal number of a class. When a relation is serial its relation-number is often called its serial type. The addition and multiplication of two relation-numbers is defined by taking two relations R and S, such that (1) their fields have no terms in common; (2) their relation-numbers are the two relation-numbers in question, and then by defining by reference to R and S two other suitable relations whose relation-numbers are defined to be respectively the sum and product of the relation-numbers in question. We need not consider the details of this process. Now if n be any finite cardinal number, it can be proved that the class of those serial relations, which have a field whose cardinal number is n, is a relation-number. This relation-number is the ordinal number corresponding to n; let it be symbolized by $\dot{n}$. Thus, corresponding to the cardinal numbers 2, 3, 4 . . . there are the ordinal numbers $\dot{2}$, $\dot{3}$, $\dot{4}$. . . . The definition of the ordinal number 1 requires some little ingenuity owing to the fact that no serial relation can have a field whose cardinal number is 1; but we must omit here the explanation of the process. The ordinal number $\dot{0}$ is the class whose sole member is the null relation—that is, the relation which never holds between any pair of entities. The definitions of the finite ordinals can be expressed without use of the corresponding cardinals, so there is no essential priority of cardinals to ordinals. Here also it can be seen that the science of the finite ordinals is merely a subdivision of the general theory of classes and relations.

Cantor's Infinite Numbers.—Owing to the correspondence between the finite cardinals and the finite ordinals, the propositions of cardinal arithmetic and ordinal arithmetic correspond point by point. But the definition of the cardinal number of a class applies when the class is not finite, and it can be proved that there are different infinite cardinal numbers, and that there is a least infinite cardinal, now usually denoted by $\aleph_0$, where $\aleph$ is the Hebrew letter aleph. Similarly, a class of serial relations, called *well-ordered* serial relations, can be defined, such that their corresponding relation-numbers include the ordinary finite ordinals, but also include relation-numbers which have many properties like those of the finite ordinals, though the fields of the relations belonging to them are not finite. These relation-numbers are the infinite ordinal numbers. The arithmetic of the infinite cardinals does not correspond to that of the infinite ordinals. The theory of these extensions of the ideas of number is dealt with in the article NUMBER. It will suffice to mention here that Peano's fourth premise of arithmetic does not hold for infinite cardinals or for infinite ordinals. Contrasting the above definitions of number, cardinals and ordinals, with the alternative theory that number is an ultimate idea incapable of definition, we find that our procedure exacts greater attention and less credulity.

The Data of Analysis.—Rational numbers and real numbers in general can now be defined according to the same general method. If m and n are finite cardinal numbers, the rational number m/n is the relation which any finite cardinal number x bears to any finite cardinal number y when $n\times x=m\times y$. Thus the rational number one, which we will denote by 1_r, is not the cardinal number 1; for 1_r is the relation 1/1 as defined above, and is thus a relation holding between certain pairs of cardinals. Similarly, the other rational integers must be distinguished from the corresponding cardinals. The arithmetic of rational numbers is now established by means of appropriate definitions, which indicate the entities meant by the operations of addition and multiplication. But in order to obtain general enunciations of theorems without exceptional cases, mathematicians employ entities of ever-ascending types of elaboration. These entities are not created but are employed by mathematicians, and their definitions should show the construction of the new entities in terms of the old. The real numbers, including irrational numbers, have now to be defined. Consider the serial arrangement of the rationals in their order of magnitude. A real number is a class (α, say) of rational numbers which satisfies the condition that it is the same as the class of those rationals each of which precedes at least one member of α. Thus,

[1]Cf. *Formulaire mathématique* (Turin, ed. of 1903); earlier formulations of the bases of arithmetic are given by him in the editions of 1898 and of 1901. The variations are only trivial.

[2]*Cf.* Russell, *loc. cit.*, pp. 199–256.

consider the class of rationals less than 2_r; any member of this class precedes some other members of the class—thus 1/2 precedes 4/3, 3/2 and so on; also the class of predecessors of predecessors of 2_r is itself the class of predecessors of 2_r. Accordingly this class is a real number; it will be called the real number 2_R. Note that the class of rationals less than or equal to 2_r is not a real number. For 2_r is not a predecessor of some member of the class. In the above example 2_R is an integral real number, which is distinct from a rational integer, and from a cardinal number. Similarly, any rational real number is distinct from the corresponding rational number. But now the irrational real numbers have all made their appearance. For example, the class of rationals whose squares are less than 2_r satisfies the definition of a real number; it is the real number $\sqrt{2}$. The arithmetic of real numbers follows from appropriate definitions of the operations of addition and multiplication. Except for the immediate purposes of an explanation, such as the above, it is unnecessary for mathematicians to have separate symbols, such as 2, 2_r and 2_R, or 2/3 and $(2/3)_R$. Real numbers with signs (+ or −) are now defined. If a is a real number, $+a$ is defined to be the relation which any real number of the form $x+a$ bears to the real number x, and $-a$ is the relation which any real number x bears to the real number $x+a$. The addition and multiplication of these "signed" real numbers is suitably defined, and it is proved that the usual arithmetic of such numbers follows. Finally, we reach a complex number of the nth order. Such a number is a "one-many" relation which relates n signed real numbers (or n algebraic complex numbers when they are already defined by this procedure) to the n cardinal numbers 1, 2 ... n respectively. If such a complex number is written (as usual) in the form $x_1e_1+x_2e_2+\ldots+x_ne_n$, then this particular complex number relates x_1 to 1, x_2 to 2, ... x_n to n. Also the "unit" e_1 (or e_s) considered as a number of the system is merely a shortened form for the complex number $(+1)e_1+0e_2\ldots+0e_n$. This last number exemplifies the fact that one signed real number, such as 0, may be correlated to many of the n cardinals, such as 2 ... n in the example, but that each cardinal is only correlated with one signed number. Hence the relation has been called above "one-many." The sum of two complex numbers $x_1e_1+x_2e_2+\ldots+x_ne_n$ and $y_1e_1+y_2e_2+\ldots+y_ne_n$ is always defined to be the complex number $(x_1+y_1)e_1+(x_2+y_2)e_2+\ldots+(x_n+y_n)e_n$. But an indefinite number of definitions of the product of two complex numbers yield interesting results. Each definition gives rise to a corresponding algebra of higher complex numbers. We will confine ourselves here to algebraic complex numbers—that is, to complex numbers of the second order taken in connection with that definition of multiplication which leads to ordinary algebra. The product of two complex numbers of the second order—namely, $x_1e_1+x_2e_2$ and $y_1e_1+y_2e_2$, is in this case defined to mean the complex $(x_1y_1+x_2y_2)\,e_1+(x_1y_2+x_2y_1)e_2$. Thus $e_1\times e_1=e_1$, $e_2\times e_2=-e_1$, $e_1\times e_2=e_2\times e_1=e_2$. With this definition it is usual to omit the first symbol e_1, and to write i or $\sqrt{-1}$ instead of e_2. Accordingly, the typical form for such a complex number is $x+yi$, and then with this notation the above-mentioned definition of multiplication is invariably adopted. The importance of this algebra arises from the fact that in terms of such complex numbers with this definition of multiplication the utmost generality of expression, to the exclusion of exceptional cases, can be obtained for theorems which occur in analogous forms, but complicated with exceptional cases, in the algebras of real numbers and of signed real numbers. This is exactly the same reason as that which has led mathematicians to work with signed real numbers in preference to real numbers, and with real numbers in preference to rational numbers.

DEFINITION OF MATHEMATICS

It has now become apparent that the traditional field of mathematics in the province of discrete and continuous number can only be separated from the general abstract theory of classes and relations by a wavering and indeterminate line. Of course a discussion as to the mere application of a word degenerates into the most fruitless logomachy. But on the assumption that "mathematics" is to denote a science well marked out by its subject matter and its methods, and that at least it is to include all topics habitually assigned to it, "mathematics" is employed in the general sense[1] of the "science concerned with the logical deduction of consequences from the general premises of all reasoning."

Geometry.—The typical mathematical proposition is: "If x, y, z . . . satisfy such and such conditions, then such and such other conditions hold with respect to them." By taking fixed conditions for the hypothesis of such a proposition a definite department of mathematics is marked out. For example, geometry is such a department. The "axioms" of geometry are the fixed conditions which occur in the hypotheses of the geometrical propositions. The special nature of the "axioms" which constitute geometry is considered in the article GEOMETRY: *Axioms*. It is sufficient to observe here that they are concerned with special types of classes of classes and of classes of relations, and that the connection of geometry with number and magnitude is in no way an essential part of the foundation of the science.

Classes and Relations.—We now must deduce the general properties of classes and relations from the ultimate logical premises. In the course of this process, some contradictions have become apparent. That first discovered is known as Burali-Forti's contradiction,[2] and consists in the proof that there both is and is not a greatest infinite ordinal number. But these contradictions do not depend upon any theory of number, for Russell's contradiction[3] does not involve number in any form. This contradiction arises from considering the class possessing as members all classes which are not members of themselves. Call this class w; then to say that x is a w is equivalent to saying that x is not an x. Accordingly, to say that w is a w is equivalent to saying that w is not a w. An analogous contradiction can be found for relations. It follows that a careful scrutiny of the very idea of classes and relations is required. Note that classes are here required in extension, so that the class of human beings and the class of rational featherless bipeds are identical; similarly for relations, which are to be determined by the entities related. Now a class in respect to its components is many. In what sense then can it be one? This problem of "the one and the many" has been discussed continuously by the philosophers.[4] All the contradictions can be avoided, and yet the use of classes and relations can be preserved as required by mathematics, and indeed by common sense, by a theory which denies to a class—or relation—existence or being in any sense in which the entities composing it—or related by it—exist. Thus, to say that a pen is an entity and the class of pens is an entity is merely a play upon the word "entity"; the second sense of "entity" (if any) is indeed derived from the first, but has a more complex signification. Consider an incomplete proposition, incomplete in the sense that some entity which ought to be involved in it is represented by an undetermined x, which may stand for any entity. Call it a propositional function; and, if ϕx be a propositional function, the undetermined variable x is the argument. Two propositional functions ϕx and ψx are "extensionally identical" if any determination of x in ϕx which converts ϕx into a true proposition also converts ψx into a true proposition, and conversely for ψ and ϕ. Now consider a propositional function $F\chi$ in which the variable argument χ is itself a propositional function. If $F\chi$ is true when, and only when, χ is determined to be either ϕ or some other propositional function extensionally equivalent to ϕ, then the proposition $F\phi$ is of the form which is ordinarily recognized as being about the class determined by ϕx taken in extension—that is, the class of entities for which ϕx is a true proposition when x is determined to be any one of them. A similar theory holds for relations which arise from

[1]The first unqualified explicit statement of *part* of this definition seems to be by B. Peirce, "Mathematics is the science which draws necessary conclusions" (*Linear Associative Algebra*, § i. [1870], republished in the *Amer. Journ. of Math.*, vol. iv. [1881]). But it will be noticed that the second half of the definition in the text—"from the general premises of all reasoning"—is left unexpressed. The full expression of the idea and its development into a philosophy of mathematics is due to Russell, *loc. cit.*

[2]"Una questione sui numeri transfiniti," *Rend. del circolo mat. di Palermo*, vol. xi. (1897) and Russell, *loc. cit.*, ch. xxxviii.

[3]*Cf.* Russell, *loc. cit.*, ch. x.

[4]Cf. *Pragmatism: a New Name for Some Old Ways of Thinking* (1907).

the consideration of propositional functions with two or more variable arguments. It is then possible to define by a parallel elaboration what is meant by classes of classes, classes of relations, relations between classes and so on. Accordingly, the number of a class of relations can be defined, or of a class of classes, and so on. This theory[1] is in effect a theory of the *use* of classes and relations, and does not decide the philosophic question as to the sense (if any) in which a class in extension is one entity. It does indeed deny that it is an entity in the sense in which one of its members is an entity. Accordingly, it is a fallacy for any determination of x to consider "x is an x" or "x is not an x" as having the meaning of propositions. Note that for any determination of x, "x is an x" and "x is not an x" are neither of them fallacies but are both meaningless, according to this theory. Thus Russell's contradiction vanishes, and the other contradictions vanish also.

APPLIED MATHEMATICS

Selection of Topics.—The selection of the topics of mathematical inquiry among the infinite variety open to it has been guided by the useful applications, and indeed the abstract theory has only recently been disentangled from the empirical elements connected with these applications. For example, the application of the theory of cardinal numbers to classes of physical entities involves in practice some process of counting. It is only recently that the *succession* of processes which is involved in any act of counting has been seen to be irrelevant to the idea of number. Indeed, it is only by experience that we can know that any definite process of counting will give the true cardinal number of some class of entities. It is perfectly possible to imagine a universe in which any act of counting by a being in it annihilates some members of the class counted during the time and only during the time of its continuance. A legend of the Council of Nicea[2] illustrates this point: "When the Bishops took their places on their thrones, they were 318; when they rose up to be called over, it appeared that they were 319; so that they never could make the number come right, and whenever they approached the last of the series, he immediately turned into the likeness of his next neighbour." Such a story cannot be disproved by deductive reasoning from the premises of abstract logic. We can only assert that a universe in which such things are liable to happen on a large scale is unfitted for the practical application of the theory of cardinal numbers. The application of the theory of real numbers to physical quantities involves analogous considerations. In the first place, some physical process of addition is presupposed, involving some inductively inferred law of permanence during that process. Thus in the theory of masses we must know that two pounds of lead when put together will counterbalance in the scales two pounds of sugar, or a pound of lead and a pound of sugar. Furthermore, the sort of continuity of the series (in order of magnitude) of rational numbers is known to be different from that of the series of real numbers. Indeed, mathematicians now reserve "continuity" as the term for the latter kind of continuity; the mere property of having an infinite number of terms between any two terms is called "compactness." The compactness of the series of rational numbers is consistent with quasi-gaps in it—that is, with the possible absence of limits to classes in it. Thus the class of rational numbers whose squares are less than 2 has no upper limit among the rational numbers. But among the real numbers all classes have limits. Now, owing to the necessary inexactness of measurement, it is impossible to discriminate directly whether any kind of continuous physical quantity possesses the compactness of the series of rationals or the continuity of the series of real numbers. In calculations the latter hypothesis is made because of its mathematical simplicity. But the assumption has certainly no *a priori* grounds in its favour and it is not very easy to see how to base it upon experience. For example, the continuity of space apparently rests upon sheer assumption unsupported by any *a priori* or experimental grounds. Thus the current application of mathematics to the analysis of phenomena can be justified by no *a priori* necessity.

[1]Due to Bertrand Russell, *cf.* "Mathematical Logic as based on the Theory of Types," *Amer. Journ. of Math.* vol. xxx. (1908). It is more fully explained by him, with later simplifications, in *Principia mathematica* (Cambridge).

[2]*Cf.* Stanley's *Eastern Church,* Lecture v.

Existence of Applied Mathematics.—In one sense there is no science of applied mathematics. When once the fixed conditions which any hypothetical group of entities are to satisfy have been precisely formulated, the deduction of the further propositions, which also will hold respecting them, can proceed in complete independence of the question as to whether or no any such group of entities can be found in the world of phenomena. Thus rational mechanics, based on the Newtonian Laws and viewed as mathematics is independent of its supposed application, and hydrodynamics remains a coherent and respected science though it is extremely improbable that any perfect fluid exists in the physical world. But this unbendingly logical point of view cannot be the last word upon the matter. For no one can doubt the essential difference between characteristic treatises upon "pure" and "applied" mathematics. The difference is a difference in method. In pure mathematics the hypotheses which a set of entities are to satisfy are given, and a group of interesting deductions are sought. In "applied mathematics" the "deductions" are given in the shape of the experimental evidence of natural science, and the hypotheses from which the "deductions" can be deduced are sought. Accordingly, every treatise on applied mathematics, properly so-called, is directed to the criticism of the "laws" from which the reasoning starts, or to a suggestion of results which experiment may hope to find. Thus if it calculates the result of some experiment, it is not the experimentalist's well-attested results which are on their trial, but the basis of the calculation.

SYNOPSIS OF EXISTING DEVELOPMENTS OF PURE MATHEMATICS

The International Catalogue.—A complete classification of mathematical sciences, as they at present exist, is to be found in the *International Catalogue of Scientific Literature* promoted by the Royal Society, and was drawn up by an international committee of eminent mathematicians, and has the highest authority. It must not be criticized from an exacting philosophical point of view. The practical object of the enterprise required that the proportionate quantity of yearly output in the various branches, and that the liability of various topics as a matter of fact to occur in connection with each other, should modify the classification.

Fundamental Notions.—Section A deals with pure mathematics. Under the general heading *"Fundamental Notions"* occur the subheadings *"Foundations of Arithmetic,"* with the topics rational, irrational and transcendental numbers, and aggregates; *"Universal Algebra,"* with the topics complex numbers, quaternions, *Ausdehnungslehre,* vector analysis, matrices and algebra of logic; and *"Theory of Groups,"* with the topics finite and continuous groups. For the subjects of this general heading *see* the articles ALGEBRA; ALGEBRAIC NUMBERS; GROUPS; CALCULUS; NUMBER; NUMBERS, THEORY OF; QUATERNIONS; VECTOR ANALYSIS.

Algebra.—Under the general heading *"Algebra and Theory of Numbers"* occur the subheadings *"Elements of Algebra,"* with the topics rational polynomials, permutations, etc., partitions, probabilities; *"Linear Substitutions,"* with the topics determinants, etc., linear substitutions, general theory of quantics; *"Theory of Algebraic Equations,"* with the topics existence of roots, separation of and approximation to, theory of Galois, etc. *"Theory of Numbers,"* with the topics congruences, quadratic residues, prime numbers, particular irrational and transcendental numbers. For the subjects of this general heading *see* the articles ALGEBRA; ALGEBRAIC FORMS; ARITHMETIC; COMBINATORIAL ANALYSIS; DETERMINANTS; EQUATIONS, THEORY OF; FRACTION; CONTINUED FRACTIONS; INTERPOLATION; LOGARITHMS; MAGIC SQUARE; PROBABILITY AND ERROR.

Analysis.—Under the general heading *"Analysis"* occur the subheadings *"Foundations of Analysis,"* with the topics theory of functions of real variables, series and other infinite processes, principles and elements of the differential and of the integral calculus, definite integrals, and calculus of variations; *"Theory of*

Functions of Complex Variables," with the topics functions of one variable and of several variables; *"Algebraic Functions and their Integrals,"* with the topics algebraic functions of one and of several variables, elliptic functions and single theta functions, Abelian integrals; *"Other Special Functions,"* with the topics Euler's, Legendre's, Bessel's and automorphic functions; *"Differential Equations,"* with the topics existence theorems, methods of solution, general theory; *"Differential Forms and Differential Invariants,"* with the topics differential forms, including Pfaffians, transformation of differential forms, including tangential (or contact) transformations, differential invariants; *"Analytical Methods connected with Physical Subjects,"* with the topics harmonic analysis, Fourier's series, the differential equations of applied mathematics, Dirichlet's problem; *"Difference Equations and Functional Equations,"* with the topics recurring series, solution of equations of finite differences and functional equations. For the subjects of this heading *see* the articles DIFFERENTIAL EQUATIONS; FOURIER'S SERIES; CONTINUED FRACTIONS; FUNCTIONS; GROUPS; CALCULUS; MAXIMA AND MINIMA; SERIES; NUMBER SEQUENCES; SPHERICAL HARMONICS; TRIGONOMETRY; CALCULUS OF VARIATIONS; DIFFERENTIAL FORMS.

Geometry.—Under the general heading *"Geometry"* occur the subheadings *"Foundations,"* with the topics principles of geometry, non-Euclidean geometries, hyperspace, methods of analytical geometry; *"Elementary Geometry,"* with the topics planimetry, stereometry, trigonometry, descriptive geometry; *"Geometry of Conics and Quadrics,"* with the implied topics; *"Algebraic Curves and Surfaces of Degree higher than the Second,"* with the implied topics; *"Transformations and General Methods for Algebraic Configurations,"* with the topics collineation, duality, transformations, correspondence, groups of points on algebraic curves and surfaces, genus of curves and surfaces, enumerative geometry, connexes, complexes, congruences, higher elements in space, algebraic configurations in hyperspace; *"Infinitesimal Geometry: applications of Differential and Integral Calculus to Geometry,"* with the topics kinematic geometry, curvature, rectification and quadrature, special transcendental curves and surfaces; *"Differential Geometry: applications of Differential Equations to Geometry,"* with the topics curves on surfaces, minimal surfaces, surfaces determined by differential properties, conformal and other representation of surfaces on others, deformation of surfaces, orthogonal and isothermic surfaces. For the subjects under this heading *see* the articles CONIC SECTIONS; CIRCLE; CURVE; CURVES, SPECIAL; GEOMETRY: *Axioms;* GEOMETRY, NON-EUCLIDEAN; PROJECTIVE GEOMETRY; ANALYTIC GEOMETRY; LINE GEOMETRY; KNOTS; MENSURATION; MATHEMATICAL MODELS; PROJECTION; SURFACE; TRIGONOMETRY.

Conclusion of the Survey.—This survey of the existing developments of pure mathematics confirms the conclusions arrived at from the previous survey of the theoretical principles of the subject. Functions, operations, transformations, substitutions, correspondences, are but names for various types of relations. A group is a class of relations possessing a special property. Thus the modern ideas, which have so powerfully extended and unified the subject, have loosened its connection with "number" and "quantity," while bringing ideas of form and structure into increasing prominence. Number must indeed ever remain the great topic of mathematical interest, because it is in reality the great topic of applied mathematics. But the complexity of the idea of number is practically illustrated by the fact that it is best studied as a department of a science wider than itself.

SYNOPSIS OF EXISTING DEVELOPMENTS OF APPLIED MATHEMATICS

Measurement of Dynamical Quantities.—Section B of the *International Catalogue* deals with mechanics. The heading *"Measurement of Dynamical Quantities"* includes the topics units, measurements and the constant of gravitation. The topics of the other headings do not require express mention. These headings are: *"Geometry and Kinematics of Particles and Solid Bodies"; "Principles of Rational Mechanics"; "Statics of Particles, Rigid Bodies, etc."; "Kinetics of Particles, Rigid Bodies, etc."; "General Analytical Mechanics"; "Statics and Dynamics of Fluids"; "Hydraulics and Fluid Resistances"; "Elasticity."* For the subjects of this general heading *see* the articles MECHANICS; DYNAMICS; GYROSCOPE; HARMONIC ANALYSIS; HYDROMECHANICS; ELASTICITY; MOTION, LAWS OF; ENERGY; THERMODYNAMICS; ASTRONOMY (*Celestial Mechanics*); SURVEYING; TIDES, and others.

Mechanics.—Mechanics (including dynamical astronomy) is that subject among those traditionally classed as "applied" which has been most completely transfused by mathematics—that is to say, which is studied with the deductive spirit of the pure mathematician.

Theory of the Universe.—Every branch of physics gives rise to an application of mathematics. A prophecy may be hazarded that in the future these applications will unify themselves into a mathematical theory of a hypothetical substructure of the universe, uniform under all the diverse phenomena. This reflection is suggested by the following articles: ETHER; MOLECULE; CAPILLARY ACTION; DIFFUSION; RADIATION.

Statistics.—The applications of mathematics to statistics (*see* STATISTICS and PROBABILITY) should not be lost sight of; the leading fields for these applications are insurance, sociology, variation in zoology and economics.

BIBLIOGRAPHY.—References to expositions of branches of mathematics are given in the appropriate articles. We refer here to sources in which the subject is considered as one whole. Most philosophers refer to mathematics more or less cursorily, either in the treatment of the ideas of number and magnitude, or in their consideration of the alleged *a priori* and necessary truths. A bibliography of such references would be in effect a bibliography of metaphysics, or rather of epistemology. The founder of the modern point of view, explained in this article, was Leibnitz, who, however, was so far in advance of contemporary thought that his ideas remained neglected and undeveloped until recently; cf. *Opuscules et fragments inédits de Leibnitz. Extraits des manuscrits de la bibliothèque royale de Hanovre,* by Louis Couturat (Paris, 1903), especially pp. 356–399, "Generales inquisitiones de analysi notionum et veritatum" (written in 1686); also *cf. La Logique de Leibnitz,* already referred to. For the modern authors who have rediscovered and improved upon the position of Leibnitz, *cf. Grundgesetze der Arithmetik, begriffsschriftlich abgeleitet von Dr. G. Frege, a.o. Professor an der Univ. Jena* (Bd. i., 1893; Bd. ii., 1903, Jena); also *cf.* Frege's earlier works, *Begriffsschrift eine der arithmetischen nachgebildete Formelsprache des reinen Denkens* (Halle, 1879), and *Die Grundlagen der Arithmetik* (Breslau, 1884); also *cf.* Bertrand Russell, *The Principles of Mathematics* (Cambridge, 1903), and his article on "Mathematical Logic" in *Amer. Quart. Journ. of Math.* (vol. xxx., 1908). Also the following works are of importance, though not all expressly expounding the Leibnitzian point of view: *cf.* G. Cantor, "Grundlagen einer allgemeinen Mannigfaltigkeitslehre," *Math. Annal.*, vol. xxi. (1883) and subsequent articles in vols. xlvi. and xlix.; also R. Dedekind, *Stetigkeit und irrationale Zahlen* (1st ed., 1872), and *Was sind und was sollen die Zahlen?* (1st ed., 1887), both tracts translated into English under the title *Essays on the Theory of Numbers* (Chicago, 1901). These works of G. Cantor and Dedekind were of the greatest importance in the progress of the subject. Also *cf.* G. Peano (with various collaborators of the Italian school), *Formulaire de mathématiques* (Turin, various editions, 1894–1908; the earlier editions are the more interesting philosophically); Felix Klein, *Lectures on Mathematics* (New York, 1894); W. K. Clifford, *The Common Sense of the exact Sciences* (London, 1885); H. Poincaré, *La Science et l'hypothèse* (Paris, 1st ed., 1902), English translation under the title, *Science and Hypothesis* (London, 1905); L. Couturat, *Les Principes des mathématiques* (Paris, 1905); E. Mach, *Die Mechanik in ihrer Entwickelung* (Prague, 1883), English translation under the title, *The Science of Mechanics* (London, 1893); K. Pearson, *The Grammar of Science* (London, 1st ed., 1892; 2nd ed., 1900, enlarged); A. Cayley, *Presidential Address* (Brit. Assoc., 1883); B. Russell and A. N. Whitehead, *Principia Mathematica* (Cambridge, 1911). (A. N. W.)

MATHER, COTTON (1663–1728), American Congregational minister and author, son of Increase Mather (*q.v.*), lived all his life in Boston, where he was born on Feb. 12, 1663. From 1685 till his death he was a minister of the Second Church there. He took his A.B. at Harvard in 1678 and his A.M. in 1681.

In 1688 and 1689 when some of the colonists opposed the royal governor, Sir Edmund Andros, Mather was one of their leaders. When Sir William Phips, one of his disciples, became governor in 1692, Mather became influential in politics, but the ill success of Phips's administration and perhaps Mather's own lack of

diplomacy lessened his power. After 1702, when Joseph Dudley became governor, he lost most of his political prestige. He was made a fellow of Harvard in 1690, but gave up this office in 1703 after his father had been ousted from the presidency of the college. He longed to be president himself, but those who opposed his conservative views on church polity, differed with him politically, or disliked his too dictatorial tone on public affairs, prevented his being chosen. He turned much of his attention to Yale which he hoped might remain a stronghold of Congregational orthodoxy now that Harvard was less strict, and in 1722 seems to have declined an offer of the presidency of the Connecticut college.

Perhaps his most tangible public service was his advocacy of inoculation for smallpox in 1721. He interested Dr. Zabdiel Boylston, and his fearless scientific attitude in the face of opposition did much to advance the new weapon against the disease.

In his own day his fame was international. He corresponded with several distinguished European scholars, was elected to the Royal Society in 1713, and the University of Aberdeen gave him an honorary degree in 1710. His contemporary reputation was based partly on his writings—he published some 450 works on history, science, biography and various aspects of theology and religion—most important of which is a collection of biographies and historical fragments bearing on the "church history of New England" and called the *Magnalia Christi Americana* (1702). In spite of manifest defects this was the most elaborate book of the kind thus far produced in the Colonies, and is still of great historical value. It has also some real literary merit. In part, too, he was famous for his scholarship—which, judged by the standards of his time, was great—for his amazingly wide reading, for his preaching, for his interest in and knowledge of current science and for his zeal in promoting piety and religion.

Ever since 1728 Cotton Mather has been more celebrated than any other American Puritan. Part of his notoriety is based on the theory that he was to some extent personally responsible for the witchcraft prosecution at Salem in 1692. He believed in witchcraft, investigated cases of supposed diabolic possession, and wrote before 1700 several books on the subject, among them an account of some of the Salem trials. Thus he may have stimulated the popular excitement of 1692, but that he tried to do so or was malicious in intent is not shown by the evidence. He warned the witch judges that some of their methods were unfair, and was convinced that some of the victims were unjustly sentenced.

A conservative, he kept abreast of many of the newer ideas of his time, and grew in tolerance toward other sects than his own. In 1718 he helped to ordain a Baptist minister; in 1726 he boasted that his own church had admitted to communion members of other denominations. In his writing he achieved some admirable prose, though he was archaic in his love of learned allusions and quotations. Nervously sensitive, hot-tempered, too eager in controversy, he had traits of the fanatic; vanity and ambition were elements in his character. None the less, throughout his life he gave himself unsparingly for what he believed was the good, spiritual and material, of his fellow men. However much some aspects of his nature and methods may repel, one must respect the nobility of his motives and his devotion to an ideal. He married three times. Nine of his 15 children died young, and only two outlived him.

See Cotton Mather's *Diary*, ed. W. C. Ford (1911–12), and the biographies by Samuel Mather (1729), Barrett Wendell (1891, 1926), and A. P. Marvin (1892). For bibliography *see* J. L. Sibley, *Biographical Sketches of Harvard Graduates*, vol. iii. (1873–85), and *Cambridge History of American Literature*, vol. i. (1917–21); *see* also K. B. Murdock, ed., *Selections from Cotton Mather* (1926), which contains a biographical and critical introduction. Many of the numerous short articles on Mather's life and activities are in the *Proceedings* of the American Antiquarian Society and of the Massachusetts Historical Society, and in the *Publications* of the Colonial Society of Massachusetts. *See* also B. Wendell, *Cotton Mather, the Puritan Priest* (1926); R. P. and L. Boas, *Cotton Mather, Keeper of the Puritan Conscience* (N.Y., 1928). (K. B. M.)

MATHER, INCREASE (1639–1723), American Congregational minister and author, was the youngest son of Richard Mather (*q.v.*). Born in Dorchester on June 21, 1639, he graduated at Harvard in 1656, took his M.A. degree at Trinity college, Dublin, in 1658, and ministered to congregations at Great Torrington, Devonshire, at Guernsey, at Gloucester, and at Weymouth and Dorchester in Dorsetshire. He returned to Boston in 1661, and in the next year married Maria, daughter of the Rev. John Cotton. He became teacher of the Second church in Boston in 1664, licenser of the press in 1674, fellow of Harvard in 1675 and in 1685 president of the college. In 1688 he went to London as the emissary of some of the Massachusetts churches to try to regain the old colonial charter. In 1690 he was made one of the Colony's official agents in England. He stayed in London till 1692, interviewing James II., William III., Queen Mary, and many others influential in politics. He enlisted in his cause the good offices not only of his Puritan brethren but of Penn the Quaker and of Bishops Burnet and Tillotson, the Anglicans. The old charter was not restored, but Mather was instrumental in making some of the terms of the new charter of 1691 more favourable to the colonists than they might otherwise have been. The king allowed him to nominate the royal governor and the other officers for the first year under the new charter. Phips, the governor of Mather's choice, proved unpopular, as did the charter itself, so that in 1701 those who combated Mather's political views or envied his power forced him from the presidency of Harvard.

For the rest of his life he was less active in public affairs, but wrote much and remained a dominating figure in Congregational councils. In 1721 he joined the campaign for inoculation for smallpox, in spite of his age and heedless of popular opposition. He published more than 150 books, most of them theological, but a few dealing with history, biography, or, in part, with science. Among the more interesting to-day are his life of Richard Mather (1670), his political tracts written in 1688–93, his *Essay for the Recording of Illustrious Providences* (1684), a collection of narratives of strange happenings in New England with discussion of a few scientific topics, his *Brief History of the War with the Indians* (1676), and his account of the Indian wars in New England, *A Relation of the Troubles . . .* (1677). His *Cases of Conscience* (1693) displays his attitude toward the witchcraft trials of 1692, and it is probable that the appearance of this book did much to end convictions for witchcraft in Massachusetts.

Harvard developed during Mather's term of office; his agency in England had important historical results; and to the fame given him by these things was added that derived from his reputation as preacher and scholar. He manifested his interest in science by forming a scientific society in Boston in 1683. His large library reflected the wide range of his reading in politics, science, the classics and history, as well as in theology. His hot temper, his stout championing of his own doctrines—though he was more moderate in debate than most of his adversaries—and his reputed ambition made enemies, who were, however, always outnumbered at home and abroad by those who revered him as a leader. He grew in tolerance, and in 1718 helped to ordain a Baptist minister in Boston. On one occasion at least, members of other sects were admitted to communion in his church. Among his many friends were Richard Baxter, the great English Puritan, and the physicist, Robert Boyle. To them he seemed, as to most later historians, the most powerful man of his time in the Puritan Colonies.

BIBLIOGRAPHY.—*See* K. B. Murdock, *Increase Mather* (1925), for a detailed biography, with a list of Mather's writings and of sources of information about him. *See* also Cotton Mather, *Parentator* (1724); W. Walker, *Ten New England Leaders* (1901); and J. L. Sibley, *Biographical Sketches of Harvard Graduates*, vol. i. (1873–85). Likenesses of him are reproduced and discussed in K. B. Murdock, *The Portraits of Increase Mather* (1924). (K. B. M.)

MATHER, RICHARD (1596–1669), American Congregational minister, was born in Lowton, Lancashire, England. At 15 he began to teach at a grammar school at Toxteth Park, near Liverpool. In 1618 he attended Brasenose college, Oxford, for a few months, but in November became minister of the Toxteth chapel. His Puritan tendencies led the ecclesiastical authorities to silence him in 1634, and on Aug. 17 of the next year he arrived at Boston (Mass.). A year later he became teacher of the church at Dorchester, and held that office until his death on April 22, 1669. He was locally celebrated as a preacher, and his books on the principles of New England Congregationalism together with

his activity in colonial church councils made him one of the most famous New England Puritans of his day. He was one of the translators of *The Whole Booke of Psalmes* (1640), the "Bay Psalm Book" designed for use in colonial churches. His greatest achievement was a statement of the creed and polity of Massachusetts Congregationalism which, with but few alterations, was printed as *A Platform of Church Discipline* (1649). This, the "Cambridge Platform," was for years the basic document of his sect in Massachusetts. He was an active advocate of the "Half-Way Covenant," a plan which provided a modified form of church membership for those who were unable to meet the tests prescribed by the original Congregational polity.

By his first wife, Katharine Holt of Bury, whom he married in 1624, he had six sons, four of whom became ministers. His second wife was Sarah Cotton, widow of the Rev. John Cotton of Boston.

Bibliography.—Increase Mather, *The Life and Death of . . . Richard Mather* (Cambridge, 1670, reprinted Boston, 1850, with Richard Mather's journal of his voyage to New England); Cotton Mather, *Magnalia* (Book III., Part 2, Chap. 20, 1702); W. Walker, *Ten New England Leaders* (1901); and K. B. Murdock, *Increase Mather* (Chap. 1–4, 1925). (K. B. M.)

MATHEW, THEOBALD (1790–1856), Irish temperance reformer, was born at Thomastown on Oct. 10, 1790. A member of the Capuchin order, he successfully conducted a temperance campaign at Cork, where he laboured for many years. His influence, great in Ireland, spread to England and America, and in 1847 he was granted a pension by Queen Victoria. He died at Queenstown on Dec. 8, 1856.

See J. F. Maguire, *Father Mathew, a Biography* (1863).

MATHEWS, CHARLES (1776–1835), English actor, was born in London on June 28, 1776. His father was "a serious bookseller," who also officiated as minister in one of Lady Huntingdon's chapels. Mathews was educated at Merchant Taylors' school. For several years, from 1794 onwards, Mathews played in Dublin. In May 1803 he made his first London appearance at the Haymarket as Jabel in Cumberland's *The Jew* and as Lingo in *The Agreeable Surprise*. From this time his professional career was an uninterrupted triumph. He was a simple and kind hearted man with a wonderful gift of mimicry. Mathews visited America in 1822 and in 1834. His last appearance in New York was on Feb. 11, 1835, when he played Samuel Coddle in *Married Life* and Andrew Steward in *The Lone House*. He died at Plymouth on June 28, 1835. In 1797 he had married Eliza Kirkham Strong (d. 1802), and in 1803 Anne Jackson, an actress, the author of the popular and diverting *Memoirs, by Mrs. Mathews* (4 vols., 1838–39).

His son Charles James Mathews (1803–1878), who was born at Liverpool on Dec. 26, 1803, was educated at Merchant Taylors' school, and then articled as pupil to an architect. On Dec. 7, 1835, he played George Rattleton in his own play *The Humpbacked Lover* at the Olympic theatre, London. In 1838 he married Madame Vestris, then lessee of the Olympic, but his management of this theatre, and subsequently of Covent Garden, and of the Lyceum, did not succeed financially. In the year of his marriage he visited America. As an actor he held in England an unrivalled place in his peculiar vein of light eccentric comedy. The easy grace of his manner, and the imperturbable solemnity with which he perpetrated his absurdities, never failed to charm and amuse, his humour being measured and restrained. He excelled in plays like *The Game of Speculation, My Awful Dad, Cool as a Cucumber, Patter versus Clatter* and *Little Toddlekins*. In 1856 Mme. Vestris died, and the next year Mathews visited the United States, where in 1858 he married Mrs. A. H. Davenport.

Mathews was one of the few English actors who played in French successfully; he appeared in Paris in 1863 in a French version of *Cool as a Cucumber*, written by himself. At the age of 65 Mathews set out on a world tour, which included a third visit to America, and on his return in 1872 he continued to act till his death on June 24, 1878. He made his last appearance in New York at Wallack's theatre on June 7, 1872, in H. J. Byron's *Not such a Fool as he Looks*. His last appearance in London was at the Opéra Comique on June 2, 1877, in *The Liar* and *The Cosy Couple*. At Stalybridge he gave his last performance on June 8, 1878, when he played Evergreen in his own comedy *My Awful Dad*.

See the *Life of Charles James Mathews*, ed. Charles Dickens (2 vols., 1879); H. G. Paine, *Actors and Actresses of Great Britain and the United States* (New York, 1886).

MATHEWS, SHAILER (1863–   ), American educator and theologian, was born at Portland (Me.), on May 26, 1863. He graduated from Colby college (1884), and continued his studies at Newton Theological institution and the University of Berlin. He was associate professor of rhetoric (1887–89) and professor of history and political economy (1889–94) at Colby college. In 1894 he went to the University of Chicago as associate professor, and in 1897 became professor of New Testament history and interpretation. In 1908 he was made dean of the divinity school. In 1912–16 he was president of the Federal Council of the Churches of Christ in America, and he visited Japan in 1915 as representative of that body. From 1903 to 1911 he was editor of *The World To-day;* in 1913–20, of *The Biblical World*. He has written a number of books including *The Social Teaching of Jesus* (1897); *A History of New Testament Times in Palestine* (1899, rev. ed., 1910); *The French Revolution* (1901, enl. ed. 1923); *The Spiritual Interpretation of History* (1916); and *The Faith of Modernism* (1924).

MATHEWS, THOMAS (1676–1751), British admiral, was born at Llandaff Court, Llandaff. He entered the navy about 1690 and after various appointments during the war with Spain (1718–20) commanded the "Kent" in the fleet of Sir George Byng (Lord Torrington). From 1722 to 1724 he had the command of a small squadron sent to repress the pirates of the coast of Malabar. He settled down at Llandaff until March 1741, when he was appointed to the command in the Mediterranean, and plenipotentiary to the king of Sardinia and the States of Italy. His unfortunate engagement with a Spanish squadron of line-of-battleships near Hyères in Feb. 1744 marked the lowest pitch reached in discipline and fighting by the fleet in the 18th century. The British fleet followed the enemy in light winds on Feb. 10, and became scattered. Mathews hoisted the signal to form the line, and then when night fell, to lie to. Lestock, who commanded in the rear, was at some distance from the body of the fleet, and obeyed the second order, with the result, apparently desired, that in the morning he was far away from Mathews. The enemy were within striking distance of the van and centre of the British fleet, and Mathews attacked their rear. Lestock never came into action at all. Several captains behaved very badly, and Mathews in anger bore down on the enemy out of his line, while the signal to keep the line was still flying at his mast head. The French and Spaniards got away, and were not pursued, though they were of inferior strength. The battle led to more than twenty courts-martial and a parliamentary inquiry. Lestock was brought to trial, and acquitted on the ground that he had obeyed orders. Mathews was condemned to be dismissed from the service on the ground that he had not only failed to pursue the enemy but had taken his fleet into action in a confused manner. Mathews died in London on Oct. 2, 1751.

See Beatson, *Naval and Military Memoirs*, vol. i. (1790; 2nd ed., 1804); Montagu Burrows, *Life of Hawke* (3rd ed., 1904). The charges and findings at the courts-martial on both Lestock and Mathews were published at the time.

MATILDA (1102–1164), queen of England and empress, daughter of Henry I. of England, by Matilda, his first wife. In 1109 she was betrothed to the emperor-elect, Henry V., and was sent to Germany, but the marriage was delayed till 1114. Her husband died in 1125, leaving her childless; and, since both her brothers were now dead, she was recalled to her father's court to receive formal recognition as his successor in England and Normandy. The reluctance of the Great Council of England to acknowledge a female sovereign was increased by her marriage to Geoffrey Plantagenet, the heir of Anjou and Maine (1129); nor was it removed by the birth of the future Henry II. in 1133. On Henry I.'s death England and Normandy accepted his nephew, Stephen, of Mortain and Boulogne. Matilda and her husband

made an attempt to win Normandy; but Matilda was at last persuaded by her half-brother, Earl Robert of Gloucester, to visit England and raise her standard in the west, where his influence was supreme. With the help of the Church and the barons of the west, Stephen was captured at Lincoln (1141); the empress was acclaimed lady or queen of England (she used both titles indifferently) and crowned at London. But her arrogance alienated the Londoners and the papal legate, Bishop Henry of Winchester. Routed at the siege of Winchester, she was compelled to release Stephen in exchange for Earl Robert, and her cause steadily declined. In 1148, having lost by the earl's death her principal supporter, she retired to Normandy, of which her husband had gained possession. Henceforward she left Henry to pursue the struggle with Stephen. She died on Jan. 30, 1164.

See O. Rössler, *Kaiserin Mathilde* (1897); J. H. Round, *Geoffrey de Mandeville* (1892).

MATILDA (1046–1115), countess or margravine of Tuscany, popularly known as the Great Countess, was descended from a noble Lombard family. Her great-grandfather, Athone of Canossa, had been made count of Modena and Reggio by the emperor Otto I., and her grandfather had, in addition, acquired Mantua, Ferrara and Brescia. Her own father, Boniface II., the Pious, secured Tuscany, the duchy of Spoleto, the county of Parma, and probably that of Cremona; and was loyal to the emperor until Henry plotted against him. Through the murder of Count Boniface in 1052 and the death of her older brother and sister three years later, Matilda was left, at the age of nine, sole heiress to the richest estate in Italy. She received an excellent education under the care of her mother, Beatrice of Bar, the daughter of Frederick of Lorraine and aunt of Henry III., who, after a brief detention in Germany by the emperor, married Godfrey IV. of Lorraine, brother of Pope Stephen IX. (1057–58). Thenceforth Matilda's lot was cast against the emperor in the great struggle over investiture, and for over 30 years she maintained the cause of the successive pontiffs, Gregory VII., Victor III., Urban II., Paschal II., with varying fortune, but with undaunted resolution. She aided the pope against the Normans in 1074, and in 1075 attended the synod at which Guibert was condemned and deprived of the archbishopric of Ravenna. Her hereditary fief of Canossa was the scene (Jan. 28, 1077) of the celebrated penance of Henry IV. before Gregory VII. She provided an asylum for Henry's second wife, Praxides, and urged his son Conrad to revolt against his father. In the course of the struggle her lands were plundered, and Pisa and Lucca lost, but she remained steadfast, and, before her death, had, by means of a league of Lombard cities, recovered all her possessions.

The donation of her estates to the Holy See, originally made in 1077 and renewed on Nov. 17, 1102, though never fully consummated on account of imperial opposition, constituted the greater part of the temporal dominion of the papacy. Matilda was twice married, first to Godfrey V. of Lorraine, surnamed the Humpbacked, who was the son of her step-father and was murdered on Feb. 26, 1076; and secondly to the 17-year-old Welf V. of Bavaria, from whom she finally separated in 1095—both marriages of policy, which counted for little in her life. Matilda was an eager student: she spoke Italian, French and German fluently, and wrote many Latin letters; she collected a considerable library; she supervised an edition of the Pandects of Justinian; and Anselm of Canterbury sent her his *Meditations*. She died at Bodeno, near Modena, on July 24, 1115, and was buried in the Benedictine church at Polirone, whence her remains were taken to Rome by order of Urban VIII. in 1635 and interred in St. Peter's.

(C. H. H.)

The contemporary record of Matilda's life in rude Latin verse, by her chaplain Domnizone (Donizo or Domenico), is preserved in the Vatican library. The best edition is that of Bethmann in the *Monumenta germ. hist. scriptores*, xii. 348–409. The text, with an Italian translation, was published by F. Davoli under the title *Vita della granda contessa Matilda di Canossa* (Reggio nell' Emilia, 1888 *seq.*).

See A. Overmann, *Gräfin Mathilde von Tuscien; ihre Besitzungen . . . u. ihre Regesten* (Innsbruck, 1895); A. Colombo, *Una Nuova vita della contessa Matilda in R. accad. d. sci., Atti*, vol. 39 (Turin, 1904); L. Tosti, *La Contessa Matilda ed i romani pontefici* (Florence, 1859); A. Pannenborg, *Studien zur Geschichte der Herzogin Matilde von Canossa* (Göttingen, 1872); F. M. Fiorentini, *Memorie della Matilda* (Lucca, 1756); E. Huddy, *Matilda Countess of Tuscany* (1900); Nora Duff, *Matilda of Tuscany* (1910); Alercati, *Nell' 8° Centenario di Matilde di Canossa. Scritti varii* (1915).

MATINS, a word now only used in an ecclesiastical sense for one of the canonical hours in the Roman Breviary, originally intended to be said at midnight, but sometimes said at dawn. In the modern Roman Catholic Church, outside monastic services, the office is usually said on the preceding afternoon or evening. In the Church of England the term matins is sometimes used for the order of public morning prayer.

MATISSE, HENRI (1869–), French painter, was born at Cateau (Nord) on Dec. 31, 1869. He studied at the École des Beaux-Arts, and under Gustave Moreau. He soon showed revolutionary tendencies, and was recognised as the boldest member of the group known as "les fauves." Though a painter of light, he did not treat it as the impressionists had done, by means of the juxtaposition of minute touches of colour, but by employing pure tones on a large scale. In this way he produced the effect of modelling, and, by the contrast of values, was able to give the illusion of space. He was particularly successful in his use of expressive distortion. Matisse spent two years in Morocco, but most of his work was carried on in southern France, at Collioure and Nice. Later he reduced the size of his canvases, painting still life and landscapes, as well as small feminine figures and brilliantly illuminated interiors. He is entitled to be considered as the most eminent master of the contemporary French School. His drawing exhibits sometimes a nervous restrained manner. Matisse's lithographic work is also of considerable importance.

Bibliography.—É. Faure, *Henri Matisse* (1920); Marcel Sembat, *Henri Matisse: trente reproductions précédées d'une étude critique* (1920); A. Basler, *Henri Matisse* (1924).

MATLOCK, market town, urban district, western parliamentary division, Derbyshire, England, on the river Derwent, 17 m. N. of Derby on the L.M.S. railway. Pop. (1931) 10,599. The township includes the old village of Matlock, the district of Matlock Bridge, and the health resorts of Matlock Bath and Matlock Bank. The town possesses cotton, corn and paper mills, while in the vicinity there are stone-quarries and lead mines.

Matlock Bath, 1½ m. S. of Matlock, with a separate railway station, overlooks the gorge of the Derwent. It has three medicinal springs, temperature 68° F, which were discovered in the 17th century. Lead mining is carried on in the district and there are extensive caverns. Similarly Matlock Bank has become celebrated for the number and excellence of its hydropathic establishments. A tramway, worked by a single cable, over a very steep gradient, affords easy communication with Matlock Bridge.

MATOS FRAGOSO, JUAN DE (1608–1689), popular Spanish dramatist, renowned for his adroit recasting of works by Lope de Vega, as in *La Venganza en el despeño* and others.

MATRASS, a glass vessel with a round or oval body and a long narrow neck, used in chemistry, etc., as a digester or distiller. The Florence flask of commerce is frequently adapted for this purpose. The word is possibly identical with an old name "matrass" (Fr. *materas, matelas*) for the bolt or quarrel of a cross-bow. If so, some identity of shape suggests a reason for the word "bolthead" also used as a name for the vessel. Another derivation may be the Arabic *matra*, a leather bottle.

MATRIARCHY. Tales are still told of villages (always outside the ken of the narrator) where only women dwell, whose population is maintained by the admission annually of one male who is put to death when his procreative task is done. Did such exist, therein might be found that combination of female dominance, female kinship, female inheritance which (strictly speaking) alone constitutes matriarchy or the rule of the mothers. Again there are communities the bulk of whose adult male population departs periodically to engage in some seasonal industry elsewhere. There the women form a permanent element in the social and economic order, but though in a degree matripotestal, these communities are in many instances patrilineal and the authority of the males is the ultimate basis.

Distribution of Matriliny.—Matriliny, however, the custom of reckoning kinship, descent, succession and inheritance in the

female line, still survives in various parts of the world. In Australia it is associated with a simple dual system. It is found in Sumatra, in Micronesia and Melanesia, again along with the dual organization. The primitive folk in Formosa have it. India has it in Assam among the Garos, again with a dual organization, and the Khasias. On the Malabar coast are matrilineal groups, and there are Brahmans whose succession is designated by marumakathayyam—of the sister's son, a feature of the matrilineal order. The Nairs, a warrior community who once practised polyandry, are matrilineal. It still survives in Africa about Lake Nyasa, among the Ila speaking peoples of Northern Rhodesia, in Ashanti, among lower groups in Dahomey, on the Gold and Ivory Coasts. The Iroquois in North America were matrilineal, and in their polity women played an important part—in the selection and dismissal of chiefs. It is found among many Indian tribes. (*See* L. Morgan, *Ancient Society.*)

Locality.—Sometimes the group is matrilineal but patrilocal, as in Africa where the wives settle in their husbands' villages. Elsewhere, as among the Khasias, the group is matrilineal and matrilocal, the husband living in his wife's village. That the locality of marriage affects the social order profoundly, needs no elaborate proof. In those cases where marriage is matrilocal and kinship is matrilineal, the wife's kin form a definite local group, ready and able to exert supreme authority in cases of conflict, but the husband, the father, has a meed of respect in the family and in his wife's community. Every social system contains both the seeds of conflict, and devices for dealing with them as and when they may arise. In matrilineal societies where patrilocality prevails, the women as in Africa have evolved organizations on the basis of sex solidarity—secret societies (*q.v.*).

Survivals.—Many customs have been interpreted as survivals of a former matrilineal order, such as the important social functions discharged by the maternal uncle in initiation rites, at birth, marriage and death (*see* AVUNCULATE). Some at least are compatible with a patrilineal system in which cross-cousin marriage was appreciated for its economic and social advantages. Here and there women are selected as priestesses, ministrants to divine beings, sometimes by reason of the demand of a male deity for a female servant—more often, by reason of the special psychological characteristics of her sex. But that may and does happen, consistently enough, in sternly patripotestal communities.

Social Theories.—From the time of Bachofen whose work on Mutterrecht was the first scientific attack on the problem, students of social theory have been tempted to see in the matrilineal system, the primitive form of society because "paternity was a matter of inference as opposed to maternity which is a matter of observation" (Maine, *Early Law and Custom*). They pointed to cases of polyandry where paternity was uncertain but laid stress on the patrilineal order of the Tibetans and Todas where paternal polyandry prevails. Ideas such as these survive, revive, die down only to reappear, sometimes reinforced by a parade of biological, psychological and sentimental argument adorned by a wealth of illustration garnered from China to Peru, which ignores the verdict of modern anthropological research that "in all parts of the world we find maternal kinship side by side with institutions of paternal authority," and "in all the matters in which the father and the mother are vitally essential to the child, kinship has to be counted on both sides." (Malinowski, *Sex and Repression in Savage Society.*) The family is a continuous instrument essential for the transmission of culture, and human society as we now know it, and as the earliest records of humanity portray it, is a cultural phenomenon, and the family is always a bilateral unit. It is true that everywhere descent, succession and inheritance are determined unilaterally, either by matrilineal or patrilineal reckoning, but it is also true that some of the elements which compose status in the most marked matrilineal society are due to paternality. Speculation may lay stress on the assumed priority of matriliny, though the unilinear theory of social evolution has long been discarded. So keen a mind as that of Maine never imagined that "any amount of evidence of law or usage, written or observed, would by itself solve the problems which cluster round the beginnings of human society," and Darwin, leader of a host of profound biological thinkers, declared firmly for the conclusion proffered by the latest expert critic that "the hypothesis according to which promiscuity has formed a general stage in the social history of mankind is one of the most unscientific ever set forth within the whole domain of sociological speculation." (Westermarck, *History of Human Marriage*, 5th ed.) From promiscuity through matriarchy to patriarchy was the scheme proposed. The family (the bilateral unit) exists always, everywhere, and motherhood and fatherhood are nowhere independent, exempt from the pressure of reciprocity, the primeval principle of social organization.

BIBLIOGRAPHY.—R. H. Lowie, *Primitive Society* (1921); W. H. R. Rivers, *Social Organizations* (1924); M. Briffault, *The Mothers* (1927); *E.R.E.* art., "Mother-right."

MATRIMONY, a game at cards played with a full whist pack upon a table divided into three compartments labelled "Matrimony," "Intrigue" and "Confederacy," and two smaller spaces, "Pair" and "Best." These names indicate combinations of two cards, any king and queen being "Matrimony," any queen and knave "Intrigue," any king and knave "Confederacy"; while any two cards of the same value are a "Pair" and the diamond ace is "Best." The dealer distributes a number of counters, on the compartments, and the other players do likewise. He then gives one card to each player, face down, and a second, face up. If any turned-up card is the diamond ace, the player holding it takes everything on the space and the deal passes. If not turned, the diamond ace has only the value of the other three aces. If it is not turned, the players, beginning with the eldest hand, expose their second cards, and the resulting combinations, if among the five successful ones, win the counters of the corresponding spaces. If the counters on a space are not won, they remain until the next deal.

MATRIX, a word derived from the Latin for womb, chiefly used in the sense of a bed or enclosing mass in which something is shaped or formed. Matrix is thus used of a mould in which a design or pattern is made in intaglio, and from which an impression in relief is taken (*see* SEALS). In mineralogy, the matrix is the mass in which a crystal mineral or fossil is embedded. In mathematics, it is an arrangement of numbers or symbols in a rectangular or square figure. (*See* ALGEBRAIC FORMS.)

In mediaeval Latin *matrix* and the diminutive *matricula* signified a roll or register, particularly one containing the names of the members of an institution, as of the clergy of a cathedral. From this use is derived "matriculation," the admission to membership of a university, also the name of the examination for such admission. *Matricula* was also the name of the contributions in men and money made by the various States of the Holy Roman empire, and in the recent German empire the contributions made by the federal States to the imperial finances were called *Matrikularbeiträge*, matricular contributions. (*See* GERMANY: *Finance.*)

MATSUDAIRA, TSUNEO (1877–), Japanese diplomat, was born in Tōkyō. He studied at the Imperial University of Tōkyō, and in 1902 entered the Foreign Office. His first experience abroad was gained in Peking where he was a secretary of legation. He became first secretary of the embassy in London, and later in Paris. From 1918–9 he was Japanese high commissioner in Siberia and in 1920 was appointed director of the bureau for European and American affairs at the Foreign Office in Tōkyō. In 1921–2 Matsudaira was chief secretary of the Japanese delegation to the Washington Conference. In 1923, he held the appointment of vice-minister for foreign affairs. In 1925, after criticism of Hanihara, the Japanese ambassador, Matsudaira was appointed ambassador and he undertook his duties with the avowed intention of bettering American-Japanese relations. He returned from Washington in the summer of 1928, and was appointed ambassador to London. His eldest daughter Setsuko was married to Prince Chichibu, brother of the Emperor of Japan, on Sept. 28, 1928.

MATSUKATA, MASAYOSHI, PRINCE MARQUIS (1835–1924), Japanese statesman, was born at Kagoshima in 1835, being a son of a *samurai* of the Satsuma clan. On the completion of the feudal revolution of 1868 he was appointed governor of the province of Tosa, and in 1874 was transferred to Tōkyō as assistant

minister of finance. In 1880 he held the portfolio of home affairs, and in 1881 was minister of finance. The condition of the currency of Japan was at that time deplorable, and national bankruptcy threatened. The coinage had not only been seriously debased, but much paper currency had been circulated as a temporary expedient for filling an impoverished exchequer. In 1878 depreciation had set in, and the inconvertible paper had by the close of 1881 grown to such an extent that it was then at a discount of 80% as compared with silver. Matsukata urged that the issue of further paper currency should be stopped at once, the expenses of administration curtailed, and the resulting surplus of revenue used in the redemption of the paper currency and in the creation of a specie reserve. These proposals were acted upon: the Bank of Japan was established, with the right of issuing convertible notes; within three years the paper currency was at par value with silver, and the currency placed on a solvent basis.

From this time Japan's commercial and military advancement made uninterrupted progress. But *pari passu* with the impetus given to trade by the successful conclusion of the war with China, the national expenditure rose within a few years from 80 to 250 million yen. The task of providing for this expenditure fell on Matsukata, who had to face the diet's opposition. But he distributed the increased taxation so equally, and chose its subjects so wisely, that the ordinary administrative expenditure and the interest on the national debt were fully provided for, while the unusual military expenditure was met from the Chinese indemnity. In 1878 Matsukata saw the advantages of a gold standard, but not until 1897 when the bill authorizing it was passed, could his scheme be realized.

Matsukata, who in 1884 was created count, twice held the office of prime minister (1891–92, 1896–98), and during both his administrations he combined the portfolio of finance with the premiership; from Oct. 1898 to Oct. 1900 he was minister of finance only. His name in Japanese history is indissolubly connected with the financial progress of his country at the end of the 19th century. In September 1907 he was advanced to the rank of marquis. From 1917 to 1922 he was keeper of the privy seal, and on resigning from this post was created a prince. He died in Tōkyō on July 2, 1924.

MATSYS (Massys or Metzys), **QUENTIN** (1466–1530), Flemish artist, was born at Louvain where he learned the trade of a blacksmith. During the greater part of the 15th century, the centres in which the painters of the Low Countries most congregated were Bruges, Ghent and Brussels. Towards the close of the same period Louvain took a prominent part in giving employment to workmen of every craft. It was not till the opening of the 16th century that Antwerp usurped the lead which it afterwards maintained against Bruges and Ghent, Brussels, Mechlin and Louvain. Quentin Matsys was one of the first men of any note who gave repute to the guild of Antwerp. A legend relates how the smith of Louvain was induced by affection for the daughter of an artist to change his trade and acquire proficiency in painting. Van Mander does not give us the name of his master. He was ten years old when Dierick Bouts died at Louvain, and his style was probably formed by the Bouts tradition, which survived in the workshop of Dierick's son, Albert. In 1491 Matsys went to Antwerp, and was there admitted into the guild of St. Luke. He was one of the first men of any note in the guild of that city, which was then rapidly becoming the most important commercial centre in the Netherlands. Early works by the master are two pictures of "The Virgin and Child" in the Brussels gallery. Matsys' most celebrated picture is the great triptych of the "Pieta," which he executed in 1511 for the joiners' company, in the cathedral of Antwerp. It is now in the Antwerp museum. Next in importance is the "Marys of Scripture round the Virgin and Child," which was ordered for the cathedral of Louvain and is now in the Brussels gallery. These pictures display great earnestness in expression, strong religious feeling, great minuteness of finish and a general absence of light or shade. As in early Flemish pictures, so in those of Matsys superfluous care is lavished on jewellery edgings and ornament. There is a tendency to accentuate individual expression. This tendency is illustrated in such pictures as "The Old Man and the Courtesan" in the Pourtales collection, Paris, and the "Market Bankers" in the Louvre, where an attempt is made to display cupidity and avarice. The "Ecce Homo" and "Mater Dolorosa" at Antwerp display serenity and dignity. Very attractive are his pictures with figures on a smaller scale, like the polyptych in Munich, the scattered parts of which have recently been fitted together; "The Virgin and Child," in the Aynard collection in Paris, and the two wings of an altarpiece representing "St. John" and "St. Agnes" standing against landscapes which stretch into the distance. These landscape backgrounds are often in the style of Patinir, who came to Antwerp in 1515, and is said to have painted backgrounds for some of Matsys' pictures. "The Crucifixion" in the Liechtenstein collection is believed to be the joint work of the two masters.

In 1517 Matsys was great as a portrait painter. He painted the portraits of Erasmus and of Peter Gillis to be sent to Sir Thomas More. The original of the Erasmus may be the picture of the Stroganoff collection, while the Gillis is in Lord Radnor's collection. It drew from Sir Thomas More a eulogy in Latin verse. Other portraits are at the museums of Chicago and Oldenburg, and in the collections of Lord Amherst and the prince of Liechtenstein. The man with a pair of eyeglasses in the Städel gallery at Frankfurt is full of vitality; he seems to be speaking. The Musée André, Paris, has an expressive profile of a man, signed and dated 1513. The artist obviously aimed at depicting the desires and emotions of the men of his day. When compared with portraits by Dürer or Holbein, Matsys' art appears subjective and personal. He came into contact with both German masters, for both in turn visited him in his house at Antwerp. Dürer's first call was made in August 1520. The two men must have had much in common, for they were both humanists. The lost original of Quentin's "St. Jerome in his Study," of which there is a copy in Vienna, owed something to Dürer's "St. Jerome," now at Lisbon. Holbein, as a young man of 27, passed through Antwerp in 1526 on his way to England, and he carried an introduction from Erasmus to Gillis, who was to send him to Matsys' house. The question as to how much Matsys was indebted to the Italian art of his time is difficult to determine. There is a picture by him from the Raczinski collection in the museum at Posen, representing the Virgin and Child playing with the lamb. These figures are obviously copied from Leonardo's famous "St. Anne, the Virgin and Child," now in the Louvre, except that the St. Anne is left out and the group is placed on a landscape background in the style of Patinir. Quentin Matsys died at Antwerp in 1530. He had two sons who were artists.

Jan Matsys (1509–1575) was at first a weak imitator of his parent. He became master in the guild of Antwerp in 1531, was banished for his heretical opinions in 1543, and stayed away until 1558. During these years he is supposed to have visited Italy or France. An early picture by him is the "Virgin kissing the Child" in the church of St. James at Antwerp, which imitates the "Madonna Enthroned" by his father, now at Berlin. A half-length "Judith," now in the museum at Boston, is of a later date and seems to recall Italian or French influences. To the same class belongs the "Lot and his Daughters" at Vienna, dated 1563.

Cornelys Matsys (1513–1579) became a master painter in 1531. There is a signed picture by him at Amsterdam, dated 1538, representing the "Prodigal Son," also a genre picture, signed and dated 1543 at Berlin. He painted landscapes in the style of his father, and he was also an engraver.

See Max Friedländer, *Van Eyck an Bruegel* (1921); Sir Martin Conway, *The Van Eycks and their followers* (1921).

MATTEAWAN, NEW YORK: *see* Beacon, New York.

MATTER: *see* Kinetic Theory of Matter; Atom; Nucleus.

MATTERHORN, one of the best-known mountains (14,782 ft.) in the Alps. It rises south-west of the village of Zermatt, and on the frontier between Switzerland (canton of the Valais) and Italy. Though on the Swiss side it appears to be an isolated obelisk, it is really but the butt end of a ridge, while the Swiss slope is not nearly as steep or difficult as the grand terraced walls of the Italian slope. It was first conquered, after a number of attempts chiefly on the Italian side, on July 14, 1865, by E. Whym-

per's party, three members of which perished with the guide by a slip on the descent. Three days later it was scaled from the Italian side by a party of men from Val Tournanche led by J. A. Carrel. Nowadays it is frequently ascended in summer, especially from Zermatt.

MATTHEW, ST. In Mark's list of the Twelve appointed by Christ (iii. 13 *seq.*), the name of Matthew is seventh, and is followed by that of Thomas. Apparently the evangelist has made some attempt to arrange the names in the order of their eminence in the early Church. His list may possibly indicate also that Matthew and Thomas were accustomed to work together; it was usual for Christian missionaries to work in pairs (Acts viii. 14, xi. 25, xiii. 2, xv. 22–39, 40, etc.), and Mark records that Christ sent out the Twelve on a mission "two by two" (vi. 7). In the corresponding list in the Third Gospel (Lk. vi. 15) Matthew's name occurs in the same position: the First Evangelist, who groups the names in pairs, gives "Thomas and Matthew" as the fourth (x. 3). A slightly different grouping is given in Luke's list of members of the primitive community in Jerusalem (Acts i. 13), "Philip and Thomas, Bartholomew and Matthew."

The First Evangelist, however, when he records from St. Mark the story of the call of Levi the tax-collector, substitutes the name "Matthew" for that of "Levi the son of Alphaeus"; he also adds "the tax-collector" to Matthew's name in his list of the Twelve (ix. 9, x. 3). According to tradition indeed it was Matthew himself who was the author of the First Gospel, but the tradition is undoubtedly a mistaken one. It probably had its origin in the fact that the evangelist made use of a collection of Christ's Sayings much valued by his community and believed to be the work of the Apostle Matthew: his identification of Matthew with Levi bears witness to the interest of his readers in that Apostle. *See* Matthew, Gospel of.

It is of course possible that the identification is a mistaken one. On the assumption that it is correct, "Matthew" (of which the probable meaning is "Jehovah's gift") would appear to be the Christian name of Levi, who had been employed as a tax-collector in the service of Herod Antipas, and whose call to be one of the immediate followers of Jesus Christ came to him as he sat at the custom house by the Lake of Galilee, presumably near Capernaum. It should be noted that Mark's story of his call resembles that of the call of Peter and Andrew and the sons of Zebedee: we should expect to find Levi somewhere in his list of the Twelve. As a tax-collector Levi would share in the distrust and contempt which these officials had earned for themselves everywhere: among the Jews the stigma of ritual uncleanness (through intercourse with Gentiles) was also attached to them.

According to Luke (v. 29) Levi afterwards made a great feast for Jesus in his house. But the evangelist is here rewriting Mark, whose statement that "he was sitting at meat in his house" does not necessarily bear the meaning put upon it by Luke; Mark may mean that Jesus was entertaining friends at his own table, inserting the incident here as another illustration of the attitude of Jesus towards "tax-collectors and sinners."

It will be seen that the New Testament affords us but scanty and uncertain information in regard to St. Matthew. Outside the New Testament the only statement of any importance in regard to the Apostle is the passage from Papias preserved by Eusebius: "So then Matthew composed the Oracles in the Hebrew language, and each one interpreted them as he could." A discussion of this statement will be found in the article Matthew, Gospel of.

Legend differs as to the scene of the Apostle's missionary labours, and as to whether he died a natural or a martyr's death. As the Evangelist Matthew is usually represented in Christian art by the "man" of Ezek. i. 10, Rev. iv. 7. (B. T. D. S.)

MATTHEW, TOBIAS or TOBIE (1546–1628), archbishop of York, son of Sir John Matthew of Ross, Herefordshire, was born at Bristol. He was educated at Wells, and then in succession at University college and Christ Church, Oxford. He was public orator in 1569, president of St. John's college, Oxford, in 1572, dean of Christ Church in 1576, vice-chancellor of the university in 1579, dean of Durham in 1583, bishop of Durham in 1595, and archbishop of York in 1606. In 1581 he had a controversy with the Jesuit Edmund Campion, and his arguments were published in Oxford in 1638 under the title, *Piissimi et eminentissimi viri Tobiae Matthew, archiepiscopi olim Eboracencis concio apologetica adversus Campianam.* While in the north he was active in forcing the recusants to conform to the Church of England. He died on March 29, 1628.

His son, Sir Tobias, or Tobie, Matthew (1577–1655), friend of Francis Bacon, was educated at Christ Church, and was early attached to the court, serving in the embassy at Paris. He sat in parliament for Newport, Cornwall, in 1601, and for St. Albans in 1604. Before this time he had become the intimate friend of Bacon, whom he replaced as member for St. Albans. When peace was made with Spain, on the accession of James I., he went to Italy, where he embraced Roman Catholicism. When he returned to England he was imprisoned. In 1608 he was exiled, but was permitted to return to England in 1617–19, and finally in 1621. At home he was known as the intimate friend of Gondomar, the Spanish ambassador. In 1623 he was sent to join Prince Charles, afterwards Charles I., at Madrid, and was knighted. He remained in England till 1640, when he was finally driven abroad by the parliament, which looked upon him as an agent of the pope. He died in the English college in Ghent on Oct. 13, 1655. In 1618 he published an Italian translation of Bacon's essays. The "Essay on Friendship" was written for him. His translation of *The Confessions of the Incomparable Doctor St. Augustine* involved him in controversy. His correspondence was published in London in 1660

For the father, *see* John Le Neve's *Fasti ecclesiae anglicanae* (1716), and Anthony Wood's *Athenae oxonienses.* For the son, the notice in *Athenae oxonienses,* an abridgment of his autobiographical *Historical Relation* of his own life, published by Alban Butler in 1795, and A. H. Matthew and A. Calthrop, *Life of Sir Tobie Matthew* (1907).

MATTHEW, GOSPEL OF ST. The Church for which this book was originally written appears to have been composed for the most part of Greek-speaking Jews, who, though broken completely with orthodox Judaism, still retained the Jewish viewpoint. For these Christians as for the Pharisee the end of the religious life is the attainment of "righteousness" by obedience to the Law, though the Law which they recognize is not the Mosaic code but that code as interpreted and supplemented by the teaching of Christ, here collected for them into five great discourses (v.–vii. 28, x., xiii. 1–52, xviii., xxiv.–xxv.), the Christian parallel to the five books of Moses. The interpretation of the Law is no longer in the hands of the scribes and Pharisees, "hypocrites," but in those of the Christian teachers. It is the Christian community that is the true Israel, and Christ, not during His earthly life but after His Resurrection, ordained that this should include Gentile as well as Jew, the terms of admission being no longer circumcision and obedience to the Law of Moses but baptism and obedience to the teaching of Christ. One of the writer's aims is to insist on the necessity of this obedience, since the community has been troubled by the activities of antinomian teachers (vii. 15 f., xiii. 41, xviii. 6, xxiv. 11, 12).

The Gospel is meant to serve as a manual of Apologetics as well as a book of Church Law. The evidence for the Christian Creed that Jesus is the Christ is found in the Old Testament, and the author is at pains to point out the correspondence between the events of the Gospel history and Old Testament predictions (*see* xxi. 2, xxvi. 15, xxvii. 34). Jesus of Nazareth is the Messiah of prophecy, and very soon those who have known Him only as the Son of Man (the writer seems to understand this title as properly applying to Jesus only under the conditions of His earthly life) will see Him as the Son of God coming in glory to judge the quick and the dead. The apocalyptic discourse in this gospel is more than double the length of the corresponding section in Mark; the immediacy of the Parousia is emphasized and predictions are more explicit (x. 23, xvi. 27, 28, xxiv. 29).

Sources.—(1) The gospel of St. Mark was the author's sole source of information for the main outlines of the life of Christ, and he has incorporated it almost entirely in his work. (2) About 200 verses of Matthew's non-Marcan material are also represented in Luke's gospel. In many instances the degree of resemblance between the two versions is so close that it is necessary to suppose that both are drawn from the same Greek source.

The symbol Q (*Quelle*, source) is commonly used to designate the common source (or sources) for these non-Marcan parallels in Matthew and Luke, which consist for the most part of sayings and discourses of Christ. (3) About 400 verses are peculiar to this gospel, of which about 100 represent narrative-matter. The author can only supplement Mark's account of the earthly life of Christ by the stories of the Birth and Infancy, two stories connected with St. Peter, the great teacher specially venerated by this Church (Peter walking on the water; the Temple tax), and by some details in regard to the Passion and Resurrection (the fate of Judas; the intervention of Pilate's wife; Pilate's exculpation of himself; the earthquake and resurrection of the saints; the sealing of the tomb and its sequel; the appearances to the women and to the Eleven). This material appears to be very largely legendary in character; there are some indications connecting it with the Aramaic-speaking Christians of Jerusalem. The eleven Old Testament quotations peculiar to Matthew (i. 23, ii. 6, 15, 18, 23, iv. 15, viii. 17, xii. 18, xiii. 35, xxi. 5, xxvii. 9) probably came from the same source, for while the evangelist himself appears to have used the Greek Old Testament and to have known no Hebrew these quotations are Christian translations from the Hebrew very little influenced by the LXX. version: it is moreover difficult to suppose that some of them (*see* ii. 15, 18) could ever have been in circulation as "proof texts" without the stories in which they are now found. Again, some of the sayings peculiar to this gospel suggest that they were ultimately derived from the Church of Jerusalem, which was so conservative in its attitude towards the Mosaic Law and so suspicious of Paul and the mission to the Gentiles, viz., sayings which appear to teach the eternal inviolability of the least commandment of the Law (v. 18, 19) and to restrict the Christian propaganda to the Jewish nation (vii. 6, x. 5, xv. 24). These however the evangelist accepts without misgiving and interprets in accordance with his own standpoint: in days of increasing lawlessness there is need to emphasize the sanctity of the Law, and the extension of the Gospel to the Gentiles was authorized by the Risen Christ.

Plan of the Book and Treatment of Sources.—The story of the life of the Lord Jesus as told by Matthew is Mark's story, provided with an appropriate beginning and ending in the stories of the Infancy and of the Resurrection appearances, pruned of details regarded by the editor as irrelevant or unedifying, and enriched by as full a record as possible of Christ's teaching. While following Mark in regard to the main outline of events, he adopts as far as he can the method of grouping together material dealing with similar topics, and skilfully builds up the long discourses characteristic of this gospel out of isolated sayings and blocks of sayings drawn from the different sources at his disposal.

The Genealogy (i. 1–17) shows the Davidic descent of the Messiah through Joseph, whose legal heir He became when Joseph recognized Mary as his wife: the story of the Virgin Birth (i. 18–25) proves him David's Lord as well as son. The Infancy narratives (ii. 1–23) show prophecy fulfilled and the early history of Moses the First Deliverer of Israel repeated in that of the Second. With the account of Messiah's Call and Preparation (iii. 1–iv. 16) the editor reaches the point at which two of his Gospel records began, Mark and Q. He conflates their accounts, and adds an explanation of a Christian difficulty in regard to the baptism of Christ (iii. 14, 15). It is in the long section which relates the Public Ministry of Christ in Galilee (iv. 17–xiii. 57) that the editor is able to employ most freely his method of grouping. The section falls into separate chapters, each concerned with a different aspect of the Ministry. In the first of these the delivery of the New Law of the Kingdom of Heaven is described (v.–vii.). This discourse, known to us as the Sermon on the Mount, seems to represent in the main the conflation of two separate discourses, one from Q, which also appears in Luke vi. 20–49, and another from his Jerusalem source, which contrasted Christian and Pharisaic righteousness (roughly v. 17–vi. 18). Having given an account of Christ's words, the editor proceeds to give an account of his Messianic works (viii.–ix. 34) by collecting together nine typical miracles. These fall into three groups of three (the evangelist is fond of numerical arrangements), and by separating the groups, first by the story of some unworthy applicants for discipleship, then by the story of the call of the despised tax-collector to be a disciple, he prepares the way for his next chapter, which describes the Mission of the Twelve and their Instructions (ix. 35–xi. 1). The "charge" which is here given is built up out of two missionary charges which were recorded in Mark and Q respectively (the Q charge appears in Luke x. 2f as delivered to the Seventy) with the addition of material drawn from other sources and contexts (*e.g.*, Mark's Apocalyptic discourse). Then comes a section describing Christ's Controversies with his opponents (xi. 2–xii. 50), followed, since Christ's use of parabolic teaching was explained as due to Jewish unbelief, by a collection of Parables of the Kingdom (xiii. 1–53). The story of the Rejection at Nazareth as an epitome of the history of the Galilean Ministry forms an apt conclusion (xiii. 53–58).

After this point the editor is unable to make so much use of the method of grouping and follows the order of the Marcan narrative, continuing however to build up discourses as before.

The Period of Wanderings (xiv. 1–xvi. 20) which begins with the story of the dangerous interest of Herod Antipas in the new prophet, closes with the Great Confession as the account of the Galilean ministry closes with the Great Rejection. "From that time" the Preaching of the Cross takes the place of the Gospel of the Kingdom (*see* iv. 17 and xvi. 21). The Marcan story of the journey to Jerusalem, the Trial and Crucifixion is followed very closely. The evangelist takes advantage of an incident in Mark to construct a long discourse giving the Christian law as to Offences in the community (xviii.). Similarly he expands three verses of Mark into the long Denunciation of the Scribes and Pharisees (xxiii.), and doubles the length of the Apocalyptic discourse in Mark by the addition of illustrative parables (xxiv., xxv.). But in regard to the events he can only add some legendary details to Mark's narrative.

Mark's Gospel, to-day, contains no account of any Resurrection appearances of Christ, and it is suggested that the "lost ending" has been preserved, in part, by Matthew. Matthew's narrative however at this point suggests that his copy of Mark ended as abruptly as does our present text and that he had no detailed tradition to draw upon to complete his story.

EVIDENCE

Authorship.—The internal evidence of the Gospel has shown us that the author was a Christian Hellenist, probably ignorant of Hebrew, who depended for his knowledge of the life and teaching of Christ upon tradition. Only a very intimate knowledge of his sources, however, would enable him to use them as he does, and the popularity of the book in the early Church is a witness to his ability.

But these results are in many respects curiously at variance with the traditional account of the authorship of the Gospel. According to Irenaeus, Origen and Eusebius the book was composed in Hebrew by the Apostle Matthew. Indications of the origin of this tradition are not wanting. (1) The Gospel itself bears witness to an interest on the part of the local Church in Matthew, for the editor identifies that Apostle with Levi the tax-collector (ix. 9, x. 3). (2) According to Eusebius, Papias in his "Expositions of Dominical Oracles" stated, apparently on the authority of John the Elder, that "Matthew composed the Oracles (*Logia*) in the Hebrew language, and each one interpreted them as he could." If, before the composition of the First Gospel, the most treasured Gospel record possessed by the local Church was a Greek translation of Matthew's "Oracles," Apostolic authority for the Gospel in which this work was incorporated might well be claimed at a time when the rival merits of various gospels began to be discussed: it could be regarded not as an improved edition of the work of Mark, who was only a follower of Apostles, but as an improved edition of an Apostolic record. It is possible indeed that the extract from Papias belongs to such a discussion of the claims of the leading Gospels. In Eusebius it is preceded by another extract from Papias which gives an account of the origin of Mark's Gospel. The tone of this is somewhat critical and suggests that the book is being compared to its disadvantage with another Gospel, presumably the Fourth. The same note of

disparagement may also be read into the second extract: "the First Gospel contains only a translation of Matthew's work. Matthew composed the Oracles in Hebrew, and the ability of translators varies."

It will be noted that in Papias' statement we have the probable origin of the tradition that the First Gospel was written in Hebrew. None, however, would have thought of connecting the statement with the First Gospel unless the tradition of its Apostolic authorship already existed.

The attempt to identify one of the sources of the First Gospel as Matthew's Logia is complicated by the obscurity of the extract from Papias. The word *logion* (oracular utterance) was frequently used in the Greek Old Testament for the "word" of the Lord, and passed into Christian use to describe "the words of the Lord Jesus" (*see* the title of Papias' own work). It is possible to take the phrase "the Logia" to mean "the Oracles of God" (*see* Rom. iii. 2) and to suppose that the Apostle's work was a collection of Old Testament "proof texts" from which the evangelist drew his peculiar Old Testament quotations (*see* above), but the existence of these quotations as a separate source apart from narrative matter is doubtful. It is more probable that the phrase should be interpreted of the "Sayings" of Christ. Apparently the evangelist made use of at least two collections of Christ's sayings, one which Luke also used (Q) and one which was marked by "particularist" tendencies. If the identification of Matthew with Levi the tax-collector is correct, it is more probable that he was the author of the former collection.

Date.—The internal evidence shows that the composition of the book must be dated after the Fall of Jerusalem in A.D. 70 (*see* xxii. 6, 7). A date after A.D. 70 must be assigned to Luke (*see* xxi. 20) and since neither evangelist used the other's work it is probable that their Gospels were composed about the same time. Details in Mark's picture of Christ and his first disciples must now be revised to be in keeping with the presuppositions of a later age. Liturgical and doctrinal formulae are beginning to crystallize (*see* xxviii. 19). The earliest certain external evidence for the existence of the First Gospel is provided by the Ignatian epistles (*c.* 110–115). These indications all point to a date between A.D. 80 and 100 as the time when the book was composed.

Place of Origin.—The evangelist had access to Palestinian tradition, but apparently only limited access. His Gospel was used by Ignatius of Antioch. Both facts suggest the probability that the community for which the book was written must be looked for in Syria. It is tempting to suppose that the Gospel which concludes with the message of Christ to make disciples of the Gentiles comes from the Church of Antioch itself, the home of the Gentile mission. The veneration for Peter here displayed is an argument in favour of this supposition, for Peter was claimed by the later Church of Antioch as its first bishop. Against it must be set the fact that evidence of the influence of the teaching of St. Paul, abundant in the Ignatian epistles, is lacking in the First Gospel.

BIBLIOGRAPHY.—For general introduction *see* Burkitt, *The Gospel History and its Transmission;* Streeter, *The Four Gospels* (1924). Standard commentaries in English on the Greek text are those by Allen (1907) which is largely concerned with literary problems, Plummer (1909), which aims at supplementing Allen's work, and by McNeile (1915): there is a small commentary by B. T. D. Smith in the Cambridge Greek Testament (1927). A full bibliography will be found in Moffatt, *Introduction to the Literature of the New Testament.*

(B. T. D. S.)

MATTHEW OF PARIS (d. 1259), English monk and chronicler known to us only through his voluminous writings. He may have studied at Paris in his youth, but the earliest fact which he records of himself is his admission as a monk at St. Albans in the year 1217. His life was mainly spent in this religious house. In 1248, however, he was sent to Norway as the bearer of a message from Louis IX. of France to Haakon VI. of Norway, who invited him, a little later, to superintend the reformation of the Benedictine monastery of St. Benet Holme at Trondhjem. Apart from these missions, he pursued the study of history, following the tradition of the monks of St. Albans. Matthew edited anew the works of Abbot John de Cella and Roger of Wendover, which in their altered form constitute the first part of his most important work, the *Chronica maiora.* From 1235, where Wendover breaks off, Matthew continued the history. He derived much of his information from the letters of important personages, which he sometimes inserts, but more from conversation with the eye-witnesses of events. Among his informants were Earl Richard of Cornwall and Henry III.

In 1257, in the course of a week's visit to St. Albans, Henry kept the chronicler beside him night and day, "and guided my pen," says Paris, "with much good will and diligence." It is therefore curious that the *Chronica maiora* gives an unfavourable account of the king's policy. Luard supposes that Matthew never intended his work to see the light in its present form, and many passages of the autograph have against them the note *offendiculum,* which shows that the writer understood the danger which he ran. Unexpurgated copies were made in Matthew's lifetime; though the offending passages are omitted or softened in his abridgment of his longer work, the *Historia Anglorum* (written *c.* 1253). He was not an official historiographer.

Matthew is a vehement supporter of the monastic orders against their rivals, the secular clergy and the mendicant friars. He is violently opposed to the court and the foreign favourites. He despises the king as a statesman, though for the man he has some kindly feeling. He attacks the court of Rome for its exactions, and displays an intense nationalism. He sometimes inserts rhetorical speeches which are not only fictitious, but misleading. In other cases he tampers with the documents which he inserts (as, for instance, with the text of Magna Carta). In spite of his inexactitude, he gives a more vivid impression of his age than any other English chronicler; and it is unfortunate that his history breaks off in 1259, on the eve of the crowning struggle between Henry III. and the baronage.

BIBLIOGRAPHY.—The relation of Matthew Paris's work to those of John de Cella and Roger of Wendover may best be studied in H. R. Luard's edition of the *Chronica maiora* (7 vols., Rolls series, 1872–83), which contains valuable prefaces. The *Historia Anglorum sive historia minor* (1067–1253) has been edited by F. Madden (3 vols., Roll series, 1866–69). Matthew Paris is often confused with "Matthew of Westminster," the reputed author of the *Flores historiarum* edited by H. R. Luard (3 vols., Rolls series, 1890). This work, compiled by various hands, is an edition of Matthew Paris, with continuations extending to 1326. Matthew Paris also wrote a life of Edmund Rich (*q.v.*), which is probably the work printed in W. Wallace's *St. Edmund of Canterbury* (1893), pp. 543–588, though this is attributed by the editor to the monk Eustace; *Vitae abbatum S. Albani* (up to 1225) which have been edited by W. Watts (1640, etc.); and (possibly) the *Abbreviatio chronicorum* (1000–1255), edit. by F. Madden, in the third volume of the *Historia Anglorum.* On the value of Matthew as an historian *see* F. Liebermann in G. H. Pertz's *Scriptores* xxviii., pp. 74–106; A. Jessopp, *Studies by a Recluse* (1893); H. Plehn, *Politische Character Matheus Parisiensis* (Leipzig, 1897).

MATTHEW OF WESTMINSTER, the name of an imaginary person who was long regarded as the author of the *Flores Historiarum.* The error was first discovered in 1826 by Sir F. Palgrave, who said that Matthew was "a phantom who never existed," and later the truth of this statement was completely proved by H. R. Luard. The name appears to have been taken from that of Matthew of Paris, from whose *Chronica majora* the earlier part of the work was mainly copied, and from Westminster, the abbey in which the work was partially written.

The *Flores historiarum* is a Latin chronicle dealing with English history from the creation to 1326, although some of the earlier manuscripts end at 1306; it was compiled by various persons, and written partly at St. Albans and partly at Westminster. The part from 1306 to 1326 was written by Robert of Reading (d. 1325) and another Westminster monk. Except for parts dealing with the reign of Edward I. its value is not great. It was first printed by Matthew Parker, archbishop of Canterbury, in 1567, and the best edition is the one edited with introduction by H. R. Luard for the Rolls series (1890). It has been translated into English by C. D. Yonge (1853). *See* Luard's introduction, and C. Bémont in the *Revue critique d'histoire* (1891).

MATTHEWS, (JAMES) BRANDER (1852–1929), American essayist and dramatic critic, was born at New Orleans on Feb. 21, 1852, and educated at Columbia university (A.B., 1871; LL.B., 1873; A.M., 1874; LL.D., 1904). Though admitted to the bar he never practised but turned to writing and the study

of literature. He was a professor at Columbia in literature, 1892–1900, and in dramatic literature, 1900–24. He wrote many short stories and critical essays which were published first in magazines and then in book form. He was for a long period a regular critic for the *New York Times.* His scholarship in such books as *Molière, His Life and His Works* (1910), *Shakespeare as a Playwright* (1913), *French Dramatists of the 19th Century* (1881), is sound but there is much repetition in his lighter essays. As a constructive dramatic critic he exercised much influence on the American stage in the years 1890–1915. He was an editor of many classics and many anthologies, and joint-author of a five-volume dictionary of *Actors and Actresses of Great Britain and the United States from the Days of David Garrick to the Present* (1886). He died in New York City on March 31, 1929.

He is the author of more than 40 books of which the following are the more important or typical: *The Theatres of Paris* (1880); *A Secret of the Sea* (1886); *Pen and Ink* (1888); *Americanisms and Briticisms* (1892); *Vignettes of Manhattan* (1894); *Studies of the Stage* (1894); *Aspects of Fiction* (1896); *Tales of Fantasy and Fact* (1896); *Development of the Drama* (1903); *American Character* (1906); *A Study of the Drama* (1910); *Introduction to the Study of American Literature* (1911); *Vistas of New York* (1912); *On Acting* (1914); *A Book About the Theatre* (1916); *These Many Years* (1917); *Principles of Playmaking* (1919); *The Tocsin of Revolt* (1922); *Rip Van Winkle Goes to the Play* (1926).

MATTHEWS, STANLEY (1824–1889), American jurist, was born in Cincinnati, Ohio, on July 21, 1824. He graduated at Kenyon college in 1840 and was admitted to the bar two years later. In 1844 he became assistant prosecuting attorney of Hamilton county, Ohio; and in 1846–49 edited a short-lived anti-slavery paper, the *Cincinnati Herald.* He was clerk of the Ohio House of Representatives in 1848–49, a judge of common pleas of Hamilton county in 1850–53, State senator in 1856–58 and U.S. district attorney for the southern district of Ohio in 1858–61. He was an officer in the Civil War but resigned from the army in 1863, and served as judge of the Cincinnati superior court in 1863–64. In 1872 he joined the Liberal Republican movement, and was temporary chairman of the Cincinnati convention which nominated Horace Greeley for the presidency, but in the campaign he supported Grant. In 1877 he appeared as counsel before the electoral commission and the same year became senator from Ohio. Because of his prominence as a railway and corporation lawyer and as one of the Republican "visiting statesmen" who witnessed the canvass of the vote of Louisiana in 1876 his nomination by President Hayes as associate justice of the Supreme Court in 1881 caused so much opposition that it was not approved until he was later renominated by President Garfield. He was, however, an honest, impartial and conscientious judge. He died in Washington on March 22, 1889.

See sketch in *A Biographical Congressional Directory, 1774–1903* (1903).

MATTHIAS, a shortened form of Mattathias, is the name of the disciple chosen to fill the place vacated by Judas Iscariot (Acts i. 21–26). The primitive method of choice (by lot), the Aramaic form of the name (which is not Graecized like the better known Matthew), and the fact that Paul received a tradition which referred to "the twelve" as distinguished from "all the apostles" (I Cor. xv. 5) lead us to infer that the story is based upon actual fact. The choice of twelve disciples by Jesus points to a consciousness of a nation-wide mission, which was contained in the community after the Crucifixion. Matthias is not mentioned again in the New Testament. Clement of Alexandria refers to the "Traditions" of Matthias; some, he says, identified him with Zacchaeus the publican. The Acts of Andrew and Matthias are a romance preserved in Greek and Syriac and, in part, in Latin. Matthias goes to the anthropophagi, where he has remarkable adventures. (W. K. L. C.)

MATTHIAS (1557–1619), Roman emperor, son of the emperor Maximilian II. and Maria, daughter of the emperor Charles V., was born in Vienna, on Feb. 24, 1557, and educated by the diplomatist O. G. de Busbecq (*q.v.*), he was invited in 1577, soon after his father's death, to assume the governorship of the Netherlands, then in the midst of the long struggle with Spain. Entering Brussels in Jan. 1578 he was named governor-general; but he was merely a cipher, and only held the position for about three years, returning to Germany in Oct. 1581. Matthias was appointed governor of Austria in 1593 by his brother, the emperor Rudolph II; he continued the policy of crushing the Protestants, although personally he appears to have been inclined to religious tolerance; dealt with the rising of the peasants in 1595, and took part in the Turkish War. A few years later the discontent felt by the members of the Habsburg family at the incompetence of the emperor became very acute.

Obtaining in May 1605 a reluctant consent from his brother, Matthias took over the conduct of affairs in Hungary, where a revolt had broken out, was formally recognized by the Habsburgs as their head in April 1606, and was promised the succession to the empire. In June 1606 he concluded the peace of Vienna with the rebellious Hungarians, and made peace with the sultan in November. This pacific policy was displeasing to Rudolph, who prepared to renew the Turkish War; but with the support of the national party in Hungary Matthias forced his brother to cede to him this kingdom, together with Austria and Moravia, both of which had thrown in their lot with Hungary (1608). The king of Hungary, as Matthias now became, was reluctantly compelled to grant religious liberty to the inhabitants of Austria. A formal reconciliation between Rudolph and Matthias took place in 1610; but affairs in Bohemia soon destroyed this fraternal peace. In 1611 the Bohemians invited Matthias to come to their aid against Rudolph, whose troops were ravaging their land. Accepting this invitation, he was crowned king of Bohemia in May 1611. Rudolph, however, was successful in preventing the election of Matthias as German king, or king of the Romans, and when he died, in Jan. 1612, no provision had been made for a successor. Matthias, however, obtained the remaining hereditary dominions of the Habsburgs, and in June 1612 was crowned emperor.

The short reign of the new emperor was troubled by the religious dissensions of Germany. His health became impaired and his indolence increased, and he fell completely under the influence of Melchior Klesl (*q.v.*), who practically conducted the imperial business, by whose advice he sought vainly to reconcile the contending religious parties. Meanwhile the younger Habsburgs, led by the emperor's brother, the archduke Maximilian, and his cousin, Ferdinand, archduke of Styria, afterwards the emperor Ferdinand II., disliking the peaceful policy of Klesl, had allied themselves with the unyielding Roman Catholics, while the question of the imperial succession was forcing its way to the front. In 1611 Matthias had married his cousin Anna (d. 1618), daughter of the archduke Ferdinand (d. 1595), but he was old and childless and the Habsburgs were anxious to retain his extensive possessions in the family.

Meanwhile the disputed succession to the duchies of Cleves and Jülich again threatened a European war; the imperial commands were flouted in Cologne and Aix-la-Chapelle, and the Bohemians were again becoming troublesome. Having decided that Ferdinand should succeed Matthias as emperor, the Habsburgs had secured his election as king of Bohemia in June 1617, but were unable to stem the rising tide of disorder in that country. Matthias and Klesl were in favour of concessions, but Ferdinand and Maximilian met this move by seizing and imprisoning Klesl. Ferdinand had just secured his coronation as king of Hungary when there broke out in Bohemia those struggles which heralded the Thirty Years' War; and on March 20, 1619, the emperor died at Vienna.

For the life and reign of Matthias *see* J. Heling, *Die Wahl des römischen Königs Matthias* (Belgrade, 1892); A. Gindely, *Rudolf II. und seine Zeit* (Prague, 1862–68); F. Stieve, *Die Verhandlungen über die Nachfolge Kaisers Rudolf II.* (Munich, 1880); P. von Chlumecky, *Karl von Zierotin und seine Zeit* (Brünn, 1862–79); A. Kerschbaumer, *Kardinal Klesel* (Vienna, 1865); M. Ritter, *Quellenbeiträge zur Geschichte des Kaisers Rudolf II.* (Munich, 1872); *Deutsche Geschichte im Zeitalter der Gegenreformation und des dreissigjährigen Krieges* (Stuttgart, 1887, *seq.*); and the article on Matthias in the *Allgemeine deutsche Biographie,* Bd. xx. (Leipzig, 1884); L. von Ranke, *Zur deutschen Geschichte vom Religionsfrieden bis zum 30-jährigen Kriege* (Leipzig, 1888); and J. Janssen, *Geschichte des deutschen Volks seit dem Ausgang des Mittelalters* (Freiburg, 1878 *seq.;* Eng. trans. by M. A. Mitchell and A. M. Christie (1896, *seq.*).

MATTHIAS I., HUNYADI (1440–1490), king of Hungary, also known as Matthias Corvinus, second son of János Hunyadi (*q.v.*) and Elizabeth Szilágyi, was born at Cluj (Kolozsvár), Transylvania, probably on Feb. 23, 1440. He shared in his father's campaigns when only twelve years of age. In 1453 he was created count of Bistercze, and was knighted at the siege of Belgrade in 1454. At fifteen he was married to Elizabeth of Cilli, but the young Elizabeth died before the marriage was consummated. On the death of his father he was inveigled to Buda by his enemies and condemned to death on the pretext of an imaginary conspiracy, but was spared on account of his youth. On the king's death he was detained for a time by George Poděbrad, governor of Bohemia, who treated Matthias hospitably and affianced him with his daughter Catherine. On Jan. 24, 1458 he was elected king of Hungary by the vast majority of the nation, despite the opposition of a section of the magnates, headed by the palatine László Garai and the voivode of Transylvania, Miklós Ujlaki; and on Feb. 14 entered Buda in state.

The situation of Hungary was at the time very dangerous, and to Matthias' numerous foreign enemies were added the magnates, headed by his own uncle and guardian Szilágyi. Despite their opposition, Matthias on Feb. 9, 1458 married his bride, whose father was crowned king of Bohemia soon after. He was now able to make fight against the Turks, to invade Serbia, and to reassert his suzerainty over Bosnia; and after the malcontents had actually crowned the emperor Frederick III. king of Hungary at Vienna-Neustadt (March 4, 1459), Matthias drove him out and forced him in April 1462 to restore the crown, although retaining certain Hungarian counties with the title of king and to recognize Matthias as king of Hungary. After a campaign against the Turks, during which he invaded Bosnia successfully, Matthias was crowned on March 29, 1464. In 1468 Matthias joined the Catholic league against his father-in-law Poděbrad and on May 3, 1469 was elected king of Bohemia by the Czech Catholics. Poděbrad, however, allied himself with the Poles, and after years of fighting and manoeuvring against the Polish counter-claimant, Ladislaus, and against the emperor Frederick, Matthias was forced at last to recognize Ladislaus as king of Bohemia, while he himself secured Moravia, Silesia and Lusatia until redeemed for 400,000 florins (Peace of Olmütz, July 1479).

The emperor promised to pay Matthias 100,000 florins as a war indemnity, and recognized him as the legitimate king of Hungary on the understanding that he should succeed him if he died without male issue, a contingency at this time somewhat improbable, as Matthias, only three years previously (Dec. 15, 1476), had married his third wife, Beatrice of Naples, daughter of Ferdinand of Aragon. Declaring war on Frederick a third time in 1481, Matthias was rapidly successful. He entered Vienna, which he made his capital thereafter, on June 1, 1485, afterwards conquering Styria, Corinthia and Carniola. Matthias consolidated his position by alliances with the dukes of Saxony and Bavaria, with the Swiss Confederation, and the archbishop of Salzburg, and was henceforth the greatest potentate in central Europe. His far-reaching hand even extended to Italy.

Though Matthias's policy was so predominantly occidental that he soon abandoned his youthful idea of driving the Turks out of Europe, he at least succeeded in making them respect Hungarian territory, and pushing his frontier southward in Bosnia. His last days were occupied in endeavouring to secure the succession for his illegitimate son János (*see* CORVINUS, JÁNOS); but Queen Beatrice, though childless, fiercely opposed the idea and the matter was still pending when Matthias expired very suddenly on Palm Sunday, April 4, 1490.

Matthias Hunyadi was indisputably the greatest man of his day, and one of the greatest monarchs who ever reigned. Like Napoleon, with whom he has often been compared, he was equally illustrious as a soldier, a statesman, an orator, a legislator and an administrator; but unlike him a fine moral character. Although naturally passionate and repeatedly provoked by ingratitude and treachery, he never was guilty of a single cruel or vindictive action. His capacity for work was inexhaustible. Frequently half his nights were spent in reading, after the labour of his most strenuous days. There was no branch of knowledge in which he did not take an absorbing interest, no polite art which he did not cultivate and encourage. His camp was a school of chivalry, his court a nursery of poets and artists.

See Vilmós Fraknói, *King Matthias Hunyadi* (Hung., Budapest, 1890, German ed., Freiburg, 1891); Karl Schober, *Die Eroberung Niederösterreichs durch Matthias Corvinus* (Vienna, 1879); János Huszár, *Matthias's Black Army* (Hung. Budapest, 1890); *Aeneas* Sylvius, *Opera* (Frankfort, 1707); *The Correspondence of King Matthias* (Hung. and Lat., Budapest, 1893); Marzio Galeotti, *De egregie sapienter et jocose dictis ac factis Matthiae regis* (*Script. reg. hung. I.*) (Vienna, 1746). *See* also HUNGARY.

MATTHISSON, FRIEDRICH VON (1761–1831), German poet, was born near Magdeburg, the son of the village pastor, on Jan. 23, 1761. In 1812 he entered the service of the king of Württemberg, was ennobled, created counsellor of legation, appointed intendant of the court theatre and chief librarian of the royal library at Stuttgart. In 1828 he retired and settled at Wörlitz near Dessau, where he died on March 12, 1831. Matthisson's poems, *Gedichte* (1787; 15th ed., 1851; new ed. 1876), were extravagantly praised by Schiller for their melancholy sweetness and their fine descriptions of scenery. His *Adelaide* has been rendered famous owing to Beethoven's setting of the song.

Matthisson's *Schriften* appeared in eight volumes (1825–29), of which the first contains his poems, the remainder his *Erinnerungen;* a ninth volume was added in 1833 containing his biography by H. Döring.

See his *Erinnerungen* (5 vols. 1810–16), and a selection from his correspondence, *Literarischer Nachlass* (4 vols. ed. F. R. Schoch, 1832).

MATTING, a general term embracing many coarse woven or plaited fibrous materials used for covering floors or furniture, for hanging as screens, for wrapping up heavy merchandise and for other miscellaneous purposes. Perforated and otherwise prepared rubber, as well as wire-woven material, are also largely utilized for door and floor mats.

In the United Kingdom, under the name of "coir" matting, a large amount of a coarse kind of carpet is made from coco-nut fibre; and the same material, as well as strips of cane, Manila hemp, various grasses and rushes, is largely employed in various forms for making door mats. Large quantities of the coco-nut fibre (*see* COCO-NUT PALM) are woven in heavy looms, then cut up into various sizes, and finally bound round the edges by a kind of rope made from the same material. The mats may be of one colour only, or they may be made of different colours and in different designs. Sometimes the names of institutions are introduced into the mats. Another type of mat is made exclusively from the above-mentioned rope by arranging alternate layers in sinuous and straight paths, and then stitching the parts together. It is also largely used for the outer covering of ships' fenders. Matting of various kinds is very extensively employed throughout India for floor coverings, the bottoms of bedsteads, fans and fly-flaps, etc.; and a considerable export trade in such manufactures is carried on.

The materials used are numerous; but the principal substances are straw, the bulrushes *Typha elephantina* and *T. angustifolia,* leaves of the date palm (*Phoenix sylvestris*), of the dwarf palm (*Chamaerops Ritchiana*), of the Palmyra palm (*Borassus flabelliformis*), of the coco-nut palm (*Cocos nucifera*) and of the screw pine (*Pandanus odoratissimus*), the munja or munj grass (*Saccharum Munja*) and allied grasses, and the mat grasses *Cyperus textilis* and *C. Pangorei*, from the last of which the well-known Palghat mats of the Madras presidency are made. Many of these Indian grass-mats are admirable examples of elegant design, and the colours in which they are woven are rich, harmonious and effective in the highest degree. Several useful household articles are made from the different kinds of grasses. The grasses are dyed in all shades and plaited to form attractive designs suitable for the purposes to which they are to be applied. This class of work obtains in India, Japan and other Eastern countries. Vast quantities of coarse matting used for packing furniture, heavy and coarse goods, flax and other plants, etc., are made in Russia from the bast or inner bark of the lime tree. This industry centres in the great forest Governments of Viatka,

Nijni-Novgorod, Kostroma, Kazan, Perm and Simbirsk.

(T. W.)

MATTO GROSSO, an inland State of Brazil, bounded N. by Amazonas and Pará, E. by Goyaz, Minas Geraes, São Paulo and Paraná, S. by Paraguay and S.W. and W. by Bolivia. It ranks next to Amazonas in size, its area, which is largely unsettled and unexplored, being 570,138 sq.m., and its population (containing many Indians) only 246,612 in 1920. The greater part of the State belongs to the western extension of the Brazilian plateau, across which runs the watershed which separates the drainage basins of the Amazon and La Plata. This elevated region is known as the plateau of Matto Grosso, and its elevations so far as known rarely exceed 3,000 feet. The northern slope of this great plateau is drained by the Araguaya-Tocantins, Xingú, Tapajos, and Guaporé-Mamoré-Madeira, all of which except the first, empty into the Amazon; the southern slope drains through a multitude of streams flowing into the Paraná and Paraguay. The general elevation in the south part of the State is much lower, and large areas bordering the Paraguay are swampy plains.

The lowland elevations in this part of the State range from 300 to 400 ft. above sea-level, the climate is hot, humid and unhealthful, and the conditions for permanent settlement are apparently unfavourable. On the highlands, however, which contain extensive open *campos,* the climate, though dry and hot, is considered healthful. The basins of the Paraná and Paraguay are separated by low mountain ranges extending north from the *sierras* of Paraguay. The resources of Matto Grosso are practically undeveloped, owing to the isolated situation of the State, the costs of transportation and the small population.

The first industry was that of mining, gold having been discovered in the river valleys on the southern slopes of the plateau, and diamonds on the head-waters of the Paraguay, about Diamantino and in two or three other districts. Gold is found chiefly in placers, and in colonial times the output was large, but the industry is now comparatively unimportant. Agriculture exists only for the supply of local needs, though tobacco of a superior quality is grown. Cattle-raising, however, has received some attention and is the principal industry of the landowners. The forests include fine woods, rubber, ipecacuanha, sarsaparilla, jaborandi, vanilla and copaiba. There is little export, however, the only means of communication until recent years being down the Paraguay and Paraná rivers by means of subsidized steamers. A railway has now been completed from São Paulo across the State to Corumbá on the Paraguay river. The capital of the State is Cuyabá, whose population in 1920 was 33,678 (including its municipal district), and the chief commercial town is Corumbá, whose population (with the municipal district) in 1920 was 19,547, at the head of navigation for the larger river boats, and 1,986 m. from the mouth of the La Plata. Communication between these two towns is maintained by a line of smaller boats, the distance being 517 miles.

The first permanent settlements in Matto Grosso seem to have been made in 1718 and 1719, in the first year at Forquilha and in the second at or near the site of Cuyabá, where rich placer mines had been found. At this time all this inland region was considered a part of São Paulo, but in 1748 it was made a separate *capitania* and was named Matto Grosso ("great woods"). In 1752 its capital was situated on the right bank of the Guaporé river and was named Villa Bella da Santissima Trindade de Matto Grosso, but in 1820 the seat of Government was removed to Cuyabá and Villa Bella has fallen into decay. In 1822 Matto Grosso became a province of the empire and in 1889 a republican State. It was invaded by the Paraguayans in the war of 1860–65.

MATTOON, a city of Coles county, Illinois, U.S.A., in the eastern part of the State, 172 m. S. of Chicago. It is on Federal highway 45, and is served by the Big Four and the Illinois Central railways. Pop. (1920) 13,552 (97% native white); estimated locally (1928) at 16,500. It has large grain elevators and railroad repair shops, and is an important shipping point for corn, wheat, oats and broom corn. The value of its manufactures (including steam engines and water-works plants) was estimated at $6,000,000 for 1928. Mattoon was founded about 1855 and chartered as a city in 1857. It was named after an early settler.

MATURIN, CHARLES ROBERT (1782–1824), Irish novelist and dramatist, was born in Dublin in 1782, the grandson of Gabriel Jasper Maturin, Swift's successor in the deanery of St. Patrick. Charles Maturin was educated at Trinity college, Dublin, and became curate of Loughrea and then of St. Peter's, Dublin. His first novels, *The Fatal Revenge; or, the Family of Montorio* (1807), *The Wild Irish Boy* (1808) and *The Milesian Chief* (1812), issued under the pseudonym of "Dennis Jasper Murphy," were mercilessly ridiculed, but the irregular power displayed in them attracted the notice of Sir Walter Scott, who recommended the author to Byron. Through their influence Maturin's tragedy of *Bertram* was produced at Drury Lane in 1816, with Kean and Miss Kelly in the leading parts. A French version by Charles Nodier and Baron Taylor was produced in Paris at the Théâtre Favart. Two more tragedies, *Manuel* (1817) and *Fredolfo* (1819), were failures, and his poem *The Universe* (1821) fell flat. He wrote three more novels, *Women* (1818), *Melmoth, the Wanderer* (1820), and *The Albigenses* (1824). *Melmoth,* which forms its author's title to remembrance, is the best of them, and has for hero a kind of "Wandering Jew." Honoré de Balzac wrote a sequel to it under the title of *Melmoth réconcilié à l'église* (1835). Maturin died in Dublin on Oct. 30, 1824.

See N. Idman, *Charles Robert Maturin: his Life and Works* (1923).

MATVYEEV, ARTAMON SERGYEEVICH (d. 1682), Russian statesman and reformer, was one of the greatest of the precursors of Peter the Great. His parentage and the date of his birth are uncertain. In 1671 the tsar Alexius and Artamon were already on intimate terms, and on the retirement of Orduin-Nashchokin, Matvyeev became the tsar's chief counsellor. Matvyeev remained paramount to the end of the reign and introduced play-acting and all sorts of refining western novelties into Muscovy. The deplorable physical condition of Alexius's immediate successor Theodore III. suggested to Matvyeev the elevation to the throne of the sturdy little tsarevich Peter, then in his fourth year. He purchased the allegiance of the *stryeltsi,* or musketeers, and then, summoning the boyars of the council, urged the substitution of Peter for Theodore. His arguments failed, and he was banished to Pustozersk, in northern Russia, where he remained till Theodore's death (April 27, 1682). The first *ukaz* issued in Peter's name summoned Matvyeev to return to the capital and act as chief adviser to the tsaritsa Natalia. He reached Moscow on May 5, and at once proceeded to the head of the Red Staircase to meet and argue with the assembled *stryeltsi,* who had been instigated to rebel by the anti-Petrine faction. They seized and flung Matvyeev into the square below, where he was hacked to pieces by their comrades.

See R. Nisbet Bain, *The First Romanovs* (London, 1905); M. P. Pogodin, *The First Seventeen Years of the Life of Peter the Great* (Rus.) (Moscow, 1875); S. M. Solovev, *History of Russia* (Rus.) (vols. 12, 13) (St. Petersburg, 1895, etc.); L. Shchepotev, *A. S. Matvyeev as an Educational and Political Reformer* (Rus.) (St. Petersburg, 1906).

MAUBEUGE, a town of northern France, in the department of Nord, situated on both banks of the Sambre, here canalized, 23½ m. by rail E. by S. of Valenciennes, and about 2 m. from the Belgian frontier. Pop. (1926) 21,835. Maubeuge (*Malbodium*) owes its origin to a double monastery for men and women founded in the 7th century by St. Aldegonde, relics of whom are preserved in the church. It subsequently belonged to the territory of Hainault. It was burnt by Louis XI., by Francis I., and by Henry II., and was finally assigned to France by the Treaty of Nijmwegen. It was fortified by Vauban. Besieged in 1793 by Prince Josias of Coburg, it was relieved by the victory of Wattignies. It was unsuccessfully besieged in 1814, but was compelled to capitulate, after a vigorous resistance, in the Hundred Days. After the war of 1870, the fortifications of Maubeuge were considerably strengthened. It was taken by the Germans in Sept. 1914 after a heavy bombardment by 11-in. howitzers, having held out longer than any other town in northern France; and it became an important base. It was retaken by the British on Nov. 9, 1918. The town has a board of trade arbitrators, and there are important

foundries, forges and blast-furnaces, together with manufactures of machine-tools.

MAUCH CHUNK (mawk chŭnk), a borough of eastern Pennsylvania, U.S.A., the county seat of Carbon county; on the Lehigh river (west bank), Federal highway 209, and the Lehigh Coal and Navigation company canal. It is served by the Central of New Jersey and the Lehigh Valley railways. Pop. (1920) 3,666 but 3,206 in 1930. Across the river is East Mauch Chunk (pop., 1930, 3,739) and 4 m. S.E. is Lehighton (*q.v.*). Mauch Chunk is on the edge of the anthracite region, in the midst of beautiful scenery. It has an altitude of 600 ft., and on either side Mt. Pisgah and Flagstaff mountain rise 1,000 ft. above the town. It is a summer resort, a supply centre and shipping point for many large collieries, and has railroad shops, silk mills and dress factories. The borough was founded in 1818 by the Lehigh Coal and Navigation company, which in 1827 built a "switchback" railway (now used for tourist traffic) to carry the coal from the mountains to the river. In 1831 the town was opened to individual enterprise, and in 1846 it was incorporated as a borough. It was the home of Asa Packer, builder of the Lehigh Valley railroad. On Summit hill there is a burning mine which has been on fire since 1832.

MAUCHLINE (mawch'lin), a town in the division of Kyle, Ayrshire, Scotland. Pop. (1931), 2,484. It lies 8 m. E.S.E. of Kilmarnock and 11 m. E. by N. of Ayr by the L.M.S. railway. It is situated on a gentle slope about 1 m. from the river Ayr. Wood knicknacks and curling stones are made, freestone quarried, and fairs held. The parish church, dating from 1829, stands in the middle of the village, and on the green a monument, erected in 1830, marks the spot where five Covenanters were killed in 1685. Robert Burns lived with his brother Gilbert on the farm of Mossgiel, about a mile to the north, from 1784 to 1788. Mauchline kirkyard was the scene of the "Holy Fair"; the "Jolly Beggars" met at "Poosie Nansie's"—still, though much altered, a popular inn; near the parish church (in the poet's day an old, barn-like structure) was the Whiteford Arms inn, where on a pane of glass Burns wrote the epitaph on John Dove, the landlord; "auld Nanse Tinnock's" house nearly faces the entrance to the churchyard; the Rev. William Auld was minister of Mauchline, and "Holy Willie," whom the poet scourged in the celebrated "Prayer," was one of "Daddy Auld's" elders; behind the kirkyard stands the house of Gavin Hamilton, the lawyer and firm friend of Burns, in which the poet was married. The braes of Ballochmyle, where he met the heroine of his song, "The Lass o' Ballochmyle," lie about a mile to the south-east.

MAUDE, CYRIL (1862–), English actor, was born in London on April 24, 1862, and was educated at Charterhouse. From 1896 to 1905 he was co-manager with F. Harrison of the Haymarket Theatre, London. In 1906 he went into management on his own account, and in 1907 opened his new theatre The Playhouse, which he retained until 1915. In 1888 he married the actress Winifred Emery (1862–1924), who had made her London début as a child in 1875, and acted with Irving at the Lyceum between 1881 and 1887. Maude made frequent visits to America. His works include: *The Haymarket Theatre* (1903); *The Actor in Room 931,* and *Reminiscences* (1927).

MAUDE, SIR FREDERICK STANLEY (1864–1917), British soldier, son of Gen. Sir Frederick Maude, V.C., was born at Gibraltar on June 24, 1864. In the South African War, as brigade-major of the Guards Brigade, he took part in the advance to Pretoria. After a spell in Canada as military secretary to the governor-general, he was engaged on the organization and training of the new Territorial Force. On mobilization in Aug. 1914 he was posted to the staff of the III. Army Corps and served in France until June 1915. In Aug. he was hurried out to the Dardanelles to take command of the 13th Division. There he took part in the evacuations of Suvla and of Helles, and in 1916 his division was dispatched from Egypt to Mesopotamia to aid in the relief of Kut-al-Amara. They arrived in time to bear a share in the final desperate endeavours to save the doomed stronghold, but the effort came to naught and after the surrender of Kut, Maude and his division remained facing the Turks on the Tigris. He was advanced in Sept. to the position of army commander in Mesopotamia.

Maude spent three months at Basra, ensuring that when the time came his field army should be capable of acting with vigour and decision. Then, in December, he suddenly pushed forward, and within a few weeks had driven the Turks in confusion out of their entrenched camp around Kut. He occupied Baghdad on March 11, and spent the next few months consolidating his position and preparing plans for a fresh offensive. He died at Baghdad of cholera on Nov. 18, 1917. (*See* MESOPOTAMIA, OPERATIONS IN.)

See Maj.-Gen. Sir C. E. Callwell, *Life of Sir Stanley Maude* (1920).

MAUGHAM, WILLIAM SOMERSET (1874–), English novelist and playwright, is the son of Robert Ormond Maugham. He was educated at King's School Canterbury, Heidelberg University, and St. Thomas's Hospital. He served in the Secret Service in the World War. *Ashenden* is based on this. His novels are largely concerned with the East; his other plays are all rather thrown into the shade by *Our Betters,* a brilliantly witty and shamelessly cynical piece of social satire that was one of the greatest theatrical successes since the War.

His novels are *Liza of Lambeth* (1897), *The Hero* (1901), *The Explorer* (1907), *The Moon and Sixpence* (1919), *The Trembling of a Leaf* (1921), *On a Chinese Screen* (1922), *The Painted Veil* (1925), *The Casuarina Tree* (1926) and *Ashenden,* 1928. His plays include *A Man of Honour* (1903), *Jack Straw* (1908), *The Land of Promise* (1914), *Carolina* (1916), *Caesar's Wife* (1919), *East of Suez* (1922), *Our Betters* (1923), *The Camel's Back* (1924), *The Constant Wife* and *The Letter* (1927). His *Plays* are published by Heinemann (1912–).

MAULE, a province of central Chile, bounded on the north by Talca, on the east by Argentina, on the south by Nuble and Concepción and on the west by the Pacific. Pop. (1928) about 200,000; area, before the annexation of Linares in 1928, 5,685 sq. miles. The western part of Maule is traversed from north to south by the coast range. The climate is mild and healthy. Agriculture and stock-raising are the principal occupations, and hides, cattle, wheat and wines are exported. Transport facilities are afforded by the Maule, which is navigable for shallow-draught barges, and by a branch of the Government railway from Cauquenes to Parral. The provincial capital, Linares (Pop. [1920] 12,051), is centrally situated. Cauquenes, the former capital, is situated on the eastern slopes of the coast cordilleras and had a population in 1920 of 10,803. The town and port of Constitución (Pop. [1920] 7,827) is situated on the south bank of the Maule, one mile above its mouth. There is a dangerous bar at the mouth of the river, but Constitución is connected with Talca by rail and has a considerable trade.

The Maule river, from which the province takes its name, is of historic interest because it is said to have marked the southern limits of the Inca empire. It rises in the Laguna del Maule, an Andean lake near the Argentine frontier, 7,218 ft. above sea-level, and flows westward about 140 m. to the Pacific. The upper part of its drainage basin contains the volcanoes of San Pedro (11,800 ft.), the Descabezado (12,795 ft.), and others of the same group of lower elevations. The upper course and tributaries of the Maule, principally in the Provinces of Linares, are largely used for irrigation.

MAUNDY THURSDAY, the Thursday before Easter. Maundy Thursday is sometimes known as *Sheer* or *Chare* Thursday, either in allusion, it is thought, to the "shearing" of heads and beards in preparation for Easter, or more probably in the word's Middle English sense of "pure," in allusion to the ablutions of the day. The chief ceremony, as kept from the early middle ages onwards—the washing of the feet of twelve or more poor men or beggars—was in the early Church almost unknown. From the 4th century ceremonial foot-washing became yearly more common, till it was regarded as a necessary rite, to be performed by the pope, all Catholic sovereigns, prelates, priests and nobles. In England the king washed the feet of as many poor men as he was years old, and then distributed to them meat, money and clothes. At Durham Cathedral, until the 16th century, every charity-boy had a monk to wash his feet. At Peterborough Abbey, in 1530, Wolsey made "his maund in Our

Lady's Chapel, having fifty-nine poor men whose feet he washed and kissed; and after he had wiped them he gave every of the said poor men twelve pence in money, three ells of good canvas to make them shirts, a pair of new shoes, a cast of red herrings and three white herrings." Queen Elizabeth performed the ceremony, the paupers' feet, however, being first washed by the yeomen of the laundry with warm water and sweet herbs. James II. was the last English monarch to perform the rite. William III. delegated the washing to his almoner, and this was usual until the middle of the 18th century. Since 1754 the foot-washing has been abandoned, and the ceremony now consists of the presentation of Maundy money, officially called Maundy Pennies. These were first coined in the reign of Charles II. The service which formerly took place in the Chapel Royal, Whitehall, is now held in Westminster Abbey. It is on Maundy Thursday that in the Church of Rome the sacred oil is blessed, and the chrism prepared according to an elaborate ritual which is given in the *Pontificale*.

MAUNOURY, MICHEL JOSEPH (1847–1923), French soldier, was born at Maintenon (Eure-et-Loir) Dec. 11, 1847. Commissioned to the artillery from the École Polytechnique in 1869, he served in the Franco-German War, and in 1883 became a professor at St. Cyr. He retired in 1912, having been military governor of Paris and a member of the Conseil Supérieur de la Guerre. On Aug. 19, 1914 he was given charge of the army improvised in Lorraine from the reserve divisions. On Aug. 24 he made a brilliant attack on the left flank of the V. German Army; and when, on Aug. 26, a new VI. Army was assembled on the Somme, the command was given to Gen. Maunoury. It was this army, which, on Sept. 4, was launched against the flank of Von Kluck's I. Army—an action which opened and exercised a decisive influence on the battle of the Marne. Maunoury continued to command the VI. Army throughout the development of the Aisne line of battle and in the early phases of trench warfare. On March 15, 1915 he was severely wounded, and thereafter held no active command. From Nov. 1915 till March 1916 he was Governor of Paris. He died on March 28, 1923, and was created marshal of France posthumously.

MAUPASSANT, HENRI RENÉ ALBERT GUY DE (1850–1893), French novelist and poet, was born at the Château of Miromesnil (Seine-Inférieure) on Aug. 5, 1850. His grandfather, a landed proprietor of a good Lorraine family, bequeathed a moderate fortune to his son, a Paris stockbroker, who married Mlle. Laure Lepoitevin. Maupassant was educated at Yvetot and at the Rouen lycée. A copy of verses entitled *Le Dieu créateur,* written during his year of philosophy, has been printed. He entered the ministry of marine, and was promoted to the Cabinet de l'Instruction publique, but legend says that, in a report by his chief, Maupassant is mentioned as not reaching the standard of the department in the matter of style. He divided his time between rowing expeditions and attending literary gatherings at the house of Gustave Flaubert, who was not, as he is often alleged to be, related to Maupassant but was merely an old friend of his mother. Maupassant seldom shared in the literary conversation, and upon those who met him—Turgenev, Alphonse Daudet, Catulle Mendès, José-Maria de Hérédia and Zola—he left the impression of a simple young athlete. Even Flaubert, to whom he submitted some sketches, was not greatly struck by their talent, though he encouraged the youth to persevere.

Maupassant's first essay was a dramatic piece twice given at Étretat in 1873 before an audience which included Turgenev, Flaubert and Meilhac. In this indecorous performance, of which nothing more is heard, Maupassant played the part of a woman. During the next seven years he served a severe apprenticeship to Flaubert, and in 1880 published a volume of poems, *Des Vers,* against which legal proceedings were taken and eventually withdrawn, and Flaubert, who had himself been prosecuted for his first book, *Madame Bovary,* congratulated the poet on the similarity between their literary experiences. *Des Vers* is an interesting experiment, which shows Maupassant hesitating in his choice of a medium; but he recognized that its chief deficiency—the absence of verbal melody—was fatal. Later in the year he contributed to the *Soirées de Médan,* a collection of short stories by Zola, Huysmans and others, and in the *Boule de suif* revealed himself to his amazed collaborators and the public as an admirable writer of prose and a consummate master of the *conte,* thereby furnishing an instance, rare in literary history, of a writer beginning with a masterpiece. This success was quickly followed by *La Maison Tellier* (1881), which confirmed the first impression and vanquished even those who were repelled by the author's choice of subjects.

In *Mademoiselle Fifi* (1883) he repeated his previous triumphs as a *conteur,* and in the same year published *Une Vie,* his first work on a larger scale. In modern literature there is no finer example of cruel observation than this sad picture of an average woman undergoing the constant agony of disillusion, while the effect of extreme truthfulness which it conveys justifies its subtitle—*L'Humble vérité.* On account of certain passages the sale of the volume at railway bookstalls was forbidden in France, with the natural result of drawing attention to the book and of advertising the *Contes de la bécasse* (1883), a collection of stories as improper as they are clever. *Au soleil* (1884) a book of travels, was less read than *Clair de lune, Miss Harriet, Les Soeurs Rondoli* and *Yvette,* all published in 1883–1884 when Maupassant's powers were at their highest; and the collections of 1885, *Contes et nouvelles, Monsieur Parent,* and *Contes du jour et de la nuit,* show a falling off in style. To 1885 also belongs *Bel-ami,* the cynical history of a particularly detestable, brutal scoundrel who makes his way by means of his handsome face. Maupassant is here no less vivid in realizing his literary men, his financiers and frivolous women than in dealing with his favourite peasants, boors and servants, to whom he returned in *Toine* (1886) and in *La Petite Rogue* (1886).

About this time appeared the first symptoms of the malady which destroyed him; he wrote less, and *Le Horla* (1887) suggests that he was already subject to alarming hallucinations. Restored to some extent by a sea-voyage, recorded in *Sur l'eau* (1888), he went back to short stories in *Le Rosier de Madame Husson* (1888), a burst of Rabelaisian humour equal to anything he had ever written. His novels *Pierre et Jean* (1888), *Fort comme la mort* (1889), and *Notre coeur* (1890) are touched with a profounder sympathy than had hitherto distinguished him; and this pity for the tragedy of life is deepened in some of the tales in *Inutile beauté* (1890). With *La Vie errante* (1890), a volume of travel, Maupassant's career practically closed. *Musotte,* a theatrical piece written with M. Jacques Normand, was published in 1891. He now began to take an interest in religious problems and for a while made the *Imitation* his handbook; but by this time inherited nervous maladies, aggravated by excessive physical exercises and by the imprudent use of drugs, had undermined his constitution; his misanthropy deepened and he suffered from curious delusions. A victim of general paralysis of which *La Folie des grandeurs* was one of the symptoms, he purposed passing the winter of 1891 at Cannes, but his reason slowly gave way; in Jan. 1892 he attempted suicide, and was removed to Paris, where he died in painful circumstances on July 6, 1893. He is buried in the cemetery of Montparnasse.

Maupassant began as a follower of Flaubert and of M. Zola, but, whatever the masters may have called themselves, they both remained essentially *romantiques.* The pupil is the last of the "naturalists": he even destroyed naturalism, since he did all that can be done in that direction. He had no psychology, no theories of art, no moral or strong social prejudices, no disturbing imagination, no wealth of perplexing ideas. Undisturbed by any external influence, his marvellous vision enabled him to become a supreme observer and given his literary sense, the rest was simple. He prided himself in having no invention; he described nothing that he had not seen. It is no paradox to say that his marked limitations made him the incomparable artist that he was.

Fundamentally he finds all men alike. In every grade of life he finds the same ferocious, cunning, animal instincts at work: it is not a gay world, but he knows no other; he is possessed by the dread of growing old, of ceasing to enjoy; the horror of death haunts him like a spectre. Maupassant does not prefer good to

bad, one man to another; he never pauses to argue about the meaning of life; his one aim is to discover the hidden aspect of things, to relate what he has observed, to give an objective rendering of it, and he has seen so intensely and so serenely that he is a most exact transcriber. And his style is exceedingly simple and strong; he is content to use the humblest word if only it conveys the exact picture of the thing seen. In ten years he produced some thirty volumes. With the exception of *Pierre et Jean*, his novels, excellent as they are, scarcely represent him at his best; a few pieces found among his papers were published posthumously; *Amitié amoureuse* (1897), a correspondence dedicated to his mother, is probably unauthentic; among the prefaces he wrote, only one—an introduction to a French prose version of Swinburne's *Poems and Ballads*—is likely to interest English readers; and of over two hundred *contes* a proportion must be rejected. But enough will remain to vindicate his claim to a permanent place in literature as the most perfect master of the short story.

See F. Brunetière, *Le Roman naturaliste* (1883); L. Lemaître, *Les Contemporains* (vols. i., v., vi.); R. Doumic, *Ecrivains d'aujourd'hui* (1894); an introduction by Henry James to *The Odd Number* . . . (1891); a critical preface by the earl of Crewe to *Pierre and Jean* (1902); A. Symons, *Studies in Prose and Verse* (1904). There are many references to Maupassant in the *Journal des Goncourt*, and some correspondence with Marie Bashkirtseff was printed with *Further Memoirs* of that lady in 1901. *See* also J. Rolland, *Guy de Maupassant* (1924); E. Boyd, *Guy de Maupassant* (1926); P. Borel, *Le Destin tragique de Guy de Maupassant, d'apres des documents originaux* (1927).

MAUPEOU, RENÉ NICOLAS CHARLES AUGUSTIN (1714–1792), chancellor of France, was born on Feb. 25, 1714, being the eldest son of René Charles de Maupeou (1688–1775), who was president of the parlement of Paris from 1743 to 1757. He was his father's right hand in the conflicts between the parlement and Christophe de Beaumont, archbishop of Paris, who was supported by the court. Between 1763 and 1768, dates which cover the revision of the case of Jean Calas and the trial of the comte de Lally, Maupeou was himself president of the parlement. In 1768, through the protection of Choiseul, whose fall two years later was in large measure his work, he became chancellor in succession to his father, who had held the office for a few days only. He determined to support the royal authority against the parlements. The struggle came over the trial of the case of the duc d'Aiguillon, ex-governor of Brittany, and of La Chalotais (*q.v.*) procureur-général of the province, who had been imprisoned by the governor for accusations against his administration. When the parlements showed signs of hostility against Aiguillon, Louis XV. annulled the proceedings.

Louis replied to remonstrances from the parlement by a *lit de justice*, in which he demanded the surrender of the minutes of procedure. On Nov. 27, 1770, appeared the *Édit de règlement et de discipline*, which was promulgated by the chancellor, forbidding the union of the various branches of the parlement and correspondence with the provincial magistratures. It also made a strike on the part of the parlement punishable by confiscation of goods, and forbade further obstruction to the registration of royal decrees after the royal reply had been given to a first remonstrance. This edict the magistrates refused to register, and it was registered in a *lit de justice* held at Versailles on Dec. 7, whereupon the parlement suspended its functions. After five summonses to return to their duties, the magistrates were surprised individually on the night of Jan. 19, 1771, by musketeers, who required them to sign yes or no to a further request to return. Thirty-eight magistrates gave an affirmative answer, but on the exile of their former colleagues by *lettres de cachet* they retracted, and were also exiled. Maupeou installed the council of state to administer justice pending the establishment of six superior courts in the provinces, and of a new parlement in Paris. The *cour des aides* was next suppressed.

Voltaire praised this revolution, applauding the suppression of the old hereditary magistrature, but in general Maupeou's policy was regarded as the triumph of tyranny. The remonstrances of the princes, of the nobles, and of the minor courts, were met by exile and suppression, but by the end of 1771 the new system was established, and the Bar, which had offered a passive resistance, recommenced to plead. But the death of Louis XV. in May 1774 ruined the chancellor. The restoration of the parlements was followed by a renewal of the quarrels between the new king and the magistrature. Maupeou and Terrai were replaced by Malesherbes and Turgot. Maupeou lived in retreat until his death at Thuit on July 29, 1792, having lived to see the overthrow of the *ancien régime*. His work, in so far as it was directed towards the separation of the judicial and political functions and to the reform of the abuses attaching to a hereditary magistrature, was subsequently endorsed by the Revolution; but no justification of his violent methods or defence of his intriguing and avaricious character is possible. He aimed at securing absolute power for Louis XV., but his action was in reality a serious blow to the monarchy.

The chief authority for the administration of Maupeou is the *compte rendu* in his own justification presented by him to Louis XVI. in 1789, which included a dossier of his speeches and edicts, and is preserved in the Bibliothèque nationale. These documents, in the hands of his former secretary, C. F. Lebrun, duc de Plaisance, formed the basis of the judicial system of France as established under the consulate. (*Cf.* C. F. Lebrun, *Opinions, rapports et choix d'écrits politiques*, published posthumously in 1829.) *See* further *Maupeouana* (6 vols., 1775), which contains the pamphlets directed against him; *Journal hist. de la révolution opérée . . . par M. de Maupeou* (7 vols., 1775); the official correspondence of Mercy-Argenteau; the letters of Mme. d'Épinay; Jules Flammermont, *Le Chancelier Maupeou et les parlements* (1883); Le Griel, *Le Chancelier Maupeou et la magistrature à la fin de l'ancien régime* (1906).

MAUPERTUIS, PIERRE LOUIS MOREAU DE (1698–1759), French mathematician and astronomer, was born at St. Malo on July 17, 1698. He served in the army for five years, employing his leisure in mathematical studies. In 1736 he acted as chief of the expedition sent by Louis XV. into Lapland to measure the length of a degree of the meridian. In 1740 he went to Berlin on the invitation of the king, and took part in the battle of Mollwitz, where he was taken prisoner by the Austrians. On his release he returned to Berlin, and thence to Paris. He went back to Berlin in 1744, and was chosen president of the Royal Academy of Sciences in 1746. He originated the principle of Least Action in 1744 (Mém. de l'Acad.). Maupertuis was a man of considerable ability as a mathematician, but was involved in constant quarrels, of which his controversies with König and Voltaire during the latter part of his life furnish examples. He died in Basle on July 27, 1759.

The following are his most important works: *Sur la figure de la terre* (1738); *Discours sur la parallaxe de la lune* (1741); *Discours sur la figure des astres* (1742); *Éléments de la géographie* (1742); *Lettre sur la comète de 1742* (1742); *Astronomie nautique* (1745 and 1746); *Vénus physique* (1745); *Essai de cosmologie* (Amsterdam, 1750). His *Oeuvres* were published in 1752 at Dresden and in 1756 at Lyons.

MAURA, ANTONIO MONTANER (1853–1925), Spanish statesman, was born in Palma de Mallorca on May 2, 1853. He was educated at Valencia and Madrid where he studied law. Though his pronunciation of Spanish was at first defective, by perseverance and force of personality he became in later years a great forensic and parliamentary orator. Elected deputy for his native city in 1881, he joined the Liberal party; but his instincts were conservative and in 1901 he went over to the Conservative party of which he eventually became leader. He was a constructive statesman, and though the chaotic state of the Spanish political fabric inspired in him a desire for reform, he always regarded the constitution as sacred. In 1903 he became Prime Minister, and his zeal for reform made him many enemies among the corrupt political factions of Spain. He negotiated with France on the subject of Spanish rights in Tangier and Morocco and with Great Britain concerning the *status quo* of the seas. In 1913 he resigned the leadership of the Conservative party, but, in response to appeals from the king, he formed governments in 1918, 1919 and 1921. True to his constitutional ideals, he refused to make common cause with the Directorate of 1923 which superseded parliamentary government in Spain. Nevertheless, Maura, who favoured "revolution from above," probably came nearer to Primo de Rivera's ideas than any considerable Spanish statesman of the old school. But he deprecated the Primo de Rivera dictatorship as arising out of an army revolt and therefore un-

likely to command public confidence. He died on Dec. 13, 1925.

MAU RANIPUR, a town of British India in Jahnsi district, in the United Provinces. Pop. (1921), 12,554. It contains a large community of wealthy merchants and bankers. A special variety of red cotton cloth, known as *kharua,* is manufactured and exported to all parts of India.

MAUREL, VICTOR (1848–1923), French singer, was born at Marseilles, and studied at the Paris Conservatoire. He made his début in opera at Paris in 1868, and in London in 1873, and was one of the finest operatic baritones of his day. He created the leading part in Verdi's *Otello,* and was equally fine in Wagnerian and Italian opera. He died in New York on Oct. 23, 1923.

MAUREPAS, JEAN FRÉDÉRIC PHÉLYPEAUX, COMTE DE (1701–1781), French statesman, was born on April 9, 1701, at Versailles, the son of Jérôme de Pontchartrain, secretary of state for the marine and the royal household. Maurepas succeeded to his father's charge at 14, began his functions in the royal household at 17, and in 1725 he undertook the actual administration of the navy. Although essentially light and frivolous in character, Maurepas used the best brains of France to apply science to questions of navigation and of naval construction. He was disgraced in 1749, and exiled from Paris for an epigram against Madame de Pompadour. On the accession of Louis XVI., 25 years later, he became a minister of state and Louis XVI.'s chief adviser. He gave Turgot the direction of finance, placed Lamoignon Malesherbes over the royal household and made Vergennes minister for foreign affairs. At the outset of his new career he showed his weakness by recalling to their functions, in deference to popular clamour, the members of the old parlement ousted by Maupeou, thus reconstituting the most dangerous enemy of the royal power. This step, and his intervention on behalf of the American states, helped to pave the way for the French Revolution. Jealous of his personal ascendancy over Louis XVI., he intrigued against Turgot, whose disgrace in 1776 was followed after six months of disorder by the appointment of Necker. In 1781 Maurepas deserted Necker as he had done Turgot, and he died at Versailles on Nov. 23, 1781.

Maurepas is credited with contributions to the collection of facetiae known as the *Étrennes de la Saint Jean* (2nd ed., 1742). Four volumes of *Mémoires de Maurepas* (1792) are spurious. Some of his letters were published in 1896 by the *Soc. de l'hist. de Paris.*

MAURER, GEORG LUDWIG VON (1790–1872), German statesman and historian, son of a Protestant pastor, was born at Erpolzheim, near Dürkheim, in the Rhenish Palatinate, on Nov. 2, 1790. He spent the years 1812–14 in Paris studying the ancient legal institutions of the Germans and, returning to Germany in 1814, he received an appointment under the Bavarian government, afterwards filling several important official positions. In 1826 he became professor in the university of Munich. In 1829 he returned to official life, and in 1832 became a member of the council of regency for the government of Greece during the minority of King Otto. He began the task of creating institutions adapted to the requirements of a modern civilized community, but was recalled in 1834, Greece, through his enlightened efforts, obtained a revised penal code, regular tribunals and an improved system of civil procedure. His *Griechische Volk vor und nach dem Freiheitskampfe bis zum 31 Juli 1834* (Heidelberg, 1835–36) is a useful source of information for the history of Greece at that time. After the fall of the ministry of Karl von Abel (1788–1859) in 1847, he was for a short time chief Bavarian minister. He died at Munich on May 9, 1872.

Maurer's most important contribution to history is a series of books on the early institutions of the Germans issued in the form of 12 separate monographs with the general title *Geschichte der deutschen Gemeindeverfassung* (1854–71).

See K. T. von Heigel, *Denkwürdigkeiten des bayrischen Staatsrats G. L. von Maurer* (Munich, 1903).

MAURETANIA, the ancient name of the north-western angle of the African continent, bounded towards the south by the Atlas range, and extending along the coast to the Atlantic as far as the point where that chain descends to the sea, in about 30° N. lat. (Strabo p. 825). The Gaetulians to the south of the Altas range, on the date-producing slopes towards the Sahara, seem to have owed a precarious subjection to the kings of Mauretania, as afterwards to the Roman Government. A large part of the country is of great natural fertility, and in ancient times produced large quantities of corn, while the slopes of Atlas were clothed with forests, which produced, besides other kinds of timber, the celebrated ornamental wood called *citrum* (Plin., *Hist. Nat.,* 13–96), for tables of which the Romans gave fabulous prices. For physical geography, *see* MOROCCO.

Mauretania, or Maurusia, as it was called by Greek writers, signified the land of the Mauri, or Moors (q.v.). The ethnical affinities of the race are uncertain; it is probable that all the inhabitants of this northern tract of Africa were kindred races belonging to the great Berber family (*see* Tissot, *Géographie comparée de la province romaine d'Afrique,* i. 400 et seq.; also BERBERS). They first appear in history at the time of the Jugurthine war (110–06 B.C.), when Mauretania was under the government of Bocchus (Sallust, *Jugurtha* 19). To this Bocchus was given, after the war, the western part of Jugurtha's kingdom of Numidia. Sixty years later, at the time of the dictator Caesar, we find two Mauretanian kingdoms, one to the west of the river Mulucha under Bogud, and the other to the east under a Bocchus. Both these kings took Caesar's part in the civil wars, and had their territory enlarged by him. In 25 B.C. Augustus gave the two kingdoms to Juba II. of Numidia (*see* JUBA), with the river Ampsaga as the eastern frontier. Claudius incorporated the kingdom into the Roman State as two provinces, viz., Mauretania Tingitana and Mauretania Caesariensis, the latter taking its name from the city Caesarea, which Juba had adopted as his capital. These provinces were governed until the time of Diocletian by imperial procurators, and were occasionally united for military purposes. Under and after Diocletian Mauretania Tingitana was attached administratively to the *dioikesis* of Spain, with which it was in all respects closely connected.

There were seven Roman colonies in Mauretania Tingitana and eleven in Mauretania Caesariensis; these were mostly military foundations situated on the coast, and served the purpose of securing civilization against the inroads of the natives, who were not suited for town life as in Gaul and Spain, but were under the immediate government of the procurators, retaining their own clan organization. Besides these there were many municipia or *oppida civium romanorum* (Plin. 5. 19 et seq.), but, as has been made clear by French archaeologists, Roman settlements are less frequent the farther we go west, and Mauretania Tingitana has yielded but scanty evidence of Roman civilization. On the whole, Mauretania was in a flourishing condition down to the irruption of the Vandals in A.D. 429.

In 1904 the term Mauretania was revived as an official designation by the French Government and applied to the territory north of the lower Senegal under French protection (*see* SENEGAL).

To the authorities quoted under AFRICA, ROMAN, may be added here Göbel, *Die West-küste Afrikas im Alterthum.*

MAURIAC, FRANÇOIS (1885–) French novelist. Mauriac's novels are concerned with the essential problems of life. They are by no means easy or light reading. The "discovery" of Mauriac was one of the triumphs of the *Cahiers Verts,* which in the post-war world took the place once held by the earlier *Cahiers de la Quinzaine.* In *Le Baiser au lépreux* (1922) the struggle is between the claims of Christianity and of human nature; the stage is set in a remote part of the Lande, and the protagonists are the two partners in an ill-assorted marriage; *Le Fleuve du Feu* (1923) handled another aspect of unhappy marriage; *Genitrix* (1924) showed the evils of too absorbing maternal love. These three books established Mauriac's reputation as one of the first novelists of his day. In one of his later books, *Destins* (1928), the conflict between Christian duty and passion is fought by a middle-aged woman who is attracted to a young man whom she has befriended.

His other works include: *La Robe prétexte* (1914); *La Chair et le Sang* (2nd ed., 1920); *Préséances* (1921); *Le Désert de l'Amour* (1925); *Orages,* poems (1925); *Les Mains jointes,* poems (1927);

Thérèse Desqueyroux (1927); *Le Roman* (1928); *Vie de Jean Racine* (1928). *See* S. de Sacy, *L'Oeuvre de François Mauriac* (1927).

MAURIAC, a town of central France, capital of an *arrondissement* in the department of Cantal, 39 m. N.N.W. of Aurillac by rail. Pop. (1926) 2,300. Mauriac, built on the slope of a volcanic hill, has a 12th-century church. The town owes its origin to the abbey, founded during the 6th century, now used as public offices and dwellings. It is the seat of a sub-prefect. There are marble quarries in the vicinity.

MAURICE [or MAURITIUS], **ST.** (d. *c.* 286), an early Christian martyr, who, with his companions, is commemorated by the Roman Catholic Church on Sept. 22. The oldest form of his story is found in the *Passio* ascribed to Eucherius, bishop of Lyons, *c.* 450, who relates how the "Theban" legion commanded by Mauritius was sent to north Italy to reinforce the army of Maximinian. Maximinian wished to use them in persecuting the Christians, but as they themselves were of this faith, they refused, and for this, after having been twice decimated, the legion was exterminated at Octodurum (Martigny) near Geneva. Gregory of Tours (*c.* 539–593) speaks of a company of the same legion which suffered at Cologne.

The cult of St. Maurice and the Theban legion is found in Switzerland (where two places bear the name in Valais, besides St. Moritz in Grisons), along the Rhine, and in north Italy. The foundation of the abbey of St. Maurice (Agaunum) in the Valais is usually ascribed to Sigismund of Burgundy (515). Relics of the saint are preserved here and at Brieg and Turin.

The *Magdeburg Centuries*, in spite of Mauritius being the patron saint of Magdeburg, declared the whole legend fictitious; J. A. du Bordien *La Légion thébenne* (Amsterdam, 1705); J. J. Hottinger in *Helvetische Kirchengeschichte* (Zürich, 1708); and F. W. Rettberg, *Kirchengeschichte Deutschlands* (Göttingen, 1845–48) have also demonstrated its untrustworthiness, while the Bollandists, De Rivaz and Joh. Friedrich uphold it.

MAURICE (MAURICIUS FLAVIUS TIBERIUS) (*c.* 539–602), East Roman emperor from 582 to 602, was of Roman descent, but a native of Arabissus in Cappadocia. He joined the army and fought with distinction in the Persian War (578–581). At the age of forty-three he was declared Caesar by the dying emperor Tiberius II., who bestowed upon him his daughter Constantina. Maurice brought the Persian War to a successful close by the restoration of Chosroes II. to the throne (591). On the northern frontier he at first bought off the Avars, but after 595 inflicted several defeats upon them through his general Crispus. By his strict discipline he provoked to mutiny the army on the Danube. The revolt spread to the popular factions in Constantinople, and Maurice consented to abdicate. He withdrew to Chalcedon, but was put to death by his successor Phocas, after witnessing the slaughter of his five sons.

The work on military art (στρατηγικά) ascribed to him is a contemporary work of unknown authorship (ed. Scheffer, *Arriani tactica et Mauricii ars militaris*, Uppsala, 1664; *see* Max Jähns, *Gesch. d. Kriegswissensch.*, i. 152–156).

See Theophylactus Simocatta, *Vita Mauricii* (ed. de Boor, 1887); E. Gibbon, *The Decline and Fall of the Roman Empire* (ed. Bury, 1896, v. 19–21, 57); J. B. Bury, *The Later Roman Empire* (1889, ii. 83–94); G. Finlay, *History of Greece* (ed. 1877, Oxford, i. 229–306).

MAURICE (1521–1553), elector of Saxony, elder son of Henry, duke of Saxony, of the Albertine branch of the Wettin family, was born at Freiberg on March 21, 1521. In Jan. 1541 he married Agnes, daughter of Philip, landgrave of Hesse. In that year he became duke of Saxony by his father's death, and he continued Henry's work of forwarding the Reformation. Duke Henry had decreed that his lands should be divided between his two sons, but as a partition was regarded as undesirable the whole of the duchy came to his elder son. Maurice made generous provision for his brother Augustus, and the desire to compensate him still further was one of the minor threads of his subsequent policy. In 1542 he assisted the emperor Charles V. against the Turks, in 1543 against William, duke of Cleves, and in 1544 against the French. The harmonious relations between the two branches of the Wettins were disturbed by the interference of Maurice in Cleves, a proceeding distasteful to the Saxon elector, John Frederick; and a dispute over the bishopric of Meissen having widened the breach, war was only averted by the mediation of Philip of Hesse and Luther. Maurice now began to covet the electoral dignity held by John Frederick, and in June 1546 he took a decided step by making a secret agreement with Charles V. at Regensburg. Maurice was promised some rights over the archbishopric of Magdeburg and the bishopric of Halberstadt; immunity, in part at least, for his subjects from the Tridentine decrees; and the question of transferring the electoral dignity was discussed. In return the duke probably agreed at all events to remain neutral during the impending war. The struggle began in July 1546, and in October Maurice declared war against John Frederick, having secured the formal consent of Charles to the transfer of the electoral dignity. John Frederick (*q.v.*) hastened from south Germany to defend his dominions. Maurice's ally, Albert Alcibiades, prince of Bayreuth, was taken prisoner at Rochlitz; and the duke, driven from electoral Saxony, was unable to prevent his own lands from being overrun. But Charles V., aided by Maurice, gained a decisive victory over John Frederick at Mühlberg in April 1547, after which by the capitulation of Wittenberg John Frederick renounced the electoral dignity in favour of Maurice, who also obtained a large part of his kinsman's lands.

Maurice soon found causes of complaint against the emperor in the continued imprisonment of his father-in-law, Philip of Hesse, whom he had induced to surrender to Charles and whose freedom he had guaranteed; and in Charles's refusal to complete the humiliation of the family of John Frederick. While assuring Charles of his continued loyalty, the elector entered into negotiations with the discontented Protestant princes. In 1550 he had been entrusted with the execution of the imperial ban against the city of Magdeburg, and under cover of these operations he was able to collect troops and to concert measures with his allies. Favourable terms were granted to Magdeburg, which surrendered and remained in the power of Maurice, and in Jan. 1552 a treaty was concluded with Henry II. of France at Chambord. Meanwhile Maurice had refused to recognize the Augsburg *Interim* (May 1548) as binding on Saxony; but a compromise was arranged on the basis of which the Leipzig *Interim* was drawn up for his lands. Charles was unprepared for the attack made by Maurice and his allies in March 1552, though he may have suspected his loyalty. Augsburg was taken, the pass of Ehrenberg was forced, and in a few days the emperor left Innsbruck as a fugitive. Ferdinand undertook to make peace, and the Treaty of Passau, signed in Aug. 1552, was the result. Maurice obtained a general amnesty and freedom for Philip of Hesse, but was unable to obtain a perpetual religious peace for the Lutherans. Charles stubbornly insisted that this question must be referred to the diet, and Maurice was obliged to give way. He then fought against the Turks, and renewed his communications with Henry of France. Returning from Hungary the elector placed himself at the head of the princes who were seeking to check the career of his former ally, Albert Alcibiades, whose depredations were making him a curse to Germany. The rival armies met at Sievershausen on July 9, 1553, where after a fierce encounter Albert was defeated. The victor, however, was wounded during the fight and died two days later.

The elector's *Politische Korrespondenz* was edited by E. Brandenburg (Leipzig, 1900–04); and a sketch of him is given by Roger Ascham in *A Report and Discourse of the Affairs and State of Germany* (1864–65). *See* also W. Maurenbrecher in the *Allgemeine deutsche Biographie*, Bd. XXII. (Leipzig, 1885); E. Brandenburg, *Moritz von Sachsen* (Leipzig, 1898). For bibliography *see* Maurenbrecher; and *The Cambridge Modern History*, vol. ii. (Cambridge, 1903).

MAURICE, SIR FREDERICK BARTON (1871–), British soldier, the eldest son of General Sir Frederick Maurice K.C.B., was born on Feb. 1, 1871, and was commissioned in the Sherwood Foresters in 1892. He saw service in the Tirah campaign (1897–98) and in South Africa (1899–1900), and from 1904 until 1914 held a series of general staff appointments, the last year as instructor at the Staff College. On the outbreak of the World War he was appointed General Staff Officer (1st grade) to the 3rd Div., B.E.F. He became brigadier-general, general staff, in 1915 and the same year Director of Military Operations at the

War Office. Here he was, during the middle period of the War, the intimate and valued assistant of Sir William Robertson, until the latter's resignation early in 1918. After the spring disasters Maurice wrote a letter to the Press challenging the accuracy of ministerial statements, considering them an attempt to shift the responsibility on to the army when several hundred thousand troops were retained in England to guard against a hypothetical invasion. By this act of moral courage he fulfilled his sense of honesty at the sacrifice of his career. Retired for the breach of discipline he became a military correspondent. After the War he devoted himself to organizing assistance for officers and their families. He then became principal of the working men's college, St. Pancras, London. He was vice-president of the British Legion.

His publications include *Forty Days in 1914* (1920); *Lord Wolseley* (with Sir George Arthur, 1924); *Robert E. Lee, the Soldier* (1925); *Governments and War* (1926).

MAURICE, JOHN FREDERICK DENISON (1805–1872), English theologian, was born at Normanston, Suffolk, on Aug. 29, 1805. He was the son of a Unitarian minister, and entered Trinity College, Cambridge, in 1823, though it was then impossible for any but members of the Established Church to obtain a degree. Together with John Sterling (with whom he founded the Apostles' Club) he migrated to Trinity Hall, whence he obtained a first class in civil law in 1827; he then came to London. He edited the *London Literary Chronicle* until 1830, and also for a short time the *Athenaeum*. He presently decided to take orders, and with this end in view entered Exeter College, Oxford. He was ordained in 1834, and after a short curacy at Bubbenhall in Warwickshire was appointed chaplain of Guy's Hospital, and became thenceforward a sensible factor in the intellectual and social life of London. In 1840 he was appointed professor of English history and literature in King's College, and to this post in 1846 was added the chair of divinity. In 1845 he was Boyle lecturer and Warburton lecturer. These chairs he held till 1853. In that year he published *Theological Essays*, and was deprived of his professorships for alleged unorthodoxy. He was at this time chaplain of Lincoln's Inn, but when he offered to resign this the benchers refused. Nor was he assailed in the incumbency of St. Peter's, Vere Street, which he held for nine years (1860–1869). During the early years of this period he was engaged in a hot and bitter controversy with H. L. Mansel (afterwards dean of St. Paul's), arising out of the latter's Bampton lecture upon reason and revelation. Maurice was a "Broad" churchman, but he often offended liberal theologians by his opposition to the Higher Criticism. His great influence arose less from his views than from the force of his personality, and the strength of his intellect, and his passionate sympathy with the oppressed.

Maurice was specially identified with two important movements for education in London. He helped to found Queen's College for the education of women (1848), and the Working Men's College (1854), of which he was the first principal. He strongly advocated the abolition of university tests (1853), and threw himself with great energy into all that affected the social life of the people. Some attempts at co-operation among working men, and the movement known as Christian Socialism, were the immediate outcome of his teaching. In 1866 Maurice was appointed professor of moral philosophy at Cambridge, and from 1870 to 1872 was incumbent of St. Edward's in that city. He died on April 1, 1872. *See* CHRISTIAN SOCIALISM.

BIBLIOGRAPHY.—His works cover nearly 40 volumes. The following are the more important works—some of them were rewritten and in a measure recast, and the date given is not necessarily that of the first appearance of the book, but of its more complete and abiding form: *Moral and Metaphysical Philosophy* (at first an article in the *Encyclopaedia Metropolitana*, 1848); *Theological Essays* (1853); *Lectures on Ecclesiastical History* (1854); *The Doctrine of Sacrifice* (1854); *The Conscience: Lectures on Casuistry* (1868); *The Lord's Prayer, a Manual* (1870). The greater part of these works were first delivered as sermons or lectures. Maurice also contributed many prefaces and introductions to the works of friends, as to Archdeacon Hare's *Charges*, Kingsley's *Saint's Tragedy*, etc.

See Sir J. Frederick Maurice, *Life of John Frederick Denison Maurice* (2 vols., 1884); B. H. Alford, *Frederick Denison Maurice* ([illegible]) and C. F. G. Masterman, *F. D. Maurice* (1907).

MAURICE OF NASSAU, prince of Orange (1567–1625), the second son of William the Silent, by Anna, only daughter of the famous Maurice, elector of Saxony, was born at Dillenburg. At the time of his father's assassination in 1584 he was being educated at the University of Leyden, at the expense of the States of Holland and Zeeland. Despite his youth he was made stadtholder of those two provinces and president of the council of state. During the period of Leicester's governorship he remained in the background, engaged in acquiring a thorough knowledge of the military art, and in 1586 the States of Holland conferred upon him the title of prince. On the withdrawal of Leicester from the Netherlands in August 1587, Johan van Oldenbarneveldt, the advocate of Holland, became the leading statesman of the country, a position which he retained for upwards of thirty years. He had been a devoted adherent of William the Silent and he now used his influence to forward the interests of Maurice. In 1588 he was appointed by the States-General captain and admiral-general of the Union, in 1590 he was elected stadtholder of Utrecht and Overysel, and in 1591 of Gelderland.

From this time forward, Oldenbarneveldt at the head of the civil government and Maurice in command of the armed forces of the republic worked together in the task of rescuing the United Netherlands from Spanish domination (for details *see* HOLLAND). Maurice soon showed himself to be a general second in skill to none of his contemporaries. He was especially famed for his consummate knowledge of the science of sieges. The twelve years' truce on April 9, 1609 brought to an end the cordial relations between Maurice and Oldenbarneveldt. Maurice was opposed to the truce, but the advocate's policy triumphed and henceforward there was enmity between them. The theological disputes between the Remonstrants and contra-Remonstrants found them on different sides; and the theological quarrel soon became a political one. Oldenbarneveldt, supported by the States of Holland, came forward as the champion of provincial sovereignty against that of the States-General; Maurice threw the weight of his sword on the side of the union. The struggle was a short one, for the army obeyed the general who had so often led them to victory. Oldenbarneveldt perished on the scaffold, and the share which Maurice had in securing the illegal condemnation by a packed court of judges of the aged patriot must ever remain a stain upon his memory.

Maurice, who had on the death of his elder brother Philip William, in February 1618, become prince of Orange, was now supreme in the State, but during the remainder of his life he sorely missed the wise counsels of the experienced Oldenbarneveldt. War broke out again in 1621, but success had ceased to accompany him on his campaigns. His health gave way, and he died, a prematurely aged man, at the Hague on April 4, 1625. He was buried by his father's side at Delft.

BIBLIOGRAPHY.—I. Commelin, *Wilhelm en Maurits v. Nassau, pr. v. Orangien, haer leven en bedrijf* (Amsterdam, 1651); G. Groen van Prinsterer, *Archives ou correspondance de la maison d'Orange-Nassau*, 1re série, 9 vols. (Leiden, 1841–61); G. Groen van Prinsterer, *Maurice et Barneveldt* (Utrecht, 1875); J. L. Motley, *Life and Death of John of Barneveldt* (2 vols., The Hague, 1894); C. M. Kemp, v.d. *Maurits v. Nassau, prins v. Oranje in zijn leven en verdiensten* (4 vols., Rotterdam, 1843); M. O. Nutting, *The Days of Prince Maurice* (Boston and Chicago, 1894).

MAURISTS, a congregation of French Benedictines called after St. Maurus (d. 565), a disciple of St. Benedict and the legendary introducer of the Benedictine rule and life into Gaul. At the end of the 16th century the Benedictine monasteries of France had fallen into a state of disorganization and relaxation; and a reform was initiated by the abbey of St. Vanne near Verdun, which spread to other houses in Lorraine, and in 1604 the reformed congregation of St. Vanne was established. A number of French houses joined the new congregation; but as Lorraine was still independent of the French crown, it was considered desirable to form on the same lines a separate congregation for France. Thus in 1621 was established the famous French congregation of St. Maur. Most of the Benedictine monasteries of France, except those belonging to Cluny, gradually joined the new congregation, which eventually embraced nearly two hundred houses. The chief

house was Saint-Germain-des-Prés, Paris, the residence of the superior-general and centre of the literary activity of the congregation. The primary idea of the movement was not the undertaking of literary and historical work, but the return to a strict monastic régime and the faithful carrying out of Benedictine life; and throughout the most glorious period of Maurist history the literary work was not allowed to interfere with the due performance of the choral office and the other duties of the monastic life. Towards the end of the 18th century a tendency crept in, in some quarters, to relax the monastic observances in favour of study; but the constitutions of 1770 show that a strict monastic régime was maintained until the end. The course of Maurist history and work was checkered by the ecclesiastical controversies that distracted the French Church during the 17th and 18th centuries. Some of the members identified themselves with the Jansenist cause; but the bulk, including nearly all the greatest names, pursued a middle path, opposing the lax moral theology condemned in 1679 by Pope Innocent XI., and adhering to those strong views on grace and predestination associated with the Augustinian and Thomist schools of Catholic theology; and like all the theological faculties and schools on French soil, they were bound to teach the four Gallican articles. It seems that towards the end of the 18th century a rationalistic and free-thinking spirit invaded some of the houses. The congregation was suppressed and the monks scattered at the revolution, the last superior-general with forty of his monks dying on the scaffold in Paris. The present French congregation of Benedictines initiated by Dom Guéranger in 1833 is a new creation and has no continuity with the congregation of St. Maur.

The great claim of the Maurists to the gratitude and admiration of posterity is their historical and critical school, which stands quite alone in history, and produced an extraordinary number of colossal works of erudition which still are of permanent value. The foundations of this school were laid by Dom Tarisse, the first superior-general, who in 1632 issued instructions to the superiors of the monasteries to train the young monks in the habits of research and of organized work.

The full Maurist bibliography contains the names of some 220 writers and more than 700 works. The lesser works in large measure cover the same fields as those in the list, but the number of works of purely religious character, of piety, devotion and edification, is very striking. Perhaps the most wonderful phenomenon of Maurist work is that what was produced was only a portion of what was contemplated and prepared for. The French Revolution cut short many gigantic undertakings, the collected materials for which fill hundreds of manuscript volumes in the Bibliothèque nationale of Paris and other libraries of France. When one contemplates the vastness of the works in progress during any decade of the century 1680–1780; and still more, when not only the quantity but the quality of the work, and the abiding value of most of it is realized, it will be recognized that the output was prodigious and unique in the history of letters, as coming from a single society. The qualities that have made Maurist work proverbial for sound learning are its fine critical tact and its thoroughness.

The chief source of information on the Maurists and their work is Dom Tassin's *Histoire littéraire de la congregation de Saint-Maur* (1770); it has been reduced to a bare bibliography and completed by de Lama, *Bibliothèque des écrivains de la congr. de S.-M.* (1882). The two works of de Broglie, *Mabillon* (2 vols., 1888) and *Montfaucon* (2 vols., 1891), give a charming picture of the inner life of the great Maurists of the earlier generation in the midst of their work and their friends. Sketches of the lives of a few of the chief Maurists will be found in McCarthy's *Principal Writers of the Congr. of S. M.* (1868). Useful information about their literary undertakings will be found in De Lisle's *Cabinet des mss. de la Bibl. Nat. Fonds St. Germain-des-Prés.* General information will be found in the *Catholic Encyclopaedia;* Heimbucher, *Orden und Kongregationen* (1907) i. § 36; Wetzer und Welte, *Kirchenlexicon* (ed. 2) and Herzog-Hauck's *Realencyklopädie* (ed. 3), the latter an interesting appreciation by the Protestant historian Otto Zöckler of the spirit and the merits of the work of the Maurists. (E. C. B.)

MAURITANIA, a colony of French West Africa, bounded on the west by the Atlantic ocean and the Spanish Rio de Oro, on the north by the territories of South Algeria, on the east by French Sudan and on the south by Senegal. The area is 670,000 sq.km. and the population 289,000. It is a Saharan region except in the neighbourhood of the river Senegal. It comprises some mountainous massifs such as Adrar Tmar (500 metres) and Tagant (450 metres), in which are several oases, and vast plains covered by sand and dunes. The coast, 600 km. long, is indented, between Cape Blanco and Cape Mirik, by several bays, notably those of Lévrier and Arguin; to the south of Cape Mirik it is flat, straight and bordered by dunes. The population is composed of a majority of Moors, chiefly Berbers crossed with Arabs and with negroes; they are the descendants of the Zenaga, who founded, in the 11th century, the empire of the Almoravides. The chief resources are gum, the salt of the sebkhas (10 to 12,000 tons), fishing around Port-Etienne, the rearing of camels, horses, sheep, goats and asses. Internal trade is very active between Moors and negroes who furnish them with millet in exchange for dates and salt. External trade is effected by river and almost solely with Senegal. The principal towns are Port-Etienne (French fisheries, wireless station), in the Bay of Lévrier, Boghé and Kaedi. The lieutenant-governor resides at Saint Louis.

See *La Mauritanie* (publication of the General Government of West Africa, 1906); Gruvel et Bouyat, *Les pêcheries de la côte occidentale d'Afrique* (Paris, 1906); E. Richet, *La Mauritanie* (Paris, 1920), with bibl.; Gruvel et Chudeau, *A travers la Mauritanie occidentale* (Paris, 1909).

MAURITIUS, an island and British colony in the Indian ocean (known whilst a French possession as the *Île de France*). It lies between 57° 18′ and 57° 49′ E., and 19° 58′ and 20° 32′ S., 550 m. E. of Madagascar. The island is irregularly elliptical—somewhat triangular—in shape, and is 36 m. long and about 23 m. broad. It is 130 m. in circumference, and its total area is about 720 square miles. The island is surrounded by coral reefs, so that the ports are difficult of access.

Dependent upon Mauritius and forming part of the colony are a number of small islands scattered over a large extent of the Indian ocean. Of these the chief is Rodriguez (*q.v.*), 375 m. E. of Mauritius. Considerably north-east of Rodriguez is the Chagos archipelago, of which the chief is Diego Garcia (*see* CHAGOS). The Cargados, Carayos or St. Brandon islets, deeps and shoals lie at the south end of the Nazareth Bank about 250 m. N.N.E. of Mauritius.

From its mountainous character Mauritius is a most picturesque island. The most level portions of the coast districts are the north and north-east, all the rest being broken by hills, which vary from 500 to 2,700 ft. in height. The principal mountain masses are the north-western or Pouce range, in the district of Port Louis; the south-western, in the districts of the Black River and Savanne; and the south-eastern range, in the Grand Port district. In the first of these, which consists of one principal ridge with several lateral spurs, overlooking Port Louis, are the Pouce (2,650 ft.), and the Pieter Botte (2,685 ft.). The highest summit is in the south-western mass of hills, the Black River mountain (2,711 ft.). The south-eastern group of hills consists of the Montagne du Bambou, with several spurs running down to the sea. In the interior are extensive fertile plains, some 1,200 ft. in height, forming the districts of Moka, Vacois, and Plaines Wilhelms; and an abrupt peak, the Piton du Milieu de l'Île (1,932 ft.) rises from the centre of the island. Other prominent summits are the Trois Mamelles, the Montagne du Corps de Garde, the Signal Mountain, near Port Louis, and the Morne Brabant.

The rivers are small, and in the dry season little more than brooks, in the wet season, raging torrents. The principal stream is the Grande Rivière, with a course of about 10 miles. The island is of volcanic origin and the more recent craters (now extinct) cross the centre of the island. The volcanic rocks are all basic in character and belong to two periods of eruption, the earlier forming the mountain mass of the Black River district and the later being basalts and dolerites poured out from craters of the central district. Many of the craters have been partially denuded but some still contain lakes, *e.g.*, Grand Bassin, Mare aux Vacois and Mare aux Joncs. Some lava-flows alternate with coral reefs. The basement rocks are represented by a mass of clay-slates in the Black River mountains and by much contorted chlorite-schists in

La Selle mountain of the centre of the island. There is evidence of a recent elevation of from 40 ft. (south) to 12 ft. (north), whilst caves and underground rivers in the lava-flows are common.

Climate.—The climate is pleasant during the cool season of the year, but oppressively hot in summer (December to April), except in the elevated plains of the interior, where the thermometer ranges from 70° to 80°, while in Port Louis and on the coast generally it ranges from 90° to 96°. The mean temperature for the year at Port Louis is 78·6°. There are two seasons, the cool and comparatively dry season, from April to November, and the hotter season, during the rest of the year. The rainfall varies greatly in different parts of the island. Cluny in the south-east has a mean annual rainfall of 145 in.; Albion on the west is the driest station, with 31 inches. The mean monthly rainfall for the whole island varies from 12 in. in March to 2·6 in. in September and October. The Observatory and Royal Botanical Gardens are at Pamplemousses, on the dry north-west side of the island. From January to mid-April, Mauritius gets severe cyclones with torrents of rain. These hurricanes generally last about eight hours, but they appear to be less frequent and violent than in former times, owing, it is thought, to the destruction of the ancient forests and the consequent drier condition of the atmosphere. The climate is now less healthy than it was, epidemics of malarial fever having frequently occurred.

Fauna and Flora.—The present fauna is very limited in extent. When first seen by Europeans the island had no mammals except a large fruit-eating bat (*Pteropus vulgaris*), plentiful in the woods; but several mammals have been introduced. Among these are two monkeys of the genera *Macacus* and *Cercopithecus*, a stag (*Cervus hippelaphus*), a small hare, a shrew-mouse, and the ubiquitous rat. A lemur and one of the curious hedgehog-like *Insectivora* of Madagascar (*Centetes ecaudatus*) have probably both been brought from the larger island. The avifauna resembles that of Madagascar; there are species of a peculiar genus of caterpillar shrikes (*Campephagidae*), as well as of the genera *Pratincola, Hypsipetes, Phedina, Tchitrea, Zosterops, Foudia, Collocalia* and *Coracopsis*, and peculiar forms of doves and parakeets. The Dodo (*Didus ineptus*) and other flightless birds were quickly exterminated by early immigrants. Remains of large tortoises have been found. The living reptiles are small and few in number. The surrounding seas contain great numbers of fish; the coral reefs abound with a great variety of molluscs; and there are numerous land-shells.

Replacement of forests by sugar-cane has reduced the native flora. The principal timber tree is the ebony (*Diospyros ebeneum*). Besides this there are bois de cannelle, olive-tree, benzoin (*Croton Benzoe*), colophane (*Colophonia*), and iron-wood; the coco-nut palm, an importation, the palmiste (*Palma dactylifera latifolia*), the latanier (*Corypha umbraculifera*) and the date-palm. The vacoa or vacois (*Pandanus utilis*), is largely grown. In the few remnants of the original forests the traveller's tree (*Urania speciosa*), grows abundantly. A species of bamboo is very plentiful in marshy situations. A large variety of fruit is produced, including the tamarind, mango, banana, pine-apple, guava, shaddock, fig, avocado-pear, litchi, custard-apple and the mabolo (*Diospyros discolor*). Many of the roots and vegetables of Europe have been introduced, as well as some peculiar to the tropics, including maize, millet, yams, manioc, dhol, gram, etc. Small quantities of tea, rice, sago, spices (cloves, nutmeg, ginger, pepper and allspice), cotton, indigo, betel, camphor, turmeric and vanilla are grown. The Royal Botanical Gardens at Pamplemousses, which date from the French occupation of the island, contain a rich collection of tropical and extra-tropical species.

Inhabitants.—The inhabitants consist of two great divisions, European, chiefly French and British, together with numerous half-caste people, Asiatics and Africans. The population of European blood, which calls itself Creole, is greater than that of any other tropical colony; many of the inhabitants trace their descent from ancient French families, and the higher and middle classes are distinguished for their intellectual culture. French is more commonly spoken than English. The Creole class is, however, diminishing, though slowly, and the most numerous section of the population is of Indian blood

The introduction of Indian coolies to work the sugar plantations dates from the period of the emancipation of the slaves in 1834–39. In 1846 the total population was 158,462, of these 56,245 being Indian; in 1921 the population was 376,680 including 206 in the garrison, 265,884 Indians and 6,820 Chinese. The Indio-Mauritians are now dominant in commercial, agricultural and domestic callings, and much town and agricultural land has been transferred from the Creole planters to Indians and Chinese. The tendency to an Indian peasant proprietorship is marked. Many Mauritian Creoles have emigrated to South Africa. The great increase in the population since 1851 has made Mauritius one of the most densely peopled regions of the world, having over 520 persons per square mile. (Pop. [1925] 393,708.)

Chief Towns.—The capital and seat of government, the city of Port Louis (pop. [1925] 53,708), is on the north-western side of the island, in 20° 10′ S., 57° 30′ E. at the head of an excellent harbour, a deep inlet about a mile long, available for ships of the deepest draught. This is protected by Fort William and Fort George, as well as by the citadel (Fort Adelaide), and it has three graving-docks connected with the inner harbour, the depths alongside quays and berths being from 12 to 28 feet. The trade of the island passes almost entirely through the port. The chief buildings are Government House, the Protestant cathedral, Roman Catholic cathedral, town hall, barracks, public offices, etc. Port Louis is surrounded by lofty hills and its unhealthy situation is aggravated by the difficulty of effective drainage owing to the small amount of tide in the harbour. Though much has been done to make the town sanitary, including the provision of a good water-supply, many people make their homes in the cooler uplands of the interior. Curepipe, 20 m. from Port Louis and at an altitude of 1,800 ft., is a favourite residential town. It was incorporated in 1888. On the railway between Port Louis and Curepipe are other residential towns—Beau Bassin, Rose Hill and Quatre Bornes. Mahébourg is a town on the shores of Grand Port on the south-east side of the island, Souillac a small town on the south coast.

Industries.—*The Sugar Plantations:* The soil of the island is a fertile ferruginous red clay in which stones are abundant. The greater portion of the plains is now a vast sugar plantation. The soil is suitable for the cultivation of almost all kinds of tropical produce, and increased attention is being paid to the growing of the coco-nut palm, aloes, tobacco, tea and cotton. Guano is extensively imported as a manure, and by its use the natural fertility of the soil has been increased to a wonderful extent. There is an agricultural department of the Government. The output of sugar for 1925–26 was 233,000 metric tons. The export of sugar represents over 90% of the total exports. The trade is chiefly with India, Burma, the United Kingdom and South Africa. Next to sugar, aloe-fibre is the most important export. In addition, a considerable quantity of molasses and smaller quantities of rum, copra and poonac, vanilla and coco-nut oil are exported. The imports are mainly rice, wheat, cotton goods, wine, coal, machinery, woollen goods, tobacco, hardware and haberdashery and guano. The rice comes principally from India and Madagascar; cattle are imported from Madagascar, sheep from South Africa and Australia, and frozen meat from Australia. In 1926 the imports were valued at £4,128,821 and the exports at £2,977,630. Nearly all the aloe-fibre exported is taken by Great Britain and France, while the molasses goes to India. This industry is chiefly in Chinese hands. The great majority of the imports are from Great Britain or British possessions.

The currency of Mauritius is rupees and cents of a rupee, the Indian rupee (=16d) being the standard unit. The metric system of weights and measures has been in force since 1878.

Communications.—There is a regular steamship service between Marseilles and Port Louis by the Messageries Maritimes, with Southampton via Cape Town by the Union Castle, and with Colombo direct by the British India Company's boats. There is also frequent communication with Madagascar, Réunion and Natal. The average annual tonnage of ships entering Port Louis is about 750,000, of which five-sevenths is British. Cable communication is maintained with Zanzibar, Australia, Réunion, Madagascar, Durban and so with Europe, etc.

Railways connect all the principal places and sugar estates on the island; that known as the Midland line, 36 m. long, beginning at Port Louis, crosses the island to Mahébourg, passing through Curepipe, where it is 1,822 ft. above the sea. There are in all over 144 m. of railway of which 24 m. are narrow gauge, all owned and worked by the Government. The first railway was opened in 1864. The roads are well kept and there is an extensive system of tramways for bringing produce from the sugar estates to the railway lines. There is a complete telegraphic and telephonic service.

Government and Revenue.—Mauritius is a crown colony. The governor is assisted by an executive council of officials, and a Council of Government of 27 members, 8 sitting *ex officio*, 9 being nominated by the governor and 10 elected on a moderate franchise. Two of the elected members represent St. Louis, the 8 rural districts into which the island is divided electing each one member. At least one-third of the nominated members must be persons not holding any public office. The legislative session usually lasts from April to December. Members may speak either in French or in English. The (1924–25) revenue was £1,311,-523, and the expenditure was £1,157,058. Up to 1854 there was a surplus in hand, but since that time expenditure has on many occasions exceeded income, and the public debt in 1925 was £1,699,057, mainly incurred however on reproductive works.

The island has largely retained the old French laws, the *codes civil, de procédure, du commerce,* and *d'instruction criminelle* being still in force, except so far as altered by colonial ordinances. A supreme court of civil and criminal justice was established in 1831 under a chief judge and three puisne judges. Mauritius occupies an important strategic position on the route between South Africa and India and in relation to Madagascar and East Africa, while in Port Louis it possesses one of the finest harbours in the Indian Ocean. A permanent garrison is maintained in the island, and the colonial contribution to the expenditure was in 1926–27 £55,249.

Religion and Education.—The majority of the European inhabitants belong to the Roman Catholic faith. Anglicans, Roman Catholics and the Church of Scotland are helped by State grants. At the head of the Anglican community is the bishop of Mauritius; the chief Roman Catholic dignitary is styled bishop of Port Louis. There are many Mohammedans, but the majority of the Indian coolies are Hindus.

The educational system, as brought into force in 1900, is under a director of public instruction assisted by an advisory committee, and consists of two branches (1) secondary instruction, (2) primary instruction. Education is free but not compulsory. For primary instruction there are Government schools and schools maintained by the Roman Catholics, Protestants and other faiths, to which the Government gives grants in aid. Secondary and higher education is given in the Royal college and associated schools at Port Louis and Curepipe.

Bibliography.—A. Macmillan, *Mauritius Illustrated* (1914); "Physical Features and Geology of Mauritius," *Q.J. Geol. Soc.* (1895); *Colonial Office List* (Annual Series); *Mauritius Almanack* (Published annually at Port Louis); *Mauritius Blue Book* (Annual, Mauritius); A. Balfour, *Reports on Medical and Sanitary Matters of Mauritius* (1922). A map (1 in. to 1 mile) was issued by the War Office in 1905.

HISTORY

Mauritius appears to have been unknown to European nations, if not to all other peoples, until the year 1505, when it was discovered by Mascarenhas, a Portuguese navigator. It had then no inhabitants, and there seem to be no traces of a previous occupation by any people. The island was retained for most of the 16th century by its discoverers, who named it "Ilha do Cerné," but they made no settlements in it. In 1598 the Dutch took possession and named the island "Mauritius," in honour of their stadtholder, Count Maurice of Nassau, but abandoned the island in 1710. From 1715 to 1767 (when the French government assumed direct control) the island was held by agents of the French East India Company, by whom its name was again changed to "Ile de France." The company was fortunate in having several able men as governors of its colony, especially the celebrated Mahé de Labourdonnais (*q.v.*), who made sugar planting the main industry of the inhabitants. Under his direction roads were made, forts built, and considerable portions of the forest were cleared, and the present capital, Port Louis, was founded. Labourdonnais also promoted the planting of cotton and indigo, and is remembered as the most enlightened and best of all the French governors. He also put down the maroons or runaway slaves who had long been the pest of the island. The colony continued to rise in value during the time it was held by the French crown, and to one of the intendants,[1] Pierre Poivre, was due the introduction of the clove, nutmeg, and other spices. Another governor was D'Entrecasteaux, whose name is kept in remembrance by a group of islands of New Guinea.

During the long war between France and England, at the commencement of the 19th century, Mauritius was a continual source of much mischief to English Indiamen and other merchant vessels; and at length the British government determined upon an expedition for its capture. This was effected in 1810; and upon the restoration of peace in 1814 the possession of the island was confirmed to Britain by the Treaty of Paris. By the eighth article of capitulation it was agreed that the inhabitants should retain their own laws, customs, and religion; and thus the island is still largely French in language, habits, and predilections; but its name has again been changed to that given by the Dutch. One of the most distinguished of the British governors was Sir Robert Farquhar (1810–23), who did much to abolish the Malagasy slave trade and to establish friendly relations with the rising power of the Hova sovereign of Madagascar.

The history of the colony since its acquisition by Great Britain has been one of social and political evolution. At first all power was concentrated in the hands of the governor, but in 1832 a legislative council was constituted on which non-official nominated members served. Under letters patent issued in 1885 and amended in 1901, 1902, and 1913, this council was transformed into a partly elected body. Of more importance than the constitutional changes were the economic results which followed the freeing of the slaves (1834–39)—for the loss of whose labour the planters received over £2,000,000 compensation. Coolies were introduced to supply the place of the negroes, immigration being definitely sanctioned by the government of India in 1842. Though under government control, the system of coolie labour led to many abuses. A royal commission investigated the matter in 1871, and since that time the evils which were attendant on the system have been gradually remedied. The last half of the 19th century was, however, chiefly notable in Mauritius for the number of calamities which overtook the island. In 1854 cholera caused the death of 17,000 persons; in 1867 over 30,000 people died of malarial fever; in 1892 a hurricane of terrific violence caused immense destruction of property and serious loss of life; in 1893 a great part of Port Louis was destroyed by fire. There were in addition several epidemics of small-pox and plague, and from about 1880 onward the continual decline in the price of sugar seriously affected the islanders, especially the Creole population. During 1902–5 an outbreak of surra, which caused great mortality among draught animals, further tried the sugar planters and necessitated government help. Notwithstanding all these calamities, the Mauritians, especially the Indo-Mauritians, have succeeded in maintaining the position of the colony as an important sugar-producing country. They have not only developed industry but have so successfully fought disease that in 1925 the death rate had fallen to non-Indian 23·8 per 1,000 and Indian 24·2.

See C. Keller, *Madagascar, Mauritius, and other East African Islands*, Eng. trans. by H. A. Nesbit (1901); De Burgh Edwardes, *The History of Mauritius* (1922).

MAUROIS, ANDRÉ (1885–), French writer, was born at Elbeuf, and educated at Rouen. He first became known to the English public by his *Silences du Colonel Bramble* (1918), based on his experiences as an interpreter during the World War. His style is delicate, but direct, and his delineation of English character has perhaps helped to make his later books also widely

[1]The régime introduced in 1767 divided the administration between a governor, primarily charged with military matters, and an intendant.

read in translation. He experiments in biography in the form of fiction, exemplified in *Ariel, ou la vie de Shelley* (1923), and this book, which had a great success, was followed by similar treatment of the life of Disraeli (1927), and of Byron (1927).

His other works include *Ni Ange ni Bête* (1919); *Les Discours du Docteur O'Grady* (1920); *Dialogues sur le Commandement* (1924); *Meïpe* (1926); *Bernard Quesnay* (1926); *Un Essai sur Dickens* (1927); *Quatre études anglaises* (1927); and *Climats* (1928).

MAURRAS, CHARLES (1868–), French writer and politician, was born at Martigues, Provence, of a royalist family. He began his journalistic career as literary critic in the *Revue Encyclopédique* and the *Gazette de France*. He then joined *L'Action Française* where he was at first the only royalist on the staff. He soon converted almost all his colleagues. After visiting Greece and Italy he published *Trois idées politiques* (1898); *Les amants de Venise* (1902); and *L'avenir de l'intelligence* (1905). This was his most productive period, during which his royalist propaganda exerted a powerful influence; he assisted Léon Daudet in transforming (1908) *L'Action Française* into a daily paper. In his *Kiel et Tanger* (1910) he criticized French foreign policy, while *Le dilemme de Marc Sangnier* (1906) dealt with religious problems. Though an avowed atheist, Maurras somewhat paradoxically favoured an alliance with the Catholic Church which he regarded as closely connected with the monarchy. Moreover, he saw in the Catholic Church an instrument for securing the political and social stability which he valued. But the strange alliance was not endorsed by the Church. *L'Action Française* lost considerable influence when the French clergy withdrew their support and defeated Daudet during his candidature for parliament in 1923 and 1925. On Oct. 29, 1926, Maurras was sentenced to two years' imprisonment and a fine of 1,000 francs for an open letter to M. Schrameck, minister of the interior, in which the minister was accused of favouring Communists; the letter might be read as an incitement to extreme violence. In 1927 consternation was created among French Catholic royalists by the promulgation of a decree (Dec. 29, 1926) placing certain of Maurras' books and *L'Action Française* itself on the index, in view of articles by Daudet and Maurras which, it was said, attacked the Holy See. This decree was accepted by the French clergy in a declaration published in Oct. 1927. In the meantime the court of appeal, while upholding the conviction of Maurras, had agreed to his release.

The articles written by Maurras during the World War appeared in eight volumes entitled *Les conditions de la victoire* (1915–20). Though the writings of Maurras produced a profound effect on French thought, his nationalist ideas failed to take deep root in his own country, but they triumphed in Italy; and *L'Idea Nazionale* with its Fascist doctrines owed much to *L'Action Française*. The French movement with which the name of Maurras is associated may be regarded as an inchoate Fascism; a minor intellectual revolution, which has not developed into any great political upheaval. Maurras himself was strongly convinced of the necessity of order in the national life, and was prepared to sacrifice much else if the discipline which he considered essential in art and morals could be enforced. Among Maurras' many works may be mentioned the following: *Jean Moréas* (1891); *Le chemin de paradis* (1894); *Anthinéa* (1901); *L'enquête sur la monarchie* (1900–09); *La politique religieuse* (1912); *Quand les Français ne s'aimaient pas* (1916); and a collection of poems *La musique intérieure* (1925).

See A. Thibaudet, *Les idées de Charles Maurras* (1920).

MAURY, JEAN SIFFREIN (1746–1817), French cardinal and archbishop of Paris, the son of a poor cobbler, was born on June 26, 1746, at Valréas in the Comtat-Venaissin. He was educated at the seminary at Avignon. In 1777 he published under the title of *Discours choisis* his panegyrics on St. Louis, St. Augustine and Fénelon, his remarks on Bossuet and his *Essai sur l'éloquence de la chaire*, a volume which contains much good criticism, and remains a French classic. The book was often reprinted as *Principes de l'éloquence*. He was Lent preacher at court in 1781, when King Louis XVI. said of his sermon: "If the abbé had only said a few words on religion he would have discussed every possible subject." In 1781 he obtained the rich priory of Lyons, near Péronne, and in 1785 he was elected to the Academy. In 1789 he was elected a member of the States General by the clergy of the bailliage of Péronne, and from the first proved to be the most able and persevering defender of the *ancien régime*, although he had drawn up the greater part of the *cahier* of the clergy of Péronne, which contained a considerable programme of reform. It is said that he attempted to emigrate both in July and in Oct. 1789; but after that time he held firmly to his place, when almost universally deserted by his friends. In the Constituent Assembly he fought against the alienation of the property of the clergy. His life was often in danger, but his ready wit always saved it, and it was said that one *bon mot* would preserve him for a month. When he did emigrate in 1792 he was at once named archbishop *in partibus*, and extra nuncio to the diet at Frankfort, and in 1794 cardinal. He was finally made bishop of Montefiascone, but in 1798 the French drove him from his retreat, and he sought refuge in Venice and St. Petersburg. Next year he returned to Rome as ambassador of the exiled Louis XVIII. In 1806 he returned to France, and in 1810 was made archbishop of Paris. He was presently ordered by the pope to surrender his functions as archbishop of Paris. This he refused to do. At the restoration he was expelled from the Academy and from the archiepiscopal palace. He retired to Rome, where he was imprisoned in the castle of St. Angelo for six months. He died in 1817, a year or two after his release, of disease contracted in prison and of chagrin.

The *Oeuvres choisies du Cardinal Maury* (5 vols., 1827) contain what is worth preserving. Mgr. Ricard has published Maury's *Correspondance diplomatique* (2 vols., Lille, 1891). For his life and character see *Vie du Cardinal Maury*, by Louis Siffrein Maury, his nephew (1828); J. J. F. Poujoulat, *Cardinal Maury, sa vie et ses oeuvres* (1855); Sainte-Beuve, *Causeries du lundi* (vol. iv.); Mgr. Ricard, *L'abbé Maury* (1746–91), *L'abbé Maury avant 1789, L'abbé Maury et Mirabeau* (1887); G. Bonet-Maury, *Le cardinal Maury d'après ses mémoires et sa correspondance inédits* (1892); A. Aulard, *Les Orateurs de la Constituante* (1882). Of the many libels written against him during the Revolution the most noteworthy are the *Petit carême de l'abbé Maury*, with a supplement called the *Seconde année* (1790), and the *Vie privée de l'abbé Maury* (1790), claimed by J. R. Hébert, but attributed by some writers to Restif de la Bretonne. For further bibliographical details *see* J. M. Quérard, *La France littéraire*, vol. v. (1833).

MAURY, MATTHEW FONTAINE (1806–1873), American naval officer and hydrographer, was born in Spottsylvania county, Virginia. He was educated at Harpeth academy, and in 1825 entered the navy as midshipman, circumnavigating the globe in the "Vincennes" during a cruise of four years (1826–30). In 1839 he met with an accident which resulted in permanent lameness, and unfitted him for active service, and in 1841 he was placed in charge of the depôt of charts and instruments, out of which grew the U.S. naval observatory and the hydrographic office. He laboured assiduously to obtain observations as to the winds and currents by distributing to captains of vessels specially prepared log-books. One result was to show the necessity for combined action on the part of maritime nations in regard to ocean meteorology. This led to an international conference at Brussels in 1853, which produced the greatest benefit to navigation as well as indirectly to meteorology. Maury's oceanographical work received recognition in all parts of the civilized world, and in 1855 he was given the rank of commander. On the outbreak of the Civil War in 1861, Maury threw in his lot with the South, and became head of coast, harbour and river defences. He invented an electric torpedo for harbour defence, and in 1862 was ordered to England to purchase torpedo material, etc. After the war he went to Mexico, and as the imperial commissioner of immigration of the emperor Maximilian, attempted to found a Virginian colony there. Incidentally he introduced there the cultivation of cinchona. The scheme of colonization was abandoned by the emperor (1866), and Maury settled for a while in England, where he was presented with a testimonial raised by public subscriptions. In 1868 a tendency toward amnesty admitting of his return to America, he accepted the professorship of meteorology in the Virginia military institute, and settled at Lexington (Va.), where he died on Feb. 1, 1873.

Among works published by Maury are the papers contributed by him to the *Astronomical Observations* of the U.S. Observatory; *Letters*

on the American and Atlantic Slopes of South America (1853); *Physical Geography of the Sea* (1855); *Letter concerning Lanes for Steamers crossing the Atlantic* (1855); *Physical Geography* (1864); *Manual of Geography* (1871).

See Diana Fontaine Maury Corbin (his daughter), *Life of Matthew Fontaine Maury* (1888) and C. L. Lewis, *Mathew Fontaine Maury, the Pathfinder of the Seas* (1927).

MAUSOLEUM, a monument erected to receive the remains of a deceased person, which may sometimes take the form of a sepulchral chapel. The term originated with the magnificent monument erected by Queen Artemisia in 353 B.C. in memory of her husband King Mausolus. Some remains of this monument were brought to England in 1859 by Sir Charles Newton and placed in the British Museum.

MAUSOLUS (more correctly MAUSSOLLUS), satrap and practically ruler of Caria (377–353 B.C.). The part he took in the revolt against Artaxerxes Mnemon, his conquest of a great part of Lycia, Ionia and of several of the Greek islands, his co-operation with the Rhodians and their allies in the war against Athens, and the removal of his capital from Mylasa, the ancient seat of the Carian kings, to Halicarnassus are the leading facts of his history. He is best known from the tomb erected for him by his widow Artemisia. The architects Satyrus and Pythis, and the sculptors Scopas, Leochares, Bryaxis and Timotheus, finished the work after her death. (*See* HALICARNASSUS.)

MAUVE, ANTON (1838–1888), Dutch landscape painter, was born at Zaandam, the son of a Baptist minister. He studied under Van Os, whose dry academic manner had, however, but little attraction for him. He benefited far more by his intimacy with his friends Jozef Israels and W. Maris. Under their influence he adopted a freer, looser method of painting, and exchanged the brilliant palette of his youthful work for a tender harmony of delicate greys, greens and light blue. He excelled in rendering the soft hazy atmosphere that lingers over the green meadows of Holland, and found his inspiration in the peaceful rural life of the fields and country lanes near Oosterbeek and Wolfhezen, the sand dunes of the coast at Scheveningen, and the country near Laren, where he spent the last years of his life. There are fourteen of Mauve's pictures at the Mesdag Museum at The Hague, and two ("Milking Time" and "A Fishing Boat putting to Sea") at the Ryks Museum in Amsterdam. The Glasgow Corporation Gallery owns his painting of "A Flock of Sheep." The finest and most representative private collection of pictures by Mauve was made by Mr. J. C. J. Drucker, London.

See H. L. Berchenhoff: *Anton Mauve* (Amsterdam 1890).

MAVIS, the name in Scotland for the song-thrush (*Turdus philomelus*), but now little used except in poetry. *See* THRUSH.

MAVROCORDATO, MAVROCORDAT or MAVROGORDATO, the name of a family of Phanariot Greeks, distinguished in the history of Turkey, Rumania and modern Greece. The family was founded by a merchant of Chios, whose son Alexander Mavrocordato (*c.* 1636–1709), became dragoman to the sultan in 1673, and drew up the treaty of Karlowitz (1699). He became a secretary of state, and was created a count of the Holy Roman Empire. His authority, with that of Hussein Kupruli and Rami Pasha, was supreme at the court of Mustapha II., and he ameliorated the condition of the Christians in Turkey. He was disgraced in 1703, but was recalled to court by Sultan Ahmed III. He left some historical, grammatical, etc. treatises of little value.

His son NICHOLAS MAVROCORDATO (1670–1730) was grand dragoman to the Divan (1697), and in 1708 was appointed hospodar (prince) of Moldavia. Deposed, owing to the sultan's suspicions, in favour of Demetrius Cantacuzene, he was restored in 1711, and soon afterwards became hospodar of Walachia. In 1716 he was deposed by the Austrians, but was restored after the peace of Passarowitz. He was the first Greek ruler of the Danubian principalities, and established the system which for a hundred years was to make the name of Greek hateful to the Rumanians. He introduced Greek manners, the Greek language and Greek costume, and set up a splendid court on the Byzantine model. Nicholas founded libraries and was himself the author of a curious work entitled Περὶ καθήκοντων (Bucharest, 1719). He was succeeded as grand dragoman (1709) by his son John (Ioannes), who was for a short while hospodar of Moldavia, and died in 1730.

Nicholas Mavrocordato was succeeded as prince of Walachia in 1730 by his son Constantine who ruled with intervals from 1735 to 1749. He was wounded and taken prisoner at Galati during the Russo-Turkish War, on Nov. 5, 1769, and died in captivity.

PRINCE ALEXANDER MAVROCORDATO (1791–1865), Greek statesman, a descendant of the hospodars, was born at Constantinople on Feb. 11, 1791. In 1812 he went to the court of his uncle Ioannes Caradja, hospodar of Walachia, with whom he passed into exile in Russia and Italy (1817). He was a member of the Hetairia Philike and was among the Phanariot Greeks who hastened to the Morea on the outbreak of the War of Independence in 1821. In January 1822 he presided over the first Greek national assembly at Epidaurus. He commanded the advance of the Greeks into western Hellas, and was defeated at Peta on July 16, but retrieved this disaster somewhat by his successful resistance to the first siege of Missolonghi (Nov. 1822 to Jan. 1823). His English sympathies brought him, in the subsequent strife of factions, into opposition to the "Russian" party headed by Demetrius Ypsilanti and Kolokotrones; and though he held the portfolio of foreign affairs for a short while under the presidency of Petrobey (Petros Mavromichales), he was in retirement until February 1825, when he again became a secretary of state. The landing of Ibrahim Pasha followed, and Mavrocordato again joined the army, only escaping capture in the disaster at Sphagia (Spakteria), on May 9, 1815, by swimming to Navarino. He was vice-president of the National Assembly at Argos (July, 1832), and was appointed by King Otto minister of finance, and in 1833 premier. From 1834 onwards he was Greek envoy at Munich, Berlin, London and—after a short interlude as premier in Greece in 1841—Constantinople. He was again prime minister in 1844 and in 1854–5. He died in Aegina on Aug. 18, 1865.

MAWSON, SIR DOUGLAS: *see* ANTARCTIC REGIONS.

MAX, ADOLPHE (1869–), Belgian politician, was born in Brussels on Dec. 31, 1869. From 1894 to 1903 he was successively provincial councillor of Brabant, councillor of the Commune and alderman of Brussels, and finally burgomaster (1909). In 1914 when the German troops entered Brussels he refused to perform his duties under the authority of the German governor, and demanded complete freedom of action. He protested vigorously against the abuses of the army of occupation, and fought with indomitable energy for the rights of his fellow subjects, and for the reduction of the heavy taxes and requisitions which were imposed on the town. He further founded a central committee to deal with supplies which, under the name of *Le Comité National,* rendered invaluable services to his countrymen. But the German authorities soon took exception to his spirited resistance, and on Sept. 26 1914 he was arrested and imprisoned in the fortress of Namur, and from there was sent into Germany, where he was closely confined. On Nov. 13 1918 he succeeded in escaping and returned to Belgium, where he was welcomed with delirious enthusiasm. Max was elected to the Chamber of Representatives in 1919; he was made minister of state on Nov. 21, 1918, and was also elected member of the Belgian Academy.

MAXENTIUS, MARCUS AURELIUS VALERIUS, Roman emperor from A.D. 306 to 312, was the son of Maximianus Herculius, and the son-in-law of Galerius. He was left out of account in the division of the empire which took place in 305. A variety of causes, however, had produced strong dissatisfaction at Rome with many of the arrangements established by Diocletian, and on Oct. 28, 306, Maxentius headed a rising and summoning his father Maximianus from retirement, captured and killed Valerius Severus and drove Galerius out of Italy when he attacked them. Maxentius quarrelled with his father, and the congress at Carnuntum for 308 again ignored him, but nothing was done to depose him. The death of Galerius in 311 precipitated a conflict; Constantine came to terms with his other rival Licinius, crossed the Alps and struck at Rome. The decisive battle was fought at Saxa Rubra on the passage of the Tiber; Maxentius was defeated,

and drowned in the Tiber (Oct. 27, 312).

See De Broglie, *L'Eglise et l'empire Romain au quatrième siècle* (1856–66), and on the attitude of the Romans towards Christianity generally, app. 8 in vol. ii. of J. B. Bury's edition of Gibbon (Zosimus ii. 9–18; Zonaras xii. 33, xiii. 1; Aurelius Victor, *Epit.* 40; Eutropius, x. 2).

MAXIM, HUDSON (1853–1927), American inventor, was born at Orneville, Me., on Feb. 3, 1853, and completed his academic studies at Kent's Hill, Me. Though his education was but slight, his interest in chemistry led him to wide reading and experimentation in the subject while he worked at other jobs. In 1875 he formulated (published in *Scientific American Supplement,* 1889) an hypothesis of the compound nature of atoms not unlike the atomic theory which was later to be generally accepted by scientists. In 1888 he began to experiment with explosives and in 1890 built a dynamite and powder factory at Maxim, N.J. Here, together with Dr. R. C. Schupphaus, he developed the Maxim-Schupphaus smokeless powder, the first made in the United States and the first to be adopted by the U.S. Government. He next invented a smokeless cannon powder, the cylindrical grains so perforated that it burned with a more rapid combustion, that was used in enormous quantities during the World War. In 1897 he sold his factory and powder inventions to the E. I. DuPont Company, but remained with the company as consulting engineer. He invented "maximite," a high explosive bursting powder which, when placed in torpedoes, resisted the shock of firing and the still greater shock of piercing armour plate without bursting, only to be set off by a delay-action detonating fuse, which was also his invention. Later he perfected a new smokeless powder called "stabillite," on account of its high stability. "Motorite," a self-combustive substance used to propel torpedoes, was also his invention. During the World War he was chairman of the committee on ordnance and explosives of the naval consulting board. Several of his own inventions at this time were donated to the Government.

He published *Science of Poetry* (1910) and *Dynamite Stories* (1916). *The Rise of an American Inventor* (1927) is his life story taken down from conversations by Clifton Johnston.

Sir Hiram Stevens Maxim (1840–1916), his brother, was the inventor of the Maxim automatic gun.

MAXIMA AND MINIMA, in mathematics. By the *maximum* or *minimum* value of an expression or quantity is meant primarily the "greatest" or "least" value that it can receive. In general, however, there are points at which its value ceases to increase and begins to decrease; its value at such a point is called a maximum. So there are points at which its value ceases to decrease and begins to increase; such a value is called a minimum. There may be several such maxima or minima, and such a minimum is not necessarily less than such a maximum. For instance, the expression $(x^2+x+2)/(x-1)$ can take all values from $-\infty$ to -1 and from $+7$ to $+\infty$ but has, so long as x is real, no value between -1 and $+7$. Here -1 is a maximum value, and $+7$ is a minimum value of the expression, though it can be made greater or less than any assignable quantity.

The first general method of investigating maxima and minima seems to have been published in A.D. 1629 by Pierre Fermat. Particular cases had been discussed. Thus Euclid in book III. of the *Elements* finds the greatest and least straight lines that can be drawn from a point to the circumference of a circle, and in book VI. (in a proposition generally omitted from editions of his works) finds the parallelogram of greatest area with a given perimeter. Apollonius investigated the greatest and least distances of a point from the perimeter of a conic section, and discovered them to be the normals, and that their feet were the intersections of the conic with a rectangular hyperbola. Some remarkable theorems on maximum areas are attributed to Zenodorus, and preserved by Pappus and Theon of Alexandria. The most noteworthy of them are the following:—

1. Of polygons of n sides with a given perimeter the regular polygon encloses the greatest area.
2. Of two regular polygons of the same perimeter, that with the greater number of sides encloses the greater area.
3. The circle encloses a greater area than any polygon of the same perimeter.
4. The sum of the areas of two isosceles triangles on given bases, the sum of whose perimeters is given, is greatest when the triangles are similar.
5. Of segments of a circle of given perimeter, the semicircle encloses the greatest area.
6. The sphere is the surface of given area which encloses the greatest volume.

The next problem on maxima and minima of which there appears to be any record occurs in a letter from Regiomontanus to Roder (July 4, 1471), and is a particular numerical example of the problem of finding the point on a given straight line at which two given points subtend a maximum angle. Tartaglia in his *General trattato de numeri et mesuri* (*c.* 1556) gives, without proof, a rule for dividing a number into two parts such that the continued product of the numbers and their difference is a maximum.

Fermat investigated maxima and minima by means of the principle that in the neighbourhood of a maximum or minimum the differences of the values of a function are insensible, a method virtually the same as that of the differential calculus, and of great use in dealing with geometrical maxima and minima. His method was developed by Huygens, Leibniz, Newton and others, and in particular by John Hudde, who investigated maxima and minima of functions of more than one independent variable, and made some attempt to discriminate between maxima and minima, a question first definitely settled, so far as one variable is concerned, by Colin Maclaurin in his *Treatise on Fluxions* (1742). The method of the differential calculus was perfected by Euler and Lagrange.

Jean (Johann) Bernoulli's famous problem of the "brachistochrone," or curve of quickest descent from one point to another under the action of gravity, proposed in 1696, gave rise to a new kind of maximum and minimum problem in which we have to find a curve and not points on a given curve. From these problems arose the "Calculus of Variations." (*See* Calculus of Variations.)

The method of the differential calculus is theoretically very simple. Let u be a function of several independent variables x_1, $x_2\,x_3, \ldots x_n$; if u is a maximum or minimum for the set of values $x_1, x_2, x_3, \ldots x_n$, and u becomes $u+\delta u$, when $x_1, x_2, x_3, \ldots x_n$, receive small increments $\delta x_1, \delta x_2, \ldots \delta x_n$; then δu must have the same sign for all possible values of $\delta x_1, \delta x_2, \ldots \delta x_n$.

$$\text{Now}\quad \delta u = \Sigma\frac{\delta u}{\delta x_1}\delta x_1+\tfrac{1}{2}\left\{\Sigma\frac{\delta^2 u}{\delta x_1{}^2}\delta x_1{}^2+2\Sigma\frac{\delta^2 u}{\delta x_1\delta x_2}\delta x_1\,\delta x_2\ldots\right\}+\ldots$$

The sign of this expression in general is that of $\Sigma(\delta u/\delta x_1)\delta x_1$, which cannot be one-signed when $\delta x_1, \delta x_2, \cdots \delta x_n$ can take all possible values, for a set of increments $\delta x_1, \delta x_2, \ldots \delta x_n$ will give an opposite sign to the set $-\delta x_1, -\delta x_2, \ldots -\delta x_n$. Hence $\Sigma(\delta u/\delta x_1)\delta x_1$ must vanish for all sets of increments $\delta x_1, \ldots \delta x_n$, and since these are independent, we must have $\delta u/\delta x_1=0$, $\delta u/\delta x_2=0, \ldots \delta u/\delta x_n=0$. A value of u given by a set of solutions of these equations is called a "critical value" of u. The value of δu now becomes

$$\tfrac{1}{2}\left\{\Sigma\frac{\delta^2 u}{\delta x_1{}^2}\delta x_1{}^2+2\Sigma\frac{\delta^2 u}{\delta x_1\delta x_2}\delta x_1\,dx_2+\ldots\right\};$$

for u to be a maximum or minimum this must have always the same sign. For the case of a single variable x, corresponding to a value of x given by the equation $du/dx=0$, u is a maximum or minimum as d^2u/dx^2 is negative or positive. If d^2u/dx^2 vanishes, then there is no maximum or minimum unless d^3u/dx^3 vanishes, and there is a maximum or minimum according as d^4u/dx^4 is negative or positive. Generally, if the first differential coefficient which does not vanish is even, there is a maximum or minimum according as this is negative or positive. If it is odd, there is no maximum or minimum.

In the case of several variables, the quadratic

$$\Sigma\frac{\delta^2 u}{\delta x_1{}^2}\delta x_1{}^2+2\Sigma\frac{\delta^2 u}{\delta x_1\delta x_2}\delta x_1\delta x_2+\ldots$$

must be one-signed. For the case of two variables the conditions are

$$\frac{\delta^2 u}{\delta x_1^2}\cdot\frac{\delta^2 u}{\delta x_2^2} > \left(\frac{\delta^2 u}{\delta x_1 \delta x_2}\right)^2$$

for a maximum or minimum at all and $\delta^2 u/\delta x_1^2$ and $\delta^2 u/\delta x_2^2$ both negative for a maximum, and both positive for a minimum. It is important to notice that by the quadratic being one-signed is meant that it cannot be made to vanish except when δx_1, δx_2, $\dots \delta x_n$ all vanish. If, in the case of two variables,

$$\frac{\delta^2 u}{\delta x_1^2}\cdot\frac{\delta^2 u}{\delta x_2^2} = \left(\frac{\delta^2 u}{\delta x_1 \delta x^2}\right)^2$$

then the quadratic is one-signed unless it vanishes, but the value of u is not necessarily a maximum or minimum, and the terms of the third and possibly fourth order must be taken into account.

A critical value usually gives a maximum or minimum in the case of a function of one variable, and often in the case of several independent variables, but such maxima and minima are purely local and the absolutely greatest and least values are not necessarily critical values. If, for example, x is restricted to lie between the values a and b and $\phi'(x)=0$ has no roots in this interval, it follows that $\phi'(x)$ is one-signed as x increases from a to b, so that $\phi(x)$ is increasing or diminishing all the time, and the greatest and least values of $\phi(x)$ are $\phi(a)$ and $\phi(b)$, though neither of them is a critical value. In general, the absolutely greatest and least values of the function may be given by $\phi(a)$ or $\phi(b)$, however many critical values exist.

Full analytical details may be found in any standard treatise on the Calculus. English writers, however, are apt to ignore any but critical values. *See* MATHEMATICAL MODELS. (A. E. J.)

MAXIMIANUS, a Latin elegiac poet of Etruscan birth who flourished during the 6th century A.D. At an advanced age he was sent on an important mission to the East, perhaps by Theodoric. The six elegies extant under his name were written in old age, lamenting the loss of his youth.

Editions by J. C. Wernsdorf, *Poetae latini minores,* vi.; E. Bährens, *Poetae latini minores,* v.; M. Petschenig (1890), in C. F. Ascherson's *Berliner Studien,* xi.; R. Webster (Princeton, 1901). There is an English version (as from Cornelius Gallus), by Hovenden Walker (1689), under the title of *The Important Lover.*

MAXIMIANUS, MARCUS AURELIUS VALERIUS, surnamed Herculius, Roman emperor from A.D. 286 to 305, was born at Sirmium in Pannonia. He rose from the ranks to distinction in the army, and having been made Caesar by Diocletian in 285, received the title of Augustus in the following year (April 1, 286). In 287 he suppressed the rising of the peasants (Bagaudae) in Gaul, but he had to acquiesce in the usurpation of Britain by Carausius. After 293 the empire was further divided, and Constantius Chlorus took over the Rhine, while Maximianus had Italy and Africa. In 297 he won a victory in Mauretania, and in 302 he shared at Rome the triumph of Diocletian, the last pageant of the kind ever witnessed there. On May 1, 305, the day of Diocletian's abdication, he also, but without his colleague's sincerity, divested himself of the imperial dignity at Mediolanum (Milan), which had been his capital, and retired to a villa in Lucania; in the following year, however, he was induced by his son Maxentius to reassume the purple. By allying himself with Constantine he made head against Galerius in Italy for a while, and then quarrelled with Maxentius; Diocletian intervened, and Maximianus abdicated again. In Constantine's absence on the Rhine next year (311) he made another attempt; Constantine returned swiftly, drove him from Arles to Marseilles, where he surrendered. Soon afterwards he was found dead.

See Zosimus ii. 7–11; Zonaras xii. 31-33; Eutropius ix. 20, x. 2, 3; Aurelius Victor, p. 39. For the emperor Galerius Valerius Maximianus *see* GALERIUS.

MAXIMILIAN I. (1459–1519), Roman emperor, son of the emperor Frederick III. and Leonora, daughter of Edward, king of Portugal, born at Vienna Neustadt on March 22, 1459. On Aug. 18, 1477, he was married at Ghent to Mary, who had inherited Burgundy and the Netherlands from her father Charles the Bold, duke of Burgundy. He at once undertook the defence of his wife's dominions from an attack by Louis XI., king of France, and defeated the French forces at Guinegatte, the modern Enguinegatte, on Aug. 7, 1479. But Maximilian was regarded with suspicion by the States of the Netherlands, and after suppressing a rising in Gelderland his position was further weakened by the death of his wife on March 27, 1482. He claimed to be recognized as guardian of his young son Philip and as regent of the Netherlands, but some of the States refused to agree to his demands and disorder was general. Maximilian was compelled to assent to the treaty of Arras in 1482 between the States of the Netherlands and Louis XI., which provided that Maximilian's daughter Margaret should marry Charles, the dauphin of France, and have for her dowry Artois and Franche-Comté, two of the provinces in dispute, while the claim of Louis on the duchy of Burgundy was tacitly admitted.

Maximilian did not, however, abandon the struggle in the Netherlands. Having crushed a rebellion at Utrecht, he compelled the burghers of Ghent to restore Philip to him in 1485, and returning to Germany was chosen king of the Romans, or German king, at Frankfort on Feb. 16, 1486, and crowned at Aix-la-Chapelle on April 9. Again in the Netherlands, he made a treaty with Francis II., duke of Brittany, whose independence was threatened by the French regent, Anne of Beaujeu, and the struggle with France was soon renewed. This war was very unpopular with the trading cities of the Netherlands, and early in 1488 Maximilian, having entered Bruges, was detained there as a prisoner for nearly three months, and only set at liberty on the approach of his father with a large force. He delayed his departure for nearly a year and took part in a punitive campaign against his captors and their allies. On his return to Germany he made peace with France at Frankfort in July 1489, and in October several of the States of the Netherlands recognized him as their ruler and as guardian of his son. In March 1490 the county of Tirol was added to his possessions through the abdication of his kinsman, Count Sigismund, and this district soon became his favourite residence.

Meanwhile the king had formed an alliance with Henry VII. king of England, and Ferdinand II., king of Aragon, to defend the possessions of the duchess Anne, daughter and successor of Francis, duke of Brittany. Early in 1490 he was betrothed to the duchess, and later in the same year the marriage was celebrated by proxy; but Brittany was still occupied by French troops, and Maximilian was unable to go to the assistance of his bride. In Dec. 1491 Anne was married to Charles VIII., king of France, and Maximilian's daughter Margaret, who had resided in France since her betrothal, was sent back to her father. Maximilian took no action, being occupied in Hungary, where the death of king Matthias Corvinus had brought about a struggle for this throne. The Roman king, who was an unsuccessful candidate, took up arms, drove out the Hungarians from Austria, and regained Vienna, which had been in the possession of Matthias since 1485; but he was compelled by want of money to retreat, and on Nov. 7, 1491 signed the Treaty of Pressburg with Ladislaus, king of Bohemia, who had obtained the Hungarian throne, agreeing that Maximilian should succeed to the crown in case Ladislaus left no legitimate male issue. Having defeated the invading Turks at Villach in 1492, the king was eager to take revenge upon the king of France; but the States of the Netherlands would afford him no assistance. The German diet was indifferent, and in May 1493 he agreed to the peace of Senlis and regained Artois and Franche-Comté.

In Aug. 1493 the death of the emperor left Maximilian sole ruler of Germany and head of the house of Habsburg; and on March 16, 1494 he married at Innsbruck Bianca Maria Sforza, daughter of Galeazzo Sforza, duke of Milan (d. 1476). Maximilian made an ineffectual appeal to the Christian sovereigns to assist him in driving the Turks from Europe. In 1494 he was again in the Netherlands, where he led an expedition against the rebels of Gelderland, assisted Perkin Warbeck to make a descent upon England, and formally handed over the Government of the Low Countries to Philip. His attention was next turned to Italy, and, alarmed at the progress of Charles VIII. in the peninsula, he signed the league of Venice in March 1495, and about the same time arranged a marriage between his son Philip and Joanna, daughter of Ferdinand and Isabella, king and queen of Castile

and Aragon. In need of help in Italian war the king called the diet to Worms in March 1495 and urged the necessity of checking the progress of Charles; proposals for the better government of the empire were brought forward at Worms as a necessary preliminary to financial and military support. Some reforms were adopted, the public peace was proclaimed without any limitation of time and a general tax was levied. The three succeeding years were mainly occupied with quarrels with the diet, with two invasions of France, and a war in Gelderland against Charles, count of Egmont, who claimed that duchy, and was supported by French troops. The reforms of 1495 were rendered abortive by the refusal of Maximilian to attend the diets or to take any part in the working of the new Constitution, and in 1497 he strengthened his own authority by establishing an Aulic Council (*Reichshofrath*), which he declared was competent to deal with all business of the empire, and about the same time set up a court to centralize the financial administration of Germany.

In Feb. 1499 the king became involved in a war with the Swiss, who had refused to pay the imperial taxes or to furnish a contribution for the Italian expedition. Aided by France they defeated the German troops, and the peace of Basle in Sept. 1499 recognized them as virtually independent of the empire. About this time Maximilian's ally, Ludovico of Milan, was taken prisoner by Louis XII., king of France, and Maximilian was again compelled to ask the diet for help. An elaborate scheme for raising an army was agreed to, and in return a council of regency (*Reichsregiment*) was established, which amounted, in the words of a Venetian envoy, to a deposition of the king. The relations were now very strained between the reforming princes and Maximilian, who, unable to raise an army, refused to attend the meetings of the council at Nuremberg, while both parties treated for peace with France. The hostility of the king rendered the council impotent. He was successful in winning the support of many of the younger princes, and in establishing a new court of justice, the members of which were named by himself.

The negotiations with France ended in the Treaty of Blois, signed in Sept. 1504, when Maximilian's grandson Charles was betrothed to Claude, daughter of Louis XII., and Louis, invested with the duchy of Milan, agreed to aid the king of the Romans to secure the imperial crown. A succession difficulty in Bavaria-Landshut was only decided after Maximilian had taken up arms and narrowly escaped with his life at Regensburg. In the settlement of this question, made in 1505, he secured a considerable increase of territory, and when the king met the diet at Cologne in 1505 he was at the height of his power. His enemies at home were crushed, and their leader, Berthold, elector of Mainz, was dead; while the outlook abroad was more favourable than it had been since his accession.

But whatever hopes of a universal monarchy Maximilian may have had were shattered by the death of his son Philip and the rupture of the Treaty of Blois. The diet of Cologne discussed the question of reform in a halting fashion, but afforded the king supplies for an expedition into Hungary, to aid his ally Ladislaus, and to uphold his own influence in the East. Having established his daughter Margaret as regent for Charles in the Netherlands, Maximilian met the diet at Constance in 1507, when the imperial chamber (*Reichskammergericht*) was revised and took a more permanent form, and help was granted for an expedition to Italy. The king set out for Rome to secure his coronation, but Venice refused to let him pass through her territories; and at Trant, on Feb. 4, 1508, he assumed the title of Roman Emperor Elect, to which he soon received the assent of pope Julius II. He attacked the Venetians, but finding the war unpopular with the trading cities of southern Germany, made a truce with the republic for three years. The Treaty of Blois which contained a secret article providing for an attack on Venice, ripened into the league of Cambray, which was joined by the emperor in Dec. 1509. He soon took the field, but after his failure to capture Padua the league broke up; and his sole ally, the French king, joined him in calling a general council at Pisa to discuss the question of Church reform.

A breach with pope Julius followed, and at this time Maximilian appears to have entertained, perhaps quite seriously, the idea of seating himself in the chair of St. Peter. After a period of vacillation he deserted Louis and joined the Holy League, which had been formed to expel the French from Italy; but unable to raise troops, he served with the English forces as a volunteer and was present at the battle of the Spurs near Thérouanne on Aug. 16, 1513. In 1500 the diet had divided Germany into six circles, for the maintenance of peace, to which the emperor at the diet of Cologne in 1512 added four others. Having made an alliance with Christian II., king of Denmark, and interfered to protect the Teutonic Order against Sigismund I., king of Poland, Maximilian was again in Italy early in 1516 fighting the French who had overrun Milan. His want of success compelled him on Dec. 4, 1516, to sign the Treaty of Brussels, which left Milan in the hands of the French king, while Verona was soon afterwards transferred to Venice. He attempted in vain to secure the election of his grandson Charles as king of the Romans. Leaving the diet of Augsburg (1518) he travelled to Wels in Upper Austria, where he died on Jan. 12, 1519. He was buried in the church of St. George in Vienna Neustadt.

Maximilian had many excellent personal qualities. Simple in his habits, conciliatory in his bearing, and catholic in his tastes, he enjoyed great popularity and rarely made a personal enemy. He was a skilled knight and a daring huntsman, and although not a great general, was intrepid on the field of battle. He reorganized the University of Vienna and encouraged the development of the universities of Ingolstadt and Freiburg. He was the author of military reforms, which included the establishment of standing troops, called *Landsknechte*. He was continually devising plans for the better government of Austria, and although they ended in failure, he established the unity of the Austrian dominions. Maximilian has been called the second founder of the house of Habsburg, and certainly by bringing about marriages between Charles and Joanna and between his grandson Ferdinand and Anna, daughter of Ladislaus, king of Hungary and Bohemia, he paved the way for the vast empire of Charles V. and for the influence of the Habsburgs in eastern Europe. But was reckless and unstable.

For absurd and impracticable schemes in Italy and elsewhere Maximilian neglected Germany, and sought to involve its princes in wars undertaken solely for private aggrandizement or personal jealousy. Ignoring his responsibilities as ruler of Germany, he only considered the question of its government when in need of money and support from the princes. As the "last of the knights" he could not see that the old order of society was passing away and a new order arising, while he was fascinated by the glitter of the mediaeval empire and spent the better part of his life in vague schemes for its revival. As "a gifted amateur in politics" he increased the disorder of Germany and Italy and exposed himself and the empire to the jeers of Europe.

Maximilian was also a writer of books, and his writings display his inordinate vanity. His *Geheimes Jagdbuch,* containing about 2,500 words, is a treatise purporting to teach his grandsons the art of hunting. He inspired the production of *The Dangers and Adventures of the Famous Hero and Knight Sir Teuerdank,* an allegorical poem describing his adventures on his journey to marry Mary of Burgundy. It was first published at Nuremberg by Melchior Pfintzing in 1517, and was adorned with woodcuts by Hans Leonhard Schäufelein. The *Weisskunig* was long regarded as the work of the emperor's secretary, Marx Treitzsaurwein, but it is now believed that the greater part of the book at least is the work of the emperor himself. It is an unfinished autobiography containing an account of the achievements of Maximilian, who is called "the young white king." It was first published at Vienna in 1775. He also is responsible for *Freydal,* an allegorical account of the tournaments in which he took part during his wooing of Mary of Burgundy; *Ehrenpforten, Triumphwagen* and *Der weisen Könige Stammbaum,* books concerning his own history and that of the house of Habsburg, and works on various subjects, as *Das Stahlbuch, Die Baumeisterei* and *Die Gärtnerei.* These works are all profusely illustrated, some by Albrecht Dürer.

A facsimile of the original editions of Maximilian's autobiographical and semi-autobiographical works has been published in nine volumes in the *Jahrbücher der kunsthistorischen Sammlungen des Kaiserhauses* (Vienna, 1880–88). For this edition S. Laschitzer wrote an introduction to *Sir Teuerdank,* Q. von Leitner to *Freydal,* and N. A. von Schultz to *Der Weisskunig*. The Holbein society issued a facsimile of *Sir Teuerdank* (London, 1884) and *Triumphwagen* (1883).

See *Correspondance de l'empereur Maximilien I. et de Marguerite*

d'Autriche, 1507–1519, ed. A. G. le Glay (1839); *Maximilians I. vertraulicher Briefwechsel mit Sigmund Prüschenk*, ed. V. von Kraus (Innsbruck, 1875); J. Chmel, *Urkunden, Briefe und Aktenstücke zur Geschichte Maximilians I. und seiner Zeit.* (Stuttgart, 1845) and *Aktenstücke und Briefe zur Geschichte des Hauses Habsburg im Zeitalter Maximilians I.* (Vienna, 1854–58); K. Klüpfel, *Kaiser Maximilian I.* (1864); H. Ulmann, *Kaiser Maximilian I.* (Stuttgart, 1884); L. P. Gachard, *Lettres inédites de Maximilien I. sur les affaires des Pays Bas* (Brussels, 1851–52); L. von Ranke, *Geschichte der romanischen und germanischen Völker, 1494–1514* (Leipzig, 1874); R. W. S. Watson, *Maximilian I.* (1902); A. Jäger, *Über Kaiser Maximilians I. Verhältnis zum Papstthum* (Vienna, 1854); H. Ulmann, *Kaiser Maximilians I. Absichten auf das Papstthum* (Stuttgart, 1888), and A. Schulte, *Kaiser Maximilian I. als Kandidat für den päpstlichen Stuhl* (Leipzig, 1906); C. Hare, *Maximilian the Dreamer* (1913).

MAXIMILIAN II. (1527–1576), Roman emperor, was the eldest son of the emperor Ferdinand I. by his wife Anne, daughter of Ladislaus, king of Hungary and Bohemia, and was born in Vienna on July 31, 1527. Educated principally in Spain, he gained some experience of warfare during the campaign of Charles V. against France in 1544, and also during the war of the league of Schmalkalden, and soon began to take part in imperial business. Having in Sept. 1548 married his cousin Maria, daughter of Charles V., he acted as the emperor's representative in Spain from 1548 to 1550, returning to Germany in December 1550 in order to take part in the discussion over the imperial succession. Charles V. wished his son Philip (afterwards king of Spain) to succeed him as emperor, but his brother Ferdinand, who had already been designated as the next occupant of the imperial throne, and Maximilian objected to this proposal. At length a compromise was reached. Philip was to succeed Ferdinand, but during the former's reign Maximilian, as king of the Romans, was to govern Germany. This arrangement was not carried out, but the insistence of the emperor disturbed the harmonious relations between the two branches of the Habsburg family; and Maximilian's illness in 1552 was even attributed to poison given to him in the interests of his cousin and brother-in-law, Philip of Spain. He took up his residence in Vienna, and was engaged mainly in the government of the Austrian dominions and their defence against the Turks. The religious views of the king of Bohemia, as Maximilian had been called since his recognition as the future ruler of that country in 1549, had always been somewhat uncertain, and he had probably learned something of Lutheranism in his youth; but his amicable relations with the Protestant princes were probably due to political considerations. Maximilian remained an adherent of the older faith, although his views were tinged with Lutheranism until the end of his life. In November 1562 Maximilian was chosen king of the Romans, or German king, at Frankfort, where he was crowned a few days later, after assuring the Catholic electors of his fidelity to their faith, and promising the Protestant electors that he would publicly accept the confession of Augsburg when he became emperor. He also took the usual oath to protect the Church, and his election was afterwards confirmed by the papacy. In Sept. 1563 he was crowned king of Hungary, and on his father's death, in July 1564, succeeded to the empire and to the kingdoms of Hungary and Bohemia.

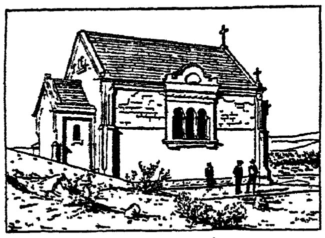
The new emperor granted religious liberty to the Lutheran nobles and knights in Austria, and refused to allow the publication of the decrees of the council of Trent. Amid general expectations on the part of the Protestants he met his first Diet at Augsburg in March 1566. He refused to accede to the demands of the Lutheran princes; on the other hand, although the increase of sectarianism was discussed, no decisive steps were taken to suppress it, and the only result of the meeting was a grant of assistance for the Turkish War, which had just been renewed. Collecting a large and splendid army Maximilian marched to defend his territories; but no decisive engagement had taken place when a truce was made in 1568, and the emperor continued to pay tribute to the sultan for Hungary. Meanwhile the relations between Maximilian and Philip of Spain had improved; and the emperor's increasingly cautious and moderate attitude in religious matters was doubtless due to the fact that the death of Philip's son, Don Carlos, had opened the way for the succession of Maximilian, or of one of his sons, to the Spanish throne. Evidence of this friendly feeling was given in 1570, when the emperor's daughter, Anne, became the fourth wife of Philip; but Maximilian was unable to moderate the harsh proceedings of the Spanish king against the revolting inhabitants of the Netherlands. In 1570 the emperor met the diet at Spires and asked for aid to place his eastern borders in a state of defence, and also for power to repress the disorder caused by troops in the service of foreign powers passing through Germany. He proposed that his consent should be necessary before any soldiers for foreign service were recruited in the empire; but the estates were unwilling to strengthen the imperial authority, the Protestant princes regarded the suggestion as an attempt to prevent them from assisting their coreligionists in France and the Netherlands, and nothing was done in this direction, although some assistance was voted for the defence of Austria. The religious demands of the Protestants were still unsatisfied, while the policy of toleration had failed to give peace to Austria. His last important act was to make a bid for the throne of Poland, either for himself or for his son Ernest. In December 1575 he was elected, but the diet which met at Regensburg was loath to assist; and on Oct. 12, 1576, the emperor died, refusing on his deathbed to receive the last sacraments of the Church which were offered him.

By his wife Maria he had a family of nine sons and six daughters. He was succeeded by his eldest surviving son, Rudolph, who had been chosen king of the Romans in October, 1575. Another of his sons, Matthias, also became emperor, three others, Ernest, Albert and Maximilian, took some part in the government of the Habsburg territories or of the Netherlands. His daughter, Elizabeth, eventually was married to Charles IX., King of France.

The religious attitude of Maximilian has given rise to much discussion, and on this subject *see* O. H. Hopfen, *Maximilian II. und der Kompromisskatholizismus* (Munich, 1895); C. Haupt, *Melanchthons und seiner Lehrer Einfluss auf Maximilian II.* (Wittenberg, 1897); F. Walter, *Die Wahl Maximilians II.* (Heidelberg, 1892); W. Goetz, *Maximilians II. Wahl zum römischen Könige* (Würzburg, 1891), and T. J. Scherg, *Über die religiöse Entwickelung Kaiser Maximilians II. bis zu seiner Wahl zum römischen Könige* (Würzburg, 1903). For a more general account of his life and work see *Briefe und Akten zur Geschichte Maximilians II.*, edited by W. E. Schwarz (Paderborn, 1889–91); M. Koch, *Quellen zur Geschichte des Kaisers Maximilian II. in Archiven gesammelt* (Leipzig, 1857–61); R. Holtzmann, *Kaiser Maximilian II. bis zu seiner Thronbesteigung* (Berlin, 1903); E. Wertheimer, *Zur Geschichte der Türkenkriege Maximilians II.* (Vienna, 1875); L. von Ranke, *Über die Zeiten Ferdinands I. und Maximilians II.* in Band VII. of his *Sämmtliche Werke* (Leipzig, 1874), and J. Janssen, *Geschichte des deutschen Volkes seit dem Ausgang des Mittelalters*, Bände IV. to VIII. (Freiburg, 1885–94), Eng. trans. by M. A. Mitchell and A. M. Christie (1896 fol.).

MAXIMILIAN (Ferdinand Maximilian) (1832–1867), emperor of Mexico, was born in Vienna on July 6, 1832, the second son of Archduke Francis Charles, and brother of the Emperor Francis Joseph. After an excellent education, he entered the navy and as first in command was largely responsible for its rehabilitation, and for the growth of Trieste as a naval centre. He was appointed governor-general of the Lombardo-Venetian kingdom in 1857, but in 1859 was summarily relieved of his post. In 1857 he married Princess Charlotte of Belgium. As early as 1859 he was approached by Mexican exiles relative to his candidature for an imperial throne in Mexico, and in Oct. 1863 he was formally offered the crown, which had been created by French armed intervention. (*See* MEXICO.) He accepted it on April 9, 1864, after renouncing his imperial rights in Austria, arrived in Mexico on May 28 and entered Mexico City on June 12. From the beginning, the experiment was doomed, for politically, strategically and economically Maximilian's position was impossible. The country was opposed to him; the liberals refused to recognize his government, though he made several attempts to conciliate them; and the conservatives and clericals were immediately alienated by his liberal measures. Financially and politically he was wholly dependent upon France, without resources with which either to pay his debts or raise armies. Nor was he, personally, fitted to cope with the problem; poor judgment, vacillation and extravagance marked his administration from the first. During 1864 and 1865 his foreign troops reduced the country to subjection, driving

the constitutional government of Juárez almost to the Rio Grande, and on Oct. 3, 1865, he was induced to issue a decree declaring Juárez and his supporters bandits. But in Dec. 1865, the United States, having emerged successfully from the Civil War, demanded the withdrawal of French troops from Mexico. Napoleon acceded in Jan. 1866, and the republican forces commenced their reconquest. The Empress Charlotte went to Europe in July 1866, in a desperate attempt to re-enlist the aid of Napoleon and the pope; she failed and the strain proved so great that she lost her mind. In October, Maximilian, determined to abdicate, fled to Orizaba, but was prevailed upon to return, and in Feb. 1867, assuming personal command of his forces, transferred his headquarters from Mexico City to Querétaro, a lonely figure in the welter of intrigue, selfishness and corruption which engulfed him. The last of the French forces retired in March; and on May 15, Querétaro was betrayed to the republican army. Napoleon's agents had made repeated efforts to secure Maximilian's escape, but he refused to save himself. He was courtmartialled, convicted, and despite universal pleas for mercy, was shot on June 19. The Empress Charlotte died at the Château de Bouchout, near Brussels, on Jan. 19, 1927, having never fully recovered her reason. (*See* JUAREZ, MEXICO.)



BY COURTESY OF C. W. HACKETT

MAXIMILIAN CHAPEL, BUILT AT THE PLACE WHERE MAXIMILIAN WAS SHOT, FROM AN ETCHING BY FRANZ JOSEPH

There is a very good account of the whole Maximilian episode by Egon Caesar, Count Corti: *Maximilian and Charlotte of Mexico* (New York, 1928), which includes an exhaustive bibliography.
(W. B. P.)

MAXIMILIAN I. (1573–1651), called "the Great," elector and duke of Bavaria, eldest son of William V. of Bavaria, was born at Munich on April 17, 1573. He married in 1595 his cousin, Elizabeth, daughter of Charles II., duke of Lorraine, and became duke of Bavaria upon his father's abdication in 1597. He refrained from any interference in German politics until 1607, when he was entrusted with the duty of executing the imperial ban against the free city of Donauwörth, a Protestant stronghold. In Dec. 1607 his troops occupied the city, and steps were taken to restore the older faith. A union of Protestant princes, formed to defend their interests, was met in 1609 by the establishment of a league, in the formation of which Maximilian took an important part. An army was collected, but his policy was strictly defensive and he refused to allow the league to become a tool in the hands of the house of Habsburg. Dissensions among his colleagues led the duke to resign his office in 1616, but he returned to the league about two years later.

After the outbreak of the Thirty Years' War Maximilian made a treaty with the emperor Ferdinand II. in Oct. 1619, and in return for large concessions placed the forces of the league at the emperor's service. He made a treaty of neutrality with the Protestant Union, and occupied Upper Austria as security for the expenses of the campaign. On Nov. 8, 1620, his troops under Count Tilly defeated the forces of Frederick, king of Bohemia, at the White Hill near Prague. Tilly then devastated the Rhenish Palatinate, and in Feb. 1623, Maximilian was formally invested with the electoral dignity and the attendant office of imperial steward, which had been enjoyed since 1356 by the counts palatine of the Rhine. After receiving the Upper Palatinate and restoring Upper Austria to Ferdinand, Maximilian became leader of the party which sought to bring about Wallenstein's dismissal from the imperial service. At the diet of Regensburg in 1630 Ferdinand was compelled to assent to this demand, but the sequel was disastrous both for Bavaria and its ruler. Early in 1632 the Swedes marched into the duchy and occupied Munich, and Maximilian had to place himself under the orders of Wallenstein, now restored to the command of the emperor's forces. The ravages of the Swedes and their French allies induced the elector to enter into negotiations for peace with Gustavus Adolphus and Cardinal Richelieu. He also proposed to placate the Protestants by modifying the Restitution edict of 1629; but these efforts were abortive. In March 1647 he concluded an armistice with France and Sweden at Ulm, but the entreaties of the emperor Ferdinand III. led him to disregard his undertaking. Bavaria was again ravaged, and the elector's forces defeated in May 1648 at Zusmarshausen. By the treaty of Westphalia it was agreed that Maximilian should retain the electoral dignity, which was made hereditary in his family; and the Upper Palatinate was incorporated with Bavaria. The elector died at Ingolstadt on Sept. 27, 1651.

See F. A. W. Schreiber, *Maximilian I. der Katholische Kurfürst von Bayern, und der dreissigjährige Krieg* (Munich, 1868); F. Stieve, *Kurfürst Maximilian I. von Bayern* (Munich, 1882); M. Högl, *Die Bekehrung der Oberpfalz durch Kurfürst Maximilian I.* (Regensburg, 1903).

MAXIMILIAN I. (MAXIMILIAN JOSEPH) (1756–1825), king of Bavaria, the son of the count palatine Frederick of Zweibrücken-Birkenfeld, was born May 27, 1756. He took service in 1777 as a colonel in the French army, and rose rapidly to the rank of major-general. From 1782 to 1789 he was stationed at Strasbourg, but at the outbreak of the revolution he exchanged the French for the Austrian service, taking part in the opening campaigns of the revolutionary wars. On April 1, 1795 he succeeded his brother, Charles II., as duke of Zweibrücken, and on Feb. 16, 1799 became elector of Bavaria on the extinction of the Sulzbach line with the death of the elector Charles Theodore.

The sympathy with France and with French ideas which characterized his reign was at once manifested. In the newly organized ministry Count von Montgelas (*q.v.*) was the most potent influence. Agriculture and commerce were fostered, the laws were ameliorated, a new criminal code drawn up, taxes and imposts equalized without regard to traditional privileges, while a number of religious houses were suppressed and their revenues used for educational and other useful purposes. In foreign politics Maximilian Joseph's attitude was from the German point of view less commendable. With the growing sentiment of German nationality he had from first to last no sympathy, and his attitude throughout was dictated by wholly dynastic, or at least Bavarian, considerations. Until 1813 he was the most faithful of Napoleon's German allies, the relation being cemented by the marriage of his daughter to Eugène Beauharnais. His reward came with the Treaty of Pressburg (Dec. 26, 1805), by the terms of which he was to receive the royal title and important territorial acquisitions in Swabia and Franconia to round off his kingdom. He assumed the style of king on Jan. 1, 1806.

The new king of Bavaria was the most important member of the Confederation of the Rhine, and remained Napoleon's ally until the eve of the battle of Leipzig, when by the convention of Ried (Oct. 8, 1813) he made the guarantee of the integrity of his kingdom the price of his joining the Allies. By the first treaty of Paris (June 3, 1814), however, he ceded Tirol to Austria in exchange for the former duchy of Würzburg. At the congress of Vienna, which he attended in person, Maximilian had to make further concessions to Austria, ceding the quarters of the Inn and Hausruck in return for a part of the old Palatinate. The king fought hard to maintain the contiguity of the Bavarian territories as guaranteed at Ried; but the most he could obtain was an assurance from Metternich in the matter of the Baden succession, in which he was also disappointed (*see* BADEN: *History*).

At Vienna and afterwards Maximilian opposed any reconstitution of Germany which should endanger the independence of Bavaria, and his insistence on full sovereignty for the German reigning princes contributed to the loose and weak organization of the new German Confederation. The Federal Act of the Vienna congress was proclaimed in Bavaria, not as a law but as an international treaty. It was partly to secure popular support in his resistance of any interference of the federal diet in the internal affairs of Bavaria, partly to give unity to his somewhat heterogeneous territories, that Maximilian on May 26, 1818 granted a liberal constitution to his people. Montgelas had fallen in 1817, and Maximilian had also reversed his ecclesiastical policy, signing on Oct. 24, 1817 a concordat with Rome by which the powers of the clergy were restored. The new parliament proved so intract-

able that in 1819 Maximilian appealed to the powers against his own creation; but his Bavarian "particularism" and his genuine popular sympathies prevented him from allowing the Carlsbad decrees to be strictly enforced within his dominions. The suspects arrested by order of the Mainz Commission he examined himself, with the result that in many cases the whole proceedings were quashed, and in not a few the accused dismissed with a present of money. Maximilian died on Oct. 13, 1825, and was succeeded by his son Louis I.

In private life Maximilian was kindly and simple. He loved to play the part of *Landesvater,* walking about the streets of his capital *en bourgeois* and entering into conversation with all ranks of his subjects, by whom he was regarded with great affection. He was twice married: (1) in 1785 to Princess Wilhelmine Auguste of Hesse-Darmstadt, (2) in 1797 to Princess Caroline Friederike of Baden.

See G. Freiherr von Lerchenfeld, *Gesch. Bayerns unter König Maximilian Joseph I.* (1854); J. M. Söltl, *Max Joseph, König von Bayern* (Stuttgart, 1837); L. von Kobell, *Unter den vier ersten Königen Bayerns. Nach Briefen und eigenen Erinnerungen* (Munich, 1894); A. Steinberger, *Vater Max, der erste Bayernkönig* (1906).

MAXIMILIAN II. (1811–1864), king of Bavaria, son of king Louis I. and of Theresa of Saxe-Hildburghausen, was born on Nov. 28, 1811. After studying at Göttingen and Berlin and travelling in Germany, Italy and Greece, he was introduced by his father into the council of State (1836). As crown prince, in the château of Hohenschwangau near Füssen, he gathered about him an intimate society of artists and men of learning, and devoted his time to scientific and historical study. When the abdication of Louis I. (March 28, 1848) called him suddenly to the throne, his choice of ministers promised a liberal régime. But he strenuously opposed the unionist plans of the Frankfort parliament, refused to recognize the imperial constitution devised by it, and assisted Austria in restoring the federal diet and in carrying out the federal execution in Hesse and Holstein. Although, however, from 1850 onwards his government tended in the direction of absolutism, he refused to become the tool of the clerical reaction, and even incurred the bitter criticism of the Ultramontanes by inviting men of learning and science (*e.g.,* Liebig and Sybel) to Munich, regardless of their religious views. Finally, in 1859, he dismissed the reactionary ministry of von der Pfordten, in favour of a moderate constitutional Government. In his German policy he hoped to attain the union of the princes against the perilous rivalry of Austria and Prussia by the creation of a league of the "middle" and small states—the so-called Trias. In 1863, however, he supported the project of reform proposed by Austria at the Diet of Princes at Frankfort. The failure of this proposal, and the attitude of Austria towards the Confederation and in the Schleswig-Holstein question, undeceived him; but before the outbreak of the war with Denmark he died suddenly at Munich on March 10, 1864. By his wife, Maria Hedwig, daughter of Prince William of Prussia, Maximilian had two sons, Louis II., king of Bavaria, and Otto, king of Bavaria, both of whom lost their reason.

See J. M. Söltl, *Max der Zweite, König von Bayern* (Munich, 1865); biography by G. K. Heigel in *Allgem. Deutsche Biographie,* vol. xxi. (Leipzig, 1885). Maximilian's correspondence with Schlegel was published at Stuttgart in 1890.

MAXIMILIAN (1867–1929), prince of Baden, born July 10, 1867 at Baden-Baden, was a son of Prince William of Baden. As the nearest agnate to the reigning grand duke, of whom he was a cousin twice removed, he was heir presumptive to the grand ducal throne. From 1907 to 1918 he was president of the first chamber of the Baden diet. During the World War Prince Max did much to improve conditions for British prisoners in Germany, as also for German prisoners, especially in Russia. On Oct. 3, 1918, when the old military and political system in Germany was on the verge of collapse, he was appointed Imperial Chancellor. It fell to his lot to initiate the negotiations for the Armistice, and also to carry through in hot haste those alterations in the old constitution which had long been demanded by the Liberals and the Socialists, but which now came too late to avert the fate of the empire and the Prussian monarchy. It also became his duty to put pressure upon the emperor in order to induce him to abdicate. As the imperial decision was delayed from day to day and the revolution became imminent, he declared on Nov. 9, 1918, the abdication of William II. as German Emperor and as King of Prussia. It was clear that the Hohenzollern dynasty was doomed; and Prince Max handed over the Government to the majority Socialist leader Ebert, who became the president of the German *Reich.* He continued, after the abdication of the grand duke, to reside at Karlsruhe, and Schloss Salem, Lake Constance. In defence of his work he published *Erinnerungen* (1927, Eng. trans., 1928). He died at Constance, Germany, Nov. 6, 1929.

MAXIMINUS, GAIUS IULIUS VERUS, Roman emperor from A.D. 235 to 238, was a Thracian shepherd, whose immense strength attracted the notice of Septimius Severus. He entered the army, and rose from the ranks to be commander of the fourth legion (under Alexander Severus), and then to the command of the army on the Rhine. On March 19, 235, he was proclaimed emperor by the soldiers, and Alexander was murdered. The three years of Maximinus' reign were spent in warfare on the Rhine and Danube; his work in the provinces, in organizing the frontiers and building roads, was invaluable. But he has left an evil reputation because he had no predilection for Italy, and no sympathy either with the Senate or the Roman populace, whom he governed somewhat severely, by his praetorian praefect, Vitalianus. Revolt eventually broke out in Africa under the Gordians (*q.v.*), and spread to Italy. Maximinus was delayed by a campaign in Pannonia the following spring (238), when he crossed the Julian Alps and besieged Aquileia. He was murdered by a conspiracy of the praetorians (? June 17).

Capitolinus, *Maximini duo;* Herodian vi. 8, vii., viii., 1–5; Zosimus i. 13–15; Gibbon (ed. Bury).

MAXIMINUS [MAXIMIN], **GALERIUS VALERIUS,** Roman emperor from A.D. 308 to 314, was originally an Illyrian shepherd named Daia. He rose to high distinction in the army, and in 305 he was raised by his uncle, Galerius, to the rank of Caesar, with the government of Syria and Egypt. In 308, after the elevation of Licinius, he insisted on receiving the title of Augustus; on the death of Galerius, in 311, he succeeded to the supreme command of the provinces of Asia, and when Licinius and Constantine began to make common cause with one another Maximinus entered into a secret alliance with Maxentius. He came to an open rupture with Licinius in 313, sustained a crushing defeat in the neighbourhood of Heraclea Pontica on April 30, and fled, first to Nicomedia and afterwards to Tarsus, where he died in August following. *See* MAXENTIUS.

See Zosimus ii. 8; Aurelius Victor, *Epit.* 40.

MAXIMS, LEGAL. A maxim is an established principle or proposition. The Latin term *maxima* is not to be found in Roman law with any meaning exactly analogous to that of a legal maxim in the modern sense of the word, but the treatises of many of the Roman jurists on *regulae, definitiones* and *sententiae juris* are in some measure, collections of maxims. Fortescue (*De laudibus,* c. 8) and Du Cange treat *maxima* and *regula* as identical. The attitude of early English commentators towards the maxims of the law was one of unmingled adulation (*see* Bacon's preface to his *Collection of Maxims*). A similar note was sounded in Scotland. In later times less value has been attached to the maxims of the law, as the development of civilization and the increasing complexity of business relations have shown the necessity of qualifying the propositions which they enunciate (*see* Stephen, *Hist. Crim. Law,* ii. 94 *n*: *Yarmouth* v. *France,* 1887, 19 Q.B.D., per Lord Esher at p. 653, and American authorities collected in Bouvier's *Law Dict. s.v.* "Maxim").

A brief reference need only be made here, with examples by way of illustration, to the field which the maxims of the law cover. Commencing with rules founded on public policy, we may note the famous principle *Salus populi suprema lex,* "the public welfare is the highest law." It is on this maxim that the coercive action of the State towards individual liberty in a hundred matters is based. Among the maxims relating to the Crown, the most important are *Rex non potest peccare*—"the king can do no wrong"—which enshrines the principle of ministerial responsibility, and *Nullum tempus occurrit regi*—"lapse of time does not bar the Crown," a

maxim qualified by various enactments in modern times. Passing to the judicial office and the administration of justice, we may refer to the rules—*Audi alteram partem*—a proposition too familiar to need either translation or comment; *Nemo debet esse judex in propriâ suâ causâ*—"no man ought to be judge in his own cause"—a maxim which French law and the legal systems based upon or allied to it have embodied in an elaborate network of rules for judicial challenge. The maxim *Boni judicis est ampliare jurisdictionem* is certainly erroneous as it stands, as a judge has no right to "extend his jurisdiction." If *justitiam* be substituted for *jurisdictionem*, as Lord Mansfield said it should be, the maxim is near the truth. A group of maxims supposed to embody certain fundamental principles of legal right and obligations may next be referred to: (a) *Ubi jus ibi remedium*—a maxim to which the evolution of the flexible "action on the case," by which wrongs unknown to the "original writs" were dealt with, was historically due, but which must be taken with the gloss *Damnum absque injuria*—"there are forms of actual damage which do not constitute legal injury" for which the law does not supply any remedy; (b) *Actus Dei nemini facit injuriam*—and its allied maxim, *Lex non cogit ad impossibilia*—upon which the whole doctrine of *vis major* (*force mejeure*) and impossible conditions in the law of contract has been built up. In this category may also be classed *Volenti non fit injuria*, out of which sprang the theory—now profoundly modified by statute—of "common employment" in the law of employers' liability (see *Smith* v. *Baker*, 1891, A.C. 325). Other maxims deal with rights of property—*Qui prior est tempore, potior est jure*, which consecrates the position of the *beati possidentes* alike in municipal and in international law, and *Sic utere tuo ut alienum non laedas*, which has played its part in the determination of the rights of adjacent owners (see *Rylands* v. *Fletcher*, L.R 3 H.L. 330). In the laws of family relations there is the maxim *Pater is est quem nuptiae demonstrant*, on which, in most civilized countries, the presumption of legitimacy depends (see *Russell* v. *Russell*, 1924, A.C. 687). In the interpretation of written instruments, the maxim *Noscitur a sociis*, which proclaims the importance of the context, still applies. So do the rules *Expressio unius est exclusio alterius*—"often a valuable servant, but a dangerous master" (*Colquhoun* v. *Brooks*, 19 Q.B.D. 406) and *Contemporanea expositio est optima et fortissima in lege*, which lets in evidence of contemporaneous user as an aid to the interpretation of statutes or documents (see *Van Diemen's Land Co.* v. *Table Cape Marine Board*, 1906, A.C. 92, 98; and *Read* v. *Lincoln, Bishop of*, 1892, A.C. 644). We may conclude this sketch with a miscellaneous summary: *Caveat emptor*, "let the purchaser beware"; *Qui facit per alium facit per se*, which affirms the principal's liability for the acts of his agent; *Ignorantia juris neminem excusat*, on which rests the ordinary citizen's obligation to know the law, and *Actio personalis moritur cum persona*, a rule now mainly confined to actions of tort and limited by numerous exceptions. For maxims of equity *see* EQUITY.

BIBLIOGRAPHY.—English Law: Bacon, *Collection of some Principal Rules and Maxims of the Common Law* (1630); W. Noy, *Treatise of the Principal Grounds and Maxims of the Law of England* (1641); E. Wingate, *Maxims of Reason* (1728); C. Lofft (annexed to his *Reports*, 1776); H. Broom, *Legal Maxims* (1924). Scots Law: Lord Trayner, *Latin Maxims and Phrases* (2nd ed., 1876); Viscount Stair, *Institutions of the Law of Scotland*, with Index by More (1832). American Treatises: A. I. Morgan, *English Version of Legal Maxims* (Cincinnati, 1878); S. S. Peloubet, *Legal Maxims in Law and Equity* (New York, 1880). (A. W. R.)

MAXIM SILENCER. A device, invented in 1908 by Hiram Percy Maxim, an American, for suppressing the sound of discharge of firearms. Attached to any tight-breech firearm, such as a rifle, it checked the sudden liberation of the powder gases into the atmosphere by imparting a whirling motion to them, which caused them to fly out from the central hole by centrifugal force. Their escape could thus not occur until they slowed down, at which time they escaped noiselessly. Meanwhile, the same mechanism that caused the powder gases to acquire a whirling motion also served as a series of acoustic resonating chambers, which acted to set up interfering resonance and trap the sound frequencies present.

Originally, the device was considered as a menace to public safety, since it was believed by many that it would chiefly serve criminals. Many of the States in the United States passed laws prohibiting its sale and use, and several countries prohibited its importation. However, this was due to the great public interest taken in the invention when it was first announced, and a lack of understanding of firearms. The arms used by criminals are almost invariably small arms, such as revolvers and pistols. The revolver cannot be silenced by the Maxim Silencer because it is not a tight-breech mechanism. Having a cylinder and a barrel, and of necessity a joint between the two latter, a leak is created. When a silencer is applied to the muzzle of the barrel of a revolver, the powder gases and noise escape at this leak. The automatic pistol cannot be silenced because of the mechanical noise made by the automatic breech mechanism. Only single shot pistols and rifles can be silenced by the Maxim Silencer.

The silencing of all forms of noises that issue from a pipe was later accomplished by the Maxim Silencer, and at the present time it is the accepted means for overcoming the noise of the exhaust of Diesel engines, gas and gasolene engines, steam engines, safety valves, air and steam releases and also the intakes or suctions of air compressors and blowers. Its construction permits gases to flow freely through, but sound is trapped and caused to dissipate itself inside the device.

MAXIMUS, ST. (*c.* 580–662), abbot of Chrysopolis, known as "the Confessor" from his orthodox zeal in the Monothelite (*q.v.*) controversy, or as "the monk," was born of noble parentage at Constantinople about the year 580. He became private secretary to the emperor Heraclius in 610. In 630 he entered the monastery of Chrysopolis (Scutari), of which he became abbot. In 633 he was one of the party of Sophronius of Jerusalem (the chief original opponent of the Monothelites) at the council of Alexandria; and in 645 he was again in Africa, when he disputed with Pyrrhus, the deposed and banished patriarch of Constantinople. In the following year several African synods, held under the influence of Maximus, declared for orthodoxy. In 649 he went to Rome, after the accession of Martin I., who in October of that year held the (first) Lateran synod, by which not only the Monothelite doctrine but also the moderating *ecthesis* of Heraclius and *typus* of Constans II. were anathematized.

About 653 Maximus was apprehended (together with the pope) by order of Constans and carried a prisoner to Constantinople. In 655 he was banished to Byzia in Thrace, and afterwards to Perberis. In 662 he was again brought to Constantinople and was condemned by a synod to be scourged, to have his tongue cut out by the root, and to have his right hand chopped off. He was then banished to Lazica, where he died on Aug. 13, 662. He is venerated as a saint both in the Greek and in the Latin Churches.

The most important of the works of Maximus will be found in Migne, *Patrologia graeca*, xc., xci., together with an anonymous life; an exhaustive list in Wagenmann's article in vol. xii. (1903) of Hauck-Herzog's *Realencyklopädie* where the following classification is adopted: (*a*) exegetical, (*b*) scholia on the Fathers, (*c*) dogmatic and controversial, (*d*) ethical and ascetic, (*e*) miscellaneous. The details of the disputation with Pyrrhus and of the martyrdom are given very fully and clearly in Hefele's *Conciliengeschichte*, iii.

MAXIMUS, the name of four Roman emperors.

I. M. CLODIUS PUPIENUS MAXIMUS, joint emperor with D. Caelius Calvinus Balbinus during a few months of the year A.D. 238. Pupienus was a distinguished soldier, who had been proconsul of Bithynia, Achaea, and Gallia Narbonensis. At the advanced age of 74, he was chosen by the senate with Balbinus to resist the barbarian Maximinus. It was arranged that Pupienus should take the field against Maximinus, while Balbinus remained at Rome to maintain order. On his march, Pupienus, having received the news that Maximinus had been assassinated by his own troops, returned in triumph to Rome. Shortly afterwards when both emperors were on the point of leaving the city on an expedition—Pupienus against the Persians and Balbinus against the Goths—the praetorians, who cherished the memory of the soldier-emperor Maximinus, seized the opportunity of revenge. When most of the people were at the Capitoline games, they forced their way into the palace and put Balbinus and Pupienus

to death.

See Capitolinus, *Lives of Maximus and Balbinus;* Herodian vii. 10, viii. 6; Zonaras xii. 16; Zosimus i. 14; Aurelius Victor, *Caesares,* 26, *epit.* 26; Gibbon, *Decline and Fall,* ch. 7 and (for the chronology) appendix 12 (Bury's edition); Stuart Jones, *Roman Empire;* A. Stein in *Realencyklopädie* 4, 888–898, 3, 1258–1265.

II. Magnus Maximus, a native of Spain, who had accompanied Theodosius on several expeditions, and from 368 seems to have had some office in Britain, where he was proclaimed emperor by the disaffected troops. Denuding, as it would seem, Hadrian's Wall of its garrison, he crossed over to Gaul, and overthrew Gratian. Theodosius being unable to avenge the death of his colleague, an agreement was made (384 or 385) by which Maximus was recognized as Augustus and sole emperor in Gaul, Spain and Britain, while Valentinian II. was to rule Italy and Illyricum. In 387 Maximus crossed the Alps and Valentinian was forced to fly to Theodosius. Theodosius now took vigorous measures. Advancing with a powerful army he defeated the troops of Maximus—at Siscia on the Save, and at Poetovio on the Danube. He then hurried on to Aquileia, where Maximus had shut himself up, and had him beheaded.

Full account with classical references in H. Richter, *Das weströmische Reich, besonders unter den Kaisern Gratian, Valentinian II. und Maximus* (1865); Gibbon, *Decline and Fall,* ch. 27; Tillemont, *Hist. des empereurs,* v.; A. Bauer, *Chronologie des Maximus* (1905); Collingwood, in *J.R.S.* 13, p. 74 *et seq.*

III. Maximus Tyrannus, made emperor in Spain by the Roman general, Gerontius, who had rebelled against the usurper Constantine in 408. After the defeat of Gerontius at Arelate (Arles) and his death in 411 Maximus renounced the imperial title and was permitted by Constantine to retire into private life. About 418 he rebelled again, but, failing in his attempt, was seized, carried into Italy, and put to death at Ravenna in 422.

See Orosius vii. 42; Zosimus vi. 5; E. A. Freeman, "The Tyrants of Britain, Gaul and Spain, A.D. 406–411," in *English Historical Review,* i. (1886).

IV. Petronius Maximus, a member of the higher Roman nobility, had held several court and public offices. He was one of the intimate associates of Valentinian III., but an outrage committed on the wife of Maximus by the emperor turned his friendship into hatred. Maximus was proclaimed emperor immediately after Valentinian's murder (March 16, 455), but after reigning less than three months, he was murdered by some Burgundian mercenaries as he was fleeing before the troops of Gaiseric who had landed at the mouth of the Tiber (May or June 455).

See Procopius, *Vand.* i. 4; Sidonius Apollinaris, *Panegyr. Aviti,* ep. ii. 13; Gibbon, *Decline and Fall,* chs. 35, 36; *Chronica Minda,* vols. 1, 2 and 3, Ed. Mommsen; Tillemont, *Hist. des empereurs,* vi.

MAXIMUS OF SMYRNA (*fl.* 4th cent. A.D.), a Greek philosopher of the Neoplatonist school, was perhaps the most important of the followers of Iamblichus. He is said to have exercised great influence over the emperor Julian, to whose love of magic and theurgy he pandered. His overbearing manner made him numerous enemies, and, after being imprisoned on the death of Julian, he was put to death by Valens. He represents the least attractive side of Neoplatonism, enlarging on the wonders and mysteries of nature, and working miracles.

MAXWELL, the name of a Scottish family, members of which have held the titles of earl of Morton, earl of Nithsdale, Lord Maxwell, and Lord Herries. The name is taken probably from Maccuswell, or Maxwell, near Kelso, whither the family migrated from England *c.* 1100. Sir Herbert Maxwell won fame by defending his castle of Carlaverock against Edward I. in 1300; another Sir Herbert was made a lord of the Scottish parliament before 1445; and his great-grandson John, 3rd Lord Maxwell, was killed at Flodden in 1513. John's son Robert, the 4th lord (d. 1546), was a member of the royal council under James V.; he was also an extraordinary lord of session, high admiral, and warden of the west marches, and was taken prisoner by the English at the rout of Solway Moss in 1542. Robert's grandson John, 7th Lord Maxwell (1553–93), was the second son of Robert, the 5th lord (d. 1552), and his wife Beatrix, daughter of James Douglas, 3rd earl of Morton. After the execution of the regent Morton, the 4th earl, in 1581 this earldom was bestowed upon Maxwell, but in 1586 the attainder of the late earl was reversed and he was deprived of his new title. He had helped in 1585 to drive the royal favourite James Stewart, earl of Arran, from power, and he made preparations to assist the invading Spaniards in 1588. His son John, the 8th lord (*c.* 1586–1613), after a life of lawlessness escaped from Scotland and was sentenced to death; having returned he was seized and beheaded in Edinburgh. In 1618 John's brother and heir Robert (d. 1646) was restored to the lordship of Maxwell, and in 1620 was created earl of Nithsdale, surrendering at this time the claim to the earldom of Morton. He and his son Robert, afterwards the 2nd earl, fought under Montrose for Charles I. during the Civil War. Robert died without sons in Oct. 1667, when a cousin John Maxwell, 7th Lord Herries (d. 1677), became third earl.

William, 5th earl of Nithsdale (1676–1744), a grandson of the third earl, joined the Jacobite insurgents in 1715, was taken prisoner at the battle of Preston and sentenced to death. He escaped from the Tower of London, was attainted in 1716 and his titles became extinct, but his estates passed to his son William (d. 1776), whose descendant, William Constable-Maxwell, regained the title of Lord Herries in 1858.

MAXWELL, ANNA CAROLINE (1851–1929), American nurse administrator, was born in Bristol, N.Y., on March 14, 1851. She graduated at the Boston City hospital, Boston, and held the position of director of nursing in Montreal, Boston and New York hospitals before establishing the school of nursing at the Presbyterian hospital in New York, 1892. During the 30 years she was head of it she gave it an excellent reputation. The nurses' residence of the new Presbyterian medical centre, New York, opened in 1928, was named the "Anna C. Maxwell hall" in her honour. For her services as head of the Presbyterian hospital unit overseas during the World War she was decorated by France. In the Spanish War of 1898 the U.S. Government appointed her director of nursing at Chickamauga. Under her leadership the scourge of disease among the soldiers was controlled. With Amy Elizabeth Pope she wrote *Practical Nursing* (1914; Spanish transl., 1919). She died at New York city on Jan. 2, 1929.

MAXWELL, JAMES CLERK (1831–1879), British physicist, was descended from the well-known Scottish family of Clerk of Penicuik, and was born at Edinburgh on Nov. 13, 1831. He was educated at the Edinburgh academy (1840–47), the University of Edinburgh (1847–50), and at Cambridge. In 1854 he took his degree as second wrangler, and shared with the senior wrangler of his year (E. J. Routh, *q.v.*) the Smith's prize. He held the chair of natural philosophy in Marischal college, Aberdeen (1856–60), and the chair of physics and astronomy in King's college, London (1860–68). He resigned and retired to his estate of Glenlair in Kirkcudbrightshire. He was summoned from his seclusion in 1871 to become the first holder of the newly founded professorship of experimental physics in Cambridge; and it was under his direction that the plans of the Cavendish laboratory were prepared. He died at Cambridge on Nov. 5, 1879.

For more than half of his brief life he held a prominent position in the very foremost rank of natural philosophers. His contributions to scientific societies began in his 15th year, when Professor J. D. Forbes communicated to the Royal Society of Edinburgh a short paper of his on a mechanical method of tracing Cartesian ovals. In his 18th year, while still a student in Edinburgh, he contributed two valuable papers to the *Transactions* of the same society—one of which, "On the Equilibrium of Elastic Solids," is remarkable, not only on account of its intrinsic power and the youth of its author, but also because in it he laid the foundation of one of the most singular discoveries of his later life, the temporary double refraction produced in viscous liquids by shearing stress. Immediately after taking his degree, he read to the Cambridge Philosophical Society a very novel memoir, "On the Transformation of Surfaces by Bending." This is one of the few purely mathematical papers he published, and it exhibited at once to experts the full genius of its author.

About the same time appeared his elaborate memoir, "On Faraday's Lines of Force," in which he gave the first indication of some of those extraordinary electrical investigations which cul-

minated in the greatest work of his life. He obtained in 1859 the Adams prize in Cambridge for a very original and powerful essay, "On the Stability of Saturn's Rings." From 1855 to 1872 he published at intervals a series of valuable investigations connected with the "Perception of Colour" and "Colour-Blindness," for the earlier of which he received the Rumford medal from the Royal Society in 1860. The instruments which he devised for these investigations were simple and convenient, but could not have been thought of for the purpose except by a man whose knowledge was co-extensive with his ingenuity. One of his greatest investigations bore on the "Kinetic Theory of Gases." This theory received enormous developments from Maxwell, who in this field appeared as an experimenter (on the laws of gaseous friction) as well as a mathematician. He derived the law of distribution of velocities of the molecules of a gas, which is known as Maxwell's law. He wrote an admirable textbook, the *Theory of Heat* (1871), and an excellent elementary treatise on *Matter and Motion* (1876).

But the great work of his life was devoted to electricity. He began by trying to translate the ideas of Faraday into the notation of the mathematicians. A considerable part of this work was accomplished during his career as an undergraduate in Cambridge. His great object, as it was also the great object of Faraday, was to overturn the idea of action at a distance. In 1846 W. Thomson (Lord Kelvin) had treated the resultant electric force at any point as analogous to the *flux of heat* from sources distributed in the same manner as the supposed electric particles and deduced formulae similar to those which had been deduced from the laws of action at a distance. This paper of Thomson's, whose ideas Maxwell afterwards developed in an extraordinary manner, seems to have given the first hint that there are at least two perfectly distinct methods of arriving at the known formulae of statical electricity. The step to magnetic phenomena was comparatively simple; but it was otherwise as regards electromagnetic phenomena, where current electricity is essentially involved.

The first paper of Maxwell's in which an attempt at an admissible physical theory of electromagnetism was made was communicated to the Royal Society in 1864. But the theory, in a fully developed form, first appeared in 1873 in his great treatise of *Electricity and Magnetism*. This work was one of the most splendid monuments ever raised by the genius of a single individual. Availing himself of the admirable generalized co-ordinate system of Lagrange, Maxwell showed how to reduce all electric and magnetic phenomena to stresses and motions of a material medium, and, as one preliminary, but excessively severe, test of the truth of his theory, he pointed out that (if the electromagnetic medium be that which is required for the explanation of the phenomena of light) the velocity of light in vacuo should be numerically the same as the ratio of the electromagnetic and electrostatic units. In fact, the means of the best determinations of each of these quantities separately agree with one another more closely than do the various values of either.

One of Maxwell's last great contributions to science was the editing (with copious original notes) of the *Electrical Researches of the Hon. Henry Cavendish*. (*See* CAVENDISH.)

His collected works were issued in two volumes by the Cambridge University Press in 1890; see *Life of James Clerk Maxwell* by L. Campbell and W. Garnett (1882). (P. G. T.)

MAXWELL, SIR JOHN GRENFELL (1859–1929), K.C.B. (1900), K.C.M.G. (1915), British general, was born on July 11, 1859. He entered the army in 1879, and after many years' service in Egypt was promoted to the command of a brigade during the advances up the Nile (1896–98) which closed with the re-occupation of Khartum. He received the K.C.B. and C.M.G. for his staff services during the S. African War, was promoted major-general in 1906, and was in command of the British troops in Egypt from 1908 to 1912.

After a short period as liaison officer with French headquarters in 1914, Maxwell was sent to take charge of the British forces which were arriving in Egypt. His defensive measures were most successful, as the one serious Turkish advance was decisively checked. He returned to England in March 1916. He was placed in command of the troops in Ireland when the Irish rebellion broke out, and in the autumn was transferred to the Northern District of England, a command which he held for two years. He was promoted full general in 1919. In 1920 he went to Egypt as a member of Lord Milner's mission. He died Feb. 21, 1929.

MAXWELLTOWN, burgh of Kirkcudbrightshire, Scotland, on the Nith, opposite to Dumfries, with which it is connected by three bridges. Pop. (1921) 6,091. It has a station on the L.M.S. line from Dumfries to Kirkcudbright. There is an observatory and museum. The chief manufactures are woollens and hosiery, besides dyeworks and sawmills. It was a hamlet known as Bridgend before 1810.

MAY, PHIL (1864–1903), English caricaturist, born at Wortley, near Leeds on April 22, 1864, the son of an engineer. His father died when the child was nine years old, and at twelve he began to earn his living. Before he was 15 he acted as timekeeper at a foundry, tried to become a jockey, and went on the stage at Scarborough and Leeds. At 17 he went to London with a sovereign in his pocket. He slept in the parks and streets until he got a job as designer to a theatrical costumier. He also drew posters and cartoons, and for about two years worked for the *St. Stephen's Review* when he went to Australia for his health. There he was attached for three years to the *Sydney Bulletin*, for which many of his best drawings were made. On his return he went to Paris by way of Rome. In 1892 he resumed his interrupted work for *St. Stephen's Review*. His studies of the London "guttersnipe" and the coster-girl rapidly made him famous. His overflowing sense of fun, his sympathy with his subjects, and his kindly wit were on a par with his artistic ability. The extraordinary economy of line which was characteristic of his drawings was the result of a laborious process which involved a number of preliminary sketches. His later work included some excellent political portraits. He became a member of the staff of *Punch* in 1896, and in his later years his services were retained exclusively for *Punch* and the *Graphic*. He died on Aug. 5, 1903.

A selection of his drawings contributed to the periodical press and from *Phil May's Annual* and *Phil May's Sketch Books*, with a portrait and biography of the artist, entitled *The Phil May Folio*, appeared in 1904.

MAY, THOMAS (1595–1650), English poet and historian, son of Sir Thomas May of Mayfield, Sussex, was born in 1595. He entered Sidney Sussex college, Cambridge, in 1609, and took his B.A. degree three years later. His father having lost his fortune and sold the family estate, Thomas May, who was hampered by an impediment in his speech, made literature his profession. In 1620 he produced *The Heir*, an ingeniously constructed comedy, and, probably about the same time, *The Old Couple*, which was not printed until 1658. His other dramatic works are classical tragedies on the subjects of Antigone, Cleopatra, and Agrippina. F. G. Fleay has suggested that the more famous anonymous tragedy of *Nero* (printed 1624, reprints in A. H. Bullen's *Old English Plays* and the *Mermaid Series*) should also be assigned to May. But his most important work in the department of pure literature was his translation (1627) into heroic couplets of the *Pharsalia* of Lucan. Its success led May to write a continuation of Lucan's narrative down to the death of Caesar. Charles I. became his patron, and commanded him to write metrical histories of Henry II. and Edward III., which were completed in 1635.

In 1646 May is styled one of the "secretaries" of the Parliament, and in 1647 he published his best known work, *The History of the Long Parliament*, an official apology for the moderate or Presbyterian party. In 1650 he followed this with another work written with a more definite bias, a *Breviary of the History of the Parliament of England*, in Latin and English, in which he defended the position of the Independents. He stopped short of the catastrophe of the king's execution, and it seems likely that his subservience to Cromwell was not quite voluntary. In Feb. 1650 he was brought to London from Weymouth under a strong guard for having spread false reports of the Parliament and of Cromwell. He died on Nov. 13 in the same year, and was buried in Westminster Abbey, but after the Restoration his remains were exhumed.

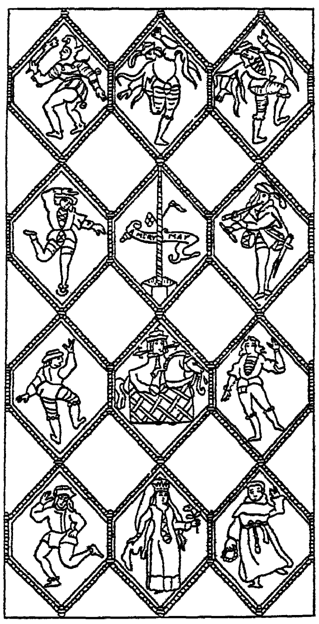
There is a long notice of May in the *Biographia Britannica*. *See* also

W. J. Courthope, *Hist. of Eng. Poetry* (1895, etc.) vol. 3; and Guizot, *Études biographiques sur la révolution d'Angleterre* (pp. 403–426, ed. 1851).

MAY, SIR THOMAS ERSKINE: *see* FARNBOROUGH.

MAY, or MEY(E), **WILLIAM** (d. 1560), English divine, was the brother of John May, bishop of Carlisle. He was educated at Cambridge, where he was a fellow of Trinity Hall, and in 1537, president of Queen's college. May was successively chancellor, vicar-general and prebendary of Ely. In 1545 he was made a prebendary of St. Paul's, and in the following year dean. His favourable report on the Cambridge colleges saved them from dissolution. He died on the day of his election to the archbishopric of York.

MAY, the fifth month of our modern year, the third of the old Roman calendar perhaps derived from the name of the goddess Maia. The ancient Romans used on May day to go in procession to the grotto of Egeria. (May day was in the middle of the Floralia.) The month was regarded as unlucky for marriages, owing to the celebration of the Lemuria, the festival of the unhappy dead.



FROM C. COX, "CHURCHWARDENS' ACCOUNTS"

OLD ENGLISH MAY-DAY REVELS

This drawing of a window in Betley Hall, Staffordshire, erected in the time of Edward IV., shows the earliest known picture of a maypole

In mediaeval and Tudor England, May day was a great public holiday. All classes of the people were up with the dawn, and went "a-maying." Branches of trees and flowers were borne back in triumph to the towns and villages, the centre of the procession being occupied by the maypole, glorious with ribbons and wreaths. The maypole was usually of birch, and set up for the day only; but in London and the larger towns the poles were of durable wood and permanently erected. They were special eyesores to the Puritans. Maypoles were forbidden by the parliament in 1644, but came once more into favour at the Restoration. In 1661 a maypole 134ft. high was set up by twelve British sailors under the personal supervision of James II., then Duke of York and lord high admiral, in the Strand.

May day was selected as an international Labour holiday by the International Socialist Congress of 1889. (*See* LABOUR DAY.)

For an account of the May day survivals in rural England *see* John Brand, *Popular Antiquities of Great Britain* (1905).

MAY, ISLE OF, an island of Fifeshire, Scotland, at the entrance to the Firth of Forth, 5 m. S.E. of Crail and Anstruther. It is more than 1 m. long, and measures at its widest about one-third m. St. Adrian settled here and was martyred by the Danes in the 9th century. The ruins exist of the small chapel dedicated to him, which was a favourite place of pilgrimage. The place where the pilgrims—of whom James IV. was often one—landed is still known as Pilgrims' Haven, and traces may be seen of the various holy wells, now brackish.

MAYA, an important tribe and stock of American Indians, the dominant race of Yucatan and other states of Mexico and part of Central America at the time of the Spanish conquest. They were then divided into many nations, chief among them being the Maya proper, the Huastecs, the Tzental, the Pokom, the Mame and the Cakchiquel and Quiché. They were spread over Yucatan, Vera Cruz, Tabasco, Campeche, and Chiapas in Mexico, and over the greater part of Guatemala and Salvador. Their traditions give as their place of origin the extreme north; thence they migrated some time before the beginning of the Christian era and reached Yucatan as early as the 5th century. Physically the Mayans are a dark-skinned, round-headed, short and sturdy type. They still form the bulk of the inhabitants of Yucatan. For their culture, ruined cities, etc., *see* CENTRAL AMERICA and MEXICO.

MAYAGÜEZ, a city on the west coast of Porto Rico. Its population by the census of 1920 was 19,067, while the population of the municipal district was 41,612. The population of the city in 1928 probably exceeded 25,000. Mayagüez was founded in 1763, but was under the jurisdiction of San Germán. In 1836 its separation was authorized by royal decree from Madrid. It has a commodious harbour, and considerable shipping is done both of exports and imports. It is connected with other cities of the island by the American railroad, and by first class highways with motor-bus service. It has a street railway, water-works, electric light and power, a public library, fire department, public market and well-paved streets. The city has developed within recent years an important manufacturing and industrial interest in the production of clothing for the markets in the States, principally of cotton of the cheaper grades. The garments are produced in manufacturing establishments employing hundreds of workers and is also carried on by piece-work in the homes of the people. This development has given employment to thousands of workers, and the wages distributed have greatly increased the prosperity and growth of the city as a commercial centre.

Mayagüez has an excellent system of public schools and is the seat of the College of Agriculture and the Mechanic Arts of the University of Porto Rico. A Federal experiment station, under the U.S. department of agriculture, is situated here. The Reform School for Boys is also here.

The principal agricultural products of the district are sugar-cane, coffee, tobacco, bananas and tropical fruits. (H. M. T.)

MAY APPLE (*Podophyllum peltatum*), a North American plant of the barberry family (Berberidaceae), called also American mandrake, native to low woods from Quebec to Manitoba and southward to Florida and Texas. It is an erect, perennial herb, 12 in. to 18 in. high, which springs from a horizontal rootstock. The stem bears two large, shield-shaped, deeply lobed leaves, sometimes nearly a foot in diameter, in the axil between which rises in May a single stout-stalked, fragrant, white flower, about 2 in. broad, with six or more petals. The fruit, which ripens in July, is an oval, fleshy, yellow, edible berry about 2 in. long. In many districts the may apple is an abundant and conspicuous spring wild flower and has received numerous local names. Its poisonous rootstalk yields the powerful drug podophyllin (*q.v.*).

MAYBOLE, burgh of barony in Ayrshire, Scotland, 9 m. S. of Ayr and 50¼ m. S.W. of Glasgow by L.M.S.R. Pop. (1931) 4,210. It received a charter from Duncan II. in 1193, and was made a burgh of regality in 1516, but for generations it remained under the subjection of the Kennedys, afterwards earls of Cassillis and marquesses of Ailsa, the most powerful family in Ayrshire. Maybole was once the capital of the district of Carrick, and the castle of the earls of Cassillis remains. The leading manufactures are of boots and shoes and agricultural implements.

MAYEN, a town of Germany, in the Prussian Rhine province, on the northern slope of the Eifel range, 16 m. W. from Coblenz, on the railway Andernach-Gerolstein. Pop. (1925) 14,287. Mayen was a Roman settlement and became a town in 1291. It is still partly surrounded by mediaeval walls, and the ruins of a castle rise above the town. There are some small industries.

MAYENNE, CHARLES OF LORRAINE, DUKE OF (1554–1611), second son of Francis of Lorraine, second duke of Guise, was born on March 26, 1554. He was absent from France at the time of the massacre of Saint Bartholomew, but took part in the siege of La Rochelle in the following year, when he was created duke and peer of France. He went with Henry of Valois, duke of Anjou (afterwards Henry III.), on his election as king of Poland. On his return to France he fought under his brother, the 3rd duke of Guise, against the Huguenots. As governor of Burgundy he raised his province in the cause of the League in 1585. The assassination of his brothers at Blois on Dec. 23 and 24, 1588 left him at the head of the Catholic party. The Venetian ambassador, Mocenigo, states that Mayenne had warned Henry III. that there was a plot afoot to seize his person and to send him

by force to Paris. At the time of the murder he was at Lyons, where he received a letter from the king saying that he had acted on his warning, and ordering him to retire to his government.

Mayenne professed obedience, but immediately made preparations for marching on Paris. After a vain attempt to release his relatives who had been arrested at Blois, he recruited troops in his government of Burgundy and in Champagne. When Mayenne entered Paris (Feb. 1589) he formed a council general to direct the affairs of the city and to maintain relations with the other towns faithful to the League. To this council each quarter sent four representatives, and Mayenne added representatives of the various trades and professions of Paris in order to counterbalance this revolutionary element. He constituted himself "lieutenant-general of the State and crown of France," taking his oath before the parlement of Paris. In April he advanced on Tours. Henry III. in his extremity sought an alliance with Henry of Navarre, and the allied forces drove the leaguers back, and had laid siege to Paris, when the murder of Henry III. by a Dominican fanatic changed the face of affairs and gave new strength to the Catholic party.

Mayenne was urged to claim the crown for himself, but he proclaimed Charles, cardinal of Bourbon, at that time a prisoner in the hands of Henry IV., as Charles X. Henry IV. retired to Dieppe, followed by Mayenne, who joined his forces with those of his cousin Charles, duke of Aumale, and Charles de Cossé, comte de Brissac, and engaged the royal forces in a succession of fights in the neighbourhood of Arques (September 1589). He was defeated and out-marched by Henry IV., who moved on Paris, but retreated before Mayenne's forces. In 1590 Mayenne received additions to his army from the Spanish Netherlands, and took the field again, only to suffer complete defeat at Ivry (March 14, 1590). He then escaped to Mantes, and in September collected a fresh army at Meaux, and with the assistance of Alexander Farnese, prince of Parma, sent by Philip II., raised the siege of Paris, which was about to surrender to Henry IV. Mayenne feared with reason the designs of Philip II., and his difficulties were increased by the death of Charles X., the "king of the league." The extreme section of the party, represented by the Sixteen, urged him to proceed to the election of a Catholic king and to accept the help and the claims of their Spanish allies.

But Mayenne, who had not the popular gifts of his brother, the duke of Guise, had no sympathy with the demagogues, and himself inclined to the moderate side of his party, which began to urge reconciliation with Henry IV. He maintained the ancient forms of the constitution against the revolutionary policy of the Sixteen, who during his absence from Paris took the law into their own hands and in November 1591 executed one of the leaders of the more moderate party, Barnabé Brisson, president of the parlement. He returned to Paris and executed four of the chief malcontents. The power of the Sixteen diminished from that time, but with it the strength of the League.

Mayenne entered into negotiations with Henry IV. while he was still appearing to consider with Philip II. the succession to the French crown of the Infanta Elizabeth, granddaughter, through her mother Elizabeth of Valois, of Henry II. He demanded that Henry IV. should accomplish his conversion to Catholicism before he was recognized by the leaguers. He also desired the continuation to himself of the high offices which had accumulated in his family and the reservation of their provinces to his relatives among the leaguers. In 1593 he summoned the States General to Paris and placed before them the claims of the Infanta, but they protested against foreign intervention. Mayenne signed a truce at La Villette on July 31, 1593. The internal dissensions of the league continued to increase, and the principal chiefs submitted. Mayenne finally made his peace only in Oct. 1595. Henry IV. allowed him the possession of Chalon-sur-Saône, of Seurre and Soissons for three years, made him governor of the Isle of France and paid a large indemnity. Mayenne died at Soissons on Oct. 3, 1611.

See the literature dealing with the house of Guise (*q.v.*).

MAYENNE, a department of north-western France, bounded on the north by Manche and Orne, east by Sarthe, south by Maine-et-Loire and west by Ille-et-Vilaine. Area, 1,986 sq. miles. Pop. (1926) 259,934. The department forms the eastern portion of the Armorican system of Palaeozoic rocks, with zones of granite running east and west in its northern part. The Mayenne cuts across the grain of the country in its course from north to south through the middle of the department; it receives a number of small tributaries. The Oudon runs parallel to it in the south of the department and then turns eastward to join it in the department of Maine-et-Loire. The land in the north-east rises to 1,368 feet. Varying zones of soil give sandy heaths alternating with marshes that make the air moist and foggy; the rainfall is rather above the average (32 in.) and the temperature is slightly lower than in neighbouring departments.

Large numbers of horned cattle and horses are reared, and the Craon breeds of horses and pigs are famous. Mayenne produces butter and poultry and much honey. The cultivation of the vine is very limited, and the most common beverage is cider. Wheat, barley, oats and buckwheat are the most important crops, and much flax and hemp is produced. Game is abundant. The timber grown is chiefly beech, oak, birch, elm and chestnut. The department produces vanadium, antimony, auriferous quartz and coal. Marble, slate and other stone are quarried. There are several chalybeate springs. Exports include agricultural produce, livestock, timber and stone. The department is served by the Ouest-État railway. It forms part of the circumscriptions of the IV. army corps, the académie (educational division) of Rennes, and the court of appeal of Angers. It comprises three arrondissements (Laval, Château-Gontier and Mayenne), with 27 cantons and 276 communes. Laval, the capital, is the seat of a bishopric of the province of Tours. The other principal towns are Château-Gontier and Mayenne. The following places are also of interest: Evron, which has a church of the 12th and 13th centuries; Jublains, with a Roman fort and other Roman remains; Lassay, with a fine château of the 14th and 16th centuries; and Ste. Suzanne, which has remains of mediaeval ramparts and a fortress with a Romanesque keep.

MAYENNE, a town of north-western France, capital of an arrondissement in the department of Mayenne, 19 m. N.N.E. of Laval by rail. Pop. (1926) 6,245. Mayenne had its origin in the castle built here by Juhel, baron of Mayenne, the son of Geoffrey of Maine, in the beginning of the 11th century. It was taken by William the Conqueror in 1068, and again after a three months' siege in 1424. It was captured several times by the opposing parties in the wars of religion and of the Vendée. At the beginning of the 16th century the territory passed to the family of Guise, and in 1573 was made a duchy in favour of Charles of Mayenne, leader of the league. Mayenne is an old feudal town, irregularly built on hills on both sides of the river Mayenne. Of the old castle overlooking the river several towers remain, also the vaulted chambers and a 13th century chapel; the building is now used as a prison. The Gothic church of Notre-Dame dates partly from the 12th century; the choir was rebuilt in the 19th century. Mayenne has a subprefecture, tribunals of first instance and of commerce, a chamber of arts and manufactures, and a board of trade-arbitration. The chief industry of the place is the manufacture of tickings, linen, handkerchiefs and calicoes.

MAYER, JOHANN TOBIAS (1723–1762), German astronomer, was born at Marbach, in Württemberg, on Feb. 17, 1723, and brought up at Esslingen. A self-taught mathematician, he had already published two original geometrical works when, in 1746, he entered J. B. Homann's cartographic establishment at Nuremberg. Here he introduced many improvements in map-making, and gained a scientific reputation which led (in 1751) to his election to the chair of economy and mathematics in the university of Göttingen. In 1754 he became superintendent of the observatory, where he laboured with great zeal and success until his death, on Feb. 20, 1762. His first important astronomical work was a careful investigation of the libration of the moon (*Kosmographische Nachrichten*, Nuremberg, 1750), and his chart of the full moon (published in 1775) was unsurpassed for half a century. But his fame rests chiefly on his lunar tables, communicated in 1752, with new solar tables, to the Royal Society of Göttingen,

and published in their *Transactions* (vol. ii.). In 1755 he submitted to the English government an amended body of MS. tables, which Bradley found to be sufficiently accurate to determine the moon's place to 75″, and consequently the longitude at sea to about half a degree. An improved set was afterwards published in London (1770), as also the theory (*Theoria lunae juxta systema Newtonianum*, 1767) upon which the tables are based. His widow received in consideration from the British government a grant of £3,000. Appended to the London edition of the solar and lunar tables are two short tracts—the one on determining longitude by lunar distances, together with a description of the repeating circle (invented by Mayer in 1752), the other on a formula for atmospheric refraction, which applies a remarkably accurate correction for temperature.

Part of Mayer's manuscript was collected by G. C. Lichtenberg (*Opera inedita*, Göttingen, 1775). It contains an easy and accurate method for calculating eclipses; an essay on colour; a catalogue of 998 zodiacal stars; and a memoir, the earliest of any real value, on the proper motion of eighty stars, originally communicated to the Göttingen Royal Society in 1760. In an unpublished manuscript Mayer sought to explain the magnetic action of the earth by a modification of Euler's hypothesis, and made the first really definite attempt to establish a mathematical theory of magnetic action (C. Hansteen, *Magnetismus der Erde*, i. 283). E. Klinkerfuss published in 1881 photo-lithographic reproductions of Mayer's local charts and general map of the moon; and his star-catalogue was re-edited by F. Baily in 1830 (*Memoirs Roy. Astr. Soc.* iv. 391) and by G. F. J. A. Auvers in 1894.

See A. G. Kästner, *Elogium Tobiae Mayeri* (Göttingen, 1762).

(A. M. C.; X.)

MAYER, JULIUS ROBERT (1814–1878), German physicist, was born at Heilbronn on Nov. 25, 1814, studied medicine at Tübingen, Munich and Paris, and after a journey to Java in 1840 as surgeon of a Dutch vessel obtained a medical post in his native town. He claims recognition as an independent a priori propounder of the "First Law of Thermodynamics," but more especially as having early and ably applied that law to the explanation of many remarkable phenomena, both cosmical and terrestrial. His first paper on the subject, "Bemerkungen über die Kräfte der unbelebten Natur," appeared in 1842 in Liebig's *Annalen*, and three years later he published *Die organische Bewegung in ihrem Zusammenhange mit dem Stoffwechsel*. There was a good deal of controversy regarding the priority of Mayer's ideas; this, together with the lack of appreciation accorded to his work, and domestic grief, affected Mayer's mind. In 1851 he was placed in an asylum and, although he was released, his mind never completely recovered. He died at Heilbronn on March 20, 1878. His papers were republished in a single volume with the title *Die Mechanik der Wärme* (1893).

Different, and it would appear exaggerated, estimates of Mayer are given in John Tyndall's papers in the *Phil. Mag.*, 1863–64 and in E. Dühring's *Robert Mayer, der Galilei des neunzehnten Jahrhunderts*, Chemnitz, 1880. Some of the simpler facts of the case are summarized by Tait in the *Phil. Mag.*, 1864.

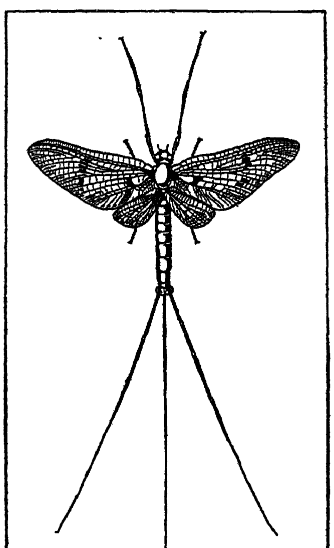
MAYFIELD, a city of south-western Kentucky, U.S.A., the county seat of Graves county; on Federal highway 45 and the Illinois Central railroad. Pop. (1920) 6,583; 8,177 in 1930. It is the trade centre of a rich farming region, raising chiefly tobacco, grain and poultry, and has a variety of manufacturing industries. The city was founded in 1811 and incorporated in 1823.

MAYFLOWER, the vessel which carried from Southampton, England, to Plymouth, Mass., the Pilgrims who established the first permanent colony in New England. It was of about 180 tons burden, and in company with the "Speedwell" sailed from Southampton on Aug. 5, 1620, the two having on board 120 Pilgrims. After two trials the "Speedwell" was pronounced unseaworthy, and the "Mayflower" sailed alone from Plymouth, England, on Sept. 6, with the 100 (or 102) passengers, some 41 of whom on Nov. 11 (O.S.) signed the famous "Mayflower compact" in Provincetown harbour, and a small party of whom, including William Bradford, sent to choose a place for settlement, landed at what is now Plymouth, Mass., on Dec. 11 (21 N.S.), an event which is celebrated, as Forefathers' day, on Dec. 22. A "General Society of Mayflower descendants" was organized in 1894 by lineal descendants of passengers of the "Mayflower" to "preserve their memory, their records, their history, and all facts relating to them, their ancestors and their posterity." Every lineal descendant, over 18 years of age, of any passenger of the "Mayflower" is eligible to membership. Branch societies have since been organized in several of the States and in the District of Columbia, and a triennial congress is held in Plymouth.

See Azel Ames, *The May-Flower and Her Log* (Boston, 1901); Blanche McManus, *The Voyage of the Mayflower* (New York, 1897); *The General Society of Mayflower: Meetings, Officers and Members, arranged in State Societies, Ancestors and their Descendants* (1901); Jas. R. Harris, *The Finding of the Mayflower*, and *The Last of the Mayflower* (Manchester, Eng., 1920); Chas. Banks, *The Officers and Crew of the Mayflower*, Proc. Mass. Hist. Soc., vol. lx., pp. 210–221 (1927). Also the articles PLYMOUTH, Mass.; MASSACHUSETTS: *History*; PILGRIM; and PROVINCETOWN, Mass.

MAY-FLY, the name given to those insects formerly classified as the family *Ephemeridae* (Gr. ἐφήμερος, lasting for a day; in allusion to their very short lives) of the old Linnean order Neuroptera. Their very distinctive characters and mode of life have since led entomologists to relegate them to a separate order of their own—the Ephemeroptera or Plectoptera.

May-flies are delicately formed, soft-bodied aërial insects, frequenting the margins of streams, rivers, and lakes. They can be easily recognized by their very short bristle-like antennae, aborted mouth-parts, and net-veined membranous wings, the hind pair being greatly reduced in size. The body is terminated by long thread-like caudal filaments, usually three in number. Their early stages are spent entirely in fresh water; most species lay their eggs in or on the surface of the water, but some descend beneath the water for the purpose, and may die there without reappearing. The eggs adhere together by means of a glutinous covering and are commonly discharged in two masses, but they soon separate in the water and become scattered by the current along the bottom. The nymphs are campodeiform with moderately developed antennae and long caudal filaments: compound eyes and ocellia are usually present; the mouth-parts are well developed and the legs long. Early in life segmentally arranged tracheal gills develop along the sides of the abdomen; in most cases they are leaf-like expansions with tracheal branches ramifying in them. The nymphs moult a number of times, in some cases more than 20 ecdyses occur, and almost the whole life of the insect is spent in this stage. As a rule they are herbivorous, but some species are undoubtedly carnivorous: they are very varied in habit, some kinds frequenting sandy bottoms, others hiding beneath stones, while a certain number burrow in mud or cling to water plants. Some are greatly flattened, and in the remarkable genus *Prosopistoma* the whole body is used as a kind of sucker for attaching the creature to stones in swift running streams: its gills are enclosed in a carapace which forms a branchial chamber, the water entering by a pair of apertures and leaving the chamber by a median exhalant opening. Other forms are active swimmers and live among aquatic vegetation.



BY COURTESY OF THE (BRITISH) MUSEUM OF NATURAL HISTORY

MAY-FLY (EPHEMERA VULGARIS), A WELL-KNOWN FLY OF TROUT STREAMS

When the time for the appearance of the perfect insect arrives the nymph crawls or swims to the surface: a fissure then appears in the dorsal cuticle and the winged insect issues and flies away in a few seconds. At this stage it is known as the sub-imago and it differs from the true imago by its duller appearance, its body and wings being covered by a very delicate pellicle. In this condition the insect soon comes to rest, and after a period varying from a few minutes up to 24 hours or more, the pellicle is finally cast off and the imago or true may-fly emerges with transparent

wings and mature reproductive organs. May-flies are always very short-lived as adults: some species emerge towards evening, pair and lay their eggs, and die before morning: others may live for a few days but they partake of no food during their fugitive life. These insects often issue from the water in great numbers about the same time: some species execute aërial dances consisting of a fluttering swift ascent followed by a more passive and leisurely descent, the two processes being many times repeated. At times their numbers are so great as to darken the air and inconvenience passers-by, especially in Switzerland and Italy.

About 470 species of may-flies are known: they are very widely distributed and about 40 species inhabit the British Isles, but these insects have been very little studied in the tropics and many other parts of the world. In the fossil state true may-flies appear first in Permian rocks and their nymphs are also known from that time. Some of the fossil may-flies are interesting in that the hind wings have undergone little or no reduction in size as occurs in living forms.

The order is to be regarded as beneficial to man: may-flies are eagerly devoured by fishes, while many of the "duns," "spinners," and some of the "drakes," made up by the fly-fisher, represent species of *Ephemera, Palingenia,* or other forms. The nymphs serve as an important source of food for fishes, and in New Zealand the introduced trout has lessened their numbers so much that some of the native may-flies are becoming extremely scarce.

The standard work on these insects is A. E. Eaton's monograph, *Trans. Linnean Soc.* (2) iii. (1883–85), which figures many species and their nymphs. *See* also L. C. Miall, *Natural History of Aquatic Insects* (1913); J. G. Needham in Ward and Whipples' *Freshwater Biology* (1918); and in *Bull. 86 New York State Museum* (1905); F. Klapalek in Brauer's *Susswasserfauna Deutschlands* pt. 8 (Jena, 1909), and E. Rousseau, *Les Larves et Nymphes Aquatiques* (Bruxelles, 1921). (A. D. I.)

MAYHEM, an old Anglo-French term of the law signifying an assault whereby the injured person is deprived of a member proper for his defence in fight, *e.g.*, an arm, a leg, a fore tooth, etc. The loss of an ear, jaw tooth, etc. was not mayhem. The most ancient punishment in English law was retaliative—*membrum pro membro,* but ultimately at common law fine and imprisonment. Various statutes were passed aimed at the offence of maiming and disfiguring, which is now dealt with by s. 18 of the Offences against the Person Act, 1861. Mayhem may also be the ground of a civil action.

In the United States, mayhem has been extended by statute to include "maim," which means to mutilate. It is punishable both as a felony and misdemeanour and also may be the ground for civil action.

MAYHEW, HENRY (1812–1887), English author and journalist, son of a London solicitor, was one of the leading spirits in the foundation of *Punch,* of which he was for the first two years joint-editor with Mark Lemon. He began his journalistic career by founding, with Gilbert à Beckett, in 1831, a weekly paper, *Figaro in London.* This was followed in 1832 by a short-lived paper called *The Thief;* and he produced one or two successful farces. His brothers Horace (1816–72) and Augustus Septimus (1826–75) were also journalists, and with them Henry occasionally collaborated. He is credited with being the first to "write up" the poverty side of London life from a philanthropic point of view; with the collaboration of John Binny and others he published *London Labour and London Poor* (1851; completed 1864) and other works on social and economic questions. He died in London on July 25, 1887.

MAYHEW, THOMAS, English 18th century cabinet-maker, was the less distinguished partner of William Ince (*q.v.*). The chief source of information as to his work is the volume of designs, *The universal system of household furniture,* which he published in collaboration with his partner in 1762–3. In the main Mayhew's designs are heavy and clumsy, and often extravagant, but he had a certain lightness of accomplishment in his applications of the bizarre Chinese style, and it is certain that much of his Chinese work has been attributed to Chippendale.

MAYNARD, FRANÇOIS DE (1582–1646), French poet, was born at Toulouse in 1582. His father was *conseiller* in the parlement of the town, and François eventually became president of Aurillac. He was secretary to Margaret of Valois, wife of Henry IV., for whom his early poems are written. He was a disciple of Malherbe, and was one of the earliest members of the Academy. The best of his poems is in imitation of Horace, "Alcippe, reviens dans nos bois." He died at Toulouse on Dec. 23, 1646.

His works consist of odes, epigrams, songs and letters, and were published in 1646 by Marin le Roy de Gomberville.

MAYNE, JASPER (1604–1672), English author, was baptized at Hatherleigh, Devonshire, on Nov. 23, 1604. He wrote a farcical domestic comedy, *The City Match* (1639) and a fantastic tragi-comedy entitled *The Amorous War* (printed 1648). His other works comprise some occasional gems, a translation of Lucian's *Dialogues* (printed 1664) and a number of sermons. He died on Dec. 6, 1672, at Oxford.

MAYNOOTH, a small town of co. Kildare, Ireland, on the Great Southern railway and the Royal canal, 15 m. W. by N. of Dublin. Pop. (1921) 886. The Royal Catholic college of Maynooth, founded in 1795, is the chief seminary for the education of the Roman Catholic clergy of Ireland. The building is a Gothic structure by A. W. Pugin, erected by a parliamentary grant obtained in 1846. The chapel was dedicated in 1890. Near the college stand the ruins of Maynooth castle, probably built in 1176. It was besieged in the reigns of Henry VIII. and Edward VI., and during the Cromwellian Wars, at which time it was demolished.

MAYO, EARLS OF. On the murder of William de Burgh, 3rd earl (*see* BURGH), his male kinsmen became native chieftains and adopted Irish names and customs. Their two main branches were those of "MacWilliam Eighter" in southern Connaught (*see* CLANRICARDE, EARLS OF) and "MacWilliam Oughter" to the north of them, in what is now Mayo.

In 1603 "the MacWilliam Oughter," Theobald Bourke, resigned his territory in Mayo, and received it back to hold by English tenure. In 1627 he was created Viscount Mayo. The 2nd and 3rd viscounts (1629–1663) suffered at Cromwell's hands, but the 4th was restored to his estates (some 50,000 ac.) in 1666. The peerage became extinct or dormant on the death of the 8th viscount in 1767. In 1781 John Bourke, a Mayo man, believed to be descended from the line of "MacWilliam Oughter," was created Viscount Mayo, and four years later earl of Mayo, a peerage still extant.

MAYO, CHARLES HORACE (1865–), American surgeon, was born at Rochester, Minn., on July 19, 1865. After studying at the Rochester high school, private schools, Northwestern university and the Chicago Medical college he began the practice of surgery at Rochester, Minn., and with his brother and father founded the Mayo Clinic. His methods have had a strong influence in moulding the practice of surgery in its various departments as these have evolved with the growth of the institution. In addition to goitre, urologic and general surgery, all of which he is still practising, his early work included operations on the eye, ear, nose and throat, and neurologic, orthopedic, thoracic and plastic surgery. He made a special study of goitre and as a result succeeded in reducing the death rate in this class of cases by half. Outside of surgery, his chief interest is in focal infection and preventive medicine. He has published many papers covering a wide range of subjects, mostly surgical. He is a charter member of the American College of Surgeons. He was awarded the Distinguished Service Medal, U.S. Army, in 1920, and commissioned brigadier general M.O.R.C. in 1921.

Beginning with 1912, graduate courses in medicine were offered at the Mayo Clinic in Rochester. Early in 1915, Charles Mayo and his brother founded The Mayo Foundation for Medical Education and Research at Rochester, and to it the brothers gave $1,500,000. By mutual agreement, the funds and resources of the foundation were placed under the direction of the regents of the University of Minnesota for promoting "graduate work in medicine and research" and the foundation became a department of the Graduate school of the University of Minnesota. (*See* SURGERY; MINNESOTA, UNIVERSITY OF.)

MAYO, RICHARD SOUTHWELL BOURKE, 6th Earl of (1822–1872), British statesman, son of Robert Bourke, the 5th earl (1797–1867), was born in Dublin on Feb. 21, 1822, and was educated at Trinity College, Dublin. He was chief secretary for Ireland in three administrations, in 1852, 1858 and 1866, and was appointed viceroy of India in 1869. He consolidated the frontiers of India and met Shere Ali, amir of Afghanistan, in durbar at Umballa in March 1869. His reorganization of the finances of the country put India on a paying basis; and he did much to promote irrigation, railways, forests and other public works. Visiting the convict settlement at Port Blair in the Andaman Islands, for the purpose of inspection, the viceroy was assassinated by a convict on Feb. 8, 1872.

See Sir W. W. Hunter, *Life of the Earl of Mayo* (1876), and *The Earl of Mayo* in the Rulers of India Series (1891).

MAYO, WILLIAM JAMES (1861–), American surgeon, was born at Le Sueur, Minn., June 29, 1861. He graduated from the University of Michigan (M.D. 1883), and from the University of Dublin (Trinity college) (M.D. in surgery, 1923). Since 1883 he has engaged in the practice of surgery in Rochester, Minn. A small hospital was organized under the local branch of the Sisters of St. Francis, which developed into St. Mary's hospital. Here he, with his younger brother, Charles Horace, developed the Mayo Clinic (organized 1889), which became famous throughout the world for the number and success of operations performed. The records of operations have been so carefully made and preserved that they form a valuable asset to medical science. Dr. W. J. Mayo specialized in the surgery of the stomach, and published a large number of papers on gastric surgery and kindred topics. In 1907 he was appointed a regent of the University of Minnesota. He was elected president of the Minnesota State Medical Society in 1895, of the American Medical Association (1905–06), of the Society for Clinical Surgery in 1911, of the American Surgical Association (1913–14), of the Society of Clinical Surgery (1911–12), of the American college of Surgeons (1917–19) and of the Congress of American Physicians and Surgeons (1925). On America's entrance into the World War he was appointed a colonel in the Medical Corps, U.S. Army, and chief consultant for all surgical service, during the period of the war, alternating with his brother, C. H. Mayo, in this capacity (1917–19). He was a brigadier general, Medical Officers Reserve Corps, U.S. Army, in 1921. *See* Surgery.

MAYO, a western county of Ireland, in the province of Connaught, bounded north and west by the Atlantic Ocean, north-east by Sligo, east by Roscommon, south-east and south by Galway. The area is 1,380,390 acres, or about 2,157 sq.m., the county being the third largest in Ireland. Pop. (1926) 172,661.

The wild and barren west of the county, including the great hills on Achill Island, is formed of "Dalradian" rocks, schists and quartzites, highly folded and metamorphosed, with intrusions of granite near Belmullet. At Blacksod Bay the granite has been quarried as an ornamental stone. Nephin Beg, Nephin (2,646 ft.) and Croagh Patrick (2,510 ft.) are typical quartzite summits, the last named belonging possibly to a Silurian horizon but rising from a metamorphosed area on the south side of Clew Bay. The schists and gneisses of the Ox Mountain axis also enter the county north of Castlebar. Muilrea to the north of the fjord of Killary Harbour, reaches a height of 2,688 ft. To the east of Lough Mask is a Carboniferous Limestone plain. Silurian rocks, with Old Red Sandstone over them, come out at the west end of the Curlew range at Ballaghaderreen. Clew Bay, with its islets capped by glacial drift, is a submerged part of a synclinal of Carboniferous strata, and Old Red Sandstone comes out on the north side of this, from near Achill to Lough Conn. The country from Lough Conn northward to the sea is a lowland of Carboniferous Limestone, with L. Carboniferous Sandstone against the Dalradian on the west.

The coast is much indented, the principal inlets being Killary Harbour between Mayo and Galway; Clew Bay, in which are the harbours of Westport and Newport; Blacksod Bay and Broad Haven, which form the peninsula of the Mullet; and Killala Bay between Mayo and Sligo. The principal islands are Inishturk, near Killary Harbour; Clare Island, at the mouth of Clew Bay, where there are many islets, all formed of drift; and Achill, the largest island off Ireland. The river Moy flows northwards, forming part of the boundary of the county with Sligo, and falls into Killala Bay. The principal lakes are Lough Mask and Lough Corrib, on the borders of the county with Galway, and Loughs Conn in the east, Carrowmore in the north-west, Beltra in the west, and Carra adjoining Lough Mask.

Erris in Mayo was the scene of the landing of the chief colony of the Firbolgs, and Moytura near Cong saw their overthrow and almost complete annihilation. At the close of the 12th century what is now the county of Mayo was granted by king John to William, brother of Hubert de Burgh. In the 14th century the land passed to a branch of the family known as "MacWilliam Oughter." Mayo was made shire ground during the first viceroyalty of Sir Henry Sydney, taking its name from the monastery of Maio or Mageo, which was the seat of a bishop. Even after this period the MacWilliams continued to exercise authority, which was regularized in 1603, when "the MacWilliam Oughter," Theobald Bourke, surrendered his lands and received them back, to hold them by English tenure, with the title of Viscount Mayo. (*See* Burgh, De.) Large confiscations were made in 1586, and on the termination of the wars of 1641; and in 1666 the restoration of his estates to the 4th Viscount Mayo involved another confiscation, at the expense of Cromwell's settlers. Killala was the scene of the landing of a French squadron in connection with the rebellion of 1798.

There are round towers at Killala, Turlough, Meelick and Balla, and an imperfect one at Aughagower. Killala was formerly a bishopric. The principal monasteries were those at Mayo, Ballyhaunis, Cong, Ballinrobe, Ballintober, Burrishoole, Cross or Holycross in the peninsula of Mullet, Moyne, Roserk or Rosserick and Templemore or Strade. The most notable old castles are Carrigahooly near Newport, and Deel Castle near Ballina.

The thin soil of the mountains barely supports a scanty population. Conditions are better in the valleys and along the coasts where the fisheries are important. Oats and potatoes are the principal crops. Cattle, sheep, pigs and poultry are reared. Coarse linen and woollen cloths are manufactured to a small extent. At Foxford woollen-mills are established at a nunnery, in connection with a scheme of technical instruction. Keel, Belmullet and Ballycastle are the headquarters of sea and coast fishing districts, and Ballina of a salmon-fishing district.

Claremorris is an important centre on the Great Southern railway. The line from Athlone runs through it and continues north to Ballina and Killala. Similarly it is served by the line from Athenry to Sligo, and has a branch to Ballinrobe. There is a branch from Manulla to Westport and Achill. North Mayo, consisting of the county electoral areas of Ballina, Killala and Swinford, returns 4 members to Dáil Eireann. South Mayo, consisting of the county electoral areas of Castlebar, Claremorris and Westport returns 5 members.

MAYOR, JOHN EYTON BICKERSTETH (1825–1910), English classical scholar, was born at Baddegama, Ceylon, on Jan. 28, 1825, and educated at Shrewsbury school and St. John's college, Cambridge. He became professor of Latin at Cambridge in 1872. His best-known work is an edition of 13 satires of Juvenal (1853, 3rd ed., 2 vols., 1881). His *Bibliographical Clue to Latin Literature* (1873), and his edition of Cicero's *Second Philippic* are widely used. He also edited Richard of Cirencester's *Speculum historiale de gestis regum Angliae 447–1066* (1863–69); Roger Ascham's *Schoolmaster* (new ed., 1883); the *Latin Heptateuch* (1889); and the *Journal of Philology.* He died at Cambridge on Dec. 1, 1910.

See *Dic. Nat. Biog.* (2nd Suppt.).

MAYOR, in modern times the title of a municipal officer who discharges judicial and administrative functions. The French form of the word is *maire.* In Germany the corresponding title is *bürgermeister,* in Italy *sindico,* in Spain *alcalde* and in Scotland provost. "Mayor" had originally a much wider significance. Among the nations which arose on the ruins of the Roman empire of the West and made use of Latin as their official and legal lan-

guage, *maior* and the Low Latin feminine *maiorissa* were convenient terms to describe important officials of both sexes who had the superintendence of others. So the male officer who governed the king's household would be the *maior domus*. In the households of the Frankish kings of the Merovingian line, the *maior domus*, who was also variously known as the *gubernator, rector, moderator* or *praefectus palatii*, was so great an officer that he ended by evicting his master. He was the "mayor of the palace" (*q.v.*). Beside the *maior domus* (the major-domo), there were other officers who were *maiores*, the *maior cubiculi*, mayor of the bedchamber, and *maior equorum*, mayor of the horse.

A word which could be applied so easily and in so many circumstances was certain to be widely used, and the post-Augustine, *maiorinus*, "one of the larger kind," was the origin of the mediaeval Spanish *merinus*, who in Castilian is the *merino*, and sometimes the *merino mayor*, or chief merino, a judicial and administrative officer of the king's. The *gregum merinus* was the superintendent of the flocks of the corporation of sheep-owners called the *mesta*, whence the sheep, and then the wool, have come to be known as *merino*—a word identical in origin with the municipal title of mayor.

In England the chief officers of the boroughs down to the 11th century were the reeves, sometimes called port reeves. The mayor appears in the 12th century, at the period when municipal life is developing rapidly (*see* BOROUGH), as the elected head of the town government. He held office alongside of the reeves (or bailiffs or, in London, sheriffs), whose duties were first to the king, as the mayor's chief duty was to the community of the borough. London obtained a mayor in 1191, and nine other boroughs had mayors by the end of John's reign. By the middle of the 13th century the practice was general.

A mayor is now in England and America the official head of a municipal government. In Great Britain the Municipal Corporations Act, 1882, regulates the election of the mayor. He is to be a fit person elected annually on Nov. 9 by the council of the borough from among the aldermen or councillors or persons qualified to be such. His term of office is one year, but he is eligible for re-election. He may appoint a deputy to act during illness or absence, and such deputy must be either an alderman or councillor. A mayor who is absent from the borough for more than two months becomes disqualified and vacates his office. A mayor is *ex officio* during his year of office and the next year a justice of the peace for the borough. He receives such remuneration as the council thinks reasonable. The office of mayor in an English borough does not entail any important administrative duties. It is regarded as an honour conferred for past services.

The mayors of certain cities in the British isles (London, York, Dublin) have acquired by prescription the prefix of "lord." In the case of London it seems to date from 1540. It has also been conferred during the closing years of the 19th century by letters patent on other cities—Birmingham, Liverpool, Manchester, Bristol, Sheffield, Leeds, Cardiff, Bradford, Newcastle-on-Tyne, Belfast, Cork. In 1910 it was granted to Norwich; and in 1928 to Nottingham, Leicester, Stoke-on-Trent and Portsmouth. The title "right honourable" is a distinction conferred only upon the lord mayors of London, York, Belfast, Melbourne, Sydney and Adelaide and upon the lord provosts of Edinburgh and Glasgow.

The English method of selecting a mayor by the council is followed for the corresponding functionaries in France (except Paris), the more important cities of Italy, and in Germany, where, however, the central government must confirm the choice of the council. Direct appointment by the central government exists in Belgium, Holland, Denmark, Norway, Sweden and the smaller towns of Italy and Spain. In France election is for four years, in Holland for six, in Belgium for an indefinite period, and in Germany usually for 12 years, but in some cases for life. In France the *maire*, and his "adjuncts" are elected directly by the municipal council from among their own number.

See also A. Shaw, *Municipal Government in Continental Europe* (1901), J. A. Fairlie, *Municipal Administration* (1901); J. Redlich, *Local Government in England*, trans. and ed. F. W. Hirst (1903); S. and B. Webb, *English Local Government* (1906, etc.); A. L. Lowell, *The Government of England* (1920). (X.; H. CA.)

UNITED STATES

The office of mayor in the United States has passed through an interesting evolution. In Colonial days, the mayor was appointed by the provincial or colonial governor, except in Elizabeth, N.J., and in the close corporations of Annapolis, Norfolk and Philadelphia, where the mayor was selected by the local governing body. The duties and powers of the colonial mayor, fashioned in part after those of the contemporary English mayor, were to preside at meetings of the council, to serve as the ceremonial head of the city, to discharge important local judicial functions and to represent the colony in local affairs.

Popular election of the mayor was introduced as early as 1806 (Nashville), but it was not generally adopted until 20 years later (*e.g.*, Boston, St. Louis, 1822; Detroit, 1824; Philadelphia, 1826; Baltimore, 1833; New York, Pittsburgh, 1834; Buffalo, Rochester, Brooklyn, 1840; Milwaukee, 1846; San Francisco, 1850). By the middle of the century practically every mayor was elected. Except in Boston (Josiah Quincy, mayor, six terms, 1823–29), and in a few other cities, the change to an elected mayor resulted in no immediate increase in the influence of the office. Within the next generation, however, due to the increasing complexity of city administration, the corruption and incompetence of councils, the vantage point of publicity and leadership accorded an elected mayor in a complex Government, and, finally the application in city organization of the principle of the separation of powers, which had been for 60 years a fetish in American national and State Government, there was brought about a gradual increase in the powers of the mayor at the expense of the council.

The mayor gradually became the centre of the administrative power of the city; this came about through the power to appoint council committees, to appoint and remove administrative officials and to investigate city departments. Though the mayor was frequently deprived of his seat in the council, as his new isolation developed, his influence in legislation was augmented through the veto power (first granted in New York, 1830), through the power to recommend legislation and through his strategic advantage in marshalling public opinion behind his programme.

By 1900 the mayor had thus become the dominating influence and centre of authority in American city government. The widespread introduction of executive budget systems in the cities (1907–15) and the spread of municipal home rule, have served still further to augment the powers of the mayor.

The Constitution of the Mayoralty at the present time may be summarized as follows, though the legal provisions and practices in the United States vary from State to State and from city to city within the same State. The mayor is the chief executive officer of the city, except in the commission and council-manager forms of government. He generally appoints the heads of the administrative departments, including such services as police, public works, health, poor relief and fire protection.

In legislative matters, though generally not a member of the council, the mayor tends to dominate the situation through his power to recommend legislation, his limited veto, his special prerogatives in fiscal legislation and his general prestige. The mayor as a chief executive is always popularly elected. He must be a local resident and elector, though in a few cases a higher age limit is set than for voters (*e.g.*, Philadelphia, Baltimore, Charleston, Montana, etc.), and in some jurisdictions the payment of taxes is a prerequisite (*e.g.*, Baltimore, Seattle, etc.). The position is universally open to women. Elections are usually held in November with other local, State and national elections, though there has been a tendency in recent years to bring about a segregation of elections.

The term of office is now generally two or four years, the longer term being almost universal in the largest cities. The mayor is subject to removal in all jurisdictions, generally by court action, though in some cases by the recall (*e.g.*, Los Angeles, San Francisco, Seattle, Boston, etc.), or by the State governor (New York and Ohio). Removals are, however, extremely rare and except where the recall is used, are known only for gross misfeasance. The mayor, except in the smallest cities, is generally a salaried official; compensation thus ranges to $25,000 a year in

New York. Re-election of the mayor is common except in a few cities where successive terms are prohibited. Because of his position and powers, the mayor is the official spokesman and ceremonial head of the city and during his term of office, at least, holds a unique position in the community.

There are in the United States some 2,000 cities. In about 1,450 of these cities the chief executive officer is the mayor. In some 350 cities which are governed and administered by a small elected commission, and in 300 cities governed by a small elected commission and administered through a city manager appointed by the commission, though the office of mayor generally exists, the duties are restricted to serving as the presiding officer of the council and acting as ceremonial head of the municipality.

BIBLIOGRAPHY.—R. M. Story, "The American Municipal Executive," *Urbana*, University of Illinois (1918); H. Lee McBain, "The Evolution of Types of City Government in the United States" (*National Municipal Review*, vol. vi., p. 19, Jan. 1917). (L. Gu.)

MAYOR OF THE PALACE. The office of mayor of the palace was an institution peculiar to the Franks of the Merovingian period. A landowner who did not manage his own estate placed it in the hands of a steward (*maior*), who superintended the working of the estate and collected its revenues. If he had several estates, he appointed a chief steward, who managed the whole of the estates and was called the *maior domus.* Each great personage had a *maior domus;* and since the royal house was called the palace, this officer took the name of "mayor of the palace." The mayor of the palace, however, did not remain restricted to domestic functions; he had the discipline of the palace and tried persons who resided there. Soon his functions expanded. If the king were a minor, the mayor of the palace supervised his education in the capacity of guardian (*nutricius*), and often also occupied himself with affairs of State. When the king came of age, the mayor exerted himself to keep this power, and succeeded. In the 7th century he became the head of the administration and a veritable prime minister. He took part in the nomination of the counts and dukes; in the king's absence he presided over the royal tribunal; and he often commanded the armies. When the custom of commendation developed, the king charged the mayor of the palace to protect those who had commended themselves to him and to intervene at law on their behalf. The mayor of the palace thus found himself at the head of the *commendati,* just as he was at the head of the functionaries.

The succession of the early mayors of the palace is obscure. When the office increased in importance the mayors of the palace did not, as has been thought, pursue an identical policy. Some—for instance, Otto, the mayor of the palace of Austrasia towards 640—were devoted to the Crown. On the other hand, mayors like Flaochat (in Burgundy) and Erkinoald (in Neustria) stirred up the great nobles against the king. Others again, sought to exercise the power in their own name both against the king and against the great nobles—such as Ebroïn (in Neustria), and later, the Carolingians Pippin II., Charles Martel and Pippin III., who, after making use of the great nobles, kept the authority for themselves. In 751 Pippin III., fortified by his consultation with Pope Zacharias, could quite naturally exchange the title of mayor for that of king; and when he became king, he suppressed the title of mayor of the palace. It must be observed that from 639 there were generally separate mayors of Neustria, Austrasia and Burgundy, even when Austrasia and Burgundy formed a single kingdom; the mayor was a sign of the independence of the region. Each mayor, however, sought to supplant the others; the Pippins and Charles Martel succeeded, and their victory was at the same time the victory of Austrasia over Neustria and Burgundy.

See G. H. Pertz, *Geschichte der merowingischen Hausmeier* (Hanover, 1819); H. Bonnell, *De dignitate majoris domus* (Berlin, 1858); E. Hermann, *Das Hausmeieramt, ein echt germanisches Amt,* vol. ix. of *Untersuchungen zur deutschen Staats- und Rechtsgeschichte,* ed. by O. Gierke (Breslau, 1878, *seq.*); G. Waitz, *Deutsche Verfassungsgeschichte,* 3rd ed., revised by K. Zeumer; and Fustel de Coulanges, *Histoire des institutions politiques de l'ancienne France: La monarchie franque* (1888). (C. Pf.)

MAYOTTE, one of the Comoro islands, in the Mozambique channel between Madagascar and the African mainland. It has belonged to France since 1843. (*See* COMORO ISLANDS.) The fertile lands grow the vanilla. Dzaoudzi is the chief centre of the archipelago.

MAYOW, JOHN (1643–1679), English chemist and physiologist (F.R.S., 1668), was born in London in May 1643. In 1658 he went up to Wadham college, Oxford, of which he became a scholar a year later, and in 1660 he was elected to a fellowship at All Souls. He graduated in law (bachelor, 1665, doctor, 1670), but made medicine his profession. He died in London in September 1679. He published at Oxford in 1668 two tracts, on respiration and rickets, and in 1674 these were reprinted, the former in an enlarged and corrected form, with three others, "De sal-nitro et spiritu nitro-aereo," "De respiratione foetus in utero et ovo," and "De motu musculari et spiritibus animalibus" as *Tractatus quinque medico-physici.* The contents of this work, which was translated into Dutch, German and French, show him to have been an investigator much in advance of his time.

Mayow, who gives a remarkably correct anatomical description of the mechanism of respiration, preceded Priestley and Lavoisier by a century in recognizing the existence of oxygen, under the guise of his *spiritus nitro-aereus,* as a separate entity distinct from the general mass of the air; he perceived the part it plays in combustion and in increasing the weight of the calces of metals as compared with metals themselves.

MAYSVILLE, a city of Kentucky, U.S.A., the county seat of Mason county; on the Ohio river at the mouth of Limestone creek, 60 m. S.E. of Cincinnati. It is on Federal highway 68, and is served by the Chesapeake and Ohio and the Louisville and Nashville railways and river steamers. Pop. (1920) 6,107; 6,557 in 1930. It has various manufacturing industries, and is an important shipping point for tobacco, live stock and wheat. Formerly it was one of the principal hemp markets of the country. The site was an early landing point for pioneers coming into Kentucky, and in 1784 a blockhouse and a double log cabin were erected. In 1787 John May (killed by the Indians in 1790) and Simon Kenton laid out the town and it was incorporated. It was chartered as a city in 1833 and became the county seat in 1848. The turnpike from Maysville to Lexington, completed in 1835, was the first of a system of roads built with State aid.

MAYWOOD, a village of Cook county, Illinois, U.S.A., on the Desplaines river, 12 m. W. of the Chicago "loop." It is served by the Chicago and North Western, the Chicago Great Western, the Chicago, Aurora and Elgin and the Indiana Harbor Belt railways, and trolley lines connecting with the Chicago system. Pop. 12,072 in 1920 (21% foreign-born white); and 25,829 in 1930 (Federal census). It is primarily a residential suburb, but there are wholesale rose gardens and various manufacturing industries, including a tin-can plant which normally employs 1,000 workers, and factories making ginger ale, marshmallows, branding irons and locomotive packings. The village was founded in 1869 by Col. William Nichols and two friends (all from Vermont), who purchased 600 ac. and were incorporated as a real estate company to develop the tract. There was a wood skirting the site on the east, and Col. Nichols had a daughter, May; hence the name. The first factory (now the can factory) was built by the company to provide employment in the hard times following the panic of 1873. Incorporation as a village was completed in 1881.

MAZAGAN (*El Jadīda*), a port on the Atlantic coast of Morocco, in 33° 16′ N. 8° 26′ W., at the bottom of a bay rocky at the extremities, sandy in the centre, a little way to the south of the mouth of the Oum-er-Rbīa. The walls, the gates surmounted by the escutcheons of the kings of Portugal, the old strong castle, all recall the Portuguese origin of Mazagan. The most remarkable building is the magnificent *salle-d'armes,* which served as a storehouse after the completion of the ramparts (1541). The new town stretches to the north and to the south of the old town. The port is constituted of an outer dock of 7 hectares, protected by two jetties, into which open the old wet-dock and a shelter for small boats. The trade amounts to 166 million francs, of which 51 millions represent imports and 115 millions exports. The share of France is 59 millions, that of Great Britain 25 millions. The exports are mainly the agricultural

products of the rich region of Doukkala, notably eggs; the imports, cotton goods destined for Marrakesh. The population is 19,159, of whom 14,141 are Muslim, 3,385 Jews, and 1,633 Europeans. Mazagan is the chief town of the *controle civil* of Doukkala.

Mazagan, founded by the Portuguese in 1502, was the centre of their settlement in Morocco and the last place which they kept there; they evacuated it in 1769. The growth of the town dates from the French protectorate (1912).

See J. Goulven, *La place de Mazagan sous la domination portugaise* (1917), and *British Consular Reports.*

MAZAMET, an industrial town of south-western France in the department of Tarn, 41 m. S.S.E. of Albi by rail. Pop. (1926) 11,186. Mazamet is situated on the northern slope of the Montagnes Noires and on the Arnette, a small sub-tributary of the Agout. Its industries are wool-spinning and the manufacture of "swan-skins," flannels and hosiery, and there are important tanneries and leather-dressing, glove and dye works. Wool and raw hides are imported from abroad.

MAZANDERAN, a province of Persia, lying between the Caspian Sea and the Elburz range and bounded E. by the province of Astarabad and W. by Gilan; about 200 m. long by 60 m. Mazanderan, like Gilan, comprises two distinct natural regions, presenting the sharpest contrasts. The northern portion consists of swampy lowlands, varying in breadth from 10 to 30 m. partly under impenetrable jungle and partly under crops. This belt is fringed northward by the Caspian, here almost destitute of good natural harbours, and rises somewhat abruptly inland to the second belt comprising the northern slopes and spurs of the Elburz which are almost everywhere covered with dense forest. The lowlands, rising but a few feet above the sea, and subject to frequent floodings, are malarious while the highlands, culminating in Mt. Demavend (18,600 ft.) enjoy a tolerably healthy climate; but the climate is capricious. Snow falls in the highlands, where for weeks it completely blocks the tracks across the Elburz. The rivers of Mazanderan are comparatively short and little more than mountain torrents. The chief is the Harhaz rising in the neighbourhood of Demavend; all are well stocked with trout, salmon, perch, carp and sturgeon.

Production.—The chief natural products of the lowlands are rice, cotton of good quality, sugar-cane, silk and citrus fruits. Hazar Jarib grows wheat and barley; while the hill district of Firuzkuh has extensive summer pastures. The main forests—of oak, ash, box, walnut, etc., are in the *miyanabad,* or middle hills. Wild boars are numerous. The domestic animals are small, including the black humped cattle, sheep and goats. Mazanderan is rich in minerals and in the Nur district iron in exploitable quantities is found in proximity to coal.

Population.—Mazanderan is divided into the ten districts of Ashraf, Hazar Jarib, Sari, Savad Kuh, Aliabad, Firuzkuh, Meshed-i-Sar, Barfurush, Bandipe, Amol and Larijan, and Nur. The coastal plains are probably the most thickly-peopled tracts in Persia, especially the delta areas at the mouths of the rivers where water can be utilized for rice cultivation. The two races chiefly represented are the Mazanderani and Gilaki. The capital is Barfurush (*q.v.*). For short periods this town has been the administrative headquarters, but usually the Governor of Mazanderan resides at Sari. The export trade is chiefly with the port of Baku and carried on almost exclusively from Meshed-i-Sar at the mouth of the Babil river, navigable for small craft up to Barfarush, 15 m. inland. The tonnage of trade in 1925–26 was 19,000 tons. Great quantities of rice are sent into the interior of Persia, principally to Tehran and Kazvin. The imports in order of value were sugar, flour, tea and metals and minerals. A salient feature of the Caspian provinces is their isolation from the rest of Persia by the formidable barrier of Elburz. The road from Tehran to Demavend, constructed in 1919 by the Persian postal administration, is passable for all classes of motors at most seasons.

Bibliography.—H. L. Wells, From Tehran towards the Caspian, *Geogr. J.*, 1896, VIII.; F. Sarre, Reise in Mazanderan, *Z. Ges. Erdk. Berl.*, 1902, pp. 99–111; H. L. Rabino, Report on the trade and general conditions of the City of Barfurush and the province of Mazanderan, *Dipl. and Cons. Report,* No. 4821. A journey in Mazanderan (from Resht to Sari), *Geogr. J.*, 1913, XLII.; Les provinces caspiennas de la Perse; Le Guilan, Rev. du Monde Musulman, 1917; F. Lafont, Les Forêts du nord de la Perse, *Bull. de l'Union Franco-Persane*, Paris, 1911; J. B. L. Noel, A reconnaissance in the Caspian provinces of Persia, *Geogr. J.*, 1921, LVII.; L. S. Fortescue, The western Elburz and Persian Azerbaijan, *Geogr. J.*, 1924, LXIII., pp. 301–318; Les provinces caspiennes de la Perse, *La Géographie,* 1925, XLIII., pp. 341–357.

MAZARIN, JULES (1602–1661), French cardinal and statesman, elder son of a Sicilian, Pietro Mazarini, the intendant of the household of Philip Colonna, and of his wife Ortensia Buffalini, a connection of the Colonnas, was born at Piscina in the Abruzzi on July 14, 1602. He was educated by the Jesuits at Rome till his seventeenth year, when he accompanied Jerome Colonna as chamberlain to the university of Alcala in Spain. On his return to Rome, about 1622, he took his degree as Doctor *utriusque juris,* and then became captain of infantry in the regiment of Colonna, which took part in the war in the Valtelline. Pope Urban VIII. entrusted him, in 1629, with the difficult task of putting an end to the war of the Mantuan succession. He was presented to two canonries in the churches of St. John Lateran and Sta. Maria Maggiore, although he had only taken the minor orders, and had never been consecrated priest; he negotiated the treaty of Turin between France and Savoy in 1632, became vice-legate at Avignon in 1634, and nuncio at the court of France from 1634 to 1636. Seeing that he had no chance of becoming a cardinal except by the aid of some great power, he accepted Richelieu's offer of entering the service of the king of France, and in 1639 became a naturalized Frenchman.

In 1640 Richelieu sent him to Savoy, where the regency of Christine, the duchess of Savoy, and sister of Louis XIII., was disputed by her brothers-in-law, the princes Maurice and Thomas of Savoy, and he succeeded not only in establishing Christine but in winning over the princes to France. He was rewarded by promotion to the rank of cardinal on the presentation of the king of France in Dec. 1641. On Dec. 4, 1642, Richelieu died, and was succeeded as minister by Mazarin. The new minister ingratiated himself with the queen, who would be regent after the king's death. Louis XIII. died on May 14, 1643, and Mazarin retained office. His skilful policy was shown in every arena on which the great Thirty Years' War was being fought out. Mazarin had inherited the policy of France during the Thirty Years' War from Richelieu. He had inherited his desire for the humiliation of the house of Austria in both its branches, his desire to push the French frontier to the Rhine and maintain a counterpoise of German states against Austria, his alliances with the Netherlands and with Sweden, and his four theatres of war—on the Rhine, in Flanders, in Italy and in Catalonia.

During the last five years of the great war it was Mazarin alone who directed the French diplomacy of the period. He made the peace of Brömsebro between the Danes and the Swedes, and turned the latter once again against the empire; he sent Lionne to make the peace of Castro, and combine the princes of North Italy against the Spaniards, and he made the peace of Ulm between France and Bavaria, thus detaching the emperor's best ally. He made one fatal mistake—he dreamt of the French frontier being the Rhine and the Scheldt, and that a Spanish princess might bring the Spanish Netherlands as dowry to Louis XIV. This roused the jealousy of the United Provinces, and they made a separate peace with Spain in January 1648; but Turenne's victory at Zusmarshausen, and Condé's at Lens led to the peace of Westphalia (1648).

At home Mazarin's policy lacked the strength of Richelieu's. The Frondes were largely due to his own fault. The arrest of Broussel threw the people on the side of the parlement. His avarice and unscrupulous plundering of the revenues of the realm, the enormous fortune which he thus amassed, his supple ways, his nepotism, and the general lack of public interest in the great foreign policy of Richelieu, made Mazarin the especial object of hatred both by bourgeois and nobles. He had tried consistently to play off the king's brother Gaston of Orleans against Condé, and their respective followers against each other, and had also, as his *carnets* prove, jealously kept any courtier from getting into

the good graces of the queen-regent except by his means, so that it was not unnatural that the nobility should hate him, while the queen found herself surrounded by his creatures alone. Events followed each other quickly; the day of the barricades was followed by the peace of Ruel, the peace of Ruel by the arrest of the princes, by the battle of Rethel, and Mazarin's exile to Brühl before the union of the two Frondes.

In exile at Brühl Mazarin saw the mistake he had made in isolating himself and the queen, and that his policy of balancing every party in the state against each other had made every party distrust him. So by his counsel the queen, while nominally in league with De Retz and the parliamentary Fronde, laboured to form a purely royal party, wearied by civil dissensions, who should act for her and her son's interest alone, under the leadership of Mathieu Molé, the famous premier president of the parlement of Paris. The new party grew in strength, and in January 1652, after exactly a year's absence, Mazarin returned to the court. In order to promote a reconciliation with the parlement of Paris Mazarin had again retired from court, this time to Sedan, in August 1652, but he returned finally in February 1653. He had retrieved his position by founding that great royal party which steadily grew until Louis XIV. could fairly have said "L'État, c'est moi." As the war had progressed, Mazarin had steadily followed Richelieu's policy of weakening the nobles on their country estates. Whenever he had an opportunity he destroyed a feudal castle, and by destroying the towers which commanded nearly every town in France, he freed such towns as Bourges, for instance, from their long practical subjection to the neighbouring great lord.

The Fronde over, Mazarin had to build up afresh the power of France at home and abroad. Beyond destroying the brick-and-mortar remains of feudalism, he did nothing for the people. But abroad his policy was everywhere successful, and opened the way for the policy of Louis XIV. By means of an alliance with Cromwell, he recovered the north-western cities of France, though at the price of yielding Dunkirk to the Protector. On the Baltic, France guaranteed the Treaty of Oliva between her old allies Sweden, Poland and Brandenburg, which preserved her influence in that quarter. In Germany he, through Hugues de Lionne, formed the league of the Rhine, by which the states along the Rhine bound themselves under the headship of France to be on their guard against the house of Austria. By the Treaty of the Pyrénées Spain recovered Franche Comté, but ceded to France Roussillon, and much of French Flanders; and what was of greater ultimate importance to Europe, Louis XIV. was to marry a Spanish princess. He died at Vincennes on March 9, 1661, leaving a fortune estimated at from 18 to 40 million livres behind him, and his nieces married into the greatest families of France and Italy.

Mazarin was not a Frenchman, but a citizen of the world, and always paid most attention to foreign affairs; in his letters all that could teach a diplomatist is to be found, broad general views of policy, minute details carefully elaborated, keen insight into men's characters, cunning directions when to dissimulate or when to be frank. Italian though he was by birth, education and nature, France owed him a great debt for his skilful management during the early years of Louis XIV., and the king owed him yet more, for he had not only transmitted to him a nation at peace, but had educated for him his great servants Le Tellier, Lionne and Colbert. Literary men owed him also much; not only did he throw his famous library open to them, but he pensioned all their leaders, including Descartes, Vincent Voiture (1598–1648), Jean Louis Guez de Balzac (1597–1654) and Pierre Corneille.

(H. M. St.; X.)

Bibliography.—See P. A. Chéruel, *Histoire de France pendant la minorité de Louis XIV.*, 4 vols. (1879–1880), which covers from 1643–1651, and its sequel *Histoire de France sous le ministère de Cardinal Mazarin*, 2 vols. (1881–82), which is the first account of the period written by one able to sift the statements of De Retz and the memoir writers, and rest upon such documents as Mazarin's letters and *carnets*. Mazarin's *Lettres* appeared in the *Collection des documents inédits*, 9 vols. For his early life to Cousin's *Jeunesse de Mazarin* (1865), and for the careers of his nieces to Renée's *Les Nièces de Mazarin* (1856). For the Mazarinades or squibs written against him in Paris during the Fronde, see C. Moreau's *Bibliographie des mazarinades* (1850), containing an account of 4,082 Mazarinades. See also A. Hassall, *Mazarin* (1903); Roca, *De Richelieu à Mazarin* (1908); C. Federn, *Mazarin* (Munich, 1922).

MAZAR-I-SHARIF, a town of Afghanistan, the capital of the province of Afghan Turkestan. Owing to the importance of the military cantonment of Takhtapul, and its religious sanctity, it has long ago supplanted the more ancient capital of Balkh. It is situated in a malarious, almost desert plain, 9 m. E. of Balkh, and 30 m. S. of the Pata Kesar ferry on the Oxus river. In this neighbourhood is concentrated most of the Afghan army north of the Hindu Kush mountains, the fortified cantonment of Dehdadi having been completed by Sirdar Ghulam Ali Khan and incorporated with Mazar. Mazar-i-Sharif also contains a celebrated mosque, from which the town takes its name. Built by Sultan Ali Mirza about A.D. 1420, it is held in great veneration by all Mussulmans, and especially by Shiites, because it is supposed to be the tomb of Ali, the son-in-law of Mohammed.

MAZARRÓN, a town of eastern Spain, in the province of Murcia, 19 m. W. of Cartagena. Pop. (1920), 17,630. There are soap and flour mills and metallurgic factories in the town, and iron, copper and lead mines in the neighbouring Sierra de Almenara. A railway 5 m. long unites Mazarrón to its port on the Mediterranean, which has important leadworks.

MAZATLÁN, a city and port of the State of Sinaloa, Mexico, reached by the Southern Pacific of Mexico railway. Pop. (1926) 28,000. The harbour is spacious and is provided with a sea wall at Olas Altas, but the entrance is obstructed by a bar. The city is built on a small peninsula. Its public buildings include a fine town-hall, chamber of commerce, a custom-house and two hospitals, besides which there is a nautical school and a meteorological station, one of the first established in Mexico. A Government wireless telegraph service is maintained between Mazatlán and La Paz, Lower California. Among the manufactories are saw-mills, foundries, cotton factories and ropeworks; the exports are chiefly hides, ixtle, dried and salted fish, gold, silver and copper (bars and ores), fruit, tortoise-shell and gums and resins.

MAZE: see Labyrinth.

MAZEPA-KOLEDINSKY, IVAN STEPANOVICH (1644?–1709), hetman of the Cossacks, belonging to a noble Orthodox family, was born possibly at Mazeptsina, either in 1629 or 1644, the latter being the more probable date. He was educated at the court of the Polish king, John Casimir, and completed his studies abroad. An intrigue with a Polish married lady forced him to fly into the Ukraine. There is a trustworthy tradition that the infuriated husband tied the naked youth to the back of a wild horse and sent him forth into the steppe. He was rescued and cared for by the Dnieperian Cossacks, and speedily became one of their ablest leaders. In 1687, during a visit to Moscow, he won the favour of the then all-powerful Vasily Golitsuin, from whom he virtually purchased the hetmanship of the Cossacks (July 25). He took a very active part in the Azov campaigns of Peter the Great and won the entire confidence of the young tsar by his zeal and energy. He was also very serviceable to Peter at the beginning of the Great Northern War, especially in 1705 and 1706, when he took part in the Volhynian campaign and helped to construct the fortress of Pechersk. The power and influence of Mazepa were fully recognized by Peter the Great. No other Cossack hetman had ever been treated with such deference at Moscow. He ranked with the highest dignitaries in the state; he sat at the tsar's own table.

Mazepa had no temptations to be anything but loyal, and loyal he would doubtless have remained had not Charles XII. crossed the Russian frontier. Then it was that Mazepa, who had had doubts of the issue of the struggle all along, made up his mind that Charles, not Peter, was going to win. But he proceeded cautiously. Indeed, he would have preferred to remain neutral, but he was not strong enough to stand alone. The crisis came when Peter ordered him to co-operate actively with the Russian forces in the Ukraine. At this very time he was in communication with Charles's first minister, Count Piper, and had agreed to harbour the Swedes in the Ukraine and close it again

the Russians (Oct. 1708). The last doubt disappeared when Menshikov was sent to supervise Mazepa. At the approach of his rival the old hetman hastened to the Swedish outposts at Horki, in Severia. Mazepa's treason took Peter completely by surprise. He instantly commanded Menshikov to get a new hetman elected and raze Baturin, Mazepa's chief stronghold in the Ukraine, to the ground. The metropolitan of Kiev solemnly excommunicated Mazepa from the high altar, and his effigy was publicly burnt by the common hangman.

Henceforth Mazepa, perforce, attached himself to Charles. What part he took at the battle of Poltava is not quite clear. After the catastrophe he accompanied Charles to Turkey with some 1,500 horsemen (the miserable remnant of his 80,000 warriors). The sultan refused to surrender him to the tsar, though Peter offered 300,000 ducats for his head. He died at Bender on Aug. 22, 1709.

See N. I. Kostomarov, *Mazepa and the Mazepanites* (Russ.) (St. Petersburg, 1885); R. Nisbet Bain, *The First Romanovs* (London, 1905); S. M. Solovev, *History of Russia* (Russ.), vol. xv. (St. Petersburg, 1895).

MAZLUM PASHA, AHMED (d. 1928), Egyptian statesman, entered the Egyptian cabinet in 1893, and was minister of finance from 1895 to 1908. He had thus a very long official experience when the constitutional changes inaugurated by Lord Kitchener in 1911–14 were effected. Mazlum Pasha was the first president of the Legislative Assembly established in 1913, and he held office until 1923. After an interval, during which he was minister of *wafks* (pious foundations) under Zaghlul Pasha, in 1924 he resumed the presidency of the Assembly for a few months. Mazlum Pasha's family was partly Turkish in origin, and he remained a typical Turkish gentleman. He died on May 8, 1928.

MAZURKA, a lively dance, originating in Poland, somewhat resembling the polka. It is danced in couples, the music being in $\frac{3}{8}$ or $\frac{3}{4}$ time.

MAZZARA DEL VALLO, a town of Sicily, province of Trapani, on the south-west coast of the island, 32 m. by rail S. of Trapani. Pop. (1921), 21,937. It has a cathedral (1093) rebuilt in the 17th century, and a castle (1073). Mazzara was in origin a colony of Selinus: it was destroyed in 409, but was a Carthaginian fortress in the First Punic War and a station on the Roman coast road.

MAZZINI, GIUSEPPE (1805–1872), Italian patriot, was born on June 22, 1805, at Genoa. During infancy and childhood his health was extremely delicate; but he soon began to devour books of all kinds and to show other signs of great intellectual precocity. He became a student at the University of Genoa at an unusually early age, and decided to graduate in law (1826). His exceptional abilities, together with his remarkable generosity, kindness and loftiness of character, endeared him to his fellow students.

The natural bent of his genius was towards literature, and he wrote a considerable number of essays and reviews, some of which have been wholly or partially reproduced in the critical and literary volumes of his *Life and Writings*. But he held the idea that Italians, and he himself in particular, "*could* and therefore *ought* to struggle for liberty of country." Therefore, he at once put aside his literary ambitions, and devoted himself to politics. His articles accordingly became more and more suggestive of advanced liberalism in politics. Having joined the Carbonari, shortly after the French revolution of 1830, he was betrayed and imprisoned in the fortress of Savona for about six months; a conviction having been found impracticable through deficiency of evidence, he was released, but forced to go into exile. He withdrew accordingly into France, living chiefly in Marseilles.

While in his lonely cell at Savona, he had finally become aware of the great mission or "apostolate" (as he himself called it) of his life; and soon after his release his prison meditations took shape in the programme of the organization which was destined soon to become so famous throughout Europe, that of *La Giovine Italia*, or Young Italy. Its aims were the liberation of Italy both from foreign and domestic tyranny, and its unification under a republican form of government; the means to be used were education, and, where advisable, revolt by guerrilla bands. In April 1831 Charles Albert, "the ex-Carbonaro conspirator of 1821," succeeded Charles Felix on the Sardinian throne, and towards the close of that year Mazzini wrote the new king a letter, published at Marseilles, urging him to take the lead in the impending struggle for Italian independence. Representations were consequently made by the Sardinian to the French government, which issued an order for Mazzini's withdrawal from Marseilles (Aug. 14, 1832); he ultimately found it necessary to retire into Switzerland.

In 1833 he was concerned in an abortive revolutionary movement which took place in the Sardinian army; several executions took place, and he himself was laid under sentence of death. Before the close of the same year a similar movement in Genoa had been planned, but failed through the youth and inexperience of the leaders. At Geneva, also in 1833, Mazzini set on foot *L'Europe Centrale*, a journal of which one of the main objects was the emancipation of Savoy. The frontier was actually crossed on Feb. 1, 1834, but the attack ignominiously broke down without a shot having been fired.

In April 1834 the "Young Europe" association "of men believing in a future of liberty, equality and fraternity for all mankind," was formed also under the influence of Mazzini; it was followed soon afterwards by a "Young Switzerland" society. Mazzini was permitted to remain at Grenchen in Solothurn for a while, but the Swiss diet exiled him at the end of 1836. In Jan. 1837 he arrived in London, where for many months he had to carry on a hard fight with poverty. As he gained command of the English language, he began to earn a livelihood by writing review articles, some of which have since been reprinted, and are of a high order of literary merit. In 1839 he entered into relations with the revolutionary committees sitting in Malta and Paris, and in 1840 he originated a working men's association, and the weekly journal entitled *Apostolato Popolare*, in which the admirable popular treatise "On the Duties of Man" was begun.

The most memorable episode in his life during the same period was perhaps that which arose out of the conduct of Sir James Graham, the home secretary, in systematically, for some months, opening Mazzini's letters as they passed through the British post office, and communicating their contents to the Neapolitan government—a proceeding which was believed at the time to have led to the arrest and execution of the brothers Bandiera, Austrian subjects, who had been planning an expedition against Naples, although the publication of Sir James Graham's life seems to exonerate him from the charge. In this connection Thomas Carlyle wrote to *The Times:* "I have had the honour to know Mr. Mazzini for a series of years, and, whatever I may think of his practical insight and skill in worldly affairs, I can with great freedom testify that he, if I have ever seen one such, is a man of genius and virtue, one of those rare men, numerable unfortunately but as units in this world, who are worthy to be called martyr souls; who in silence, piously in their daily life, practise what is meant by that."

Towards the end of 1847 Mazzini published a letter addressed to the new pope, Piux IX., indicating the nature of the religious and national mission which the Liberals expected him to undertake. The leaders of the revolutionary outbreaks in Milan and Messina in the beginning of 1848 had long been in secret correspondence with Mazzini; and their action, along with the revolution in Paris, brought him early in the same year to Italy, where he took a great and active interest in the events which dragged Charles Albert into a war with Austria; he actually for a short time bore arms under Garibaldi immediately before the reoccupation of Milan. In the beginning of the following year he was nominated a member of the short-lived provisional government of Tuscany formed after the flight of the grand-duke, and almost simultaneously, when Rome had, in consequence of the withdrawal of Pius IX., been proclaimed a republic, he was declared a member of the constituent assembly there. A month afterwards, the battle of Novara having again decided against Charles Albert in the brief struggle with Austria, into which he had once more been drawn, Mazzini was appointed a member of the Roman triumvirate, with supreme executive power (March 23, 1849). Rome was now invested by the French, and that Mazzini suc-

ceeded, however, for so long a time, and in circumstances so adverse, in maintaining a high degree of order within the turbulent city is a fact that speaks for itself. The surrender of the city on June 30 was followed by Mazzini's not too precipitate flight by way of Marseilles into Switzerland, whence he once more found his way to London. He had a firm belief in the value of revolutionary attempts, however hopeless they might seem; he had a hand in the abortive rising at Mantua in 1852; and again a considerable share in the ill-planned insurrection at Milan on Feb. 6, 1853, the failure of which greatly weakened his influence.

The year 1857 found him yet once more in Italy, where, for complicity in émeutes which took place at Genoa, Leghorn and Naples, he was again laid under sentence of death. Undiscouraged in the pursuit of the one great aim of his life, he returned to London, where he edited his new journal *Pensiero ed Azione,* in which the constant burden of his message to the overcautious, practical politicians of Italy was: "I am but a voice crying *Action;* but the state of Italy cries for it also. So do the best men and people of her cities. Do you wish to destroy my influence? *Act.*" The same tone was at a somewhat later date assumed in the letter he wrote to Victor Emmanuel, urging him to put himself at the head of the movement for Italian unity, and promising republican support. As regards the events of 1859–60, however, it may be questioned whether, through his characteristic inability to distinguish between the ideally perfect and the practically possible, he did not actually hinder more than he helped the course of events by which the realization of so much of the great dream of his life was at last brought about. After the irresistible pressure of the popular movement had led to the establishment not of an Italian republic but of an Italian kingdom, Mazzini could honestly enough write, "I too have striven to realize unity under a monarchical flag," but candour compelled him to add, "The Italian people are led astray by a delusion; . . . but monarchy will never number me amongst its servants or followers."

In 1865, as protest against the uncancelled sentence of death under which he lay, Mazzini was elected by Messina to the Italian parliament, but, feeling unable to take the oath of allegiance to the monarchy, he never took his seat. In the following year, when a general amnesty was granted after the cession of Venice to Italy, the sentence of death was at last removed. In May 1869 he was again expelled from Switzerland at the instance of the Italian government for having conspired with Garibaldi; after a few months spent in England he set out (1870) for Sicily, but was promptly arrested at sea and carried to Gaeta, where he was imprisoned for two months. The occasion of the birth of a prince was seized for restoring him to liberty. In the last years of his life he attempted to organize the working classes of Italy on a democratic semi-mystical basis, and he entered into relations with the leading internationalists such as Marx and Bakunin. But he could not work with them and soon lost all touch with working-class circles and was deeply disappointed at the growing influence of the Socialists. He died at Pisa on March 10, 1872. The Italian parliament, by a unanimous vote, expressed the national sorrow with which the tidings of his death had been received. A public funeral took place at Pisa on March 14, and the remains were afterwards conveyed to Genoa.

Bibliography.—The published writings of Mazzini, mostly occasional, are very voluminous. An edition was begun by himself and continued by A. Saffi, *Scritti editi e inediti di Giuseppe Mazzini,* (1861–91); many of the most important are found in the partially autobiographical *Life and Writings of Joseph Mazzini* (1864–70) and the two most systematic—*Thoughts upon Democracy in Europe,* a remarkable series of criticisms on Benthamism, St. Simonianism, Fourierism, and other economic and socialistic schools of the day, and the treatise *On the Duties of Man,* an admirable primer of ethics, dedicated to the Italian working class—will be found in *Joseph Mazzini: a Memoir,* by Mrs. E. A. Venturi (1875). Of the 40,000 letters of Mazzini only a small part have been published. In 1887 two hundred unpublished letters were printed at Turin (*Duecento lettere inedite di Giuseppe Mazzini*); in 1895 the *Lettres intimes* were published in Paris, and in 1905 Francesco Rosso published *Lettere inedite di Giuseppe Mazzini* (Turin, 1905). A popular edition of Mazzini's writings has been undertaken by order of the Italian government.

For Mazzini's biography *see* Jessie White Mario, *Della vita di Giuseppe Mazzini* (Milan, 1886), a useful if somewhat too enthusiastic work; Bolton King, *Mazzini* (1903); A. Luzio's *Giuseppe Mazzini* (Milan, 1905) contains a great deal of valuable information, bibliographical and other, and Dora Melegari in *La giovine Italia e Giuseppe Mazzini* (Milan, 1906) publishes the correspondence between Mazzini and Luigi A. Melegari during the early days of "Young Italy." Nello Rosselli, *Mazzini e Bakounini* (Turin, 1927) is important for the last phase of his life. For the literary side of Mazzini's life *see* Peretti, *Gli scritti letterarii di Giuseppe Mazzini* (Turin, 1904).

(J. S. B., L. V.)

MAZZONI, GIACOMO (1548–1598), Italian philosopher, was born at Cesena and died at Ferrara. He occupied chairs in the universities of Pisa and Rome, was one of the founders of the Della Crusca Academy, and had the distinction, it is said, of thrice vanquishing the Admirable Crichton in dialectic. He published in 1597 *In universam Platonis et Aristotelis philosophiam praecludia.* He also wrote *De triplici hominum vita,* wherein he outlined a theory of the infinite perfection and development of nature, and two works in defence of Dante: *Discorso composto in difesa della comedia di Dante* (1572), and *Della difesa della comedia di Dante* (1587, reprinted 1688) He was an authority on ancient languages and philology, and gave a great impetus to the scientific study of the Italian language.

MAZZONI, GUIDO (1859–), Italian poet, was born at Florence, and educated at Pisa and Bologna. He became professor of Italian at Padua, 1887, and at Florence, 1894. He was influenced by Carducci. His chief volumes of verse are *Versi* (1880), *Nuove poesie* (1886), *Poesie* (1891), *Voci della vita* (1893).

Mc, Mᶜ, are alphabetized as Mac in this work.

MEAD, LARKIN GOLDSMITH (1835–1910), American sculptor, was born at Chesterfield, N.H., on Jan. 3, 1835. He was a pupil (1853–55) of Henry Kirke Brown. During the early part of the Civil War he was at the front for six months as an artist for *Harper's Weekly*; and in 1862–65 he was in Italy, part of the time attached to the United States consulate at Venice, while William D. Howells, his brother-in-law, was consul. He returned to America in 1865, but subsequently went back to live at Florence. His first important work was a statue of Ethan Allen, now at the State House, Montpelier, Vermont. His principal works are: the monument to President Lincoln, Springfield, Ill.; "Ethan Allen" (1876), National Hall of Statuary, Capitol, Washington; an heroic marble statue, "The Father of Waters," New Orleans; and "Triumph of Ceres," made for the Columbian Exposition, Chicago. He died at Florence on Oct. 15, 1910.

MEAD, RICHARD (1673–1754), English physician, 11th child of Matthew Mead (1630–1699), Independent divine, was born on Aug. 11, 1673, at Stepney, London. He studied at Utrecht and Leyden and in 1695 he graduated in philosophy and physics at Padua. In 1696 he returned to London. His *Mechanical Account of Poisons* appeared in 1702, and in 1703 he was admitted to the Royal Society, to whose *Transactions* he contributed in that year a paper on the parasitic nature of scabies. In the same year he was elected physician to St. Thomas's hospital. On the death of John Radcliffe in 1714, Mead became the recognized head of his profession; he attended Queen Anne on her deathbed, and was physician to George II. He died in London on Feb. 16, 1754.

See T. Lemon, *Memoirs of Richard Mead* (1755).

MEAD, WILLIAM RUTHERFORD (1846–1928), American architect, brother of Larkin Goldsmith Mead, was born at Brattleboro, Vt., on Aug. 20, 1846. After graduating from Amherst college in 1867, he studied with Russell Sturgis in New York, and then in Europe for two years. Since 1879 he has been a member of the firm of M'Kim, Mead and White, architects of the Boston public library, Columbia university, College of the City of New York, U.S. post office and municipal office buildings, New York city; Brooklyn Institute of Arts and Sciences, Bank of Montreal, and many other well-known university and metropolitan buildings. Mead is (1928) president of the American academy in Rome. He has been awarded the gold medal of honour of the National Institute of Arts and Letters, and in 1922 was made a Knight Commander of the Crown of Italy. He died in Paris, June 30, 1928.

MEAD. The name of a drink made by the fermentation of honey mixed with water. Alcoholic drinks made from honey were

common in ancient times, and during the middle ages throughout Europe. The Greeks and Romans knew of such under the names of *ὑδρόμελι* and *hydromel; mulsum* was a form of mead with the addition of wine. The word is common to Teutonic languages. "Metheglin," an adaptation of the Welsh *meddyglyn,* means "spiced or medicated drink," and is not etymologically connected with "mead."

MEADE, GEORGE GORDON (1815–1872), American soldier, was born of American parentage at Cadiz, Spain, on Dec. 31, 1815. He graduated from West Point in 1835, and served in Florida against the Seminoles. Resigning from the Army in 1836 he became a civil engineer and constructor of railways, and was engaged under the war department in survey work, until 1842 when he re-entered the army as second-lieutenant in the corps of the topographical engineers. In the war with Mexico he was on the staffs successively of Gens. Taylor, J. Worth and Robert Patterson, and was breveted for gallant conduct at Monterey. Until the Civil War he was engaged in various engineering works, mainly in connection with lighthouses, and later as a captain of topographical engineers in the survey of the northern lakes.

In 1861 he was appointed brigadier-general of volunteers, and had command of the 2nd brigade of the Pennsylvania reserves in the Army of the Potomac, under Gen. McCall. Receiving a severe wound at the action of Frazier's Farm, he was absent from his command until the second battle of Bull Run, after which he obtained the command of his division. He distinguished himself at the battles of South Mountain and Antietam, also at Fredericksburg he and his division won great distinction by their attack on the position held by Jackson's corps, and Meade was promoted to the rank of major-general of volunteers. Soon afterwards he was placed in command of the V. Corps. At Chancellorsville he displayed great intrepidity and energy, and on the eve of the battle of Gettysburg was appointed to succeed Hooker. In the famous three days' battle he inflicted a complete defeat on Gen. Lee's army. His reward was the commission of brigadier-general in the regular army. In the autumn of 1863 a war of manoeuvre was fought between the two commanders, on the whole favourably to the Union arms.

Grant, commanding all the Armies of the United States, joined the Army of the Potomac in the spring of 1864, and remained with it until the end of the war; but he continued Meade in his command, and successfully urged his appointment as major-general in the regular army (Aug 18, 1864). After the war Meade commanded successively the military division of the Atlantic, the department of the East, the third military district (Georgia and Alabama) and the department of the South. He died at Philadelphia on Nov. 6, 1872.

See I. R. Pennypacker, *General Meade* ("Great Commanders" series, 1901).

MEADOW BEAUTY (RHEXIA VIRGINICA)

MEADOW BEAUTY (*Rhexia virginica*), a North American plant of the melastoma family (Melastomaceae), called also deer-grass and Handsome Harry, native to sandy marshes from Maine to Ontario and Iowa and southward to Florida and Texas. It is a rather stout, squarish-stemmed perennial about a foot high, with smooth, oval, light green, three-ribbed, somewhat pointed leaves, and handsome purplish-magenta flowers, 1 in. to 1½ in. wide, blooming about midsummer. The floral parts consist of an urn-shaped calyx with a four-lobed limb; four broad, rounded petals; eight stamens with golden anthers; and a single pistil with a four-celled ovary, which develops into a four-valved many-seeded pod (capsule). The pistil protrudes beyond the anthers, thereby ensuring cross-fertilization, which is effected by honey-bees and other insects. In the Southern States there are several allied species, among which are the Maryland (*R. mariana*) and the ciliate meadow beauty (*R. ciliosa*).

MEADOWLARK (*Sturnella magna*), a well-known North American bird which, like the skylark (*Alauda arvensis*) of Europe, frequents meadows and sometimes sings on the wing. It is about 11 in. long, with brown back, yellow breast and black throat. The meadowlark is not related to the true larks, which are represented in America by the horned lark (*Otocoris alpestris*), but is an aberrant member of the American family Icteridae, which includes the blackbirds and orioles of that continent. The meadowlark has a musical whistle of three notes. It inhabits eastern North America southward to northern South America, but is replaced in the west by the allied western meadowlark (*S. neglecta*), which has a much richer and more varied song.

MEADVILLE, a city of north-western Pennsylvania, U.S.A., the county seat of Crawford county; on French creek and Federal highways 19 and 322, and served by the Bessemer and Lake Erie and the Erie railways, interurban trolleys and motor-bus lines. Pop. (1920) 14,568; 16,698 in 1930. It is the seat of Allegheny college (Methodist Episcopal; 1815) and the Pennsylvania college of music; is the commercial centre of a fertile agricultural region, in which there is also found natural gas; and has extensive railroad shops and various other manufacturing industries, with an output in 1925 valued at $10,070,046. There are wild and rugged ravines of great beauty near the city, and it is surrounded by the foot-hills of the Alleghenies. Meadville is the oldest settlement in north-western Pennsylvania. It was founded by David Mead in 1793 as a fortified post, laid out as a town in 1795, incorporated as a borough in 1823 and chartered as a city in 1866.

MEAGHER, THOMAS FRANCIS (1823–1867), Irish revolutionary leader, orator and American soldier, was born in Waterford, Ireland, on Aug. 3, 1823. He graduated at Stonyhurst college, Dublin. He became a member of the Young Ireland Party in 1845, and in 1847 was one of the founders of the Irish Confederation. In July 1848, the confederation created a "war directory" of five, of which Meagher was a member, and he and William Smith O'Brien travelled through Ireland arousing the countryside for a revolution against English rule. The attempt of 1848 proved abortive; Meagher was arrested in August, and in October was tried for high treason before a special commission at Clonmel. He was found guilty and was condemned to death, but his sentence was commuted to life imprisonment in Van Diemen's Land, whither he was transported in the summer of 1849. Early in 1852 he escaped, and in May reached New York city. He made a tour of the cities of the United States as a popular lecturer, and then studied law and was admitted to the New York bar in 1855. He found himself a leader of the Irish element in New York city and edited several influential Irish journals. At the outbreak of the Civil War he was made captain of a company (which he had raised) in the 69th Regiment of New York volunteers and fought at the first battle of Bull Run; he then organized an Irish brigade, of whose first regiment he was colonel until Feb. 3, 1862, when he was appointed to the command of this organization with the rank of brigadier-general. He took part in the siege of Yorktown, the battle of Fair Oaks, the seven days' battle before Richmond and the battles of Antietam, Fredericksburg, where he was wounded, and Chancellorsville, where his brigade was reduced in numbers to less than a regiment, and Gen. Meagher resigned his commission. On Dec. 23, 1863 his resignation was cancelled, and he was assigned to the command of the military district of Etowah, with headquarters at Chattanooga. At the close of the war he was appointed by President Johnson secretary of Montana Territory, and there, in the absence of the territorial governor, he acted as governor from Sept. 1866 until his accidental death in the Missouri river near Fort Benton, Mont., on July 1, 1867. Meagher's championship of President Johnson's principles of reconstruction and his religion made him unacceptable to the powerful vigilante organization which then ruled Montana, and in his efforts to dislodge the vigilantes from control he was unsuccessful.

See M. Cavanaugh, *Memoirs of General Thomas Francis Meagher* (1892); *Meagher of the Sword* (ed., A. Griffith, 1916); C. J. Bowers, *The Irish Orators* (1916).

MEALYWING, the name applied, from the white, powdery secretion with which they are covered, to about 50 species of small insects comprising the family *Coniopteryidae.* In these

forms, which are the smallest and most aberrant members of the order Neuroptera (*q.v.*), the hind-wings are much reduced in size. They are decidedly beneficial to man, since their larvae feed on aphides, scale-insects, etc. About six species occur in Great Britain and the same number in the United States.

MEAN. The adjective "mean" is chiefly used in the sense of "average," as in mean temperature, mean birth or death rate, etc.

In astronomy (*q.v.*) the "mean sun" is a fictitious sun which moves at a uniform rate in the celestial equator and has its right ascension always equal to the sun's mean longitude. The time recorded by the mean sun is mean-solar or clock time; it is regular as distinct from the non-uniform solar or sun-dial time. The "mean moon" is a fictitious moon which moves around the earth with a uniform velocity and in the same time as the real moon. The "mean longitude" of a planet is the longitude of the "mean" planet, *i.e.*, a fictitious planet performing uniform revolutions in the same time as the real planet.

Mean in Mathematics.—The term "mean," in its most general sense, is given to some function of two or more quantities which (1) becomes equal to each of the quantities when they themselves are made equal, and (2) is unaffected in value when the quantities suffer any transpositions. The three commonest means are the arithmetical, geometrical and harmonic; of less importance are the contraharmonical, arithmetico-geometrical and quadratic.

The arithmetical mean of n quantities is the sum of the quantities divided by their number n. The geometrical mean of n quantities is the nth root of their product. The harmonic mean of n quantities is the arithmetical mean of their reciprocals. The significance of the word "mean," *i.e.*, middle, is seen by considering 3 instead of n quantities; these will be denoted by a, b, c. The arithmetic mean b, is seen to be such that the terms a, b, c are in arithmetical progression, *i.e.*, $b=\frac{1}{2}(a+c)$; the geometrical mean b places a, b, c in geometrical progression, *i.e.*, in the proportion $a : b :: b : c$ or $b^2=ac$; and the harmonic mean places the quantities in harmonic proportion, *i.e.*, $a : c :: a-b : b-c$, or $b=2ac/(a+c)$. The contraharmonical mean is the quantity b given by the proportion

$$a : c :: b-c : a-b, \text{ i.e., } b=(a^2+c^2)/(a+c).$$

The arithmetico-geometrical mean of two quantities is obtained by first forming the geometrical and arithmetical means, then forming the means of these means, and repeating the process until the numbers become equal. They were invented by Gauss to facilitate the computation of elliptic integrals. The quadratic mean of n quantities is the square root of the arithmetical mean of their squares.

MEANING. Speaking broadly any thing or action which suggests another without actually being a picture or copy of it may be said to have meaning. In so far as it has meaning it is called a mark or a sign or a symbol. A portrait depicts a person, a picture depicts a landscape, but neither "means" its original in the way in which their names or descriptions (or other symbols) do. Anything might be made the symbol of another either by purely arbitrary association or by some more natural association based on objective connections. In one or other of these ways the Union Jack has become the symbol of the British empire, Stars and Stripes, of the United States; the giving of a ring is the symbol of engagement or of marriage; the lily is the symbol of purity; rosemary of sweet remembrance; and so on. Some things are actually called after what they symbolize or mean rather than after what they are in themselves—"forget-me-nots," for example. Other things are called by names which are descriptive partly of what they are, and partly of what they symbolize—*e.g.*, "marriage ring," "loving cup." In so far as the labours of science and of art reach beyond observation and description they are mainly concerned with discovering the meanings of things. But the meanings sought by the man of science may not be those which the poet looks for. And there may have been some scientific virtue and restraint in the man of whom Wordsworth hummed rather plaintively:

> The primrose by the river's brim
> A yellow primrose was to him,
> And it was nothing more.

Meaning is the creation of thought. All sorts of things, including all sorts of sounds and forms, might exist even if there were no thinking beings; but in the absence of thinking beings they could only be what they are, they could not *mean* anything else, they could not serve as symbols. Symbols are only symbols for thought—the thought which reads in one thing the reference to another. In fact, concepts and ideas, which are the very stuff of all thought, are just meanings or apprehensions of meaning.

Language, of course, is the most familiar, most useful, and most potent system of symbols. And the problems of meaning have been studied chiefly in connection with language. In logic it is customary to distinguish the different kinds of meaning which terms may have. The most important distinctions are the following: (a) *The meaning of a term in extension* (or its application) consists of the objects to which it is applicable; and one may be said to know this more or less if, as frequently happens, one can apply the term correctly even if he cannot define it adequately. (b) *The meaning of a term in intension* (or its signification) consists of any quality or characteristic which the term suggests. One may distinguish between the *variable intension* of a term, in so far as it may suggest different qualities to different people, from *standard* (or conventionally fixed) *intension* (or connotation), which is more or less the same for all who use the language correctly; and both may be distinguished from *complete or comprehensive intension* or the totality of qualities, etc., which the term would suggest to one who had a complete knowledge of the things which the term denotes (or means in extension). Sometimes the term "meaning" is used as synonymous with "significance." But "significance" unlike "signification" has reference to *value* rather than to *meaning*. Occasionally "meaning" is also used instead of "intention" or "purpose."

See J. N. Keynes, *Formal Logic* (1910); C. K. Ogden and I. A. Richards, *The Meaning of Meaning* (1927); Lady V. Welby, *What is Meaning?* (A. Wo.)

MEASLES (*Morbilli, Rubeola*), an acute infectious disease occurring mostly in children, and possibly caused by a filter-passing virus (*q.v.*). The course of the disease is as follows. After exposure to infection, for from eight to twelve days there is an incubation period unaccompanied by evident symptoms. Then follows the sudden onset of acute catarrh of the mucous membranes. Minute white spots in the buccal mucous membrane frequently occur, and are diagnostic if present. Sneezing, a watery discharge, sometimes bleeding, from the nose, redness and watering of the eyes, dry, noisy cough, hoarseness, and occasionally sickness and diarrhoea, characterize this stage. With these, fever (102°–104° F), abating after the second day, rapid pulse, headache, thirst and restlessness are usually present. In young children, convulsions may usher in, or occur in the course of, this stage, which lasts for four or five days. On the fourth or fifth day after the invasion, the characteristic eruption appears on the skin, being first noticed on the brow, cheeks, chin, behind the ears and on the neck. It consists of small dusky red or crimson spots, slightly elevated above the surface, at first isolated, but tending to become grouped into patches of irregular, occasionally crescentic, outline, with portions of skin free from the eruption intervening. The face acquires a bloated appearance, which, taken with the catarrh, renders diagnosis at this stage a matter of no difficulty. The eruption spreads downwards over the body and limbs, which are soon thickly studded with the red spots or patches. Sometimes these become confluent over a considerable surface. The rash continues to come out for two or three days, and then begins to fade in the order in which it first showed itself, namely from above downwards. About a week after its first appearance nothing remains beyond a faint staining of the skin. Usually during convalescence slight, branny desquamation occurs. At the commencement of the eruptive stage the fever, catarrh, etc., become aggravated, the temperature often rising to 105° or more, and red patches similar to those on the surface of the body may be observed on the throat. These symptoms usually decline when the rash has attained its maximum, the temperature falling suddenly. In favourable cases convalescence is rapid.

Measles may, however, occur in a very malignant form, the

rash being feebly developed, and dark purple, while there is great prostration with intense catarrh of the respiratory or gastro-intestinal mucous membrane. Such cases occur mostly in circumstances of bad hygiene or in isolated communities that have long been free from epidemics of measles. On the other hand, cases of measles are often so mild that other treatment than a few days in bed, is unnecessary.

Measles derives its chief importance from the risk of pulmonary complications. These are most frequent in the colder seasons of the year and in very young and delicate (particularly, rickety) children. Under these conditions the catarrh instead of abating, advances, and broncho-pneumonia (*see* BRONCHITIS, PNEUMONIA) supervenes. By far the greater proportion of the mortality in measles is due to this complication. Or there may remain as direct results of the disease chronic ophthalmia, or discharge from the ears with deafness, and occasionally a form of gangrene affecting the tissues of the mouth or cheeks and other parts of the body, leading to disfigurement and gravely endangering life.

Apart from those immediate risks there may remain after measles a weakened condition of the general health, which paves the way for subsequent tuberculosis.

Measles is a disease of the earlier years of childhood, though not unknown in nurslings or infants under six months old. It is rare in adults, since an attack in childhood mostly confers immunity for the rest of life. All races of men appear liable, and when a community has long been immune from outbreaks introduction of infection is followed by a devastating epidemic. Thus in Fiji in 1875 it was estimated that about one-fourth of the inhabitants died within three months.

In many lands, such as the United Kingdom, measles is rarely absent from large centres of population, and from time to time epidemics arise among those who have not been protected by a previous attack. The risk of conveying infection is greatest during the catarrhal stage before the rash appears. Hence the difficulty of timely isolation, and the readiness with which the disease is spread in schools and families. While contagion is generally direct, it can also be conveyed by particles from the nose and mouth which, after being expelled by coughing or sneezing are deposited on clothes, toys, etc.

Treatment.—The treatment embraces isolation of the sick to the fullest possible extent and at as early a period as possible. Epidemics have often been curtailed by such a precaution. The unaffected children in a family should be kept from school for three weeks from the latest possible date of infection, and all clothing in contact with the patient or nurses should be disinfected. In extensive epidemics it is often necessary to close the schools for a time. As regards medical treatment, in an ordinary case of measles little is required beyond what is necessary in febrile conditions generally. The serious complications call for special measures (*see* BRONCHITIS; PNEUMONIA; etc.). During convalescence the patient must be guarded from exposure to cold. Serum from a convalescent case of measles contains sufficient anti-body to be used as a preventive; 5 to 10 cc. when injected subcutaneously into an infant when the exposure has not lasted for more than six days will either prevent the disease or greatly lessen its severity. Thirty cc. of blood from a person who has had measles in childhood equals 5 cc. of convalescent serum.

"German measles" (*Rötheln*, or *Epidemic Roseola*) is a contagious eruptive disorder resembling both measles and scarlet fever, but exhibiting its distinct individuality in protecting from neither. It occurs most commonly in children, and is occasionally seen in extensive epidemics. Beyond isolation, no special treatment is called for. The disease is often mistaken for true measles, and many of the alleged second attacks of the latter malady are probably cases of rötheln. The chief points of difference are the following: (1) the stage of invasion, which in measles lasts four days and is accompanied by fever and catarrh, in rötheln is either absent or slight, and lasts only for one day. (2) The eruption of rötheln, although as regards its locality and manner of progress similar to measles, differs in appearance, the spots being smaller, paler and with less tendency to grouping in crescentic patches. The rash attains its maximum in about one day, and quickly disappears. There is not the same increase of temperature in this stage as in measles. (3) White spots on the buccal mucous membrane, found in measles, do not occur in rötheln. (4) The milder character of rötheln throughout its whole course, and the absence of complications.

BIBLIOGRAPHY.—R. Debré and P. Joannon, *La rougeole* (Paris, 1926, bibl.); J. E. McCartney, "A review of recent work on measles," *Lancet* (1927, bibl.); R. Debré, P. Joannon and K. Papp, "L'immunisation active contre la rougeole," *Ann. de Méd.* (1926); W. S. C. Copeman, "On some recently developed methods for measles prophylaxis," *Journ. Hyg.* (1925, bibl.); J. L. Halliday, "Relationship between Housing Conditions and the Incidence and Fatality of Measles," *Med. Res. Counc. Spec. Rep.* Ser. No. 120 (London, 1928).

MEASUREMENT. The determination of the magnitude of anything in terms of a suitable unit. Such units may be quite arbitrary, *e.g.*, the pound, foot, second or degree centigrade, or may be derived from a combination of the arbitrary units, *e.g.*, pounds per cubic foot. The procedure adopted depends entirely on the nature of the quantity to be measured and on the accuracy required. Details will be found in the article on METROLOGY.

MEASURES AND WEIGHTS. This subject may be most conveniently discussed under two headings—I. Scientific and II. Commercial. The scientific basis of the systems of units employed is also dealt with in the article PHYSICAL UNITS and the unit of TIME is discussed in the article bearing that title.

I. SCIENTIFIC

1. In Great Britain, the Irish Free State, Northern Ireland and the United States of America two systems of weights and measures are now recognized—the imperial and the metric. The fundamental units of these systems are—of length, the yard and the metre; and of mass, the pound and the kilogram. The term "weight" denotes a magnitude of the same nature as a force; the weight of a body is the product of the mass of the body by the acceleration of gravity, a quantity which varies with the locality in which it is measured. (*See* MECHANICS.) The normal weight of a body is the product of the mass of the body by the normal acceleration of gravity, the value adopted for this latter quantity by the Comité International des Poids et Mesures (C.I.P.M.) at Paris being 980·665 cm./sec.^{2}.

2. **The Metric System.**—The standards of the International Metric System are fixed by an International Conference on Weights and Measures established by a treaty—the Convention du Mètre—signed in Paris on May 20th, 1875. This treaty created an International Bureau, which was built at Sèvres on a piece of land declared by the French Government to be international property, and governed by an International Committee (C.I.P.M.). (See *La Creation du Bureau International des Poids et Mesures* by its Director, Dr. Ch.-Ed. Guillaume.) The international prototype standards are kept at Sèvres, and copies have been made to serve as national standards for the 31 Governments which subscribe to the treaty.

The Conference meets once every six years and, at its seventh meeting in 1927, the metre (*Mètre-à-traits*) was defined:—

> The unit of length is the metre, defined by the distance at the temperature of melting ice between the centres of two lines traced on the platinum-iridium bar deposited at the International Bureau of Weights and Measures, and declared prototype of the metre by the first general conference on weights and measures, this bar being subjected to normal atmospheric pressure and supported by two rollers, at least 1 centimetre diameter, situated symmetrically in the same horizontal plane and at a distance of 572 millimetres from each other.

This metre (m.) (fig. 1) is the only unit of metric extension by which all other metric measures of extension, whether linear, or superficial, are ascertained.

The legal definition does not now refer to any natural standards or to physical constants, though originally the metre (*mètre-des-archives*) was intended to be one ten millionth part of the quadrant of the earth's meridian. It has, however, been shown by A. A. Michelson that a standard of length might be restored, if necessary, by reference to the measurement of wave-lengths of light

(*see* INTERFEROMETER), and the Conference decided (1927) to adopt as an alternative and provisional definition of the metre 1,553,164·13 of the wave lengths of the red light emitted by a cadmium vapour lamp excited under certain specified conditions. The relative accuracy of the value of the metre in terms of light waves is one part in ten millions.

The international prototype kilogram (kg.) is a cylinder of platinum, alloyed with 10 per cent. of iridium, of approximately equal height and diameter. Originally the kilogram was intended to be the mass of a cubic decimeter of water at its temperature of maximum density, 4° C. All other metric weights, and all measures having reference to metric weight are referred to secondary standards in Great Britain and the United States.

The international unit of volume in the metric system is the volume occupied by the mass of 1 kilogram of pure water at its maximum density and under normal atmospheric pressure; this volume is known as a *litre* (l). (Normal atmospheric pressure is the pressure exerted by a column of mercury 76cm. high at the temperature of melting ice and at a place where gravity has its standard value. The density of mercury at 0° C. is 13·5951 g. per cu.cm. so that normal atmospheric pressure $=76\times13\cdot5951\times980\cdot665 = 1\cdot013250\times10^6$ dynes per sq.cm. (Atmospheric pressure at latitude 45° differs from the above in that the gravitational acceleration is taken as 980·616 cm./sec.²) An elaborate investigation at the International Bureau has shown the volume of the litre to be 1·000027 cubic decimetres (*Travaux et Mémoires du Bureau International*, 1910, tome XIV). In determinations of volume which do not admit of a high degree of accuracy the cubic decimetre can be taken as equivalent to the litre.

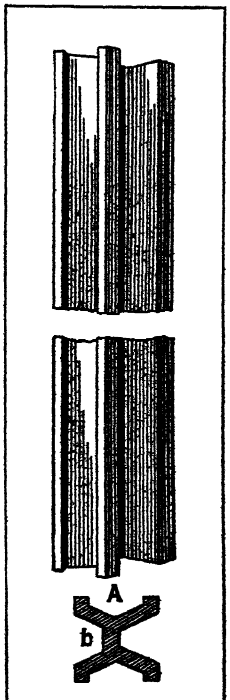


FIG. 1.—NATIONAL STANDARD METRE, 1897
Iridio-platinum bar of Tresca section as shown at A. The two microscopic lines are engraved on the measuring axis of the bar at "b," one near each end

In Great Britain and Northern Ireland the metric standard of capacity is the litre, represented (Order in Council, May 19, 1890) by the capacity of a hollow cylindrical brass measure whose internal diameter is equal to one-half its height, and which at 0° C., when filled to the brim, contains one kg. of distilled water of the temperature of 4° C., under an atmospheric pressure equal to 760 millimetres at 0° C. at sea-level and latitude 45°; the weighing being made in air, but reduced by calculation to a vacuum. In such definition an attempt has been made to avoid former confusion of expression as to capacity, cubic measure, and volume; the litre being recognized as a measure of capacity holding a given weight of water.

3. **The British System.**—The imperial standard yard is defined (Weights and Measures Act, 1878) as the distance, at 62·00° F, between two fine lines engraved on gold studs sunk in a bronze bar. This bar was cast by Troughton & Simms in 1844.

Recent comparisons by the National Physical Laboratory (N.P.L.) show that this 1878 yard=0·9143987m.; the present legal equivalent of the yard in the metric system is 0.914399 m., a value which makes 1 inch=2·54 cm. correct to 1 part in a million (*International Critical Tables* (I.C.T.), Vol. 1. p. 7).

The imperial standard pound avoirdupois is a cylinder of pure platinum about 1·35 in. high and 1·15 in. diameter (fig. 3). The grain is one seven thousandth part of this pound and the troy pound is equivalent to 5,760 grains. The standard pound is 0·45359243 kg.

The standard gallon is the volume of 10 lb. avoirdupois of pure water as weighed in air against brass weights, the temperature of the air and the water being 62° F., and the barometric pressure 30 in. of mercury. This legal definition is incomplete in that it does not state the density of the brass weights; in official comparisons the density is taken to be 8·143 g. per cu.cm. Legally the gallon is equivalent to 4·5459631 l (*see* para. 5). The fluid ounce (apothecaries' measure) has a volume of $\frac{1}{20}$ pint ($\frac{1}{160}$ gal.) thus 16 fluid ounces of pure water weigh 1 pound (avoirdupois).

In the measurement of the cubic inch it has been found (*Proc. Roy. Soc.*, 1895, p. 143) that the mass of a cubic inch of distilled water freed from air, and weighed in air against brass weights (density=8·13), at the temperature of 62° F, and under an atmospheric pressure equal to 30 in. (at 32° F), is equal to 252·297 grains weight of water at its maximum density (4° C). Hence a cubic foot of water would weigh 62·281 lb. avoir., and not 62·321 lb. as at present legally taken.

The imperial standard measure of capacity is a hollow cylinder (fig. 4) made of brass, with a plane base, of equal height and diameter; which when filled to the brim, as determined by a plane glass disc, contains 10 lb. weight of water at 62° F weighed in air against brass weights, when the barometric pressure is 30 in. A secondary standard measure for dry goods is the bushel of 1824, containing 8 imperial gallons, represented by a hollow bronze cylinder having a plane base, its internal diameter being double its depth. It may be noted that the term "Imperial" first occurs in the Weights and Measures Act of 1824.

In the United States the fundamental units of the national system are defined in terms of the metric system, and originated from British standards which, in some cases, have been altered since the original U.S. legislation was passed (*Dictionary of Applied Physics* [D.A.P.], vol. iii., p. 594; I.C.T., vol. i., p. 13). Thus the United States unit of capacity, the gallon, is the old Queen Anne gallon and is equal to 231 cu. in., or 3·785 l. The U.S. pound is the same as the British pound, and the U.S. yard ($\frac{3600}{3937}$m.) is about 3 parts in a million greater than the British yard.

4. **Materials.**—The Matthey alloy iridio-platinum (90% platinum, 10% iridium) is probably of all substances the least affected by time or circumstance and it is therefore used for the prototype metre and kilogram. It is very costly and though its coefficient of linear expansion (8.7×10^{-6} per deg. C) is small, it is not negligible, hence ordinary length standards are often made of Guillaume's alloy (invar) of nickel (35.7%) and steel (64.3%). This metal can be highly polished and is capable of receiving fine graduations. Its coefficient of expansion is very small—only 0.9×10^{-6} per deg. C. There appears to be some objection to the use of iridio-platinum for weights, as, owing to its great density (21·57 g. per cu.cm.) the slightest abrasion will make an appreciable difference in weight; sometimes, therefore, quartz or rock-crystal is used; but to this also there is some objection, as, owing to its low density (2.65 g. per cu.cm.) the exposed surface is unduly large and a large buoyancy correction is necessary. For small standard weights platinum (density=21.45) and aluminium (density=2·67) are used, and also an alloy of palladium (60%) and silver (40%) (density=11.00).

Ordinary weights, whether lacquered or plated with gold or platinum frequently gain in weight for years without any visible alteration and lacquered weights are liable to vary with large variations in the humidity of the air (for example by 0·2 mg. per 100 g.).

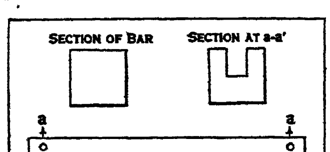


FIG. 2.—PRESENT IMPERIAL STANDARD YARD, 1844

5. **Effects of Temperature and Pressure.**—The graduations on the imperial standard yard (fig. 2) are sunk below the surface of the bar, partly to protect them from damage, but chiefly so that they may lie in the plane of the neutral axis of the bar. The Tresca section of the prototype metre (fig. 1) gives these advantages and, in addition, (*a*) renders it possible to graduate the bar along the whole of its length, and (*b*) gives great strength for the weight of metal used.

The variation in the length of a metal bar with temperature makes it necessary to define the temperature at which standards involving extension are to be used. The choice of 0° C by the

C.I.P.M. as the temperature at which the prototype metre is to be used makes this temperature definite and independent of the vagaries of any thermometric substance, but it is exceedingly inconvenient for industrial standards. For such purposes scales and gauges are frequently adjusted to be standard at 20° C (*e.g.*, in the United States).

The Fahrenheit scale is still used for imperial standards, and the temperature selected, 62° F (16·667° C) is much more convenient than 0° C for workshop use. At the time of the construction of the imperial standards in 1844, Sheepshanks's Fahrenheit thermometers were used; but it is difficult to say now what the true temperature then, of 62° F, may have been as compared with 62° F of the present normal hydrogen scale.

The influence of the variation of atmospheric pressure on standards of length is very small. A change in atmospheric pressure from 28 to 31 in. would cause the length of the prototype metre (fig. 1) to alter by 0·000048 mm., and the standard yard (fig. 2) by 0·000002 in.

When masses are compared by means of their weights allowance must be made for the buoyant effect of the air. This is equal to the density of the air times the volume of the body and therefore varies with the pressure, temperature and humidity of the air in the balance case. It follows that definitions which involve comparisons of the weights of bodies of different densities are not complete unless these atmospheric conditions are specified together with the densities of the materials to be employed. Most weights are marked by their makers in terms of the brass weights which balance them in air. For precision work such weights must be calibrated against a standard whose "weight in vacuo" is known.

If m_0 be the mass of the body weighed and ρ_0 its density; m the true mass of the weights used to counterpoise it on an equal arm balance, ρ the density of these weights and σ the density of the air, then $m_0-\frac{m_0}{\rho_0}\sigma=m-\frac{m}{\rho}\sigma$ or with sufficient accuracy for most purposes (but not for weighing gases) $m_0=m+m\left(\frac{1}{\rho_0}-\frac{1}{\rho}\right)\sigma$.

The first equation may be used to calculate the relation between the litre and the imperial gallon. In that case $m=10$ lb.$=$ 4·5359243 kg.; ρ the density of brass is taken to be 8·143 g. per cu.cm. (para. 3); $\rho_0=$ density of water at 62° F$=$0·9988611 g. per cu.cm. and σ, the density of air$=$0·001218738 g. per cu.cm. —a value obtained by supposing the air to contain 4 volumes in 10,000 of carbon dioxide; to be at a temperature of 62° F, and at the pressure exerted by a column of mercury 30 inches high at 62° F in London, where the value of $g=$standard value (lat. 45°)$\times$1·000577. Substituting for m, ρ_0, ρ and σ gives $m_0=$4·5407857 kg., whence 1 gallon $\doteq m_0/$0·9988611$=$4·5459631 litres. It must be realized that this calculation gives the legal equivalent, the last two figures, at least, have no experimental justification.

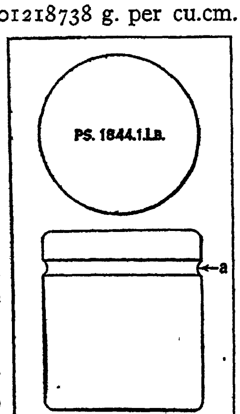


FIG. 3.—IMPERIAL STANDARD POUND, 1844
Platinum pound avoirdupois, of cylindrical form, with groove at "a" for lifting

6. **National Standards and Standardizing Institutions.**—In all countries the national standards of weights and measures are in the custody of the State, or of some authority administering the government of the country. An act of 1866 placed the imperial and metric standards of the British Empire in the custody of the Board of Trade and, under the direction of a Royal Commission on Standards, a Standards Department of the Board was developed in 1870 to conduct all comparisons and other operations with reference to weights and measures which it might be the duty of the State to undertake (*e.g.*, the comparison of standards used by Inspectors of Weights and Measures). Similar standardizing offices are established in other countries. (*See* STANDARDS.) Verified "Parliamentary Copies" of the imperial standards are placed at the Royal Mint, with the Royal Society, at the Royal Observatory and in the Palace of Westminster. Besides the State departments dealing with weights and measures there are other standardizing institutions. In Germany the Physikalisch-Technische Reichsanstalt at Charlottenburg was established in 1887 under Herman von Helmholtz as a national testing and research institution. In England the National Physical Laboratory at Teddington, Middlesex, was formed in 1900. Here all kinds of measuring instruments used in industry are standardized, physical constants determined and materials tested. In the United States similar work is performed by the National Bureau of Standards, Washington, established in 1901; and, in France, by the Laboratoire d'Essais Méchaniques, Physiques, Chimiques, et de Machines, controlled by the Conservatoire National des Arts et Métiers.

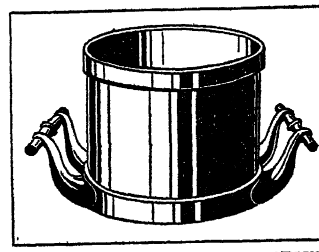


FIG. 4.—PRESENT IMPERIAL STANDARD GALLON, 1824

National standards committees or associations also exist in some twenty countries. Of these the oldest is the British Engineering Standards Association (B.E.S.A.) originally formed in 1901 by the Institutions of Civil, Mechanical and Electrical Engineers, the Institute of Naval Architects, and the Iron and Steel Institute. The American Standards Association was formed in 1917 and, following a conference in New York in 1926, an International Standards Association was set up with Sir Richard Glazebrook as first president.

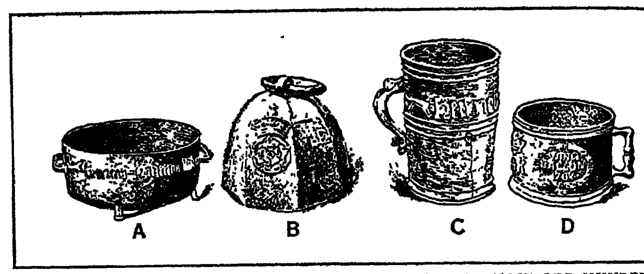


FIG. 5.—A. WINCHESTER BUSHEL OF HENRY VII.; B. STANDARD HUNDREDWEIGHT (112 LB.) OF ELIZABETH; C. ALE GALLON OF HENRY VII.; D. THE OLD WINE GALLON

7. **Ancient Standards of England and Scotland.**—A "troy pound" and a new standard yard, as well as secondary standards, were constructed by direction of parliament in 1758–1760, and were deposited with the Clerk of the House of Commons. When the Houses of Parliament were burned down in 1834, the pound was lost and the yard was injured. The injured standard was then lost sight of, but it was in 1891 brought to light by the Clerk of the Journals, and has now been placed in the lobby of the residence of the Clerk of the House, together with a standard "stone" of 14 lb. (*Report on Standards deposited in the House of Commons,* Nov. 1, 1891.)

FIG. 6.—THE SCOTS CHOPPIN OR HALF-PINT, 1555

In the measurement of liquids the old "wine gallon" (231 cu. in.) was in use in England until 1824, when the present imperial gallon (fig. 4) was legalized; and the wine gallon of 1707 is still referred to as a standard in the United States. Together with the more ancient standard of Henry VII. and of Queen Elizabeth, this standard is deposited in the Jewel Tower at Westminster. They are probably of the Norman period, and were kept in the Pyx Chapel at Westminster, now in the custody of the Commissioners of Works. A sketch of these measures is given in fig. 5. (S. Fisher, *The Art Journal,* Aug. 1900.)

Besides these ancient standards of England (1495, 1588, 1601)

there are at the council chambers of Edinburgh and Linlithgow some of the interesting standards of Scotland, as the Stirling jug or Scots pint, 1618; the choppin or half-pint, 1555 (fig. 6); the Lanark troy and tron weights of the same periods (fig. 7). (Buchanan, *Ancient Scotch Standards.*)

English Weights and Measures Abolished.—The yard and handful or 40 in. ell, abolished in 1439. The yard and inch, or 37in. ell (cloth measure), abolished after 1553; known later as the Scotch ell = 37·06. Cloth ell of 45 in., used till 1600. The yard of Henry VII. = 35·963 in. Saxon moneyers pound, or Tower pound, 5400 grains, abolished in 1527. Mark, $\frac{2}{3}$ pound = 3600 grains. Troy pound in use in 1415, established as monetary pound 1527. Troy weight was abolished, from the 1st of January 1879, by the Weights and Measures Act 1878, with the exception only of the Troy ounce, its decimal parts and multiples, legalized in 1853, 16 Vict. c. 29, to be used for the sale of gold and silver articles, platinum and precious stones. Merchant's pound, in 1270 established for all except gold, silver and medicines = 6750 grains, generally superseded by avoirdupois in 1303. Merchant's pound of 7200 grains, from France and Germany, also superseded. ("Avoirdepois" occurs in 1336, and has been thence continued: the Elizabethan standard was probably 7002 grains.) Ale gallon of 1601 = 282 cub. in., and wine gallon of 1707 = 231 cub. in., both abolished in 1824. Winchester corn bushel of 8×268·8 cub. in. and gallon of 274$\frac{1}{4}$ are the oldest examples known (Henry VII.), gradually modified until fixed in 1826 at 277·274, or 10 pounds of water.

FIG. 7.—LANARK STONE TROY WEIGHT, 1618

French Weights and Measures Abolished.—Often needed in reading older works.

ligne,	12 = pouce,	12 = pied,	6 = toise,	2000 = lieue de poste.
·08883 in.	1·0658	12·7892	76·735	2·42219 miles.
grain,	72 = gros,	8 = once,	8 = marc,	2 = poids de marc (or livre),
·8197 gr.	59·021	472·17	3777·33	1·0792 lb.

Rhineland foot, much used in Germany, = 12·357 in. = the foot of the Scotch or English cloth ell of 37·06 in., or 3×12·353.

II. COMMERCIAL

1. **Denominations.**—The denominations of trade weights and measures at present used in the United Kingdom are represented by "Board of Trade standards," by which are regulated the accuracy of the common weights and measures handled in shops, etc. (*Board of Trade Model Regulations,* 1892; Weights and Measures Acts, 1878, 1889, 1892, 1893.)

Imperial Measures of Length.—100 feet, 66 feet or a chain of 100 links, rod, pole, or perch, measures from 10 feet to 1 foot; 18 inches; yard of 36 inches, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, yard, nail, inch, and duodecimal, decimal and binary parts of the inch.

Imperial Measures of Capacity.—Liquid measures from 32 gallons to 1 gallon, quart, pint, $\frac{1}{2}$ pint, gill, $\frac{1}{2}$ gill, $\frac{1}{4}$ gill. Dry measures of bushel, $\frac{1}{2}$ bushel, peck, gallon, quart, pint, $\frac{1}{2}$ pint.

Apothecaries' Measures.—40 fluid ounces to $\frac{1}{2}$ fl. oz., 16 fluid drachms to $\frac{1}{2}$ fl. dr., 60 minims to 1 minim.

Avoirdupois Weights.—Cental (100 lb), 56 lb ($\frac{1}{2}$ cwt.), 28 lb, 14 lb (stone), 7, 4, 2, 1 lb; 8, 4, 2, 1, $\frac{1}{2}$ ounce (8 drams); 4, 2, 1, $\frac{1}{2}$ drams.

Troy Weights.—The ounce (480 gr.) and multiples and decimal parts of the ounce troy from 500 ounces to 0·001 oz.

Apothecaries' Weights.—10 oz. to 1 oz. (480 gr.); 4 drachms to $\frac{1}{2}$ oz.; 2, 1 drachms; 2 scruples to $\frac{1}{2}$ scruple; and 6 grains to $\frac{1}{2}$ grain.

Pennyweights.—20 dwt. (480 grains), 10, 5, 3, 2, 1 dwts.

Grain Weights.—4000, 2000, 1000 gr. (making 7000 gr. or 1 lb), 500 to 0·01 gr.

2. The international trade metric weights and measures (1897) handled in shops, etc., of which there are also Board of Trade standards, are set out as follows:—

Length.—Decametre or 10 metres; double metre; metre or 1000 millimetres; decimetre or 0·1 metre; centimetre or 0·01 metre; millimetre.

Capacity.—20 litres; 10 litres or decalitre; 5, 2, 1, 0·5, 0·2, 0·1 (decilitre); 0·05, 0·02, 0·01 (centilitre); 0·005, 0·002, 0·001 (millilitre) litres.

Cubic Measures.—1000 (litre), 500, 200, 100, 50, 20, 10, 5, 2 cubic centimetres, 1 c.c. or 1000 cubic millimetres.

Weights.—20, 10, 5, 2, 1 kilograms; 500 to 1 gramme; 5 to 1 decigram; 5 to 1 centigram; 5 to 1 milligram. (Series 5, 2, 2′, 1, *i.e.* with a duplicate weight of "2.")

3. **Equivalents.**—The metric equivalents of the units of the metric system in terms of the imperial system, as recalculated in 1897, are as follows (*Metric Equivalents,* King's Printers, 1898):—

IMPERIAL TO METRIC

1 yard	=	0·914399 m.
1 square yard	=	0·836126 m².
1 cubic inch	=	16·387 c.c.
1 gallon	=	4·5459631 l.
1 pound (7000 grains)	=	0·45359243 kg.
1 ounce troy (480 gr.)	=	31·1035 grammes.
1 fluid drachm	=	3·552 millilitres (ml.)
1 fluid ounce	=	2·84123 centilitres (cl.).

METRIC TO IMPERIAL

1 metre (m.)	=	39·370113 inches.
1 square metre (m².)	=	10·7639 square feet.
1 cubic decimetre (c.d.) or 1000 cubic centimetres (c.c.)	=	61·024 cubic inches.
1 litre (l.)	=	1·7598 pints.
1 kilogram (kg.)	=	2·2046223 lb avoir.
1 gramme (g.)	=	15·4323564 grains or 0·7716 scruple.

The equivalents of the old Russian weights and measures, in terms also of the imperial and metric weights and measures, were recalculated in 1897 (*C.I.P.M., Procès-verbaux* [1897], p. 155). The following are the leading equivalents:

1 Russian pound = { 0·025 pood. / 96 zolotniks. / 9216 dolis. } = 0·40951240 kg. = 0·90282018 lb avoir.

1 arshin = { 0·00066 verst. / 0·33 sagène. / 16 verchoks. / 280 liniias. } = 0·711200 metre. = 0·777778 yard.

1 vedro = { 10 shtoffs / = 100 charkas } = 12·299 litres = 2·7056 gallons.

1 chetvert = 8 chetveriks = 2·0991 hectolitres = 5·7719 bushels.

4. **Local Control.**—The necessary local inspection and verification of weights and measures in use for trade (as distinct from the verbal and written use of weights and measures) is in the United Kingdom undertaken by inspectors of weights and measures, who are appointed by the local authorities, as the county and borough councils. An inspector is required to hold a certificate of qualification, and for his guidance general regulations are made by his local authority as to modes of testing weights, measures and weighing instruments. In Europe the local inspection is generally carried out through the State, and a uniform system of local verification is thereby maintained.

5. **Errors.**—In the verification of weights and measures a margin of error is permitted to manufacturers and scale-makers, as it is found to be impossible to make two weights, or two measures, so identical that between them some difference may not be found either by the balance or the microscope. For common weights and measures this margin (tolerance, remedy or allowance, as it is also called) has been set out by the Board of Trade for all the various kinds of weights and measures in use for commercial purposes in the United Kingdom, and similar margins of error are recognized in other countries. For instance, on 1 lb. avoir. weight made of brass, 2 grains in excess are allowed; on 1 oz. troy or apothecaries' weight, +0·2 grain is allowed; on 1 pint pot, 4 fluid drachms is permitted; on 1 brass yard, 0·05 inch in excess or 0·02 inch in deficiency in length is allowed for ordinary trade purposes.

6. **Foreign Weights and Measures.**—Throughout the Brit-

ish Empire the imperial system of weights and measures is legal.

In Russia the use of metric weights and measures has been compulsory since Jan. 1, 1927.

In India the native weights, etc., ancient and arbitrary, are still followed. In 1889 the British yard was adopted for the whole of India (Measures of Length Act) at a normal temperature of 85° F as standardized to the imperial yard at 62° F. The metric system was also introduced, mainly for railway purposes, in 1870 and 1871 (Indian Acts). Certified measures of the yard, foot and inch are kept by the Commissioners of Police at Calcutta, Madras and Bombay.

In standardizing a weight for use in India, correction has to be made for the weight of air displaced by the material standard, and for such purpose the normal temperature of 85°, at atmospheric pressure 29·8 inches, latitude 22° 35′ 6·5″ (Calcutta), $g = \{g_{45°} \times 0{\cdot}9982515$ is taken. The "tola" (180 grains) is properly the Government unit of weight for currency; and 80 tolas make the "Government seer."

7. **Customary Weights and Measures.**—In some districts of the United Kingdom, as well as in provincial districts of other countries, old local and customary denominations of weights and measures are still found to be in use, although their use may have been prohibited by law. So powerful is custom with the people.

8. **Legislation.**—In everyday transactions with reference to weights and measures, the British legislature also exercises control in industrial pursuits. For instance, in weighing *live* cattle, owners of markets are required to provide adequate accommodation. Useful statutes have also been passed to protect the working class, as in checking the weighing instruments used in mines in Great Britain, over which instruments wages are paid, and in the inspection of similar instruments used in factories and workshops. The Merchandise Marks Act 1887 makes it an offence also to apply in trade a false description, as to the number, quantity, measure, gauge or weight of goods sold; and this Act appears to reach offences that the Weights and Measures Acts may perhaps not reach.

9. **Pharmaceutical Weights and Measures.**—By the Medical Act of 1858 and the Act of 1862, the General Council of Medical Education and Registration of the United Kingdom are authorized to issue a "Pharmacopoeia" with reference to the weights and measures used in the preparation and dispensing of drugs, etc. The British Pharmacopoeia issued by the Council in 1898 makes no alteration in the imperial weights and measures required to be used by the Pharmacopoeia of 1864. For all pharmaceutical purposes, however, the use of the metric system alone is employed in all paragraphs relating to analysis, whether gravimetric or volumetric. For measures of capacity the Pharmacopoeia continues to use imperial measuring vessels graduated at the legal temperature of 62° F. The official names of the metric capacity units are defined at 4° C, as generally on the Continent. The new Pharmacopoeia also follows foreign practice, and employs metric measures of capacity and volumetric vessels graduated at 15·5 C, or 60° F. Specific gravity bottles are also adjusted at 60° F, the figures indicating specific gravities being quotients obtained by dividing in each instance the weight of the solid or liquid by the weight of an equal bulk of water, both taken at 60° F.

10. **Gauges.**—"Gauges," as understood at one time, included only those used in the measurement of barrels, casks, etc., and hence the term "gauger." For engineering and manufacturing purposes the more important linear gauges are, however, now used, adjusted to some fundamental unit of measure as the inch; although in certain trades, as for wires and flat metals, gauges continue to be used of arbitrary scales and of merely numerical sizes, having no reference to a legal unit of measure; and such are rarely accurate. Three standard gauges have been authorized for industrial use by Orders in Council: Whitworth gauges for cylinders (¼ in. to 6 in.) and planes (0·01 in. to 0·1 in.) by Order dated August 1881; the Imperial Wire Gauge (S.W.G.) having numbered sizes from 7/0 (0·5 in.) to 50 (0·001 in.) (Order dated August 1883), and the Birmingham Gauge (B.G.) with sizes from 15/0 (1·000 in.) to 52 (0·00095 in.) (July 1914).

11. **Screws.**—The screw is an important productive measuring instrument, whether used as a micrometer-screw of less than an inch in length, or as a master-screw of 20 feet in length. The probable errors and eccentricities of small micrometer-screws have been carefully investigated to ±0·00001 inch; but the accuracy of leading screws used in workshops has not been sufficiently verified. For some engineering purposes it would appear to be desirable to produce master-screws to an accuracy of $\frac{1}{2000}$ of an inch to the foot of screw, so as to serve indirectly for the verification of "guiding screws" for general use in workshops. Attempts in this direction were originally made by Whitworth, Clement, Donkin, Rogers, Bond and others, but we still need a higher accuracy in screw-threads. The tolerances permissible in screw threads are discussed in Report No. 84 of the British Engineering Standards Association (B.E.S.A.). Screw threads used in the United States have been standardized by the National Screw Thread Commission. (See *Miscellaneous Publications of the Bureau of Standards No. 89.*)

Table of the Principal Weights and Measures now in use, and of their Equivalents in Imperial or in Metric Weights and Measures (excluding those already discussed)

Acre	United States	4,840 square yards.
	Great Britain	4,046·849 square metres.
Almude	Portugal	16·5 litres.
	Spain	4·625 litres = $\frac{1}{12}$ fanega (dry measure).
Ångström Unit (Spectroscopy)		10^{-10} metre = $\frac{1}{10,000}$ micron.
Anker	Latvia	38·256 litres, or 30 stoof.
Anoman (Ammomam, Amomam)	Ceylon	0·699 quarter (dry measure), 5·60 bushels.
Ara	Italy	1 metric are, 119·6 sq.yds.
Archin, or Arshin	Turkey	1 new archin (Law 1881) = 1 metre (39·37 inches) = 10 parmaks (decimetres) = 100 khats (centimetres), 1 mill = 1,000 archins (kilometre). Pharoagh = 10 mills. Another pharoagh = 2 hours' journey.
Archin	Bulgaria	0·758 metre (masons). 0·680 metre (tailors).
Archine, or Archinne	Russia, Estonia	28 inches, or 0·7112 metre.
Ardeb	Egypt	5·447 bushels (Customs). 5 bushels (old measure).
Are		100 sq.metres = 119·6 sq.yds.
Area	Spain	1 metric are.
Arpent	France, Canada	Legal arpent was equal to 100 sq. perches = 51·07 metric ares. In Quebec = 180 French feet.
Arroba	Portugal	14·68 to 15 kilogrammes.
	Spain	Wine = 3·55 gallons; oil = 2·77 gallons.
Artaba	Persia	1·809 bushel. Menor = 2·76 gallons (liquid).
Aune	Belgium	1 metre. Formerly 1·312 yard.
	France	1·885 metre (1812).
	Jersey	4 feet.
Barilo	Rome	12·834 gallons.
Bat, or Tical	Siam	234 grains.
Batman	Persia	6½ lb. av.; varies locally.
	Turkestan	125 kg. (variable).
Behär	Arabia	439·45 lb. av., nearly.
Berri	Turkey	1·084 mile (old measure).
Boisseau	Belgium	15 litres.
Boutylka	Russia	1·353 pint (wine bottle).
Braça	Portugal	2·22 metres.
Braccio	Spain	0·670 metre (commercial).
	Rome	Braccio-d'ara = 29·528 inches.
Brasse	France	5·328 feet.
Braza	Argentina	5·682 feet.
Bu, or tsubo	Japan	$\frac{100}{30{\cdot}25}$ = 3·306 square metres (area). Also = $\frac{1}{100}$ shaku (length).
Bushel	United States, Canada	2,150·42 cubic inches, about 0·96944 imperial bushel. 1 bushel = 8 gallons = 32 quarts = 64 pints.
Bunder	Netherlands	2·471 acres (old hectare).
Cable length		720 feet.

Cabot	Jersey	10 pots, or 4 gallons, 1 quart 3 gills imperial measure.
Candy	Bombay	560 lb. av.
	Madras	493·7 lb. av.
Cantar	Turkey	124·7 lb. av. (old weight).
Cantara	Spain	1 arroba.
Cantara piccolo	Italy	74·771 lb. av.
Capicha	Persia	0·58 gallon.
Carat		Metric = 200 mg.; for diamonds = 1/150 oz. troy.
Catty	China	1⅓ lb. av. *See* Tael.
	N. Borneo	1⅓ lb. av.
	Siam	2·675 lb. av., or 1/50 hap.
Cawnie	Madras	1·322 acre.
Cental	U. States } Canada }	100 lb. av. (As in Great Britain.)
Centigramme		= 1/100 grm. = 0·154 grain.
Centilitre		= 1/100 litre = 0·07 gill.
Centimetre		= 0·394 inch = 1/100 m.
Centimetre, cubic (c.c.)		= 0·061 cubic inch, or 1 c.c.
Centimetre, square		= 0·155 square inch.
Centner	Austria	50 kilogrammes = 110·231 lb. av.
	Denmark	50 kilogrammes = 110·231 lb. av.
	Switzerland	50 kilogrammes = 110·231 lb.
Chain	Canada	66 feet.
	Cyprus	0·33 pic.
Chang	China	10 ch'ih = 11 ft. 9 inches (Treaty).
	Siam	1,200 grammes.
Chapah	N. Borneo	1⅘ lb. av.
Charka	Russia	0·866 gill = 0·218 pint.
Chee. *See* Tahil.		
Chek	Hong Kong	14⅝ inches.
Chenica	Persia	0·289 gallon.
Chetverte	Russia	5·772 bushels = 8 tchetveriks, or 2·099 hectolitres.
Ch'ien	China	58⅓ grains (silver weight).
Ch'ih	China	Varies throughout China from 11 to 15·8 inches. For Customs purposes the Treaty ch'ih = 14·1 inches, and 5 ch'ih = 1 pu.
Ch'ih	Peking	= 12·3 } = 12·5 } public works.
		= 12·4 statistics.
		= 12·6 architects.
		= 12·7 common.
		= 13·1 tribunal of mathematics.
	Shanghai	= 13·2 Board of Revenue.
		= 14·1 Customs.
Chilogramme	Italy	1 kilogramme.
Chin or Catty	China	1⅓ lb. av. (Treaty).
Ching	China	121 sq.feet (Treaty).
Ch'ing	China	72,600 sq.feet (Treaty).
Chittack	Bengal	5 tolas, or 900 grains.
Ch'ok	Corea	7¾ in. (linear); 12⅛ in. (building).
Chô	Japan	As unit length = 360 shaku.
		As unit area = 3,000 bu.
Chüo	China	1,815 sq.feet (Treaty).
Chupah	Singapore	1·66 lb. av. of water at 62° F., as a measure of capacity.
	Malacca	144 oz. av. of water.
Chupak	Straits Settlements	1 quart.
Collothun	Persia	1·809 gallon.
Coss	Bengal	1·136 metre.
Covado	Portugal	0·66 metre.
Covid, or Cubit	Madras	18 to 21 inches.
	Bombay	18 inches.
	Siam	18 inches.
Covido	Arabia	18 inches approximately.
Covido (Great)		27 inches.
Cuartillo	Spain	1·16 litre (dry); 0·504 litre (liquid).
Daktylon (Royal)	Greece	1 centimetre.
Daribah	Egypt	43·58 bushels (Customs).
Decagramme		= 10 grms. = 5·64 drams av.
Decalitre		= 10 litres = 2·2 gallons.
Decametre		= 10·936 yards.
Déçiatina	Russia	= 2,400 square sagènes = 2·7 acres.
Decigramme		= 1/10 grm. = 1·54 grain.
Decilitre		= 1/10 litre = 0·176 pint.
Decimetre		= 3·937 inches = 0·1 metre.
Decimetre, cubic		= 1,000 c.c. = 61·024 cu.in.
Decimetre, square		= 100 sq. cm. = 15·5 sq.in.
Denar	Italy	1 gramme.
Denaro	Rome	18·17 grains (old weight).
Deunam	Turkey	1 metric are.

Diraa	Egypt	0·58 metre = 1 pic.
Diraa, or Drâa, or Pic	Egypt	{27 inches usually. {21·3 inches Nile measure.
	Turkey	27 inches (old measure of pike).
Dirhem	Egypt	1·761 dram av. (Customs).
		3·0884 grammes (Cairo).
Dito	Italy	1 centimetre.
Djerib	Turkey	1 hectare.
Dolia, or Dola	Russia	{0·686 grain. {96 doli = 1 zolotnick.
Drachma	Netherlands	3·906 grammes.
	Turkey	154·324 grains.
Drachmé (Royal)	Greece	1 gramme (gold weight).
	Constantinople	= 57·871 grains. *See* Ock.
Dram. See *Oke*.		
Dram	Persia	1 gramme.
Ducat	Vienna	53·873 grains.
Duim	Netherlands	1 centimetre.
Eimer	Austria	12·448 gallons.
El	Netherlands	1 metre. (Old el = 27·08 inches.)
Ell	Jersey	4 feet.
Ella	N. Borneo	1 yard.
Elle	Latvia	0·537 metre.
	Livonia	0·6096 metre.
	Switzerland	0·6561 yard.
Estadio	Portugal (old)	258 metres.
Faden	Latvia	4·077 stere.
Faltche	Moldavia	1 hectare, 43 ares, 22 centiares.
Fanega	Argentina	3·773 bushels.
	Portugal	55·364 litres.
	Spain	1·526 bushel.
	Peru	1½ bushel.
		1·615 acre, but varies locally.
Fass	Germany	1 hectolitre.
Feddan	Egypt	1·038 acre (Masri). Also 1·127 acre locally.
		1·266 acre (old).
Fen	China	5·83 grains (silver weight).
Firkin	Great Britain	9 gallons (dry measure).
Fjerdingkar	Denmark	0·9564 bushel.
Fod	Denmark	1·0297 foot.
	Norway	0·3137 metre.
Foglietto	Rome	0·8 pint.
Foot	U. States	12 inches.
	Canada	French foot = 12·8 inches.
	Amsterdam }	11·147 in. }
	South Africa } Old Rhenish }	12·356 in. } old measure.
Fot	Sweden	11·689 in. 10 fot = 1 stöng. 1 ref = 10 stänger. 1 mil = 360 ref.
Founte, or Funt or Livre	Russia	0·90282 lb. av.
Foute, or Pied	Russia	1 English foot.
Frasco	Argentina	2⅔ litres.
Funt	Poland	405·504 grammes.
Fuss	Vienna	12 zolls = 1·037 foot.
	Switzerland	3⅓ fuss = 1 metre.
		See *Stab*.
Gallon	United States } Canada }	{231 cubic inches = 8·3389 lb. av. of water at 39·8° Fahr. At 62° Fahr. = 0·8325 imp. gallon.
Gantang	Straits Settlements	32 gallons.
	N. Borneo	144 oz. av. weight of water as measure of capacity.
Garnetz	Russia	0·3607 peck.
Gin. See *Kati*.		
Gisla	Zanzibar	Measure of 360 lb. av. of rice.
Go	Japan	180·39 cubic centimetres.
Grain	Russia	0·960 grain (apothecaries).
Gramme (gr.)		= 15·4323564 grains av. troy.
		= 0·2572 drachm, or 0·7716 scruple.
		= 0·03215 oz. troy.
Grammé (Royal)	Greece	1 millimetre.
Gramo	Spain	1 gramme.
Grano	Rome	0·757 grain.
Grao	Portugal	0·768 grain; also measure 0·18 in.
Grein	Netherlands	= 0·065 gramme.
Guz, or Gudge	India: Bengal	36 inches.
	" Bombay	27 inches.
	" Madras	33 inches, Government Survey.

Guz, or Gudge	Persia	The guz, gueza or zer varies from 24 to 44 inches. A guz of 40·95 inches (Guz, Azerbáiján) is common. Government standard guz = 36½ inches. There is a guz for retail trade of 25 inches.
	Arabia	25 inches to 37 inches (Bassorah).
Hat'h, or Moolum, or Cubit	Bengal	18 inches.
	Bombay	18 inches, or cubit.
Hectare		= 100 ares, or 2·471 acres.
Hectogramme		100 grm. = 3·53 oz. av.
Hectolitre		100 litres = 2·7 bushels.
Hectometre		= 109·36 yards.
Hiyaka-me	Japan	5.797·198 grains.
Hiyak-kin	Japan	132½ lb. av.
Hogshead	Great Britain	63 gallons (dry measure).
Hoon. See *Tahil.*		
Hu	China	12½ gallons, nearly.
Hulmit	Latvia	11·48 litres.
Immi	Switzerland	1·5 litre.
Joch	Austria-Hungary	1·422 acre.
Kaima	Sweden	0·576 gallon.
Kan	Netherlands	1 litre.
	Hong Kong	1⅓ lb. av.
Kanne or Kanna	Germany	1 litre, or formerly 1·762 pint.
	Sweden	0·576 pint.
Kantar, or Cantaro	Egypt	99·0492 lb. av. = 100 rotls (Customs). 45 kilogrammes of cotton. 44·5 kilogrammes other produce.
Karwar	Persia	100 batman.
Kassabah	Egypt	3·8824 yards (Customs).
Kati, Catty or Gin	China, Straits Settlements	1⅓ lb. av.
Keddah	Egypt	2·0625 litres.
Keila, or Pishi	Zanzibar	Measure of 6 lb. av. of rice.
Ken	Japan	5·965 ft., 1·81 metre.
Kerât	Turkey	1⅛ inch measure (old).
		3·09 grains weight (old).
Kette, or Chain	Germany	14·994 ellen, or 10·936 yards.
Keu	Siam	40 inches.
Khat (New)	Turkey	1 centimetre.
Kile	Cyprus	8 gallons.
Killow	Turkey	0·97 bushel.
Kilogramme		= 1,000 grm. = 2·2046223 lb. av.
Kilometre		= 0·6214 mile.
Kin	Japan, China	0·601 kilogramme = 1·325 lb.
Klafter	Austria	= 2·0740 yards.
	Switzerland	1·9685 yard.
Knot	Great Britain	1 nautical mile = 6,080 feet.
Köddi	Arabia	1·67 gallon.
Koilon (Royal)	Greece	1 hectolitre. Old koilon = 33·16 litra.
Koku	Japan	= 39·7033 gal. = 4·9629 bushels.
Kon	Corea	1⅓ lb. av.
Korn-tonde	Norway	138·97 litres.
	Sweden	3·821 bushels.
Korn-top Maal	Norway	160 litres.
Korrel	Netherlands	1 decigramme.
Kotyle (Royal)	Greece	1 decilitre.
Kouza	Cyprus	9 quarts.
Koyan	Straits Setts.	5,333⅓ lb. av.
Krina	Bulgaria	12·8 litres.
Kung	China	78·96 inches (Treaty).
Kup	Siam	10 inches.
Kwan or Kuwan	Japan	8·281 lb. = $\frac{15}{4}$ kg.
Kwarta	Poland	1 litre.
Kyat	Burma	100 kyats = 3·652 lb. av.
Lak't	Bulgaria	0·650 metre.
Last	Netherlands	30 hectolitres.
Latro	Czechoslovakia	1·917 metres.
Léang	China	583⅓ grains (silver weight).
Lèkhà	Bulgaria	229·83 sq.metres.
Li	China	About ⅓ mile = 360 pu. Varies with length of ch'ih.
		A small weight 0·583 grain.
Liang	China	1⅓ oz. 16 liang = 1 chin = 1⅓ lb. av.
Libbra	Italy	0·7477 lb. av.
Libbra (nuova)	Italy	1 kilogramme.
Libra	Argentina	1·0127 lb. av.
Libra (Castilian)	Spain, Mexico	1·014 lb.

Libra, or Arratel	Portugal	1·012 lb. av.
Light Year (astronomy)		$9·4627 \times 10^{12}$ kilometres.
Line or Ligne	Paris	$\frac{1}{12}$ point, or 0·089 inch.
Liniia	Russia	0·1 inch. 1 archine = 280 liniias.
Litra (Royal)	Greece	1 litre = 100 mystra.
Litre	Cyprus	2⅘ quarts.
Litre (metric)		= 1·7598 pint.
Litro	Spain, Italy	1 litre.
Livre (lb.)	Russia	0·90282 lb. av. Apoth. livre = 11·5204 oz. troy.
Livre-poids	Belgium	Kilogramme.
	France	0·4895 kilogramme.
Loket	Czechoslovakia	0·593 metre (Prague); 0·594 metre (Moravia); 0·579 metre (Silesia).
Loth	Germany	New loth = 1 decagramme. Old loth, nearly ½ oz. av.
	Switzerland	15·625 grammes.
	Vienna	270·1 grains. Postal loth, 257·2 grains.
Maass	Austria	1·245 quart.
	Switzerland	2·64 gallons.
Maatze	Netherlands	1 decilitre.
Mace	China	58⅓ grains.
	N. Borneo	93⅓ lb. av.
Mahud	Arabia	2·04 lb. av.
Maik	Burmah	3 maik = cubit = 19½ inches.
Marc, or Mark	France	0·2448 kilogramme (old weight).
	Sweden	0·4645 lb. av.
	Vienna	4,331·37 grains = 24 karato.
Marco	Portugal	= 8 oncas = 229·5 grammes.
	Spain	3,550·54 grains.
Maund	India	82·286 lb. av., Government.
		72½ lb. (old bazaar).
		74·67 lb. av., factory.
		28 lb. nearly, Bombay.
		25 lb. nearly, Madras.
		37 to 44 lb., Juggerat.
		Local maunds vary on either side of 80 lb.
Megametre (astronomy)		1,000,000 metres.
Metre (m.)	United States	39·37 inches.
	Great Britain	39·370113 inches = 1 m.
Metre, cubic		= 1,000 c.d. = 35·315 cubic feet.
Metre, square		= 100 square decimetres = 10·764 square feet.
Metro	Spain, Italy	1 metre.
Metz	Austria	1·691 bushel.
Micron (μ)	Austria	= $\frac{1}{1000}$ millimetre.
Micron (1μ)	Czechoslovakia	10^{-6} metre.
Miglio	Rome	0·925 mile.
Mijle	Netherlands	1 kilometre.
Mil, or Mill	Turkey	1,000 archins (new mil).
	Denmark	4·680 miles.
	Great Britain	10^{-3} inch.
Mile	France, Germany	Nautical mile = 1,852 metres.
Mile (postal)	Austria	4·714 miles.
Milha	Portugal	1·296 mile.
Mille	France	1·949 kilometre.
Milligramme	France	= $\frac{1}{1000}$ gramme = 0·015 grain.
Millilitre	France	= $\frac{1}{1000}$ litre.
Millimetre	France	= 0·03937 inch = $\frac{1}{1000}$ m.
Miscal	Persia	71 grains.
Mkono	East Africa	45·72 centimetres.
Mna	Greece	1½ kilogramme = 1·172 oka.
Momme	Japan	$\frac{1}{1000}$ kwan.
Morgen	Denmark, Norway, Prussia	0·631 acre.
	Netherlands (Old)	8,124·4346 square metres.
	South Africa	8,550 square metres.
Mou	China	Commonly 806·65 sq.yd. Varies locally. Shanghai = 6,600 sq.ft. (Municipal Council). By Customs Treaty = 920·417 sq.yds., based on ch'ih of 14·1 inches.
Mud	Netherlands	1 hectolitre.
Myriagramme		= 10 kilogrammes = 22·046 lb. av.
Ngoma	East Africa	7½ keilas.
Nin	Siam	$\frac{10}{12}$ inch

Obolos	Greece	1 decigramme.
Ock	Turkey	Legal ock (1881) = 100 drachmas. New batman = 10 ocks, and kantar = 10 batmans ock = 1 kilogramme.
Octavillo	Spain	0·29 litre.
Oitavo	Portugal	1·730 litre.
Oke	Bulgaria	1·28 litre (for liquids). 1·282 kilogramme (old).
	Cyprus	$2\frac{4}{5}$ lb. av. = 400 drams (Cyprus).
	Egypt	2·751 lb. av. (Customs). 2·805 lb. (Alexandria).
	Greece	2·80 lb. = 1·282 kilogramme. 1·33 litre.
	Turkey	1·1518 pint. 2·834 lb. av. (old weight).
Onça	Portugal	28·688 grammes.
Once	France	30·59 grammes (old).
Oncia	Rome	436·165 grains.
Onze	Netherlands	1 hectogramme. 10 onzen = pond.
Ounce	U. States	Av. ounce = 437·5 grains.
Packen	Russia	1,083·382 lb. av.
Palamé (Royal)	Greece	1 decimetre.
Palm	Holland	1 decimetre.
Palmo	Portugal	0·22 metre.
	Spain	8·346 inches.
Para	N. Borneo	90 lb. av.
Parah	Ceylon	5·59 pints.
Parasang. See *Persakh*.		
Parmak. See *Archin*.		
Parsec (astronomy)		$3{\cdot}084 \times 10^{13}$ km.
Passeree	Bengal	5 seers.
Pé	Portugal	$\frac{1}{3}$ metre (old).
Pecheus (Royal)	Greece	1 metre = 1·543 old pecheuse.
Pecul	China	$133\frac{1}{3}$ lb. av.
Perche	France, Canada	22 square pieds de roi. In Quebec 18 French feet.
Persakh, or Parasang	Persia	Probably 3·88 miles = 6,000 guz.
Pfund	Estonia	430 grammes.
	Germany	= 16 unzen = 32 loth, 1·01 to 1·23 lb. av. old weight. Zoll. pfund (1872) = 500 grammes.
	Latvia	419 grammes.
	Prussia	Old zoll lb. = 1·1023 lb. av.
	Switzerland	500 grammes = 16 unze. Apoth. pf. = 375 grammes.
	Vienna	Pfund = 560·06 grammes. Zoll. pfund (1871) = 500 grammes.
Pharoagh. See *Archin*.		
Pic	Cyprus	2 feet.
Picul	Japan, Straits Settlements, Hong Kong	$133\frac{1}{3}$ lb. av.
	North Borneo	A measure of 180 lb. weight of water.
Picki	Greece	0·648 metre.
	China	25 gallons (dry measure).
Pie	Rome	11·73 inches.
Pie de Burgos	Spain	11·13 inches.
Pied	Belgium	11·81 inches = 10 pounces.
	Canada	12·79 inches.
Pied de Roi	Paris	0·3248 metre.
Pike	Turkey	See *Diraa*
Pint	United States	0·8325 imperial pint.
Pinta	Italy	1 litre.
Pinte	France	0·931 litre.
Pipa	Portugal	534 litres (Oporto). 420 litres (Lisbon). 500 litres (officially).
Pipe	Gibraltar	105 to 126 gallons.
Pishi. See *Keila*.		
Poide de Marc	France	0·2448 kilo = 8 onces.
Polegada	Portugal	27·77 millimetres.
Pond	Netherlands	1 kilogramme. Apothecaries, pond = 375 grammes.
Pot	Denmark	1·7 pint = 4 paegle.
	Switzerland	2·64 pints or 1·5 litre.
	Belgium	$1\frac{1}{2}$ litre (dry). $\frac{1}{2}$ litre (liquid).
	Norway	0·965 litre.
Pouce	France	1·066 inch (old measure).
	Russia	1 inch.
Poud, or Pood	Russia	0·016122 ton = 36 lb.

Pound	United States	Standard troy lb. = 5,760 grains. Avoir. lb. = 7,000 grains.
	Russia	0·90282 lb. av. (0·4095 kilogramme).
	Jersey	7,561 grains = 16 oz. Jersey = 1 livre.
Pu	China	70·5 inches = 5 ch'ih.
Puddee	Madras	2·89 pints. 100 cubic inches = Government puddee.
Pulgada	Spain	0·927 inch.
Pund	Denmark	1·1023 lb. av., or 500 grammes.
	Norway	0·4981 kilogramme.
	Sweden	6,560 grains. Varies locally. 5,500·5 grains (apoth.).
Quart	United States	See *Bushel*.
Quarto	Rome	2·024 bushels.
	Portugal	3·46 litres.
Quintal	Spain	100 libras (Castilian) = 101·4 lb.
	Portugal	58·752 kilogrammes, or $129\frac{1}{2}$ lb. av.
	Argentina	100 libras, or 101·27 lb. av.
Quintal (metric)	France	= 100 kilogrammes = 1·968 cwt.
Quintale	Italy	1 metric quintal.
Ralte	Persia	1 litre.
Ratel	Persia	1·014 lb. av.
Rattel, or Rottle	Arabia	1·02 lb. av., nearly (dry measure). 17·219 lb. av. weight.
Ri	Japan	2·440 miles (itinerary). 2·118 miles (natural).
Rode	Denmark	3·762 metres.
Roede	Netherlands	1 dekametre.
Rotl, or Rottolo	Egypt	0·9905 lb. av. (Customs). 0·9805 lb. av. (Govt.).
	Cairo	2·206 lb. great rottolo. 0·715 lb. less rottolo.
	Alexandria	2·124 lb. great rottolo. Rottolo mina = $\frac{2}{5}$ oka.
Rottol	Turkey	2·513 pints (old measure).
Rubbio	Spain	1·012 quarter (dry measure).
Sagène	Russia	7 feet.
Scheffel	Germany	50 litres, formerly 14·50 metzen (Prussia).
Schepel	Netherlands	1 decalitre.
Schoppen	Germany	$\frac{1}{2}$ litre, formerly 0·11 gallon.
	Switzerland	0·375 litre.
Se	Japan	118·615 square yards (·9918 are).
Seer	India	Government seer = $2\frac{2}{35}$ lb. av. Bengal, 80 tolas weight of rice (heaped measure), about 60 cubic inches (struck measure). Southern India = weight of 24 current rupees. Madras, 25 lb. nearly. Juggerat, weight of 40 local rupees. Bombay, old seer, about 28 lb.
	Ceylon	Measure of 1·86 pint.
	Persia	16 miscals, or 1,136 grains weight (Sihr).
		Note.—In India the seer, like the maund, varies considerably; usually 40 seers go to a maund.
Seidel	Austria	0·6224 pint.
Sen	Siam	44·4 miles, nearly.
Ser	India	1 litre (Indian Law, 1871).
Shaku	Japan	$\frac{10}{33}$ m., also 9·18273 square decimetres; also 18·039 cubic centimetres ($\frac{1}{100}$ shô).
Sheng	China	1·813 pint.
Shih	China	160 lb.
Shô	Japan	1·804 litre.
Skaal-pund	Sweden	435·076 grammes, or 0·959 lb. av.
	Norway	0·4981 kilogramme, or officially $\frac{1}{2}$ kilogramme.
Skeppe	Denmark	17·39 litres.
Skjeppe	Norway	17·37 litres.
Stab	Germany	1 metre, or $3\frac{1}{3}$ old fuss, but varied.
Stadron (Royal)	Greece	1 kilometre.
Stere (metric)		1 cubic metre.
Stero	Italy	1 metric stere.
Stopa	Poland	0·288 metre.
Streepe	Holland	1 millimetre.
Stremma	Greece	1 metric are. 238·1 square pecheus (Constantinople).
Strich	Germany	1 millimetre.

Striche	Switzerland	$3\frac{1}{3}$ strich = 1 millimetre.
Stunde	Germany	Old itinerary measure, 2·3 to 3·4 miles.
Stunde	Switzerland	4·8 kilometres. Stunder = 5 stunden, or 24 kilometres.
Sultchek	Turkey	Cubic measure (1881) whose sides equal a parmak (decimetre).
Sung	Corea	4 lb. av., nearly.
Tael	Siam	$936\frac{1}{4}$ grains.
	Hong Kong	$1\frac{1}{3}$ oz. av.
	China	Silver weight, $1\frac{1}{3}$ oz. av.
	Japan	10 momme.
	(No current *coin* of the tael.)	
Tahil	Straits Settlements	$1\frac{1}{3}$ oz. av. = 10 chee = 100 hoon.
Tam	Hong Kong	$133\frac{1}{3}$ lb. av.
Tan	China	= 25 gallons. Also $133\frac{1}{2}$ lb. weight.
Tang	Burma	2 miles, nearly.
Tang-sun	China	About $3\frac{1}{2}$ miles = 10 li.
Tank	Bombay	$17\frac{1}{72}$ grains, or 72 tanks = 30 pice.
Teng	Burma	Burmese measures of capacity depend on the teng or basket. Officially a basket is 2,218·2 cubic inches, but the teng varies locally:— Akyab = 23 lb. of rice. Bassein = 51 lb. of rice. Moulmein = 48 lb. of rice. Rangoon = 48 to 50 lb. of rice.
Thanan	Siam	1 litre.
Thangsat	Siam	4·688 gallons.
To	Japan	18·0391 litres = 3·9703 gal. = 1·98 pecks.
Toise	France	2·1315 yards.
Tola	India	180 grains. Legal weight of rupee.
Tomand	Arabia	187·17 lb. av. of rice.
Ton	United States	2,240 lb. av., also a net ton of 2,000 lb.
Tönde	Denmark	131·392 litres (liquid measure). 139·121 litres (dry measure).
Tonne, or Millier	France, Germany	1,000 kilogrammes.
Tonne (metric)		1,000 kilogrammes = 0·9842 ton.
Tonnelada	Portugal	793·15 kilogrammes.
Tonos	Greece	29·526 cwt.
Tou	China	18 pints approximately.
Tovar	Bulgaria	128·2 kilogrammes.
T'sun	China	1·41 inch (Treaty measure).
Tu	China	100·142 miles = 25 li, based on the ch'ih of 14·1 inches.
Vara	Peru	33 inches.
	Spain	2·782 feet.
	Argentina	2·841 feet.
	Portugal	1·11 metre.
Vat	Holland	1 hectolitre. 768 mingelen. 1 mingelen = 1·20 to 1·237 litre.
Vedro	Russia	2·7056 gallons = 10 schtoffs, or 12·3 litres.
	Bulgaria	12·8 litres.
Verchok	Russia	1·75 inch.
Versta, or Verst	Russia	0·66288 mile.
Vierkanteroede	Holland	1 metric are.
Viertel	Denmark	1·7 gallon.
	Switzerland	15 litres.
Viss	Rangoon	$3\frac{91}{140}$ lb. av.
Wa.	Siam	2 metres.
Wigtje	Netherlands	1 gramme.
Wisse	Netherlands	1 metric stere.
Yard	United States	36 inches.
	Mexico	838 centimetres.
Zac.	Netherlands	1 hectolitre.
Zar (metric)	Persia	1 metre.
Zer (Persia). See *Guz*.		
Zoll	Switzerland	$3\frac{1}{3}$ zoll = 1 decimetre. Old zoll nearly one inch. (See also *Pfund*.)
Zolotnik	Russia	65·8306 grains, or 96 doli.

BIBLIOGRAPHY.—In addition to the references in the text see *British Weights and Measures*, by Col. Sir C. M. Watson (1910) for the history thereof; and the *Travaux et Mémoires* of the C.I.P.M. for methods used for the comparison of standards. A long list of foreign weights and measures is given in vol. 1 of the International Critical Tables (1926) to which reference has already been made. The *Standards Yearbook* (U.S. Government Printing Office, Washington) contains a summary of the current work of the C.I.P.M. and of the various national and international standardizing associations. *History of Standard Weights and Measures of the United States* by Louis A. Fisher (Miscellaneous Publications of the Bureau of Standards no. 64).

(H. J. CH.; O. WO.)

MEASURES AND WEIGHTS, ANCIENT. The history of weights has been greatly extended, by (1) the discrimination of the ages of Egyptian weights by their forms; (2) the study of 3,400 weights and many capacity measures from Egypt; (3) the finding of the names and marks of four standards in Palestine, which confirms their independent position; (4) increased knowledge of prehistoric weights. Such material supersedes most of the fragmentary and vague statements of ancient authors, upon which we were formerly dependent.

The English standards of inches and grains are the most familiar, and are here placed on the left side of the column, while the equivalents in millimetres and grammes are inset on the right side. Only the values actually found are here described, without any theoretical amounts, or assumed connections. There is nothing easier than to frame systems of plausible relations between measures, but the exact amounts must be ascertained and the historic probability of descent, before such theories can be valued.

LINEAL MEASURES. *The units derived from 20·62 inches*

inches 20·62 This standard of the cubit was used in Egypt from the time of the predynastic royal tombs onwards. **mm. 524** The first accurate example yet published is in the size of the pyramid of Snefru (3rd dyn.), at 20·66, but still more exactly 20·62 in the pyramid of Khufu. The pure system of it was:

n,	100 = meh cubit,	100 = khet
·206	20·62	2062 inches

But it was mixed with other systems as:

zebo, digit	4 = shep, palm	7 = meh, cubit	100 = khet, reel	120 = ater or skhoinos
·737	2·947	20·62	2062	3·9 miles.

This was termed the "royal cubit" throughout history. The Babylonian 20·89 of Gudea may be another form, and probably the origin, of this. It appears in Asia Minor as 20·55 to 20·94; in tombs at Jerusalem as 20·57; in six English stone circles as 20·55. The eastern system was:

uban,	5 = qat,	6 = ammat,	6 = qanu,	60 = sos,	30 = parasang,	2 = kaspu
·695	3·475	20·85	125·1	7506	225,180	450,360

The same cubit of 20·68 appears in stone buildings of New Mexico.

12·45 This foot is $\frac{3}{5}$ of the cubit of 20·75. It is found in Athens as 12·44, Aigina 12·40, Mile- **316** tos 12·51, Olympia 12·62, Etruria 12·45, mediaeval England 12·47. The system was:

foot,	10 = akaina,	10 = plethron,	6 = stadion
12·45	124 5	1245	7470

From the foot was formed a cubit of 18·7, **474**

foot,	$1\frac{1}{2}$ = cubit,	4 = orguia,	100 = stadion
12·45	18·7	74·7	7470

13·8 Another foot was formed of $\frac{2}{3}$ of the cubit, adopted by Philetairos of Pergamon as a **350** standard.

17·72 This was the short cubit of Egypt, actually found as a measuring rod and having 6 palms **450** it was directly connected as $\frac{6}{7}$ of the 20·67 cubit. As 17·6 it is recognized as the early Jewish cubit.

The digit and derived measures.

inches **·729** This digit was $\frac{1}{40}$ of the diagonal of the 20·62 cubit. mm. **18·51** The diagonal of the cubit, 40 digits, is found as a wand of the middle prehistoric age, 29·1 long. Another multiple was the half of this, 20 digits, called the remen, used as a basis of land measure. By having two systems, one the diagonal of the other, it was possible to denote one square half the area of another.

digit,	100 = orguia,	10 = amma,	10 = stadion: itinerary
·729	72·9	729	7290

inches		mm.
18·23	25 digits = Greek cubit of 18·23	463
12·15	$\frac{2}{3}$ of 18·23 is the Greek foot of 12·15, from which was a decimal system.	309

foot, 12·15	10=akaina, 121·5	10=plethron: agrarian 1215

This measure is rare in comparison with the 12·45 foot. It has been supposed to have been used for the Parthenon, but the 11·69 foot agrees more closely with that. The $\frac{2}{3}$ of 25 digits, being a fractional amount, was inconvenient, and the foot of 12·15 was divided binarily into 16 digits, of 96 to the orguia, or ·759 inch. Such seems to have been the original connection of the different Greek systems, but much more dated material is needed.

11·613 From the digit of ·729, on which the Greek measures were based, as for the Parthenon **294·9**
11·69, the Italic foot of 16 digits was formed of 11·66, or as it was later at Rome 11·613; the series was

digitus, ·726	4=palmus, 2·90	4=pes, 11·61	5=passus, 58·06	125=stadium, 7258	8=milliare 58,060

This was widely spread by Roman influence, varying up to 11·8. It has an earlier history, being used for the Parthenon and perhaps the Theseion as 11·69, and as an Etruscan measure (**11·59**), also in prehistoric times at Stonehenge (**11·68**), and probably in other stone circles and hill figures (**11·60**). Such are the linked systems of great extent, from which have been derived many units.

13·3 This widespread measure is first found in Egypt, as wooden cubit rods of 26·5 to 26·74, **338**
of the 12th dynasty: later, a very accurate standard slab of this unit, divided in 7 palms, reaches 26·80. In Asia Minor it is found as 13·35 in buildings, in Greece 13·36, at Lachish 13·18 (900 B.C.), in Syria (A.D. 620) as 13·22, carried on as the Stambuli cubit of 26·6. Hultsch takes it as 13·1, and connects it with the Drusian foot of 2 digits longer than the Roman foot, or 13·10. This was the Belgic foot which Drusus had to adopt as a northern standard for the border settlements of the Agri Decumates. Hence it connects with the base of English land measure,

foot, 13·2	6=fathom, 79·2	10=chain, 792,	10=furlong, 7920	10=old mile 79,200

It was the commonest building foot in mediaeval England (**13·2**), and its age is seen by its use as the measure for Silbury hill (13·0). It was also the basis for French architecture, the *canne* of 78·24, or six feet of 13·04. Unfortunately this old equivalent for the metre has now disappeared.

19·2 This unit is found in Persepolis (**19·2**), and modern Persia (**2×19·3**), also the cubit of **488**
Gudea and of the tower of Babylon (**19·5**); in the west in Asia Minor (**19·3**) and as the Pythic foot (**9·75**, **½19·5**). Two-thirds of this, a foot of 12·83, seems to be a unit of buildings at Knossos.

20·0 The great U of 39·96 (Oppert) is possibly a variant of the preceding, found in some Assy- **507**
rian buildings as 19·97.

21·6 By the recorded circuit of Khorsabad the U is 10·806, hence the series of multiples on the **549**
tablets is:

susi, ·18	20=palm, 3·6	3=U, 10·8	6=qanu, 64·8	2=sa, 129·6	60=us, 7776	30=kasbu 233,280

In Phrygia this was 21·8 at Ushak; in Italy it was 21·86 in Lucania, and half of 21·7 or 21·9 as the Oscan foot. It may occur in square prehistoric earthworks in England. In Egypt there are late cubits of 21·11, 21·16, 21·33 which may be the same. In Persia it was likewise a smaller form, as:

vitasti, 10·7	2=arasni, 21·4	360=asparsa, 7704	30=parathanha, 231,120	2=gav. 462,240

22·2 This important unit was used in Phoenicia, at Byblos 11·10, for the Erechtheion 11·09, and **564**
in Punic colonies, Carthage, Sardinia, and the Hauran, 11·08–11·17. The double of 11·30 is the commonest unit of tombs at Jerusalem.

inches **25·1** There are very few evidences of this measure. Divisions on a wall at Abydos give 25·13. The contents of the brazen sea of Solomon, taking mm. **638**
the bath as 2380 c.c., would imply a cubit of 23·0 if cylindrical, or 26·2 if hemispherical. This at least proves a cubit much longer than the Egyptian. Oppert concluded that Assyria had a cubit one-sixth longer than 21·6, *i.e.*, 25·2. Measures of buildings point to 25·28 in Palestine, and 25·34 in Persia, where the *guerze* is 25 inches.

There are not included here some suggestive but debatable evidences of various units, such as the course heights of the pyramid of Khufu (*Anc. Eg.* **1925,39**), and the subsidiary marks of units on the standard cubits.

It may be noted how usually a stadium or furlong measure has been established; there are seven named above, 7258, 7290, 7470, 7506, 7704, 7776 and 7920 inches. These may result from convenient lengths for the plough furrow. It is easy to find coincidences with so many values to choose from.

Areas are passed by, as they involve very uncertain factors of methods of cultivation, length of furrow, influence of measures of seed, and varying ability of ploughing due to soil.

CAPACITY MEASURES

The approximate values of Egyptian capacities are anciently stated by the odd quantities that certain vases held; but as these were probably measured to some unknown point below the brim, the result cannot be exactly defined. The standard vessels, here described, intended for gauging, give better determinations than have been known before.

cubic inches **29·1** The amount of the Egyptian hen by five regular measures (of metal or stone) averages 29·2 ± ·5 cu. in., from ten bronze vessels 29·0 ± ·3, from eight marked vases 29·2 ± ·6. So 29·1 c.c. **477**
may best be adopted. If it held 5 debens of water the deben weight would be 1,470 grains, which is nearly a middle value. The multiples are

ro, 3·64	8=hen, 29·1	4=hennu, 116·4	10=apt, 1164	4=tama, 4656	25=sa 116,400

20·8 **21·6** There is a double grouping of the Syrian kotyle, on 20·8 and on 21·6. This is supported by the literary difference between the old **341** **354**
Syrian 21 and Seleucidan 22 cu. in. (Hultsch). The cause for this change may have been that the old unit of 20·8 belonged to 25 beqa of water, and later it was raised so as to fall within the limit of 25 sela of water. The change would be caused by the sela superseding the beqa as a usual weight standard. In Egypt this was the commonest measure, of which there is a series of the 3rd dynasty, and a stone cylinder standard from the 4th, of 20·8. The series of early and late values is:

kotyle,	2=xestes,	18=sabitha or saton,	3=bath, artaba
20·8	41·6	7488	22,464
21·6	43·2	7776	23,328

There was also the metretes of 5 saton, 37,440 to 38,880.

33·2 The Syrian log was not unusual in Egypt. Nearly in the midst of the values for it, there **544**
is a bronze cylinder measure with names of Amenhetep III., of 33·26. If this log were to agree with 50 necef, the most usual Syrian weight, it would not be over 32·6 in early times, and would only reach 33·2 in the 18th dynasty. The Phoenician, Babylonian and Jewish systems vary as follows, the Egyptian amounts being placed to the latter series.

P. log, 31	4=kab, 123		6=saton 740		30=kor 22,200	
B. log, 33	4=kapitha, 132			18=epha, 2380	10=homer, 23,800	6=akhane 142,800
J. log, E. 33·2	4=kab, 132·8	3=hin, 398·4	2=seah 796·8	3=ephah, 2391	10=homer 23,910	

17·4 The Attic kotyle is found in the size of six similar bronze bowls of late form in Egypt, **285**
from ½ to 2 kotyles. The mean is 17·15. This amount is too small for an Attic weight, for if the khous were 8 minae of water, the largest bowl size would only agree with the lowest mina. But if the kotyle of water weighed half the mina of Chios

[o]r Persia (khoirine system), this would place it at 16·6 to 17·5. [I]n this dilemma the Persian kapetis has some influence. According to Herodotus (1,192) the Attic kotyle: kapetis : : 12 : 51, or [1] : 17. The kapetis is shown by two bowls mentioned below, to [b]e 74·5 or 75·3, therefore the kotyle would be 17·53 or 17·72. If we take 17·4 that would leave the 51 of Herodotus the nearest whole number, and the small difference would thus be divided among the three factors. The series is for:

Liquids

kyathos,	$1\frac{1}{2}$=oxybaphon,	4=kotyle,	12=khous,	12=metretes
2·9	4·35	17·4	208·8	25,056

Solids

kyathos,	6=kotyle,	4=khoinix,	8=hekteos,	6=medimnos
2·9	17·4	696	5568	33,408

cu. in. Two bowls of Persian age, from Egypt, are of c.c.
74·5 74·5 and 75·26, clearly the Persian kapetis. 1221
Their relation to the kotyle value is stated above. The multiples were:

kapetis,	48=artaba,	40=	akhane
74·5	3576		143,040
	maris,	72=	
	1987		

58·5 A system found at Gythion (Rev. Arch., 1872) is based upon 58·5 cu. in., and seems to belong 958
to the Egyptian hen, double of which is 58·2.

kotyle,	4=hemihekton,	4=khous,	3=*n*
58·5	234	936	2808

1701 The most important Roman system is far from being established. The data are but few 27870
and discrepant.

	amphora	sextarius	amphora	sextarius
If amphora=cube ft	1569 cu. in.	32·7 cu. in.	25,709 c.c.	536 c.c.
Amphora 80 lib. water..	1575 1605	32·8 33·4	25,807 26,300	538 548
By Farnese congius.....	1654	34·4	27,102	563
St. Geneviève congius...	1700	35·4	27,856	580
Naples measures.......	1701 1703	35·44 35·48	27,872 27,905	581 581
Pompeian standard.....	1732	36·1	28,377	591
Caervoran standard.....	1824	38·0	29,888	623

There does not seem any course better than to accept the two accurately made measures in the Naples Museum of 709·7 and 283·5 cu. in. as being 20 and 8 sextaria; this would give 1702 for the amphora, agreeing with the St. Geneviève congius. The Naples vessels are only measured by lineal gauging, but that cannot be far in error. The system was:

quartarius,	4=sextarius,	6=congius,	4=urna,	2=amphora
8·86	35·44	212·6	850·5	1701

Of the above sources the first two may be only approximate, and the Farnese congius is not above suspicion of a renaissance origin. The Pompeian measures seem too rough internally, and look as if they had held a beaten copper lining. The Caervoran measure is marked as $17\frac{1}{2}$ sextarii, and this yields 38·0 cu. in.

Weights

The whole subject of weights as treated here is based on the Egyptian material, as that is by far the earliest and the best known historically, and in amount the largest published. The arrangement found in Egypt serves best to classify the standards of other countries. The broad view is that each people or tribe had a separate standard, and that these were brought into different countries by invasion or trade. Those standards which were most alike gradually approximated by errors of copying, and lost their individuality entirely before any of the literary records. Thus 17 standards in Egypt which had originally come from various foreign sources, became simplified to 8. They are here described in the order of their amount.

grains The peyem standard is marked P.Y.M. on grammes
116, three Palestine weights. The varieties named 7·52,
121, here were all known before the 6th dynasty; 7·86,
124 the two heavier were mixed at the 20th dynasty, the lighter one joined in the 26th. 8·06
There are twelve weights known marked with numerals, and the standard, called *shoti* in Egypt, is named on papyri as being 12 to the deben, or between 115 and 126 grains. The multiples were:

n	4=peyem,	10=noshem,	10=*r*,	4=*s*
30	120	1200	12,000	48,000 grains.

The noshem was 1225 grains according to a triply inscribed weight; the shekel or peyem being 122·5.

grains Two standards of the daric existed in the Old grammes
127·5, Kingdom, but they were blended in the 18th 8·26,
131·5 dynasty. The same separation is seen in the 8·55
weights from Ur, with a light group at 126·1 and a heavy group at 129·4. The earliest in Egypt is of S.D.40, or the beginning of the eastern immigration of Gerzean age; these centre on 125·5. The early weight of Dungi is of 125·9. A maneh of 50 shekels at 126·0 was used in Syria and Knidos. In Italy it was divided into unciae, and termed the litra. Italic bronze ingots of a talent are based on 126·0. On the heavier standard the Persian karasha was 10 shekels of 128·65. The coinage under the Persians (from which is taken the name Daric) was of 129·2, and some coins reach 131. The heavy standard at Knossos is 131·8, 132·9. This daric standard spread over Asia Minor and across the Euxine, also westward to Corinth, the Adriatic isles, South Italy, and even to Ireland (gold work 128·0). The series is:

um,	60=sikhir,	6=shekel,	60=maneh,	60=trade talanton
·36	21·5	129	7750	465,000

134·0, The Stater or Attic standard is the least prominent in Egypt; the forms are poor, and only 8·68,
135·8 two examples bear numerals. The two stand- 8·80
ards were unified by the 18th dynasty, and the multiples are decimal. In Greece the system was:

khalkous,	8=obelos,	6=drachma,	100=mina,	60=talanton
1·4	11·17	67	6700	402,000

In Greek use there was a lighter form for coinage, 133, and a heavier form in trade, centring on 135. The names of obelos and drachma, or a dart and a handful (of darts), show how objects were used for weights in Greece. The names must have arisen in the use of iron or bronze weapons, and the silver coins were the exchange values. This standard passed into Italy, where it was halved for the Etruscan and Sicilian libra, and divided into 12 unciae. It was the talanton of Antioch and of the Ptolemies, and survived in Egypt as the rotl, divided duodecimally as in Italy, and so producing the dirhem which was the standard coin of Arabic Egypt.

144 The qedet was the national standard of Egypt, brought in by the dynastic people. There are 9·33
very few marked weights because it was so usual. Though there were not distinct groups in early times, yet there were local differences, as weights "of Heliopolis" are on 140 unit, while one of Amasis is 150. Alabaster cones are the earliest, belonging to the 1st dynasty; they are multiples of a third of the qedet; from Ur are six small weights that are multiples of a twelfth of the qedet so the division in thirds comes from Babylonia. There are many qedet weights from Gezer and Gerar, also from Knossos and Troy. A large knuckle-bone of bronze from Gela, inscribed "I am of the Gelonians" is 100 qedets. The unit, however, did not spread much in other countries, nor start other standards.

b,	4=*c*,	3=qedet,	2=khenp deben,	5=deben,	10=sep,	5=*d*
12	48	144	288	1440	14,400	72,000

The deben was binarily divided in Ethiopia for the gold trade, down to the *pek*, which was $\frac{1}{128}$. A set of measures for gold dust gives every stage of this division.

154·4, The necef is named on six Palestine weights; 10·0,
162 it may be the nusa weight mentioned in the Harris papyrus. It was first identified by the 10·5
weight of Syrian tribute to Tehutmes III. being in odd numbers of qedet, but soluble as multiples of this amount. The two varieties of this unit did not blend till the 26th dynasty; the lighter was the Syrian standard of named weights, and was the

earlier one at Gezer. The system was decimal, multiplying up to 1,000, and halving down to ⅛th. By the tribute lists it was North Syrian, and in later times is found at Berytus and Antioch, Cilicia (pre-Persian), Asia Minor, and a bronze lion from Abydos of 2,500 necef. On going west there is a ¼ necef at Knossos. It appears in the jewellery of the 17th dynasty at Thebes, a collar of gold weighing 10×158·5, and bangles 2×161·3, 162·9. This collar is of the same form as the three Swedish collars weighing 60×158·2, 70×155·9 and 80×158·7, all on the necef basis. Where all this necef jewellery was made is yet unknown, but it was entirely foreign both to Egypt and to Sweden. There are about 50 Irish gold objects on the heavy necef of 162 to 169. The Greek system was:

stater,	50=mina,	50=talanton
160	8000	400,000
		60=Greek talanton
		480,000

grains 171, 185 — A mark ♉ is often used for this unit, but the name is not known in full. As many copies of cowry shells are on this (but on no other) standard, it is called the khoirine, and perhaps the monogram is XO, as those letters were in use long before Greek writing. — grammes 11·08, 12·00

The bulk of the early examples is from 176 to 190; but there was a rarer form at 171–3, down to the 18th dynasty, and not blended with the majority till the 23rd. Three very fine numbered weights from Gerar closely agree in giving 179·3 to 179·8; the stone cowries are the same, but rather more divergent, 177·7 to 180·0. The multiples in Egypt are decimal up to 1,000, and fractions down to $\frac{1}{10}$. In later times it became the Persian silver standard, but all the theories of the derivation of an 86 grain weight, from the ratio of gold to silver, are blown away by the fact that this standard is thousands of years older. At Khorsabad silver plates are 40 khoirines in weight. As a monetary unit it is known at Arados, Cilicia, Lydia and Macedonia. It is known as the Chian standard, with a mina of 8,410 to 8,886. It was used on the Danube in Roman times, and recognized as a mina of 20 unciae. The classical system was:

obolos,	6=siglos,	100=mina,	60=talanton
14·3	86	8,600	516,000

196, 210 — The oldest standard known is the beqa, found in early Amratian graves in Egypt (7000–8000 B.C.), and named upon three weights in — 12·70, 13·61

Palestine. This is often called the gold standard because many of these weights bear the hieroglyph for gold. The names of kings are more frequent on this than on other standards. The lighter and heavier forms were not unified until the 23rd dynasty, though both were used before for royal weights. The system was decimal up to 2,000 beqa, with fractions down to $\frac{1}{18}$. The earliest weights (Amratian) are short cylinders with domed ends; later (Gerzean) is a dome with convex base. From the marks, the variety of forms, and fine work, this is the most attractive series of weights. Abroad the standard is often found at Gerar and there are several weights from Knossos (**194–205**); in the west are six double axes from Elbe and Rhine, on a unit of 191, and 50 examples of Irish gold, on 200 to 202. The iron currency bars found in Celtic England are stated to be on multiples of 191, though they vary rather widely. Some of these western forms are due to the Greek adoption of the beqa as the standard of Aigina (**199**), which was widely spread by trade in Asia Minor and Ionia, as well as in Greece (the old mina of Athens), and passed on to Italy. There as the Etruscan pound (it originated the Roman libra), which at its lightest was 25×187, divided into 12 unciae.

5050, 421 — The heaviest value of the Roman libra is given by the early aurei as 5050, uncia 421. The influence of unification with other standards — 327·24, 27·27

created many types of the libra, and it is instructive to see the groups at 393 (**6** Attic coin drachma), 407 (**6** Attic trade drachma), 412 (Roman trade), 417 (Roman solidi), 421 (Roman aurei), 427 (octodrachm Ptolemaic) and 435 (**2** Phoenician staters). The Attic trade value was adopted for the average pigs of lead, which are 250 librae of 4,900 grs.; the Attic coinage value influenced the Celtic weights, Mayence 4767, Glamorgan 4770. The system was:

siliqua,	6=scripulum,	4=sextula,	6=uncia,	12=libra
2·9	17·5	70·1	421	5050

In later times the gold solidus, or sextula, was called the nomisma.

grains 220 — The Phoenician or Alexandrian unit is best termed the sela, which, though a later name, — grammes 14·26

serves to distinguish it from other shekels. It was a diffuse unit from the beginning, varying in the Old Kingdom from 214·7 to 227·0; it gradually diminished to as low as 210. The multiples are decimal up to 4,000, and fractions to $\frac{1}{16}$. This is found as the unit of the Syro-Mesopotamian tribute under Tehutmes III., and later as one of the most usual coinage units, such as the Maccabaean shekel. It was carried by trade to Carthage and Spain, and formed the Italic mina. Gold bars from Abukir of Roman age are each 25 shekels of 211·7, 212·9, and 213·0. The series is:

drachma,	4=shekel,	25=mina,	120=talanton
55	220	5500	660,000

It extended widely into prehistoric Europe. At Knossos the great octopus weight shows a unit of 223·7, an ox-head from the Diktaian cave shows 227·2, a gold bar from Mykenai 233·1, another from Enkomi 222·6. The Vapheio cups are 20 sela of 213, and 216·5. Electrum jewellery from the temple of Ephesos is on a unit of 219·0. In Babylon the maneh of the age of Entemenna (2850 B.C.) is 50 of 210·1. The average of 19 ingots of bronze from Hagia Triada gives a talanton of 2,000 shekels of 226·0. Two double axes from the Rhine and four Ligurian ingots agree on 50 shekels of 225·4. The Irish gold has a large group agreeing with an average of 226·0. Thus there was a great spread of the unit, doubtless due to Phoenician trade.

Bibliography.—*Ancient Egypt* 98 (1922); *Proc. Soc. Bibl. Arch. X.*, 464; R. S. Conway, *Italic Dialects* ii., 521; *Anc. Eg.* 119 (1925); *Proc. S. Bibl. Arch.* 302 (1893); Fauré, *Rev. Archéologique* ii., 117 (1904) (listed figures are his multiples, not actual measures); Petrie, *Hill figures of England;* Kennedy, *Trans. Victoria Inst.* (1915); *Anc. Eg.* 33 (1923); Montelius, *Prim. Civil. Sweden in Heathen Times,* p. 128; *Öster, Arch. Inst.* x. 127; *Proc. Soc. Ant.* 184 (1905); Petrie, *Qurneh* xxix.; *Rev. Assyriologie,* xviii. 319; Petrie, *Tools and Weapons;* University College, *Proc. Soc. Ant.* 186 (1894); Petrie, *Weights and Measures.* The 1887 edition gives more detail of the authorities, which is summarized here; and for the material evidence in general, reference should be made to Petrie, *Ancient Weights and Measures* and *Glass Stamps and Weights* (1926). (W. M. F. P.)

MEASURING TOOLS: *see* Machine Tools; Woodworking Machinery and various articles under specific titles.

MEAT, in the narrowest sense, the flesh of veal, beef, pork, lamb and mutton producing animals. In a broader sense, meat includes the flesh of other animals such as fowls and birds. In a still broader sense, meat includes all the parts of the animal body used as food. This would classify lean flesh, fat flesh, skin, edible glands and organs all as meat. Such products contain water, protein, fat and mineral matter, together with small amounts of glycogen, meat extractives and other miscellaneous organic substances. The fat content will vary with the fatness of the animal. As the fat increases the other constituents decrease. The accompanying table gives the composition of typical flesh of various degrees of fatness.

Percentage Composition of Flesh (Beef)

	Water	Protein	Fat	Ash	Other constituents
Lean flesh	73	20	5	1	1
Medium fat flesh	65	17	16	0·9	0·9
Very fat flesh	35	9	55	0·5	0·5
Fat flesh (no lean)	9·7	2·5	87·5	0·1	0·1

Other edible parts differ more or less from the flesh in composition, although the same constituents are present and in somewhat similar proportions. The following table gives the composition of certain edible organs and parts. While the analyses given are for tissues of the beef animal, they represent rather accurately the

composition of the same parts of other animals.

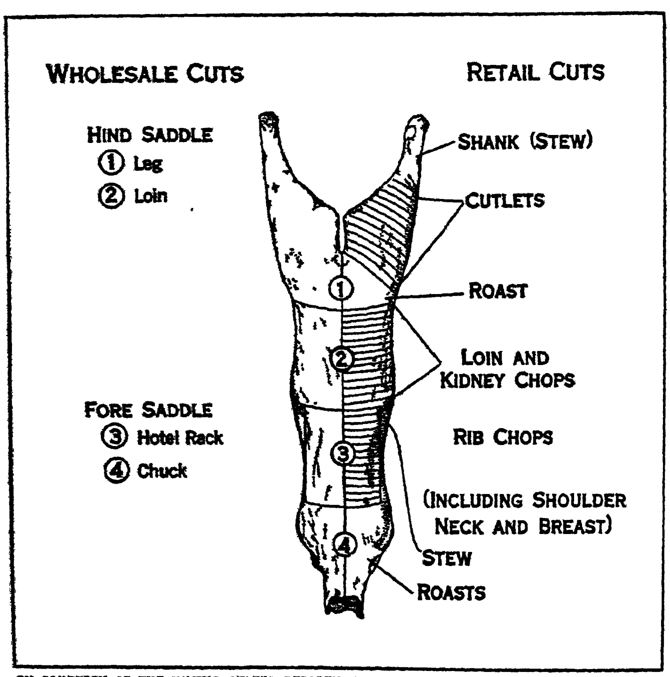
Percentage Composition of Edible Organs (Beef)

	Water	Protein	Fat	Ash	Other constituents
Liver . . .	69·5	20·0	2·5	1·5	6·5
Kidney . . .	77	16·5	3·5	1·1	1·9
Heart . . .	77·5	16·0	3·5	1·0	2·0
Tongue . . .	67	16·0	13·5	0·9	2·5
Brains . . .	71	10·8	13·5	1·7	3·0
Tripe . . .	80	10·6	8·0	0·9	0·5

Digestibility.—The various meats and organs of animals are almost completely digested in the stomach and intestines. On the average, the fats are about 96% digestible, while the proteins may be even more completely digested. In addition to being almost entirely digestible, these animal foods are satisfying; that is, they remain in the stomach longer than starch and sugar foods and so they postpone the feeling of hunger. The fatter meats remain in the stomach longer than the leaner meats.

Food Value.—The food value of meat depends upon its content of protein, fat, mineral matter (or ash) and vitamins. The protein is the most important constituent, both on account of the quantity present and also because of its quality. Proteins have 18 or 20 constituent parts or kinds of "building stones," known as amino acids. These are of varying importance as food. Meat, especially the lean flesh, liver, kidney, heart and tongue, has a very complete assortment of these amino acids, and therefore stands very high in the scale of protein foods.

Meat has some of all the necessary minerals. It is especially valuable for its phosphorus and iron. Recent investigations,

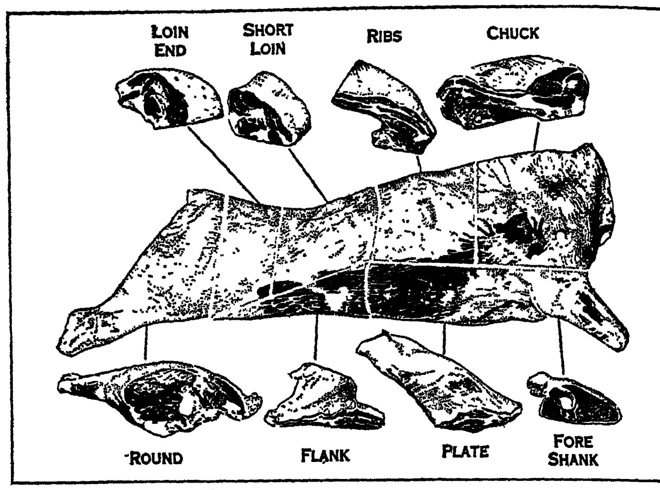


BY COURTESY OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

VEAL CHART SHOWING VARIOUS PARTS AND THEIR USES

especially with cases of pernicious anaemia, have shown that liver, kidney and lean meat are some of the most important iron-containing foods. The meats are low in calcium, another very important mineral element. This deficiency should be supplied by milk, cheese and the green, leafy vegetables. Meats, fish and cereals contain an excess of acid-forming over base-forming mineral elements. Vegetables and most fruits contain an excess of base-forming mineral elements. In order to balance the diet with respect to this factor, one should use foods from both groups in about equal proportions. Meat and potatoes, tongue and spinach, corned beef and cabbage, and spare ribs and sauerkraut are examples of combinations which meet this requirement.

Meats contain some of the important vitamins. Liver and kidney are especially rich in vitamins. Tongue and heart have a somewhat lower vitamin content. Lean flesh has ample quantities of vitamins B (the pellagra-preventing part of this complex) and E (the anti-sterility vitamin). The other vitamins are found in small quantity in flesh. The body fats may contain fair amounts of vitamin A. The content of vitamin C (the scurvy-preventing vitamin) is of little importance when the meat is cooked. How-

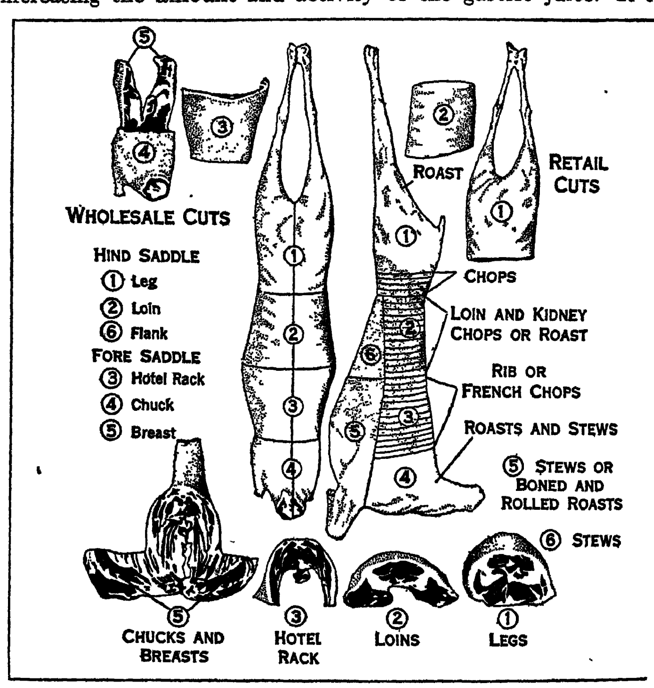


BY COURTESY OF SWIFT & CO.

STANDARD BEEF CUTS, CHICAGO STYLE

ever, Eskimos and Arctic explorers have proven that fresh and under-cooked meat, when eaten in quantity, will cure or prevent scurvy.

Use in the Diet.—Meats are of importance in the diet not only on account of their food value but also because of thei flavour and their stimulating effect upon the flow of digestiv juices. Meat, especially the extractives, stimulates digestion by increasing the amount and activity of the gastric juice. It con



BY COURTESY OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

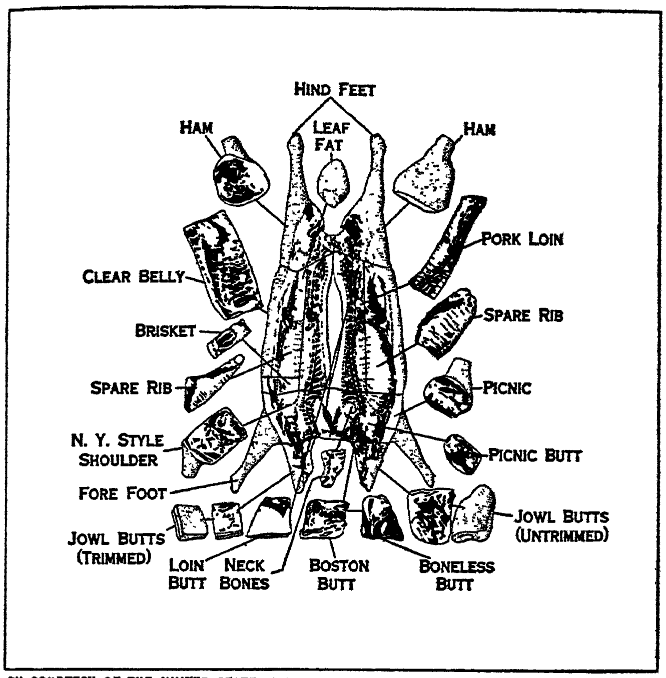
LAMB CHART SHOWING THE VARIOUS PARTS AND THEIR USES

trasts nicely in flavour with starchy and bland foods, and helps in adding flavour to mixed dishes and to the diet as a wh Since the proteins are very complete, they help to balance less complete proteins found in cereals and vegetables.

Healthfulness.—Properly inspected, stored and prepa meat is a healthy food, useful in the diet of most normal pe Being a good food of fairly high water content, fresh meat r be stored in refrigerated rooms or boxes until it is consu Otherwise it may spoil, just as milk, eggs, fish and other

protein foods. Cured meats keep better than fresh meats. In common with most of these same foods, the animals and their meats should be given careful inspection by competent persons to ensure their wholesomeness. This is done under Government inspection in all establishments engaged in interstate trade.

The use of meats in a mixed diet can not be said to lead to any disease or disturbance of bodily metabolism. Certain sects



BY COURTESY OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

FRESH PORK CHART, SHOWING VARIOUS CUTS

or groups of individuals believe such things, but science and the medical profession have shown there is no basis for such beliefs. On the contrary, the use of meats in a mixed diet is one of the factors that will lead to good health through proper nourishment.

See also MEAT TRADE. (C. R. M.)

MEAT COOKERY. Butcher's meat may be roasted, baked, fried, grilled (broiled) or stewed. It may also be combined with pastry (*q.v.*) in meat pies, puddings, vol-au-vents, etc.; with cereals, vegetables (*see* CEREALS, VEGETABLE COOKERY and PULSES); and used in soups (*q.v.*).

Roasting and Baking.—To prepare meat for roasting or baking, wipe the meat, trim and truss it into shape if necessary to prevent spreading. Certain joints need boning and rolling, *e.g.*, a breast of mutton. In this case the bones are removed by slipping a sharp knife along the bone without cutting through the flesh. Boned meats may be spread with forcemeat. Bones should be used for stock. Basting is the most important of all requirements for roasting. Sufficient fat usually runs out of fat meats for the purpose but in meats which are deficient in fat, *e.g.*, veal, additional fat is necessary. Dredging the joint with flour helps to seal in the juices and also improves the colour of a roast joint and makes a better gravy. (*See* GRAVIES.) Small joints may be covered with brown paper to keep them from browning too much. Hams may be covered with a flour and water paste and baked in the oven. Pork which has a tough outer skin ought to be seared with a knife before roasting for the convenience of the carver. Stuffed meats are usually served with a thickened gravy; plain roasts with a clear gravy.

Boiling.—Joints for boiling should be securely tied with string. Fresh meats are placed in boiling salted water with pot herbs, *i.e.*, carrot, onion, ½ turnip and a *bouquet garni* (parsley, bay leaf, thyme, etc.). Boil for ten minutes, skimming the water carefully. Where vegetables are being boiled with the meat for serving, these should not be added until the requisite time needed for cooking. It is usual to serve special vegetables or sauces with boiled meats to give extra flavour: *e.g.*, boiled mutton and caper sauce; bacon and pease pudding; boiled beef and carrots.

Ox tongues and hams require 24 hours' soaking before cooking to draw out the salt and pickle. Salted and pickled meats should be put into cold water and brought slowly to the boil. All boiled meats should be simmered after the first ten minutes.

Boiled meats which are to be used as cold dishes should be dressed, *e.g.*, ox tongues need skinning immediately after cooking, and when cool should be glazed. Hams also need skinning and should then be covered while warm with grated toast.

Calf's head should be cut down the middle, leaving the tongue whole. Remove the brains and soak the head in cold water for an hour. Soak the brains separately in salted water; then place them in cold water with a little lemon juice and boil for 15 minutes. When cooked mix with chopped sage and onion (one teaspoonful). Put the head into cold water, bring to a boil and rinse in cold water. Return to the fire in a pan with vegetables, spices and seasoning, and simmer until tender. Blend the brains with a melted butter sauce and pour over the head. Garnish with slices of lemon.

Stewing.—This is the most inexpensive method of meat cookery and may take the form of a white or clear stew, *e.g.*, Irish stew, hot pot, or, a brown or white thickened stew, *e.g.*, stewed veal. For a clear stew place the meat direct in a pan with just enough water or stock to cover it. Season and add vegetables according to taste. For brown stew dip the meat in seasoned flour and fry in fat, then remove the meat and add sufficient flour to absorb the remaining fat in the pan and form a *roux*. Cook the *roux* until brown and add the stock which should be sufficient only to cover the meat. If onions are added these ought to be fried after the meat. A more elaborate stew is made by adding other ingredients, *e.g.*, mushrooms, vegetables, etc., together with special sauces.

A white stew is made with white stock, or milk and water, and the *roux* is not allowed to brown. In this case, the meat is not fried. A *blanquette* of veal is made by cutting the veal into small pieces. Place these in a pan with white stock to cover. Peel two onions, stick with cloves, add one carrot and herbs. Bring to a boil and simmer for one hour. Strain off the liquor, thicken the latter with a flour liaison, cook and slightly cool. Add the yolk of an egg and chopped parsley. Pour over the veal.

Grilling or Broiling.—Trim off surplus fat and skin, beat into shape and, if necessary, tie with string. Oil the gridiron and heat it before using. Turn the meat frequently with tongs or two spoons. Do not use a fork. Grilled meats are usually served dry with *maître d'hôtel* butter (parsley, lemon juice and butter blended together), or merely moistened with the fat and juice which have run out of the meat.

Frying.—Unless the meat is minced and protected in batter, meat should always be "dry" fried, *i.e.*, in a frying pan. White internal organs, *e.g.*, sweetbreads, etc., ought to be scalded before cooking. Liver should be cut into thin strips; kidneys need skinning after washing. A "mixed grill" is commonly cooked by frying in place of grilling.

Meat is frequently reheated in the form of slices of meat warmed in good gravy, hash, curries (cold meat warmed in a curry sauce); or minced and formed into rissoles, etc. In all reheating the aim should be to avoid re-cooking. Judicious flavouring and careful cooking are the essentials in re-heated meat dishes.

Galantines.—These are cold meat dishes consisting of a mixture of several boned minced meats, poultry or game deprived of all gristle and skin and usually mixed with hard-boiled eggs and truffles to garnish. To prepare, pound all the ingredients except the garnishes in a mortar, add seasoning, shape into the desired form and tie in a floured cloth. Boil gently for two hours in water with pot herbs and seasoning to taste. After cooking remove cloth, reshape if necessary by pressing and rolling, and place under heavy weights. Finally, brush over with glaze. Trim off a slice from each end and garnish with fresh parsley.

Brawn.—Correctly speaking, brawn should be made from pig's or sheep's head but so-called brawns are made of rabbit, etc. Wash the head thoroughly, place in cold water to cover, bring to

a boil, add pot herbs and seasoning and simmer until the flesh leaves the bones. Skim while cooking. Cut up the cooked flesh into small pieces together with the tongue. Remove skin and gristle. Reduce the liquor to one half, and strain over the meat. Cool slightly and pour into a wetted mould. Spices may be added to brawns if desired.

See also COOKERY; GRAVIES; SAUCE. (J. A. SI.)

MEATH, a county of Ireland, in the province of Leinster, bounded east by the Irish sea, south-east by Dublin, south by Kildare and Co. Offaly, west by Westmeath, north-west by Cavan and Monaghan, and north-east by Louth. Area 579,320 ac., or about 905 sq. miles. Pop. (1926) 62,909.

In the north is a broken country of Silurian rocks with much igneous material, partly contemporaneous, partly intrusive, near Slane. Carboniferous limestone stretches from the Boyne valley to the Dublin border, giving rise to a flat plain especially suitable for grazing. Outliers of higher Carboniferous strata occur on the surface; but the Coal Measures have all been removed by denudation. The coast extends about 10 m., but there is no harbour of importance. Laytown is a small seaside resort, 5 m. S.E. of Drogheda. The Boyne enters the county at its south-western extremity, and flows north-east to Drogheda. At Navan it receives the Blackwater, which flows south-west from Cavan. Both these rivers are noted for their trout, and salmon are taken in the Boyne, which is navigable for barges as far as Navan whence a canal is carried to Trim. The Royal canal passes along the southern boundary from Dublin.

A district known as Meath (Midhe), including the present county as well as Westmeath and Longford, with parts of Cavan, Kildare and Co. Offaly was formed by Tuathal (*c.* 130) into a kingdom to serve as mensal land or personal estate of the Ard Ri or over-king of Ireland. Kings of Meath reigned until 1173, and their descendants claimed the title as late as the 15th century, but Hugh de Lacy was confirmed in the lordship of the country by Henry II. But though Meath was declared a county in the reign of Edward I. (1296), and though it came by descent into the possession of Edward IV., it was long before it was fully subdued and its boundaries clearly defined. In 1543 Westmeath was created a county apart from that of Meath, but as late as 1598 Meath was still regarded as a province by some, who included in it the counties Westmeath, East Meath, Longford and Cavan. Early in the 17th century it was at last established as a county, and no longer considered as a fifth province of Ireland.

There are two ancient round towers, the one at Kells and the other in the churchyard of Donaghmore, near Navan. By the river Boyne near Slane there is an ancient burial-place called Brugh, with 20 burial mounds, the largest of which is that of New Grange, a domed tumulus above a circular chamber. The mound is surrounded by remains of a stone circle, and the whole forms one of the most remarkable extant erections of its kind. Tara (*q.v.*) is the seat of a royal palace referred to by Thomas Moore. The more important monastic ruins are those of Duleek, said to have been the first ecclesiastical building in Ireland of stone and mortar; the extensive remains of Bective abbey; and those of Clonard, where also were a cathedral and a famous college. Of the old fortresses, the castle of Trim still presents an imposing appearance.

The soil is principally a rich deep loam on limestone gravel, but varies from a strong clayey loam to a light sandy gravel. Oats, potatoes and turnips are the principal crops. Cattle, sheep and poultry are increasing. Agriculture is almost the sole industry, but coarse linen is woven by hand-looms, and there are a few woollen manufactories. The main line of the Great Southern railway skirts the southern boundary, with a branch line north from Clonsilla to Navan and Kingscourt (Co. Cavan). From Kilmessan on this line a branch serves Trim and Athboy. From Drogheda (Co. Louth) a branch of the Great Northern railway crosses the county from east to west by Navan and Kells to Oldcastle. The administrative county of Meath returns three members to Dáil Eireann.

MEAT TRADE. The principal meat-exporting countries are Argentina, Australia, New Zealand and Uruguay. The total exports from these countries in 1927 were:—

	Beef	Mutton and lamb	Total
	Tons	Tons	Tons
Argentina	687,281	71,468	758,749
Australia	60,148	25,586	85,734
New Zealand	21,500	139,000	160,500
Uruguay	100,845	27,146	127,991

Brazil exported 24,183 tons of beef in 1927. Canada exports live cattle and sheep to the United States and in 1927 also sent 22,979 tons of beef to that country. To Great Britain in the same year she sent 8,263 head of cattle and 260 tons of frozen meat. South Africa is developing an export trade in beef and in 1927 shipped 6,044 tons, mostly to Italy. The quantity in that year was reduced by the effect of drought; in 1926 it reached 15,184 tons. Patagonia is an exporter of mutton and lamb and in 1927 shipped 27,760 tons.

The total quantity of frozen and chilled meat exported from all sources in 1927 is calculated at 1,256,900 tons. Of this quantity about one-fifth was produced in the British dominions and practically all the remainder in South America.

The total quantity imported into Great Britain and Ireland in 1927 was 949,304 tons, leaving about 300,000 tons, for all other importing countries.

English Meat Production.—It appears on the face of it, anomalous that while the quantity of meat imported into Great Britain is known, the quantity produced in Great Britain is unknown, and can only be approximately estimated. The reason, however, is obvious. The annual agricultural returns give the number of cattle and sheep in the country on a given day, but there are no returns of the number slaughtered in the course of the year, or of the quantity of meat which was thus produced.

The average numbers of animals sold for slaughter off farms in 1926–27 were estimated as:—cattle 1,285,000, calves 834,000, sheep and lambs 5,588,000; and the meat produced as—beef 360,250 tons, veal 32,400 tons, mutton and lamb 129,750 tons, making a total of 522,400 tons.

The following table shows the estimated total consumption in Great Britain and Ireland for the years 1922 and 1927, respectively:—

	1922	1927
	Tons	Tons
Beef		
Home-grown	767,300	819,900
Imported	556,229	673,136
Mutton and lamb		
Home-grown	254,600	303,300
Imported	292,438	276,168
	1,870,567	2,072,504
Deduct re-exports	44,597	23,859
	1,825,970	2,048,645

It will be seen that in 1927, 45% of the beef and 47½% of the mutton and lamb consumed were imported.

British Imports.—The total imports of meat in 1927 into Great Britain and Ireland, including carcasses of cattle imported alive, amounted to 949,304 tons. The quantities received from each of the main sources of supply are shown below:—

	Beef	Mutton and lamb	Total
	Tons	Tons	Tons
Argentina	577,916	76,824	654,740
Australia	32,137	31,398	63,535
Brazil	8,391	..	8,391
Chili (Patagonia)	..	13,815	13,815
New Zealand	16,543	136,866	153,409
North America	5,348	154	5,502
South Africa	352	..	352
Uruguay	29,418	15,863	45,281
Other countries	503	1,248	1,751
	670,608	276,168	946,776

Of the total imports of beef 77% is "chilled" and the remainder frozen, while all mutton and lamb comes in a frozen state.

It should be added that there is a considerable importation of tinned or canned beef and mutton. This is distinct from what is commonly termed the "meat trade" and is subject to different commercial conditions. In 1927 the imports of tinned or canned beef amounted to 52,025 tons and tinned or canned mutton and lamb to 2,535 tons.

The International Meat Trade.—The development of the vast commercial organization by which some 1¼ million tons of meat are collected, transported across the sea, and distributed, has taken place in little more than fifty years.

The American people were first confronted with their own continental problem and from the solution of this came the development of a meat export trade. In the development of the internal trade there were three stages. During the early settlement of the United States and down to about 1850 conditions were similar, all over the country, to those prevailing to-day in Great Britain where meat is produced near the centres of population. As the eastern States became more thickly populated cattle-raising moved west and droving to market became general, as in Great Britain. When the railway system rapidly developed the trade was organized and centralized at a few great collecting and distributing centres, of which Chicago was chief. The "packing industry" originated in America long previously when pork was "packed" in barrels for the West Indies. The term "packing-house products" or "packed products" thus came into use and was applied to all dressed meat. At first the industry was carried on only in the winter months but the artificial creation of winter conditions in the packing-houses during the hot summer months enabled them to continue operations without interruption throughout the year.

Refrigeration Systems.—Refrigeration, in the modern sense, was invented in 1861 but it was some years before it became satisfactory and reliable for purposes of transportation.

The successful transportation, under refrigerated conditions, of dressed meat from the packing-houses in the middle west to the eastern seaboard paved the way for shipment across the ocean. In 1874 frozen beef "as hard as stone" was sent to Smithfield market in boxes, but the consignment was small and the financial result unsatisfactory. The first shipment of "chilled" beef was made from New York on Oct. 1, 1875. It arrived in good condition and with this consignment the trade in chilled beef was established. By 1880 all the steamship lines running across the Atlantic were equipped with cold storage plants. The refrigerating equipment was at first somewhat crude, usually consisting of an ice box and fans to circulate the cold air. Another device was to pump a freezing mixture—salt and ice—along pipes between the hanging carcasses.

Argentina and Australia followed closely on the United States. In 1878 frozen meat was first brought from South America and in 1879 the first shipment was made from Sydney.

There were of course many difficulties to be surmounted and much experimental work was done before the methods of refrigeration were perfected. The creation of "freezing-works" soon followed and the meat is now all frozen or chilled before being placed in the cold chambers of the vessels for the voyage. But for about forty years the trade has been organized on its present lines and its magnitude and importance have steadily increased throughout the meat-producing countries of the world.

World's Future Meat Supplies.—One of the most marked results of the World War was to increase the demand for meat on the Continent. There are no statistics of any value on the point but there are indications that while the number of meat-consumers increases steadily, the average consumption per head tends to decrease. It is accepted as a sociological truism that as the standard of comfort rises dietary becomes more varied. The consumption of meat in working-class houses in England, for example, was probably greater in the middle of the 19th century than in the 20th century when there is a larger variety of food available. Nevertheless the total world demand for meat is almost certainly greater than at any previous period and increases annually.

During the World War there was, especially in Europe, a serious depletion of the stock of food animals. Exporting countries, such as Argentina, were heavily drawn upon to meet the enormous requirements of the Allied armies while the central Powers used up a large proportion of their flocks and herds as well as making heavy purchases from such neutral countries as were accessible. But since the war successful efforts have been made to repair the losses and replenish the stock. The International Agricultural Institute published statistics showing that the number of cattle in 1926 exceeded the number in 1913 by 12·2%, the comparative figures, by continents, being as follows in thousands:—

	1913	1926
Europe	137,861	139,477
N. and Central America	74,336	81,467
S. America	86,662	101,051
Asia	142,087	154,356
Africa	33,174	47,926
Oceania	13,856	23,089
	487,976	547,366

In addition to this increase of 60 millions in the number of cattle there was also in the same period an increase of 12½ millions in the number of sheep.

There is no reason to suppose that South America has yet come within measurable distance of the limits of its capacity for meat production. Vast areas of land suitable for carrying cattle and sheep still await development. The improvement of the native stock proceeds continuously and, in Argentina especially, the results of the importation of high-class bulls from Great Britain are widely evident. The process is necessarily slow but, apart from increased numbers, there is a steady increase in the output of meat per animal, as a more economic type replaces the old "scrub."

The geographical potentialities of Australia for rearing more cattle and sheep are immense but they are at present restricted by physical difficulties. There can be no doubt that these difficulties will in time be largely overcome and Australia's contribution to the world's supplies will be indefinitely increased. In South Africa the production and export of meat have been only very recently taken up with vigour, but there is little doubt that within the next two or three decades it will become an important contributor to the total supply.

BIBLIOGRAPHY.—J. T. Critchett and J. Raymond, *A History of the Frozen Meat trade* (1912); G. E. Putman, *Supplying Britain's Meat* (1923); *Report on the trade in refrigerated beef, mutton & lamb*, Ministry of Agriculture and Fisheries (1925); *Annual review of the chilled and frozen meat trade*, pub. by W. Weddel and Co. Ltd. (1927).

(R. H. R.)

IN THE UNITED STATES

Measured by the value of its output, the meat packing industry was the third largest industry in the United States, according to the latest census figures available (1925). The plant value of the products of this industry in 1925 was $3,050,286,291. Fresh meat products, consisting of beef, veal, mutton, lamb and pork represented by far the greatest proportion of this total. The value of the cured meat products also was large, exceeding three-fourths of a billion dollars.

These values, although somewhat smaller than in 1919 when prices were at a peak, probably are fairly representative of the annual volume of business of the meat packing industry. Illinois leads all the States in the value of products of the meat packing industry, with a volume valued in 1925 at $680,591,940. Kansas is second with products valued at the plant at $248,939,792. New York is third, with products valued at the plant at $233,901,277. Other States in which the plant value of the products of the meat packing industry exceeds $100,000,000 in value are Iowa, Missouri, Nebraska, Minnesota, Ohio, Pennsylvania and California.

The average consumption *per caput* of meat in the United States in 1927 was 139·3 pounds. This was divided among the different meats as follows: beef, 58; veal, 7·4; lamb, 5·4; pork, 68·5. In addition, consumption *per caput* of lard averaged 13·8 pounds.

This represents a daily consumption *per caput* of approximately 2½ oz. of beef; ⅓ oz. of veal; ¼ oz. of lamb, and 3 oz. of pork, or a total of slightly more than 6 oz. A census of distribution, taken in 1927 in 11 cities, showed that the amount of money expended for meat and poultry (not including meat and poultry consumed in hotels and restaurants) averaged $27.18 *per caput*. The consumption of meat fluctuates somewhat from year to year, varying of course with the supply available and the export demand. Consumption *per caput* of meats and lard in 1927, which was 153·1 lb., compared closely with the average annual consumption *per caput* for the preceding 20 years, which was approximately 152 pounds. The total production of meat in the United States in 1927 was 16,872,000,000 pounds. Of this amount approximately 350,000,000 lb. were exported and the remainder consumed in the United States. Lard production in 1927 amounted to 2,356,000,000 pounds, of which 717,000,000 pounds, or 30%, were exported.

Millions of head of live stock are required to provide this enormous quantity of meat. According to estimates of the United States department of agriculture, the number of live stock on farms and ranges in the United States on Jan. 1, 1928, was as follows:

Cattle	55,696,000
Hogs	58,969,000
Sheep	44,545,000

Live stock producers receive for their meat animals an average of about $7,000,000 daily. The United States, the greatest live stock producing and meat consuming nation, has about 13% of the world's cattle; 7% of the world's sheep, and probably more than 25% of the world's hogs. In addition to its commercial importance, the live stock and meat industry is of peculiar economic significance. The reason for this is that live stock utilizes a large amount of grass, hay, etc., not suitable for consumption by man, and transform it into meat. Live stock also provides the outlet for a large proportion of the grain crops. Approximately 85% of the corn crop (maize), for example, is used for the feeding of live stock.

Imports of meat into the United States are relatively small, representing ordinarily less than 1% of the total supply. The export trade in meat products of the United States always has been important. Meat exports from the United States consist almost entirely of pork products. Although exports in 1928 were considerably lower than they were during the World War, in 1927 they exceeded 1,170,000,000 lb. in quantity and $172,500,000 in value. Among meat products, lard is the most important. Exports during 1927 approximated 700,000,000 lb., worth $92,000,000. Hams, shoulders and bacon also are important articles of export.

System of Distribution.—The bulk of the supply of live stock in the United States is produced west of the Mississippi river, and the bulk of the meat is consumed in the territory east of that river. This situation makes necessary an elaborate and efficient system of distribution. As the first step in this system, which distributes more than 50,000,000 lb. of meat daily, animals are shipped by rail or hauled by motor truck from farms to stockyards where packing plants are situated. These plants, of which there are several hundred, varying greatly in size, are located in all parts of the country, but are most numerous in such centres as Chicago, St. Louis, Kansas City, Omaha, St. Paul, St. Joseph, Missouri, Milwaukee, Indianapolis, Cleveland, Detroit, Cincinnati, Pittsburgh, Philadelphia, Baltimore and New York. From the packing plants the meat is distributed to all parts of the nation and of the world. This is accomplished through branch plants, branch selling houses, and "car routes" and by trucks. Goods are not sold directly to the consumer, but are sold to retailers. Branch selling houses sometimes do a limited amount of manufacturing, confining their operations largely to sausage-making and to the smoking of hams and bacon.

Car routes are operated in regions where the trade cannot conveniently or adequately be supplied from a plant or from branch houses. Ordinarily, car route orders are obtained by a salesman from dealers in a number of villages or cities in a given territory, after which the goods are packed at the plant in a refrigerator car for shipment. Motor truck routes are handled similarly. Many retailers obtain their meat supplies by truck from wholesale markets at plants or branch houses adjacent to their places of business.

The number of retailers who handle meat probably exceeds 200,000. According to the occupational census of 1920, 122,105 persons were employed as butchers and meat dealers. In addition, many grocers and delicatessen dealers sell meat. (W. HA.)

MEAUX, a town of northern France, capital of an arrondissement in the department of Seine-et-Marne, and chief town of the agricultural region of Brie, 28 m. E.N.E. of Paris by rail. Pop. (1926) 12,307. In the Roman period Meaux was the capital of the Meldi, a small Gallic tribe, and in the middle ages of the Brie. It formed part of the kingdom of Austrasia, and afterwards belonged to the counts of Vermandois and Champagne, the latter of whom established important markets on the left bank of the Marne. Its communal charter, received from them, is dated 1179. The town suffered much during the Jacquerie, the peasants receiving a severe check there in 1358; during the Hundred Years' War; and also during the Religious Wars, in which it was an important Protestant centre. In September 1567 Meaux was the scene of an attempt made by the Protestants to seize the French king Charles IX., and his mother Catherine de' Medici. This doubtless had some share in influencing Charles to assent to the massacre of St. Bartholomew. It was the first town which opened its gates to Henry IV. in 1594. On the high-road for invaders marching on Paris from the east of France, Meaux saw its environs ravaged by the army of Lorraine in 1652, and was laid under heavy requisitions in 1814, 1815 and 1870. Not far from Meaux the two battles of the Marne took place in Sept. 1914 and in July 1918. The town proper stands on the right bank of the Marne; on the left bank lies the old suburb of Le Marché, with which it was united by a 16th century bridge. The cathedral of St. Stephen dates from the 12th to the 16th centuries, and was restored in the 19th century. The pulpit where Bossuet used to preach has been reconstructed. The episcopal palace (17th century) is built over a 13th century building, and is now used as a museum. North of the Cathedral is the Vieux Chapitre, a 13th century building.

Meaux has a considerable trade in agricultural products. The Canal de l'Ourcq, which surrounds the town, and the Marne furnish the means of transport. Meaux is the seat of a bishopric dating from the 4th century, and has a sub-prefecture, and tribunals of first instance and of commerce.

MECCA (Arab, *Makkah*), the chief town of the Hejāz in Arabia and the great holy city of Islām. It is situated about 45 m. due E. of Jidda, its Red Sea port, and about half way between the Gulf of Akaba and Bab-el-Mandeb. The city lies in a hollow among the hills which form part of the uptilted western edge of the ancient Arabian plateau. To the west the land falls steeply to the low coastal strip bordering the Red sea. The basin in which the city lies is about 2 m. long and ½ m. broad, and forms part of a north to south valley. The high lands around include Jebel Kadâ, Jebel Laala, Jebel Gaygaán, Jebel Kudâ and Jebel Khandama. These vary in height, but are all over 1,500 feet. Jebel Khandama is the highest, being about 3,000 ft. above sea-level. Minor heights, the lower spurs of the former, actually overlook the city. It is said in the Koran (*Sur.* xiv. 40) that Mecca lies in a sterile valley, and the old geographers observe that the whole Haram or sanctuary around the city is almost without cultivation or date palms, while fruit trees, springs, wells, gardens and green valleys are found immediately beyond. But Mecca owed its early importance to the fact that it was a great focus of routes for the caravan trade of the desert. It was probably a station on the great incense route, and thus Ptolemy may have learned the name, which he writes Makoraba. At all events, long before Mohammed we find Mecca established in the twofold quality of a commercial centre and a privileged holy place, surrounded by an inviolable territory (the Haram), which was not the sanctuary of a single tribe but a place of pilgrimage, where religious observances were associated with a series of annual fairs at different points in the vicinity. Indeed,

in a city with the nomad hordes without, commerce was possible only under the sanction of religion, and through the provisions of the sacred truce which prohibited war for four months of the year, three of these being the month of pilgrimage, with those immediately preceding and following. The first of the series of fairs in which the Meccans had an interest was at Okaz, on the easier road between Mecca and Taif, where there was also a sanctuary, and from it the visitors moved on to points still nearer Mecca (Majanna, and finally Dhul-Majāz, on the flank of Jebel Kabkab behind Arafa) where further fairs were held, culminating in the special religious ceremonies of the great feast at Arafa, Quzah (Mozdalifa), and Mecca itself. The system of intercalation in the lunar calendar of the early Arabs was designed to secure that the feast should always fall at the time when the hides, fruits and other merchandise were ready for market, and the Meccans, who knew how to attract the Bedouins by hospitality, bought up these wares in exchange for imported goods, and so became the leaders of the international trade of Arabia. Their caravans traversed the length and breadth of the peninsula. Syria, and especially Gaza, was their chief goal. The Syrian caravan intercepted, on its return, at Badr. (*See* Mohammed.) The great desert market had received merchants from many lands, while in the ancient Kaʻba were installed deities representative, possibly, of the various groups of visiting merchants. It is said that at the time of the Prophet the Kaʻba contained, among others, an image of the Virgin and the Child Jesus. As so often happens in great marts, ideas as well as merchandise were exchanged, and with time there grew up the idea that these minor deities had much in common: the universal overcame the local. To this ancient and sacred mart came Mohammed, with his vision of the unity of God, learnt, it seems, from the Hebrew prophets, and here the vision took shape, to be carried to the ends of the earth by the swords of his followers.

The victory of Mohammedanism made a vast change in the position of Mecca. The merchant aristocracy became satraps or pensioners of a great empire; but the seat of dominion was removed beyond the desert, and though Mecca and the Hejāz strove for a time to maintain political as well as religious predominance, the struggle was vain, and terminated on the death of Ibn Zubair, the Meccan pretendant to the caliphate, when the city was taken by Hajjāj (A.D. 692). The sanctuary and feast of Mecca received, however, a new prestige from the victory of Islām. Purged of elements obviously pre-Islāmic, the new religion became grafted on the life of the city, the Kaʻba became the holiest site, and the pilgrimage the most sacred ritual observance of Mohammedanism, drawing worshippers from so wide a circle that the confluence of the petty traders of the desert was no longer the main feature of the holy season.

In the middle ages this trade was much more important than it is now. Ibn Jubair (ed. Wright, p. 118 *seq.*) in the 12th century describes the mart of Mecca in the eight days following the feast as full of gems, unguents, precious drugs, and all rare merchandise, from India, ʻIraq, Khorāsān, and every part of the Muslim world. Since the fall of Ibn Jubair the political position of Mecca has always been dependent on the movements of the greater Mohammedan world. In the splendid times of the caliphs immense sums were lavished upon the pilgrimage and the holy city; and conversely the decay of the central authority of Islām brought with it a long period of faction, wars and misery, in which the most notable episode was the sack of Mecca by the Carmathians at the pilgrimage season of A.D. 930. The victors carried off the "black stone," which was not restored for 22 years, and then only for a great ransom, when it was plain that even the loss of its palladium could not destroy the sacred character of the city. Under the Fatimites Egyptian influence began to be strong in Mecca; it was opposed by the sultans of Yemen, while native princes claiming descent from the Prophet —the Hāshimite amīrs of Mecca, and after them the amīrs of the house of Qatāda (since 1202)—attained to great authority and aimed at independence; but soon after the final fall of the Abbasids the Egyptian overlordship was definitely established by sultan Bībars (A.D. 1269). The Turkish conquest of Egypt transferred the supremacy to the Ottoman sultans (1517), who treated Mecca with much favour, and during the 16th century executed great works in the sanctuary and temple. The Ottoman power, however, became gradually almost nominal, and that of the amīrs or sherīfs increased in proportion, culminating under Ghālib, whose accession dates from 1786. Then followed the wars of the Wahhābīs (*see* Arabia and Wahhābīs) and the restoration of Turkish rule by the troops of Mehemet ʻAli. By him the dignity of sherīf was deprived of much of its weight, and in 1827 a change of dynasty was effected by the appointment of Ibn ʻAun. Afterwards Turkish authority again decayed. When the great Mohammedan sultanates had become too much occupied in internecine wars to maintain order in the distant Hejāz, those branches of the Hassanids which, from the beginning of Islām, had retained rural property in Arabia usurped power in the holy cities and the adjacent Bedouin territories. About A.D. 960 they established a sort of kingdom with Mecca as capital. The influence of the princes of Mecca has varied from time to time, according to the strength of the foreign protectorate in the Hejāz or in consequence of feuds among the branches of the house, until about 1882 it was for most purposes much greater than that of the Turks. During the last quarter of the 19th century Turkish influence became preponderant in western Arabia, and the railway from Syria to the Hejāz tended to consolidate the sultan's supremacy. Difficult times for the Turkish power arose with the revival of the Wahhābīs movement after 1912. The revolt of King Husayn of the Hejāz during the World War of 1914–18 completed the overthrow of the Turks. The period 1919–1925 saw the rapid rise to power of Ibn Saʻud and the Wahhābīs and the overthrow of the Hâshimite Government. After a fight at Hadda in the Taif mountains, Ibn Saʻud occupied Mecca, without bloodshed, in Oct. 1924.

The City.—The hills east and west of Mecca, which are partly built over and rise several hundred feet above the valley, so enclose the city that the ancient walls only barred the valley at three points, where three gates led into the town. In the time of Ibn Jubair the gates still stood though the walls were ruined, but now the gates have only left their names to quarters of the town. At the northern or upper end was the Bāb el Māʻlā, or gate of the upper quarter, whence the road continues up the valley towards Minā and Arafa as well as towards Zeima and the Nejd. Beyond the gate, in a place called the Hajūn, is the chief cemetery, commonly called el Māʻlā, and said to be the resting-place of many of the companions of Mohammed. Here a cross-road, running over the hill to join the main Medīna road from the western gate, turns off to the west by the pass of Kadā, the point from which the troops of the Prophet stormed the city (A.H. 8). The lower or southern gate, at the Masfala quarter, opened on the Yemen road, where the rain-water from Mecca flows off into an open valley. Beyond, there are mountains on both sides; on that to the east, commanding the town, is the great castle, a fortress of considerable strength. The third or western gate, Bāb el-Omra (formerly also Bāb el-Zāhir, from a village of that name), lay almost opposite the great mosque, and opened on a road leading westwards round the southern spurs of the Red mountain. This is the way to Wādi Fātima and Medīna, the Jedda road branching off from it to the left. Considerable suburbs now lie outside the quarter named after this gate; in the middle ages a road led for some miles through partly cultivated land with good wells, as far as the boundary of the sacred territory and gathering place of the pilgrims at Tanīm.

The length of the sinuous main axis of the city from the farthest suburbs on the Medīna road to the suburbs in the extreme north, now frequented by Bedouins, is, according to Burckhardt, 3,500 paces. About the middle of this line the longitudinal thoroughfares are pushed aside by the vast courtyard and colonnades which compose the great mosque. The mosque is enclosed by houses with windows opening on the arcades and commanding a view of the Kaʻba. Immediately beyond these, on the side facing Jebel Abu Kobais, a broad street runs south-east and north-west across the valley. This is the Masʻā (sacred course) between the eminences of Safā and Marwa,

and has been from very early times one of the most lively bazaars and the centre of Meccan life. The other chief bazaars are also near the mosque in smaller streets.

The houses of ancient Mecca pressed close upon the Ka'ba, the noblest families, who traced their descent from Koṣai, the reputed founder of the city, having their dwellings immediately round the sanctuary. To the north of the Ka'ba was the Dār el-Nadwa, or place of assembly of the Koreish. The multiplication of pilgrims after Islām soon made it necessary to clear away the nearest dwellings and enlarge the place of prayer around the Ancient House. Omar, Othmān and Ibn Jubair had all a share in this work. The city is fortunate in having a good supply of water, and water works were laid down by Sultan Selim II. in 1571. Heavy rains or cloudbursts on the hills around have the effect of seriously flooding the city, and in spite of the building of various dams it is no uncommon sight to see the Sûk es-Saglûr, one of the main streets, a real water course. Many of the houses in Mecca are built of a fine dark grey granite, which is obtained near Jebel Umar. During the period before the World War of 1914–18 the Turks did much to improve the streets and the general condition of the city and its population, and prosperity greatly increased. To the eastward of the Haram, in a small depression known as Jiyâd, was the Turkish residential area and it still remains a good quarter of the city. The population of the city at present (1929) is estimated between 50,000 and 60,000. The only architectural feature is the great mosque (*see* below), which is at the same time the university hall, where, between two pilgrim seasons, lectures are delivered on Mohammedan law, doctrine and connected branches of science. A poorly provided public library is open to the use of students. The madrassehs or buildings around the mosque, originally intended as lodgings for students and professors, have long been let out to rich pilgrims. There are baths, ribats or hospices for poor pilgrims from India, Java, etc., a hospital and a public kitchen for the poor.

The Great Mosque and the Ka'ba.—Long before Mohammed the chief sanctuary of Mecca was the Ka'ba, a rude stone building without windows, and having a door 7ft. from the ground. The Ka'ba has been rebuilt more than once since Mohammed purged it of idols and adopted it as the chief sanctuary of Islām, but the old form has been preserved, except in secondary details. It is essentially a pre-Islāmic temple, adapted to the worship of Islām on the basis of the story that it was built by Abraham and Ishmael by divine revelation as a temple of pure monotheism, and that it was only temporarily perverted to idol worship from the time when 'Amr ibn Lohai introduced the statue of Hobal from Syria till the victory of Islām. The chief object of veneration is the black stone, which is fixed in the external angle facing Safā in the south-east corner. Its technical name is the black corner, the others being named the Yemen (south-west), Syrian (north-west), and 'Iraq (north-east) corners, from the lands to which they approximately point. The black stone is a small dark mass with an aspect suggesting volcanic or meteoric origin, fixed at such a height that it can be conveniently kissed. The history of this heavenly stone, given by Gabriel to Abraham, does not conceal the fact that it was originally the most venerated of a multitude of idols and sacred stones which stood all round the sanctuary in the time of Mohammed. The Prophet destroyed the idols, but he left the characteristic form of worship—the *ṭawāf*, or sevenfold circuit of the sanctuary, the worshipper kissing or touching the objects of his veneration—and besides the black stone he recognized the so-called "southern" stone, the same presumably as that which is still touched in the ṭawāf at the Yemen corner (*Muh. in Med.*, pp. 336, 425). The ceremony of the ṭawāf and the worship of stone was common to Mecca with other ancient Arabian sanctuaries. It is still the first duty of one who has returned to the city or arrived there as a pilgrim.

Islām associated legends with those spots within the Ka'ba previously sacred to older cults; such are the *Multazam,* on the east side, between the black and 'Iraq corners, where prayer should be offered; the *Ma'jan* ("kneading place") where Abraham is said to have stood to build the Ka'ba, and the *Ḥijr* on the north-side which is included in the ṭawāf, and two slabs of *verde antico* within it are called the graves of Ishmael and Hagar, and are places of acceptable prayer. Even the golden or gilded *mīzāb* (water-spout) that projects into the Ḥijr marks a place where prayer is heard, and another such place is the part of the west wall close to the Yemen corner.

The feeling of religious conservatism which has preserved the structural rudeness of the Ka'ba did not prohibit costly surface decoration. In Mohammed's time the outer walls were covered by a veil (or *kiswa*) of striped Yemen cloth. The caliphs substituted a covering of figured brocade, and the Egyptian Government still sends with each pilgrim caravan from Cairo a new kiswa of black brocade, adorned with a broad band embroidered with golden inscriptions from the Korān, as well as a richer curtain for the door. The door of two leaves, with its posts and lintel, is of silver gilt. Ibn Jubair describes the floor and walls as overlaid with richly variegated marbles, and the upper half of the walls as plated with silver, thickly gilt, while the roof was veiled with coloured silk. Modern writers describe the place as windowless, but Ibn Jubair mentions five windows of rich stained glass from 'Iraq. Between the three pillars of teak hung 13 silver lamps. A chest in the corner to the left of one entering contained Korāns, and at the 'Iraq corner a space was cut off enclosing the stair that leads to the roof. The door to this stair (called the door of mercy—Bāb el-Raḥma) was plated with silver by the caliph Motawakkil. Here, in the time of Ibn Jubair, the *Maqām* or standing stone of Abraham was usually placed for better security, but brought out on great occasions.

The great founder of the mosque in its present form, with its spacious area and deep colonnades, was the caliph Mahdī, who spent enormous sums in bringing costly pillars from Egypt and Syria. The work was still incomplete at his death in A.D. 785, and was finished in less sumptuous style by his successor. Subsequent repairs and additions, extending down to Turkish times, have left little of Mahdī's work untouched, though a few of the pillars probably date from his days.

After the Ka'ba the principal points of interest in the mosque are the well Zamzam and the Maqām Ibrāhīm. The former is a deep shaft enclosed in a massive vaulted building paved with marble, and, according to Mohammedan tradition, is the source (corresponding to the Beer-lahai-roi of Gen. xvi. 14) from which Hagar drew water for her son Ishmael. The legend tells that the well was long covered up and rediscovered by 'Abd al-Moṭṭalib, the grandfather of the Prophet. Sacred wells are familiar features of Semitic sanctuaries. The Maqām Ibrāhīm is also connected with a relic of pre-Islamic tradition, the ancient holy stone which once stood on the Ma'jan, and is said to bear the prints of the patriarch's feet. The legend seems to have arisen from a misconception, the Maqām Ibrāhīm in the Korān meaning the sanctuary itself; but the stone itself is certainly very ancient.

Safā and Marwa.—In religious importance these two points or "hills," connected by the Mas'ā, stand second only to the Ka'ba. Safā is an elevated platform surmounted by a triple arch, and approached by a flight of steps. It lies south-east of the Ka'ba, facing the black corner, and 76 paces from the "Gate of Safā," which is architecturally the chief gate of the mosque. Marwa is a similar platform, formerly covered with a single arch, on the opposite side of the valley. It stands on a spur of the Red mountain called Jebel Kuayḳian. The course between these two sacred points is 493 paces long, and the religious ceremony called the "sa'y" consists in traversing it seven times, beginning and ending at Safā. The lowest part of the course, between the so-called green milestones, is done at a run. This ceremony is part of the omra and is generally said to be performed in memory of Hagar, who ran to and fro between the two eminences, vainly seeking water for her son. The observance, however, is certainly of pre-Islamic origin; and at one time there were idols on both the so-called hills. (*See* especially Azraqī, pp. 74, 78.)

The Ceremonies and the Pilgrimage.—Before Islām the Ka'ba was the local sanctuary of the Meccans, where they prayed and did sacrifice, where oaths were administered and hard cases submitted to divine sentence according to the immemorial custom of Semitic shrines. But, besides this, Mecca was already a place

of pilgrimage. The custom had already such a hold on the Arabs, that Mohammed could not afford to sacrifice it to an abstract purity of religion, and thus the old usages were transplanted into Islām in the double form of the omra or vow of pilgrimage to Mecca, which can be discharged at any time, and the ḥajj or pilgrimage at the great annual feast. The latter closes with a visit to the Ka'ba, but its essential ceremonies lie outside Mecca, at the neighbouring shrines where the old Arabs gathered before the Meccan fair.

The omra begins at some point outside the Ḥaram (or holy territory), generally at Tanim, both for convenience sake and because Ayesha began the omra there in the year 10 of the Hegira. The pilgrim enters the Ḥaram in the antique and scanty pilgrimage dress (iḥrām), consisting of two cloths wound round his person in a way prescribed by ritual. His devotion is expressed in shouts of "Labbeyka" (a word of obscure origin and meaning); he enters the great mosque, performs the ṭawāf and the sa'y and then has his head shaved and resumes his common dress. This ceremony is now generally combined with the ḥajj, or is performed by every stranger or traveller when he enters Mecca, and the iḥrām (which involves the acts of abstinence already referred to) is assumed at a considerable distance from the city. But it is also proper during one's residence in the holy city to perform at least one omra from Tanim in connection with a visit to the mosque of Ayesha there. The triviality of these rites is ill concealed by the legends of the sa'y of Hagar and of the ṭawāf being first performed by Adam in imitation of the circuit of the angels about the throne of God. There is a tradition that the Ka'ba was a temple of Saturn (Shahrastānī, p. 431); perhaps the most distinctive feature of the shrine may be sought in the sacred doves which still enjoy the protection of the sanctuary. These recall the sacred doves of Ascalon (Philo vi. 200 of Richter's ed.), and suggests Venus-worship as at least one element (*cf.* Herod i. 131, iii. 8; Ephr. Syr., *Op. Syr.* ii. 457).

To the ordinary pilgrim the omra has become so much an episode of the ḥajj that it is described by some European pilgrims as a mere visit to the mosque of Ayesha; a better conception of its original significance is got from the Meccan feast of the seventh month (Rajab), described by Ibn Jubair from his observations in A.D. 1184. Rajab was one of the ancient sacred months, and the feast, which extended through the whole month and was a joyful season of hospitality and thanksgiving, no doubt represents the ancient feasts of Mecca more exactly than the ceremonies of the ḥajj, in which old usage has been overlaid by traditions and glosses of Islām. The omra was performed by crowds from day to day, especially at new and full moon. The new moon celebration was nocturnal; the road to Tanim, the Mas'ā, and the mosque were brilliantly illuminated; and the appearing of the moon was greeted with noisy music. An Arab market was held, where the Bedouins of the Yemen mountains came in thousands to barter their cattle and fruits for clothing, and deemed that to absent themselves would bring drought and cattle plague in their homes. Though ignorant of the legal ritual and prayers, they performed the ṭawāf with enthusiasm, throwing themselves against the Ka'ba and clinging to its curtains. They also entered the Ka'ba. The 29th of the month was the feast day of the Meccan women.

The central and essential ceremonies of the ḥajj or greater pilgrimage are those of the day of Arafa, the 9th of the "pilgrimage month" (Dhu'l Ḥijja), the last of the Arab year; and every Muslim who is his own master, and can command the necessary means, is bound to join in these once in his life, or to have them fulfilled by a substitute on his behalf and at his expense. Neglect of many other parts of the pilgrim ceremonial may be compensated by offerings, but to miss the "stand" (*woqūf*) at Arafa is to miss the pilgrimage. Arafa or Arafat is a space, artificially limited, round a small isolated hill called the Hill of Mercy, a little way outside the holy territory, on the road from Mecca to Taif. The road is first northwards along the Mecca valley and then turns eastward. It leads through the straggling village of Mina, occupying a long narrow valley (Wādi Mina), two to three hours from Mecca, and thence by the mosque of Mozdalifa over a narrow pass opening out into the plain of Arafa, which is an expansion of the great Wādi Naman, through which the Taif road descends from Mount Kara. The lofty and rugged mountains of the Hodheyl tower over the plain on the north side and overshadow the little Hill of Mercy, which is one of those bosses of weathered granite so common in the Hejāz. Arafa lay quite near Dhul-Majaz, where, according to Arabian tradition, a great fair was held from the 1st to the 8th of the pilgrimage month; and the ceremonies from which the ḥajj was derived were originally an appendix to this fair. Now, on the contrary, the pilgrim is expected to follow as closely as may be the movements of the prophet at his "farewell pilgrimage" in the year 10 of the Hegira (A.D. 632). He therefore leaves Mecca in pilgrim garb on the 8th of Dhu'l Ḥijja, called the day of *tarwīya* (an obscure and pre-Islamic name), and, strictly speaking, should spend the night at Mina. It is now, however, customary to go right on and encamp at once at Arafa. The night should be spent in devotion, but the coffee booths do a lively trade, and songs are as common as prayers. In the afternoon of the next day the essential ceremony begins; it consists simply in "standing" on Arafa shouting "Labbeyka" and reciting prayers and texts till sunset. After the sun is down the vast assemblage breaks up, and a rush (technically *ifāḍa, daf', nafr*) is made to Mozdalifa, where the night prayer is said and the night spent. Before sunrise next morning (the 10th) a second "stand" like that on Arafa is made for a short time by torchlight round the mosque of Mozdalifa, but before the sun is fairly up all must be in motion in the second *ifāḍa* towards Mina. The day thus begun is the "day of sacrifice," and has four ceremonies—(1) to pelt with seven stones a cairn (*jamrat al 'aqaba*) at the eastern end of W. Mina, (2) to slay a victim at Mina and hold a sacrificial meal, part of the flesh being also dried and so preserved, or given to the poor, (3) to be shaved and so terminate the *iḥrām*, (4) to make the third *ifāḍa, i.e.*, go to Mecca and perform the ṭawāf and sa'y (*'omrat al-ifāḍa*), returning thereafter to Mina. The sacrifice and visit to Mecca may, however, be delayed till the 11th, 12th or 13th. These are the days of Mina, a fair and joyous feast, with no special ceremony except that each day the pilgrim is expected to throw seven stones at the *jamrat al 'aqaba*, and also at each of two similar cairns in the valley. The stones are thrown in the name of Allah, and are generally thought to be directed at the devil. This is, however, a custom older than Islām, and a tradition in Azraqī, p. 412, represents it as an act of worship to idols at Mina. As the stones are thrown on the days of the fair, it is not unlikely that they have something to do with the old Arab mode of closing a sale by the purchaser throwing a stone (Bīrūnī, p. 328). The pilgrims leave Mina on the 12th or 13th, and the ḥajj is then over. (*See* further ISLAM.)

The statistics of the pilgrimage cannot be given with certainty and vary much from year to year. For a *fatwa* or judicial decision may be obtained that it is not obligatory for the Muslim to journey to Mecca when the routes are in the hands of hostile forces. Estimates of the crowd vary from 50,000 to 70,000. In these vast assemblies, with little sanitary accommodation, infectious diseases spread rapidly.

BIBLIOGRAPHY.—Besides the Arabic geographers and cosmographers, we have Ibn 'Abd Rabbih's description of the mosque, early in the 10th century (*'Iḳd Farīd*, Cairo ed., iii. 362 *sqq.*), but above all the admirable record of Ibn Jubair (A.D. 1184), by far the best account extant of Mecca and the pilgrimage. It has been much pillaged by Ibn Baṭūta. The Arabic historians are largely occupied with fabulous matter as to Mecca before Islām; for these legends the reader may refer to C. de Perceval's *Essai*. How little confidence can be placed in the pre-Islamic history appears very clearly from the distorted accounts of Abraha's excursion against the Hejāz, which fell but a few years before the birth of the Prophet, and is the first event in Meccan history which has confirmation from other sources. *See* Nöldeke's version of Ṭabarī, p. 204 *sqq.* For the period of the Prophet, Ibn Hishām and Wāḳidī are valuable sources in topography as well as history. Of the special histories and descriptions of Mecca published by Wüstenfeld (*Chroniken der Stadt Mekka*, 3 vols., 1857–49, with an abstract in German, 1861), the most valuable is that of Azraqī. It has passed through the hands of several editors, but the oldest part goes back to the beginning of the 9th Christian century. Kutbeddin's history (vol. iii. of the *Chroniken*) goes down with the additions of his nephew to A.D. 1592.

For European descriptions of Mecca from personal observation *see* Burckhardt's *Travels in Arabia* (cited above from the 8vo ed., 1829). *The Travels of Aly Bey* (Badia, London, 1816) describe a visit in 1807; Burton's *Pilgrimage* (3rd ed., 1879) often supplements Burckhardt;

Von Maltazan's *Wallfahrt nach Mekka* (1865) is lively but very slight. 'Abd el-Razzāq's report to the Government of India on the pilgrimage of 1858 is specially directed to sanitary questions; C. Snouck-Hurgronje, *Mekka* (2 vols., and a collection of photographs, The Hague, 1888–89), gives a description of the Meccan sanctuary and of the public and private life of the Meccans as observed by the author during a sojourn in the holy city in 1884–85 and a political history of Mecca from native sources from the Hegira till 1884. Eldon Rutter, *The Holy Cities of Arabia*, vol. i. (1928), is the most recent work. For the pilgrimage *see* also Snouck-Hurgronje, *Het Mekkaansche Feest* (1880).

MECHANICAL DRAWING: *see* DRAWING, ENGINEERING.

MECHANICAL ENGINEER. By the beginning of the 19th century the development of the steam engine had resulted in a large increase in the size and number of machines in operation and the factory system was beginning to appear. The millwright and smith were not competent to devise and construct the new machines and consequently the profession of mechanical engineer came into being. The name of mechanical engineer became common about the middle of the century. The British Institution of Mechanical Engineers was founded in 1847. About 1890 the field of mechanical engineering was restricted by the separation of the important field of electrical engineering. The field of the mechanical engineer comprises (1) power generation and transmission, (2) transportation of both men and goods, including railway, marine, automobile and aeronautic, as well as hoisting, conveying and pumping and (3) production, which includes machine tools as well as the final products of manufacture. Functionally considered, the work of the mechanical engineer may be classified as design, construction, operation, research and investigation, maintenance and sales. The great majority of mechanical engineers are employees of organizations engaged in production or transportation; a small percentage only is engaged in the private practice of their profession as consultants. In the United States, the education of the mechanical engineer is normally by a four-year undergraduate course in a degree-granting college or university. On completion of the course, a large percentage of the students enter the employment of industrial organizations as apprentices for a period of one or two years; in most of the larger companies this work is organized so as to give opportunities for gaining experience in various departments, with about three months spent in each. In Great Britain, there are only 14 universities which grant degrees in engineering and only a small fraction of the engineers are trained in them. The normal preparation for the profession is by a five-year apprenticeship. Theoretical instruction is obtained by evening work at local technical institutions, of which there are about 150. These institutions usually grant diplomas on the completion of a prescribed course. In Scotland the university instruction occupies about six months of the year and it is customary for the students to alternate between study and work during the apprenticeship. In England, this alternation is not usual, and apprenticeship follows the completion of the university work. In Germany the conditions are in general similar to those in Great Britain.

(L. S. MA.)

MECHANICAL HANDLING. Before mechanical handling became an important operation in all industries a variety of appellations were assigned to machines for such purposes. At first the designation most favoured was "labour saving devices," because it was applicable both to the mechanical and to the economical aspect; this designation has now been practically superseded by the one which heads this article. The term was coined in America about the year 1900, but since 1920 it has been replaced there by the term "materials-handling."

The mechanical plant of a modern factory consists generally of two classes of machinery in addition to the power plant; that for manufacturing a certain commodity, usually by a complex series of operations; and the handling machinery which brings the raw material to the factory, moves it automatically from process to process, and finally conveys the finished commodity to the warehouse or forwarding depôt. The manufacturing process increases the intrinsic value of the goods; but the mechanical handling operations do not add to the value of the product and such work must therefore be performed at a minimum of expense.

Mechanical handling devices are divided into two main sections, viz., continuous and intermittent. The former convey the material in a comparatively small but uniform and uninterrupted stream, while the latter convey larger units in intermittent succession. Continuous devices are subdivided into appliances for lifting material, *i.e.*, bucket elevators and appliances for moving material horizontally, *i.e.*, conveyors.

Bucket Elevators.—Bucket elevators, though always included under continuous devices, are not absolutely continuous on account of the almost imperceptible hiatus between the small successive loads. They consist essentially of an endless belt, chain, or chains, which pass over an upper and lower terminal, and to which suitably shaped buckets are attached in close succession. Such devices may be used vertically, running at a high speed, for relatively light material, such as grain. For minerals a slower speed is necessary and the upper or delivery end of the elevator must therefore be disposed at an incline in order to ensure clean delivery, *i.e.*, without spilling.

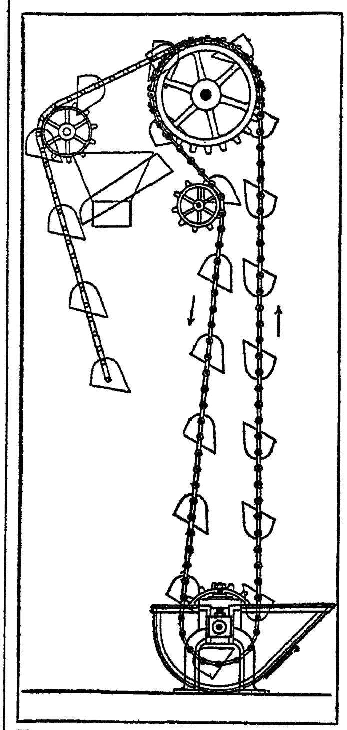


FIG. 1.—VERTICAL ELEVATOR, FROM WHICH CLEAN DELIVERY IS ENSURED BY TWO ALTERNATE APPLICATIONS OF A JOCKEY PULLEY

If the inclined disposition is not suitable for the site a jockey pulley can be used to attain the same end, as shown in fig. 1. But for this purpose two endless chains are necessary, which support the buckets between them.

In the following brief descriptions of continuous handling devices no reference is made to the inclines up or down which they may negotiate. (For this information *see* diagram, fig. 9.)

TYPES OF CONVEYORS

One of the oldest conveyor devices is the *worm* or *screw* conveyor. It consists of a stationary trough of wood or steel plates, in which a helix rotates and pushes the material fed into it from end to end. Its capacity is relatively small, it is apt to injure friable materials, and its driving power is high; on the other hand, where mixing of the material is essential, as in the handling of poultry food, flour, etc., the worm is quite good; it has the further advantage that material can be fed on from any number of points and can likewise be withdrawn at any alternative point

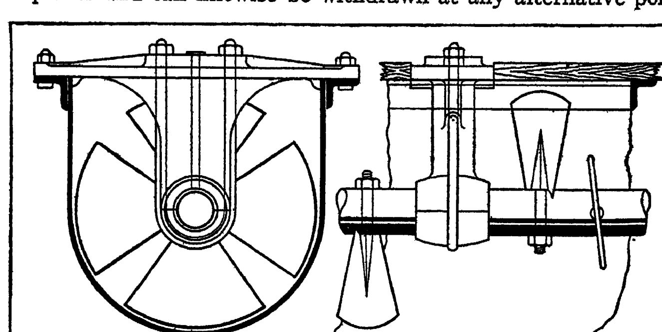


FIG. 2.—PORTION OF A PADDLE WORM, SHOWING STEEL TROUGH AND INTERMEDIATE BEARING

or points, through openings in the base of the trough, which can be closed by sliding gates when not required. There are a number of types of the worm conveyor, one of which is shown in fig. 2.

The *pushplate, scraper* or *drag* conveyor is similar in principle to the foregoing, but the material is pushed along by an endless running chain or chains, to which are attached dragging or pushing plates. This device may be used for handling larger quantities than the worm conveyor, but it shares its advantages as well

as disadvantages, so far as power consumption and possible injury to the material is concerned. It is fed similarly to the worm, in and out at any number of points, when the idle return run of the chain passes over the top of the working run. In fig. 3 this is illustrated diagrammatically.

The *U-link* conveyor is an obvious modification of this type, in which the chain itself is so formed that it will drag the material

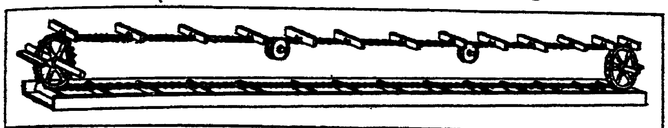


FIG. 3.—SIMPLE TYPE OF PUSH-PLATE CONVEYOR

along without any other attachment. The links are in the form of the letter U.

The *De Brouwer* or *push-bar* conveyor is widely employed in gas works for handling incandescent coke. This always runs in a trough filled with water. The trough is made with a renewable cast-iron base and the two chains, one on either side, which support the pushing bars, are protected in recesses, and thus do not come in contact with the coke.

All types of these conveyors, including those yet to be described, are fitted with power-driven sprockets at their delivery ends, and at their other ends with similar terminal sprockets arranged with tension take-ups for keeping the chains taut.

Band or Belt Conveyors.—Types of conveyors will now be considered where the material is carried on top of the conveying device, which method is more gentle. The foremost of these is the band or belt conveyor, illustrated diagrammatically in fig. 4. This device consists essentially of two terminal drums over which an endless band travels, supported on its carrying as well as on its return run by idler rollers, pitched closely on the loaded run and two or three times the distance apart on the return run. Such idlers are ordinary small diameter rollers of steel in some instances, as, for example, for handling goods in packing cases; or more frequently a combination of three or more shorter rollers which give the band a trough-like shape when bulk material such as grain or coal is handled in large quantities. The idlers for the conveying strand may be as close as 2 to 3 ft. apart, or even up to a distance of 6 feet.

The belt or band itself can be made of various materials, that being chosen which will best suit the goods handled. Compound cotton-duck-and-rubber belting is most frequently employed. The pulley side has a rubber coating of about $\frac{1}{16}$ in., while on the edges and working side are thicker layers of rubber, finally the whole is vulcanized. For light work, cotton belting of the Gandy type may suffice, and the idlers are sometimes replaced by a board of hard wood. Balata belting is also used, as well as woven wire

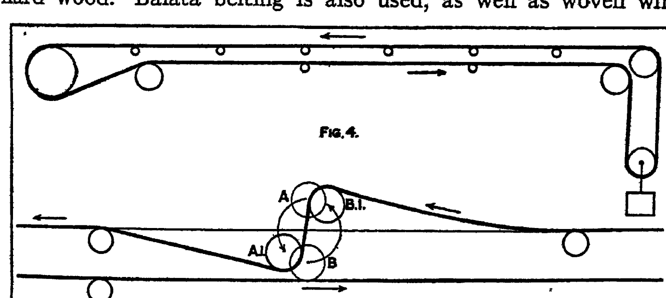


FIG. 4.—DIAGRAM SHOWING GENERAL ARRANGEMENT OF BAND CONVEYOR
FIG. 5.—ACTION OF A THROW-OFF CARRIAGE, SHOWN DIAGRAMMATICALLY

and even Swedish charcoal steel bands, which are quite as flexible as any of the foregoing.

The only disadvantage of the band conveyor is that while it can be fed at any number of points by making adequate provision, the withdrawal of the material *en route* is somewhat complicated. It is true that, with an oblique plough, material can be scraped off at intermediate points if the band speed is low, but even then it is a makeshift and shortens the life of any but a steel band, for which such ploughs are therefore ordinary standard practice. For all textile and textile-rubber bands what is known as a "throw-off" or tripper gear is necessary. Such a throw-off device is shown diagrammatically in fig. 5. The full lines denote the machine in action, the band passing over idlers A^1 and B^1; as shown in dotted lines, idlers A and B are out of action when the band with its load passes by.

The Shuttle Conveyor is an important application of the band conveyor. Its use can best be visualized by an example. For

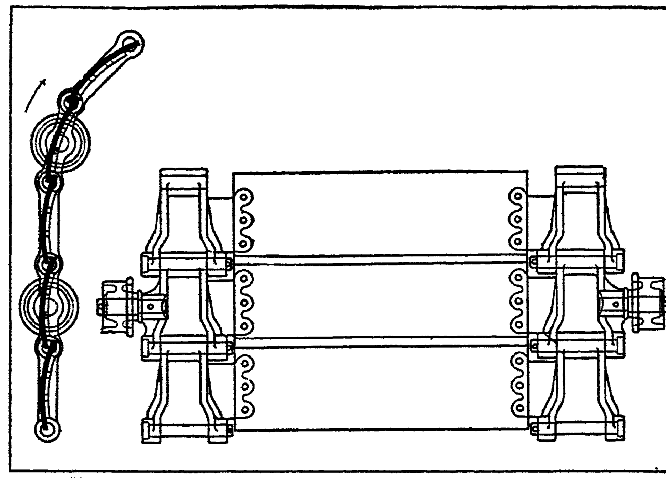
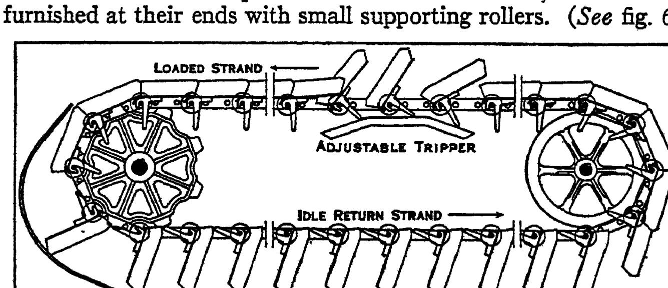


FIG. 6.—PORTION OF APRON CONVEYOR WITH STEEL SLATS

instance, in a very long boiler house, where it is essential that the coal be delivered in a central position, an elevator or a skip hoist is installed to lift the coal to a level above the bunkers. Instead of providing two band conveyors, one on the right and the other on the left, for distributing purposes, only one length is installed, reaching from the elevator or skip hoist to the bunker most remote from the central position. This is mounted on rails and is made reversible so that it can be run either to the right or to the left.

With regard to the speed at which band conveyors may run, this may be said, broadly, to be 600 ft. per minute when handling maize, etc., while when handling lump coal it should not be more than 150 to 250 ft. per minute.

Articulated Band Conveyors.—A number of conveyors are in use on the same principle as the band conveyor, but where endless chains replace the band and to which are attached a variety of carrying elements. These may be likened to, and in fact are, articulated band conveyors. These all run at relatively slow speeds. The type most frequently used is the slat or apron conveyor. It has the usual two sprocket terminals. Every link or every other link of the chains is provided with slats of iron, or of wood, furnished at their ends with small supporting rollers. (*See* fig. 6.)



BY COURTESY OF BABCOCK & WILCOX

FIG. 7.—DIAGRAM SHOWING MAIN FEATURES OF TIPPING-TRAY CONVEYOR

For handling small coal, etc., conveyors with steel slats, bent up at the sides, are employed. They are called continuous trough conveyors and form articulated troughs. A modification is introduced for the purpose of effecting intermittent delivery. It is known as the *Tipping-Tray Conveyor* and is illustrated in fig. 7.

Reciprocating Conveyors.—(*See* fig. 8.) These are essentially steel troughs which are set into frequent reciprocating motion, so that with the forward stroke the material travels with the trough, while the trough returns to its initial position without the material, which travels forward in an almost continuous stream.

Coal Face Conveyors.—All the foregoing types are employed in collieries, but their construction is somewhat different on account of the confined head-room in the coal seams. They are generally from 100 to 180 yd. long to reach from gate to gate, and are so built that they can be readily taken down as the coal face recedes and be re-erected elsewhere.

When inclines have to be negotiated in favour of the load, what is known as a *retarding conveyor* is employed, similar in principle to that last described, but with wire ropes instead of chains to which cast-iron discs are clamped at regular intervals. Such devices need no driving power, but rather a brake, if the incline is steep enough.

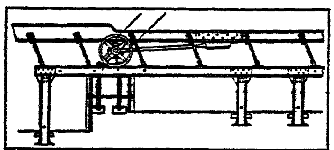


FIG. 8.—"ZIMMER" TYPE OF RECIPROCATING TROUGH CONVEYOR

All types of chain conveyors so far discussed employ endless chains running on vertical sprockets, so that the two strands are disposed one above the other. In another type, known as general purpose conveyors, the chains run over horizontal sprockets, so that the two strands are side by side, or by the addition of guide idlers they may run over a more complex path on an essentially horizontal plane.

Gravity Roller Conveyors.—Gravity roller conveyors consist of benches, the upper surface of which is provided with light rollers of two to three inches in diameter, placed close together

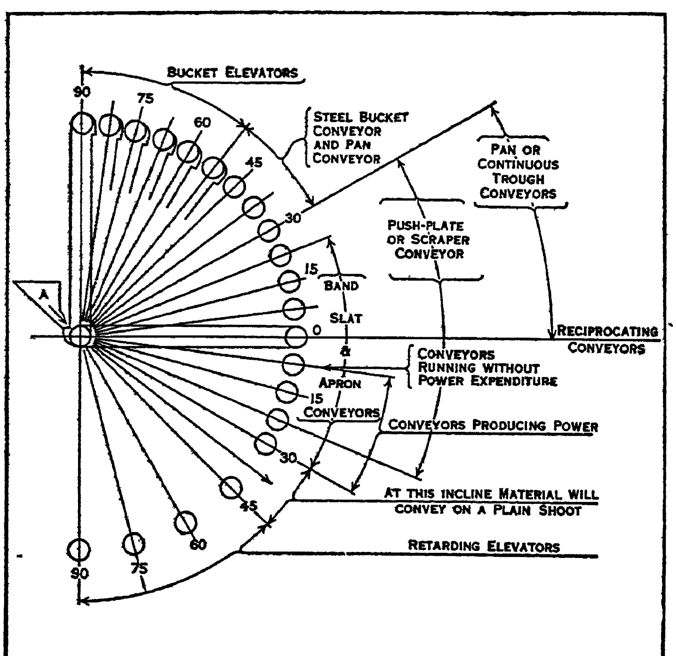


FIG. 9.—DIAGRAM SHOWING THE INCLINES AT WHICH VARIOUS TYPES OF CONTINUOUS CONVEYORS ARE APPLICABLE

and running in ball bearings disposed at a downward gradient of 2% to 5%, so that any object with a flat base, such as a packing case, can run down by gravity.

A great variety of types of continuous handling machinery are employed in modern factories. Sometimes when conveying material from one point to another it is exceedingly difficult to determine which of the many devices obtainable is best suited for the specific purpose in hand. The accompanying diagram, fig. 9, will be helpful in such a case. On the left hand side it shows a hopper A, containing a material which will run down an incline of 45°, and which will therefore convey itself by gravity to any one of the conveying devices represented by radial lines in the diagram. The circles to the left of the datum line represent the receiving terminals of all types of conveyors or elevators. The devices shown by circles in a variety of positions may be what are usually known as bucket elevators, bucket conveyors, etc., according to the incline at which they work. At an angle of 90° to the datum line, and above, such a device would be a bucket elevator, and would remain so at any angle to about 67·5°, when it would merge, stage by stage, into a bucket, tray, push-plate, slat, apron or band conveyor, the latter on the datum line.

All devices above the datum line must, obviously, be power-driven, the actual power expenditure depending upon the height to which the material has to be raised, plus power necessary to overcome friction. If it be assumed that all the devices shown on the diagram are of the same capacity, *i.e.*, carry the same load in a unit of time, the driving power needed will decrease gradually until the conveyor parallel with the datum line is reached, where only frictional resistance has to be overcome. Below the datum line gravity enters into the calculation, so that at a downward gradient of about 7½° gravity alone is sufficient to overcome frictional resistance and the conveyor will run by itself. Finally, there are positions which would need a retarding conveyor or inverse elevator. As the down gradient increases, gravity assists further, *pro rata*, and if suitable gear is applied to one of the conveyor terminals energy may be collected to actuate other machines, to be converted into heat by a brake, or to be dissipated.

The usual type of conveyor for moving material both horizontally and vertically is known as the bucket conveyor. It resembles the bucket elevator very closely, but the buckets are rather different.

Another type is the V-bucket conveyor, the buckets of which are V-shaped and attached to two endless chains, one at each side. The portion of such a conveyor which runs horizontally, constitutes a scraper conveyor, and that which runs vertically, a bucket elevator. At the junction of the horizontal and vertical runs the material drops automatically into the buckets. The path of the conveyor may be L-shaped or in the form of an oblong, but the machine must always discharge on a horizontal run if ever so short.

If the buckets are not rigidly connected to the chains but supported on trunnions and above their centre of gravity they constitute what is known as the *gravity bucket conveyor.* Devices of this kind are generally so disposed in power-houses that the lower horizontal run passes along the basement floor, ascends at one end of the building, traverses the top floor above the bunkers and descends at the other end, thus forming an oblong. Owing to their method of suspension the buckets always remain in a perpendicular position, except when they are tipped and thus emptied by coming in contact with a tripping device at the various points of discharge. They are filled in the basement by a rather complex feeding device while the chain of buckets is under way. Gravity bucket conveyors were at one time largely used in power-houses, where they sometimes handled coal on the ascending and upper horizontal run, discharging the coal into the bunkers, while the lower run collected the ashes. They are slow-running, rather expensive machines, but very reliable. As, however, they are now but rarely installed, no further comment is necessary. Pneumatic handling is dealt with in a separate article. (*See* PNEUMATIC CONVEYING.)

Intermittent Handling Devices.—The following types are the most important under this heading: ropeways and aerial cableways; mono-rails and telphers; finger-tray elevators; and skip hoists. The last two devices only are dealt with here, the others form the subjects of separate articles.

Finger- or Swing-Tray Elevator.—This device serves the same purpose as a bucket elevator, but handles larger intermittent loads such as packages, cases, baskets, sacks, barrels, etc. It can receive goods on any one floor and set them down on any other. The loads are picked up on the ascending strand and set down on the descending one. The device consists of one or two endless chains with corresponding upper and lower sprocket terminals.

The Skip Hoist.—This device may be likened to a bucket elevator having only one bucket, which, instead of running continuously in the same direction as the former, works intermittently up and down a vertical or steeply inclined rail-track. With a twin installation one skip is in the loading position while the other is discharging; usually the discharge is over the top, like a "monkey-on-a-stick."

The size of the skip is determined by the tonnage to be handled

and the depth of the pit. The skip may be of either the top or bottom discharge type. In the former instance the skip is provided with a bail, to the base of which it is hinged. At its upper end are trod wheels, which follow at the discharge point along an approximately horizontal path, whereby the skip is tipped and emptied. As a rule there are also a pair of trod wheels which guide the lower end. With bottom-discharge skips, as the name implies, a door is provided at the base of the skip, which at the same time forms a shoot, and which is kept closed during travel, generally by means of a pair of wheels which engage in a certain way. At the discharging point these rails are interrupted, when the weight of the contents forces open the door and thereby effects discharge.

In operation the initial speed of travel of a skip hoist is slow, increasing to a maximum of 5 ft. per sec.; decreasing when approaching upper delivery point. The speed may be controlled by the form of the drum on which the wire rope is wound, this being lemon-shaped; or in large installations by automatic speed variation of the motor. Skip hoists are in use for twin installations, with maximum handling capacity of 500 tons per hour and skips holding 6 cu. yds. (*See* MASS PRODUCTION.)

See H. H. Broughton, *Electrical Handling of Materials* (1921–23); H. V. Hetzel, *Belt Conveyors and Belt Elevators* (1922, 2nd ed., 1926); G. F. Zimmer, *Mechanical Handling and Storing of Material* (1916, 3rd ed., 1922). (G. F. Z.)

MECHANICAL IMPROVEMENT: *see* POWER TRANSMISSION.

MECHANICAL MAN: *see* ROBOT; AUTOMATIC MACHINES.

MECHANICAL REFRIGERATION: *see* REFRIGERATION AND ICE MANUFACTURE.

MECHANICS. This branch of applied mathematics deals with the motions of bodies; with the forces by which those motions are conditioned, and with the balance of forces on a body at rest. The word implies a connection with machinery (Gr. μηχάνη); but this and other practical applications are to-day more commonly included under the heading of "applied mechanics," which covers such subjects as elasticity and the strength of materials, hydromechanics and aerodynamics, mechanism, ballistics, etc. (*qq.v.*).

Theoretical mechanics, the foundation of all these subjects, may be divided into two closely related parts: *dynamics,* which is concerned with moving bodies, and *statics,* which treats of equilibrium, or rest. Dynamics—so-called because one aspect of the interaction between bodies, by which their motions are conditioned, is the occurrence of what we recognize as *force* (Gr. δύναμις)—may again be subdivided into *kinematics,* which deals with motion from the standpoint of measurement and precise description, and dynamics proper, which is concerned with causes, or "laws" of motion. Statics, the theory of balanced forces, can be established on foundations of its own, as an independent science; but it is now customary to base it on the laws of dynamics, of which science it thus becomes a special branch. This procedure will be followed in this article, which attempts to present the essential features of the Newtonian scheme.

Speaking broadly, two standpoints are possible. The first presents dynamics as a science which has been constructed, by induction, on a basis of experiment. Corresponding with the axioms of Euclidean geometry (which "neither require, nor are capable of proof") we have, in dynamics, "laws of motion," *e.g.,* a body which is not disturbed by force continues to move with uniform speed in a straight line. These "laws," it is claimed, can be put to the test of experiment; and on them, step by step (as in the successive propositions of Euclid), is developed a system not only embracing in its scope all motions which occur in the material universe, but which has been proved by actual trial to maintain contact with that universe at every stage.

Difficulties in Verification of Laws.—It is recognized, of course, that practical limitations prevent an exact verification of any theoretical "law"; but a far more serious objection can be advanced against this presentation of dynamics, in that it involves an "argument in a circle": with whatever refinement the experiment is made, it cannot be interpreted without recourse to ideas which are themselves an essential part of the theory under examination. For example, if we seek to verify the "law" which has been stated above, our first requirement is a body free from the action of force; but no such body is available for test, because any body to which we can have access is subject to the earth's attraction. Therefore we must arrange that the attraction, since it cannot be eliminated, shall be neutralized, and this is attempted in what is known as "Attwood's machine": the body under test is connected, by a light string passing over a freely-running pulley, with a second body of equal weight; and under these conditions it is found that, started with any initial velocity, it retains that velocity almost unchanged. However quite apart from the fact that a small reduction in velocity (which may reasonably be attributed to friction) is always observed in any actual experiment, there are difficulties in accepting this result as a proof of the "law" in question. We have found that a body moves with (substantially) uniform speed and direction; but it is *not* a body on which no force is acting, and without recourse to the principles of dynamics (themselves dependent on the law) we have no grounds for asserting that the forces which act upon it do in fact neutralize one another.

Dynamics as an Abstract Science.—Difficulties of this kind are avoided if we adopt the alternative standpoint, according to which dynamics, as a purely abstract science, may legitimately be founded upon any set of initial assumptions (or "laws of motion") which is convenient and not self-contradictory. In constructing this theoretical system, we are under no obligation to verify that contact with the actual universe is maintained at every stage; for the system is concerned with the motions of purely ideal bodies whose properties are postulated in its fundamental assumptions, and provided that it is developed by logical processes, according with the accepted principles of mathematics, its conclusions will be valid consequences of those assumptions. Whether it will lead to results having any correspondence with the observed motions of actual bodies is an entirely separate question, which must be decided *a posteriori,* by comparing these results with experiment. But the available tests apply only to the system as a whole: we cannot devise an experiment which will verify any one of its assumptions apart from the rest.

It follows that any special importance which these assumptions may have, in relation to the actual universe, arises solely from the fact that they constitute the simplest possible description. To describe the motions of the bodies which form our solar system, we may either, as in the Ptolemaic system, specify the motions of those bodies relative to the earth, or, as in the Copernican system, specify their motions relative to the sun. Either description (provided that its details are correct) is equally valid, and the superior merit of the Copernican system consists solely in the fact that its description is simpler. It remained for Newton to discover a still more simple description, by inventing a comprehensive theory of dynamics which follows logically from three fundamental assumptions, or "laws." However his theory is still description, it does not explain; for whilst, like the axioms of geometry, his laws are incapable of proof, they cannot by any stretch of imagination be regarded as self-evident and therefore needing no proof.

Newton's assumptions are incapable of proof, *i.e.,* of direct verification by experiment, for reasons which have been indicated already; but, from the standpoint now considered, such verification is in no way essential to the development of his theoretical system, and the appeal to experiment, by which that system is related with the actual universe, can equally well be made when the system is complete. Whatever view be taken of the philosophical question, it must be admitted that the real evidence for his "laws," as an expression of the facts of nature, is to be found, not in laboratory experiments aimed at direct verification, but in the close accord with experience of every conclusion which has been based upon them.

KINEMATICS

Speed.—1. The notion of *speed, e.g.,* of a car or railway train, is familiar in every-day experience. When we say that a train is travelling with a speed of 60 miles per hour, we mean that it is moving at a rate which, maintained constant, would take it 60 miles along its route in one hour, one mile in every minute, or 88

feet in every second. We do not mean that this rate is in fact constant: a train which is travelling at 60 miles per hour may, during the next few minutes, increase its speed, stop, or even retrace its path. What we mean is that the actual distance travelled will be 88 ft., very nearly, in the next second, 8·8 ft., almost exactly, in the next tenth of a second, and so on: given the instantaneous value of the speed, we can foretell the distance more closely, the shorter the interval of time.

Kinematics gives precision to this idea of speed by fixing attention on an interval which is indefinitely short. Let s be the distance of the train from its starting point, t the time which has elapsed since the start; then, as the train moves, s will increase with t. If the speed is constant from the start (say S miles per hour), and if s is measured in miles and t in hours, then evidently s and t will be connected by the relation

$$s=St, \tag{1}$$

and in a further interval of t' hours the increase in s will be s' miles, where

$$s'=St'. \tag{2}$$

When the speed s is variable, (1) will no longer hold; but the relation (2) will still be satisfied, provided that t' (and therefore s') is indefinitely small. On this understanding we have

$$S=\frac{s'}{t'};$$

i.e., in the notation of the calculus,

$$S=\frac{ds}{dt}; \tag{3}$$

so the speed S may be found by *differentiating* the distance s with respect to the time t.

2. Almost all cars, and occasionally trains, carry an instrument which records the distance travelled. If we take simultaneous readings of this instrument and of a clock, we can plot, in accordance with the principles of graphical representation, points which relate corresponding values of s and t; and if a large number of such points are plotted and connected by a continuous curve, this curve may be taken to represent the relation between s and t over the whole period of the observations. A curve of this nature is called a distance-time or s-t diagram: if P (fig. 1) is a point on the curve, we know that the car or train was, at a time represented (on the time-scale) by the length OL, at a distance from the starting-point, which is represented (on the distance scale) by the length OH.

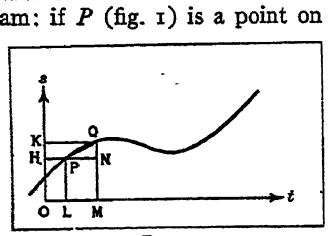


FIG. 1

Now let Q be another point on the curve. Then we know that the distance from the starting-point, at a time represented by the length OM, is the distance represented by the length OK; and it follows that a distance represented by the length HK was travelled in an interval of time represented by the length LM. This means that the average speed during that interval of time is given by

$$\frac{\text{distance represented by } HK, \text{ or } QN}{\text{time represented by } LM, \text{ or } PN};$$

i.e., it is measured by the *slope* of the line PQ.

Speed Represented by Slope of Tangent.—If the speed were in fact constant, this slope would be constant for all intervals of time; so we see that the s-t diagram for motion at constant speed is a straight line. In general the speed will vary during the interval considered; but its variation may be neglected if the interval be sufficiently small; *i.e.*, if Q be sufficiently near to P. Ultimately, when the interval is infinitesimal, PQ is the tangent at P. We thus obtain a graphical interpretation of the formula (3): in a distance-time diagram, the speed at a time corresponding to P is measured (on an appropriate scale) by the slope of the tangent at P. Even when the formula (3) cannot be used, because s is not known as a mathematical function of t, the speed can be estimated by graphical methods.

Distance Represented by Area Under Curve.—3. Mathematically, the formula (3) implies that

$$s=\int S dt; \tag{4}$$

i.e., the distance s may be found by *integrating* the speed S with respect to time t. Let S and t be related, after the manner of fig. 1, in a speed-time diagram (fig. 2): the graphical interpretation of (4) is that the area under the portion PQ of the speed-time diagram measures (on an appropriate scale) the distance travelled in the interval represented by LM.

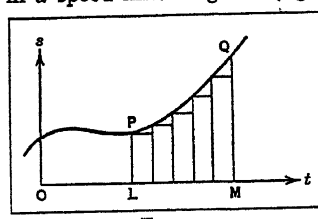


FIG. 2

To establish this rule independently, we have only to notice, (1) that it would be obviously true if the speed were uniform—in which case PQ would be a horizontal straight line, and the area would be proportional to (speed)×(length of interval); (2) that it would be true if the speed changed suddenly at the ends of finite but short intervals, and remained constant during those intervals, so that the speed-time curve consisted of a number of small steps, as indicated in fig. 2; and (3) that the conditions contemplated in (2) will be indistinguishable from the actual conditions, and the stepped diagram indistinguishable from the actual curve, if the intervals are sufficiently short.

Acceleration.—4. When the speed varies, we use the term acceleration to denote the rate at which it increases. Thus, if the speed of a train changes from 6 to 10 ft. per second in an interval of 2 seconds, the total increase in speed during this interval is $10-6=4$ ft. per second, and hence the average rate of increase, *i.e.*, the average acceleration of the train, is $\frac{4}{2}=2$ ft. per second per second. In symbols, if the speed increases by S' in an interval of time t', then the average acceleration is measured by

$$\frac{S'}{t'}.$$

To obtain an accurate measure of varying acceleration, we make the time interval t', as before, indefinitely small. Corresponding to (3) we have, as an expression for the instantaneous acceleration f,

$$f=\frac{dS}{dt}, \tag{5}$$

and corresponding to (4) we have

$$S=\int f\,dt. \tag{6}$$

Thus the acceleration f may be found by differentiating the speed S, and the speed by integrating the acceleration, with respect to the time t. Similarly, in relation to graphical methods, we may say that:

(a) in a speed-time diagram, the acceleration corresponding to a point P is measured (on an appropriate scale) by the slope of the tangent at P;

(b) The area under a portion PQ of the acceleration-time diagram measures (on an appropriate scale) the increase of speed in the corresponding interval of time.

Velocity.—5. In this discussion of speed and acceleration, we have not been concerned to know the route of our train. Distance (s) has meant distance measured, from some arbitrary starting point, along the route; and in this sense a train can be said to be distant s from the starting point, although it may be, if the route is circuitous, much nearer "as the crow flies." Speed and acceleration have been understood, similarly, as measured along the route. Direction has had no meaning, except in the sense that the train may be travelling forwards or back, *i.e.*, with positive or negative speed.

These ideas were sufficient, because we were concerned with motion in some definite path, or route If, instead of the train, our concern had been with a ship, we should have had to consider the direction, as well as the speed, of its motion at every instant.

Whereas the position of the train could be specified by means of one quantity (the distance s), two quantities are required to fix the position of the ship: thus, if O (fig. 3) is a fixed point on the earth's surface, and ON, OE are lines through O in a northerly and easterly direction, the position P can be specified by assigning values to the distances PK, PL. Let QPR be the path of the ship. Then, as the ship moves from P in the direction of R, the distances PK, PL, *i.e.*, the lengths OL and OK, will increase. Let x and y (according to the usual convention) denote these distances, or coordinates. Then the speed u with which the ship is travelling east will be the rate at which x increases; *i.e.*, we shall have, as in equation (3)

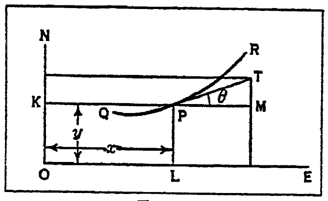


FIG. 3

$$u = \frac{dx}{dt}. \tag{7}$$

Similarly, the speed v with which the ship is travelling north will be given by

$$v = \frac{dy}{dt}. \tag{8}$$

The actual direction of motion, when the ship is at P, is along the tangent at P to the path QPR; the speed along the path has, at this instant, some definite value S. We say that the ship has a *velocity* S in the direction of the tangent. Thus velocity is a quantity which has the nature of a speed, but which also possesses direction; in equations (7) and (8), we may say that u is the eastward and v the northward velocity of the ship.

Composition and Resolution of Velocities.—6. We have seen that the actual velocity S of the ship at P may be regarded as a combination of the two velocities u and v: when u and v are both known, it must evidently be determinate, both in magnitude and direction. To find the required relations between S, u and v, we have only to imagine that the ship, on reaching P, maintains its velocity unchanged. The path then becomes a straight line PT (fig. 3), and in an interval t the ship will go to T, where

$$PT = St, \tag{9}$$

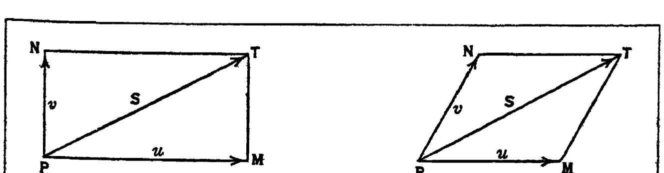
as in (1). Also, since u is the eastward velocity, and LH (or PM) the eastward distance covered in the interval t, we have

$$PM = ut; \tag{10}$$

hence, dividing corresponding sides of (9) and (10), we deduce that

$$\left.\begin{aligned} \frac{u}{S} &= \frac{PM}{PT} = \cos\theta, \\ \text{and similarly,}\quad \frac{v}{S} &= \frac{MT}{PT} = \sin\theta. \end{aligned}\right\} \tag{11}$$

The Parallelogram Law.—Thus (fig. 4) the component velocities u, v and the resultant or total velocity S can be represented both



FIGS. 4–5

in direction and magnitude by the sides and diagonal, respectively, of a parallelogram. In this particular instance the parallelogram is a rectangle; but the same result can be established when (as in fig. 5) the directions of u and v (*i.e.*, the directions of the coordinates x and y) are not perpendicular. The total velocity S may be regarded as made up of two velocities, u, v, represented in direction and magnitude by PM and PN, the sides of any parallelogram of which PT is a diagonal.

Composition and Resolution of Accelerations.—7. Similar relations hold for accelerations; *i.e.*, a resultant or total acceleration F may be resolved into two components (*e.g.*, an eastward acceleration f_x combined with a northward acceleration f_y) which are related with F by the parallelogram law. Corresponding to equation (5), we shall have

$$\left.\begin{aligned} f_x &= \frac{du}{dt}, \\ &= \frac{d^2x}{dt^2}, \text{ by (7)}, \\ \text{and}\quad f_y &= \frac{dv}{dt}, \\ &= \frac{d^2y}{dt^2}, \text{ by (8)}. \end{aligned}\right\} \tag{12}$$

KINEMATICS OF THREE DIMENSIONS

The Vector Law.—8. Two coordinates x, y suffice to define the position of a ship, because this is (practically speaking) a body moving in one plane. To define the position of an aeroplane, we require a third coordinate; viz., the height z above some standard level. Corresponding to (7) and (8), we have the expression

$$w = \frac{dz}{dt}, \tag{13}$$

for the vertical component of velocity; and corresponding to (12) the expression

$$f_z = \frac{dw}{dt} = \frac{d^2z}{dt^2}, \tag{14}$$

for the vertical component of acceleration.

The parallelogram law has an obvious extension in three dimensions. If OP, the diagonal of a parallelopiped (fig. 6), represents a velocity or acceleration in direction and magnitude, this may be resolved into components represented in direction and magnitude by OA, OB, OC, the sides of the parallelopiped. Speaking generally, we say that velocities and accelerations may be resolved and compounded according to the vector law.

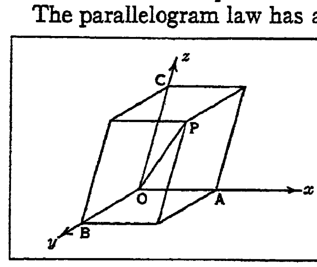


FIG. 6

Motion of a Projectile in Vacuo.—9. A simple example will serve to explain the application of these kinematical principles. We may assume (as a deduction from experiment) that a body moving *in vacuo* near the surface of the earth has a constant total acceleration g directed vertically downwards: making this assumption, we proceed to calculate its path, or *trajectory.*

To define the position of the moving body (or *projectile*), we take axes Ox, Oy, Oz, fixed in relation to the earth. We take Oz to be directed vertically upwards; *i.e.*, in the line of the resultant acceleration. Then the acceleration has no component along Ox or Oy, and we have from (12) and (14),

$$\left.\begin{aligned} \frac{du}{dt} &= f_x = 0, \text{ whence } u = \text{const.}, \\ \frac{dv}{dt} &= f_y = 0, \text{ whence } v = \text{const.}, \\ \frac{dw}{dt} &= f_z = -g, \text{ whence } w = (\text{const.}) - gt. \end{aligned}\right\} \tag{15}$$

Now let Oy be taken horizontal and perpendicular, at some definite instant ($t=0$), to the direction of motion; then, at this instant, there is no component velocity in the direction Oy; *i.e.*, $v=0$. Hence, according to the second of equations (15), v will be zero always; *i.e.*, the trajectory lies wholly in the plane zOx.

The problem is now two-dimensional. If u_0, w_0 are the initial components of velocity (viz., at time $t=0$), we have from (7) and (15),

$$\left.\begin{aligned}\frac{dx}{dt}&=u_0,\text{ whence } x=(u_0t+\text{const.}),\\ \text{and}\quad \frac{dz}{dt}&=w_0-gt,\text{ whence } z=(w_0t-\tfrac{1}{2}gt^2+\text{const.}).\end{aligned}\right\}\tag{16}$$

Finally, let O (fig. 7) be the position of the particle at the instant $(t=0)$. Then the constants in (16) will vanish, and we may write

$$\left.\begin{aligned}t&=x/u_0,\\ z&=w_0t-\tfrac{1}{2}gt^2=\frac{w_0}{u_0}x-\frac{1}{2}\frac{g}{u_0^2}x^2.\end{aligned}\right\}\tag{17}$$

The form of this relation between z and x shows that the path is a parabola; z vanishes when $x=0$ (*i.e.*, at the point O), and again when

$$x=\frac{2u_0w_0}{g}=R.\tag{18}$$

10. Equation (18) gives the *range* OP of a projectile, on any inclined plane Ox, in terms of the circumstances of projection. If OT be the tangent to the trajectory at O, and if OT represents the velocity at this point, then ON, OM (fig. 7) will represent u_0 and w_0, according to the parallelogram law. Hence we see that

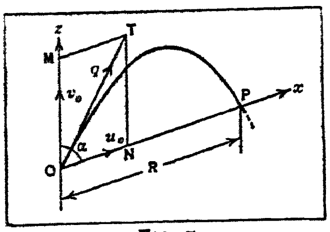


FIG. 7

$$\begin{aligned}q^2&=u_0^2+w_0^2+2u_0w_0\cos\alpha,\\ &=(u_0-w_0)^2+2u_0w_0(\cos\alpha+1),\\ &=(u_0-w_0)^2+gR(\cos\alpha+1),\end{aligned}\tag{19}$$

by (18), where R is the range. Clearly, if q and α are fixed, R will be greatest when $u_0=w_0$; *i.e.*, when OT, the direction of projection, is equally inclined to Ox and Oz. The maximum range for the plane Ox is

$$R_{\max}=\frac{q^2}{g(1+\cos\alpha)},\tag{20}$$

and all points on Ox whose distance from O is less than $R_{\max}$ will be within range of a projectile started with velocity q.

11. Now suppose that q is fixed but α varied; then we have a different value of the maximum range for every slope. Writing r for $R_{\max}$, the value corresponding to α, we have from (20)

$$\frac{l}{r}=1+\cos\alpha,\text{ where } l=\frac{q^2}{g}\tag{21}$$

Equation (21) holds of all points which are just within range of O, for a projectile started with velocity q: its form shows that such points lie on a parabola (APQ, fig. 8), having its focus at O and vertex at A, where $OA=q^2/2g$. The (parabolic) trajectory which goes through P is shown by a dotted line; its original direction OT bisects the angles AOP, and it touches the parabola APQ. Every direction of projection gives a maximum range for some plane; hence the parabola APQ will be touched at some point by every trajectory having initial velocity q, and all points inside it are within range of O. It is called the "parabola of safety." (*See* also the special article on KINEMATICS.)

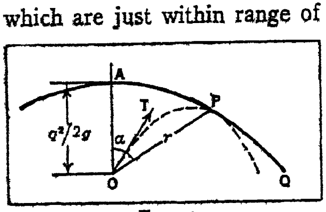


FIG. 8

DYNAMICS

12. The general problem of dynamics is to investigate the motions of two or more bodies, as affected by interaction. Such interaction may be caused by collision, as of two billiard balls, or it may be due to mutual attraction, as of the earth and the sun. Following Newton, we shall describe it as operating by the exertion of *force*; when two bodies A and B interact, we say that A exerts a force on B, and that B exerts a force on A. From a strictly logical standpoint the notion of force is unnecessary; but it is convenient, since it enables us (in theory) to confine attention to a single body. Thus, in the problem just discussed, we are really concerned with the relative motion of two bodies, the projectile and the earth; but we can confine attention to the projectile, once we have postulated that its interaction with the earth is equivalent, so far as its own motion is concerned, to the imposition of a force which gives it a constant downward acceleration g.

The "Laws of Motion."—13. Newton's "laws of motion" are postulated relations between forces and their effects. If we were concerned merely to formulate an abstract scheme of dynamics, having no necessary relation to the material universe, we could postulate any relations that are self-consistent. Newton was concerned to "explain" (*i.e.*, to describe) the observed motions of the heavenly bodies, and the special significance of his relations lies in the fact that they lead to deductions which are confirmed by experiment. This fact, however, does not compel us to appeal to direct experiment for a justification of his "laws": as stated already, we are quite at liberty to postulate them arbitrarily, as fundamental axioms of an abstract dynamical scheme, and to leave for subsequent investigation the question whether this scheme does in fact correspond with "reality."

Newton's First Law.—14. The first question which presents itself is, what is the behaviour of a body which is not affected by force? Newton's answer to this question is contained in his first law: "Every body remains in a state of rest or of uniform motion in a straight line, unless it is compelled by impressed forces to change that state." This law, sometimes called the "law of inertia," had been propounded by Galileo in 1638, nearly fifty years before the appearance of Newton's *Principia.*

To give precision to the foregoing statement, we must explain what we mean by "a state of rest." The position of a body in space can be defined (§ 8) by specifying the values of three coordinates x, y, z, relative to axes Ox, Oy, Oz. When x, y and z have constant values (not varying with time), we may say that the body is at rest in relation to Ox, Oy, Oz; if these axes are moving in space, the body will move with them: if they are fixed in space, the body may be said to be in a state of absolute rest. The difficulty in this description (if we keep in mind the question of an ultimate appeal to experiment) is to state what we mean by "axes fixed in space." From a logical standpoint, this is a serious difficulty in the Newtonian scheme. For practical purposes however we may be content with the assertion, that we are at liberty to postulate the existence of *some* fixed system of axes, when we formulate our abstract scheme of dynamics; and that we shall be involved in no sensible error, when we come to a comparison with the real universe, if we assume that these axes are at rest in relation to the "fixed" stars. By "uniform motion in a straight line" Newton means, in our language, "velocity constant in magnitude and direction." So the answer to our first question is definite: the motion of a body not affected by force may be described, in accordance with the kinematical principles of §§ 5–8, as a motion, referred to a system of axes fixed in space, in which the component velocities u, v, w do not vary with time.

Newton's Second Law.—15. It follows from this discussion that, if u, v, w vary with time (*i.e.*, if the body has acceleration in relation to the fixed axes), then forces must be assumed to act. The next question is, how do forces affect the motion of a body?

Newton's second law states: "Change of motion is proportional to the impressed force, and takes place in the direction of the straight line in which that force is impressed." "Change of motion," in our language, may be taken to mean *acceleration*: we deduce that the possession by a given body of an acceleration F in any direction implies that a force P, proportional to F, must be acting in that direction; *i.e.*,

$$P=MF,\tag{22}$$

where M has some constant value.

16. Let F be equivalent to (or the *resultant* of) three component accelerations f_x, f_y, f_z in the directions of the fixed axes Ox, Oy, Oz. Then the possession by the given body of an acceleration f_x alone would imply the existence of a force X, parallel to Ox and

of magnitude

$$X = Mf_x;$$

similarly, its possession of accelerations f_y and f_z, alone, would imply the existence of forces Y and Z respectively, where

$$Y = Mf_y,$$
$$Z = Mf_z.$$

We postulate that two or more forces acting simultaneously produce an acceleration which is a combination (*i.e.*, the resultant) of the accelerations which they would produce when acting separately; and since F is the resultant of the accelerations f_x, f_y, f_z, we deduce that the forces X, Y and Z, acting together, produce the same effect as the single force P. So P may be regarded as the resultant of three component forces X, Y, Z; and since these four forces are proportional to the accelerations F, f_x, f_y, f_z, it follows that forces, like accelerations, can be resolved or compounded by the vector law.

Inertia.—17. This last result will be made the basis of the science of *statics* (§ 37). If now we imagine the body to be changed, it is clear that, whilst Newton's second law will still hold, the constant of proportionality M in equation (22) may be different. We must regard M as a quantity associated with a given body: it is termed *inertia* (*i.e.*, sluggishness), because, according to equation (22), the acceleration produced by a given force will be less, the greater the value of M. Inertia, regarded as a measurable quantity, is commonly designated by the term *mass*, and defined as the quantity of matter in the body.

When the mass of a body is specified, and the magnitude and direction of the force which acts upon it, the acceleration F can be deduced, and we are left with a problem in kinematics; *e.g.*, if we know that the earth exerts on any body a constant downward force, we may conclude that it gives to the body a constant downward acceleration, denoted by the symbol g; so the problem of a projectile in vacuo may be treated as an example in kinematics (§§ 9–11).

Newton's "Third Law."—18. As we have stated above, force is to be regarded merely as one aspect of a mutual action between two bodies. If a body A experiences a force P in consequence of interaction with another body B, then B will also be subjected to force. This principle is propounded in Newton's third law of motion: "Action and reaction are equal and opposite;" *i.e.*, we postulate that the force experienced by B will be a force equal in magnitude but opposite in direction to the force P, and having the same line of action.

On the basis of these three laws, with a further postulate regarding the mutual attraction of two bodies at a distance (*i.e.*, the "law of gravitation"), Newton erected the whole structure of his dynamical scheme. That structure, as we have already inferred, is purely mathematical, concerned to work out, according to the laws of kinematics, the consequences of accelerations which are postulated in the so-called "laws of motion." Force and mass are secondary notions, not really essential to the scheme, but they simplify its presentation, and for this reason it is convenient to retain them, and even to introduce further dynamical concepts which may be based upon the fundamental relation (22). These concepts we now proceed to develop. We shall show that the laws of motion, applied to a single mass, lead to relations which hold in respect of any system of masses, and form the basis of general equations (*see* DYNAMICS).

Units of Measurement.—19. Before we can employ equation (22) to deduce exact numerical results, we must define the units in which force, mass and acceleration are to be measured. The unit of acceleration will be that which involves a unit increase of velocity in a unit of time; and the unit of velocity will be the velocity of a point which moves through a unit of distance in a unit of time. Thus, in the first place, we have to fix the fundamental units of length and time: if, for example, we choose the foot and the second, the unit of velocity will be 1 ft. per sec. and the unit of acceleration will be 1 ft. per sec. per sec. Inertia being defined (§ 17) as a constant quantity associated with a given body, independent of its velocity or acceleration, the unit of mass will be another fundamental (and therefore arbitrary) unit. It must be defined as the mass of some particular piece of matter; *e.g.*, the standard pound or kilogram.

When we have specified the fundamental units of length, mass and time, we may deduce, according to (22), the corresponding unit of force. If, for example, we adopt the "C.G.S. system," in which the fundamental units are the centimetre, gram and second, the unit force will be that force which produces an acceleration of 1 cm. per sec. per sec. when it acts on a mass of 1 gram: this unit is termed the *dyne*. If we adopt as units the foot, pound and second, the unit force will be that which produces an acceleration of 1 ft. per sec. per sec. when it acts on a mass of 1 pound: this unit is termed the *poundal*.

A unit of force derived in this way from (22) is termed an *absolute unit*, since it is the same in all places and at all times. Now consider the case of a body of unit mass falling freely under the influence of the earth's attraction. In (22) if g is the measured acceleration, we have

$$M = 1, \ F = g;$$

hence the attractive force, *i.e.*, the "weight" of the body, consists of g absolute units. Measured in centimetres per second per second, g is 981, nearly; so the weight of 1 gram is a force of 981 dynes, and conversely, the unit of force in the C.G.S. system (*i.e.*, 1 dyne) is about $\frac{1}{981}$ of a gram weight. Measured in feet per second per second, g is 32·2 nearly; so the weight of 1 pound is a force of 32·2 poundals, and conversely, the poundal is a force of about $\frac{1}{32.2}$ lb. weight, *i.e.*, roughly equal to the weight of half an ounce.

For scientific purposes, great advantages are possessed by an *absolute* system of measurement, and the C.G.S. system is now almost universally employed (*see* UNITS, PHYSICAL), but in practical applications of mechanics (*e.g.*, engineering) it is customary to take as the unit of force the weight of one pound; *i.e.*, a force of g poundals. This change of units will evidently involve a change in the form of (22). A force which in poundals is measured by MF will be measured in pounds weight by MF/g, where $g = 32{\cdot}2$ approximately: hence we have the expression

$$P = \frac{MF}{g} \tag{23}$$

for the accelerating force measured in pounds weight, when M, the mass accelerated, is measured in pounds, and F, the acceleration, is measured in feet per second per second.

The same expression will hold for the accelerating force measured in grams weight, when M is the mass in grams and F the acceleration in centimetres per second per second, provided that g is given the appropriate value 981. From a scientific standpoint, the use of *gravitational* units of force, such as is contemplated here, is open to the objection that the value of g varies to a slight extent with position on the earth's surface, and hence the weight of one pound or gram is not, strictly speaking, a constant quantity. In what follows, we shall assume that absolute units are employed, so that the relation between force, mass and acceleration is expressed by (22).

DEDUCTIONS FROM THE LAWS OF MOTION

Impulse and Momentum.—20. We have now given precise meaning to (22), and we proceed to deduce some consequences which follow from this equation, in virtue of kinematical relations which have been shown to hold between acceleration, velocity and "distance." Let us confine attention, in the first place, to motion in a straight line, which we may take to be parallel to Ox. If P is the force in this direction, M the mass of the body considered, and f_x the acceleration produced, we have as in (22)

$$P = Mf_x.$$

Also, by the first of (12), $\quad f_x = \dfrac{du}{dt}.$

Hence we may write $\qquad P = M\dfrac{du}{dt}, \qquad (24)$

or (since M is constant) $\quad P=\frac{d}{dt}(Mu).$ (25)

The quantity Mu, *i.e.*, the product of the mass and velocity, is termed the *momentum* of the body considered. We may express equation (25) in the statement that P, the *force* acting on a body, is equal to the rate of change of momentum.

Suppose now that P is maintained constant for an interval of time T. Then from (25), by integration, we deduce that

$$\int_0^T Pdt=PT=(Mu)_1-(Mu)_0, \tag{26}$$

where $(Mu)_0$ *and* $(Mu)_1$ denote the values of the momentum at the beginning and end, respectively, of the interval T. The product PT, viz., the product of the force and the time for which it acts, is termed the "time-effect," or *impulse*. We may express equation (26) in the statement that change of momentum is equal to the impulse of the applied force. When, on the other hand, P varies during the interval considered, this statement will still hold, provided that the term 'impulse' is applied to the integral $\int_0^T Pdt$, *i.e.*, to the sum of the "time effects" of the applied force for all parts of that interval.

21. The significance of these ideas is apparent when we come to consider the behaviour of bodies which interact. According to the third law of motion (§ 18), if a force P is exerted at any instant upon one of two interacting bodies (A), then a force $-P$ is exerted at the same instant upon the other interacting body (B). Let M_A and u_A denote the mass and velocity of A: then we have, as in (25),

$$P=\frac{d}{dt}(M_Au_A). \tag{27}$$

Similarly, if M_B and u_B denote the mass and velocity of B, we have

$$-P=\frac{d}{dt}(M_Bu_B). \tag{28}$$

By addition of (27) and (28), we deduce that

$$0=\frac{d}{dt}(M_Au_A)+\frac{d}{dt}(M_Bu_B),$$

and hence, by integration,

$$M_Au_A+M_Bu_B=\text{const.}; \tag{29}$$

i.e., the total momentum of two bodies is not affected by interaction.

If external forces act in addition, these will produce effects which are represented by (26). If P_A is the external force on A, and P_B the external force on B, we deduce from this equation that

$$\int(P_A+P_B)dt=(M_Au_A+M_Bu_B)_1-(M_Au_A+M_Bu_B)_0;$$

i.e., the total impulse of the externally applied forces is equal to the change produced in the total momentum of a system of two masses (A and B). It is not difficult to see that this statement may be generalized for a system containing any number of masses.

22. Next, instead of motion in a straight line, let us consider motion of the most general type. The resultant force P on the body can be resolved, at any instant, into three component forces X, Y, Z, and (§ 16) we may write

$$X=Mf_x=M\frac{du}{dt}, \tag{30}$$

a relation similar to (24). As in § 20, we may deduce that

$$\int Xdt=(Mu)_1-(Mu)_0; \tag{31}$$

i.e., the impulse of the component force X, which acts in the direction Ox, is equal to the change in (Mu), the momentum in that direction.

Again, we can prove as before, for any system of masses, that the total impulse of the externally applied forces in any direction, is equal to the total change of momentum in that direction; *i.e.*, the total momentum of a system, in any direction, is unaffected by interactions between the masses which compose it; this is the *principle of linear momentum*.

We observe that momentum, like velocity, is a quantity which can be resolved and compounded according to the vector law. If u, v, w are the components of a total velocity q, the total momentum of the body is measured by Mq, and Mu is the resolved part of this total momentum in the direction of Ox.

"Centre of Mass" of a System.—23. These results can be expressed in another way. According to our definition, the resolved part of the total momentum, in the direction Ox, of a system of masses $M_A, M_B, M_C, \cdots$ etc. is given by

$$\begin{aligned} &M_Au_A+M_Bu_B+M_Cu_C+\cdots, \\ &=M_A\frac{dx_A}{dt}+M_B\frac{dx_B}{dt}+M_C\frac{dx_C}{dt}+\cdots, \text{ by (7)}, \\ &=\frac{d}{dt}[M_Ax_A+M_Bx_B+M_Cx_C+\cdots], \end{aligned} \tag{32}$$

since the masses $M_A, M_B, M_C, \cdots$ etc. are severally constant. Let $\bar{M}$ be the total mass of the system, so that

$$\bar{M}=M_A+M_B+M_C+\cdots \text{ etc.},$$

and let $\bar{x}$ be defined by the equation

$$\bar{M}\bar{x}=M_Ax_A+M_Bx_B+M_Cx_C+\cdots \text{ etc.} \tag{33}$$

Then, according to (32), the total momentum of the system in the direction Ox may be expressed in the form

$$\frac{d}{dt}(\bar{M}\bar{x}),$$

or, since $\bar{M}$ is constant, as

$$\bar{M}\frac{d\bar{x}}{dt}=\bar{M}\bar{u} \text{ (say)}. \tag{34}$$

We conclude that $(\bar{M}\bar{u})$, and therefore $\bar{u}$, will be unaffected by interactions between $A, B, C, \cdots$ etc.; so that $\bar{u}$, the velocity of the point defined by $\bar{x}$, will be constant if no external forces act on the system. When external forces $X_A, X_B, X_C, \cdots$ etc. act on $M_A, M_B, M_C, \cdots$, their total impulse in any interval will be equal to the change in $(\bar{M}\bar{u})$. Hence, by differentiation, we obtain the relation

$$\begin{aligned} X_A+X_B+X_C+\cdots &= \frac{d}{dt}(\bar{M}\bar{u}) \\ &= \bar{M}\frac{d\bar{u}}{dt}=\bar{M}\frac{d^2\bar{x}}{dt^2}. \end{aligned} \tag{35}$$

If $Y_A, Y_B, Y_C, \cdots$ etc. and $Z_A, Z_B, Z_C, \cdots$ etc. are component forces in the directions of y and z respectively, we find in the same way that

$$\left.\begin{aligned} Y_A+Y_B+Y_C+\cdots &= \bar{M}\frac{d\bar{v}}{dt}=\bar{M}\frac{d^2\bar{y}}{dt^2}, \\ Z_A+Z_B+Z_C+\cdots &= \bar{M}\frac{d\bar{w}}{dt}=\bar{M}\frac{d^2\bar{z}}{dt^2}, \end{aligned}\right\} \tag{36}$$

where $\bar{y}, \bar{z}, \bar{v}, \bar{w}$ are defined by equations similar to (33) and (34).

Now (35) and (36) are precisely the equations which we should obtain for the motion of the point whose co-ordinates are $\bar{x}, \bar{y}, \bar{z}$, if we imagined the whole mass $\bar{M}$ of the system to be concentrated at this point, and to be acted upon by the resultant of all the given external forces, *i.e.*, by a force whose components are

$$(X_A+X_B+X_C+\cdots), (Y_A+Y_B+Y_C+\cdots), (Z_A+Z_B+Z_C+\cdots).$$

If these components are severally zero, we shall have from (35) and (36)

$$\frac{d\bar{u}}{dt}=\frac{d\bar{v}}{dt}=\frac{d\bar{w}}{dt}=0;$$

i.e., the point $\bar{x}, \bar{y}, \bar{z}$, will move with constant velocity in a straight line.

The point $\bar{x}, \bar{y}, \bar{z}$, defined as above, is termed the *centre of mass* (or "mass-centre") of the system. We shall find that it has addi-

tional significance when we come to consider the science of *statics* (sec. 47).

Work and Energy.—24. According to the rules of differentiation, we may write the first of equations (12) in the form

$$f_x = \frac{du}{dt} = \frac{du\,dx}{dx\,dt},$$

and then, by (7), we have

$$f_x = u\frac{du}{dx} = \frac{1}{2}\,\frac{d(u^2)}{dx}. \tag{37}$$

So we may write equation (30) in the alternative form

$$X = \tfrac{1}{2}M\,\frac{d(u^2)}{dx},$$

$$= \frac{d}{dx}\,(\tfrac{1}{2}Mu^2),\text{ since } M \text{ is constant.}$$

Integrating, we have the equation

$$\int_0^1 Xdx = [\tfrac{1}{2}Mu^2]_1 - [\tfrac{1}{2}Mu^2]_0, \tag{38}$$

in which the suffixes 0 and 1 relate to the beginning and end, respectively, of the displacement considered.

If X has a constant value throughout the displacement, the integral on the left of (38) is equivalent to $X(x_1-x_0)$, *i.e.*, to the product of the force and of the distance through which it acts. We call this quantity the *space-effect* of X, or the work done by X, in the displacement considered: if the displacement had been opposite in sense to the force, so that this product had had a negative value, we should have said that work was done *against* the force. When X varies during the displacement, we may say that the total work done by X is the sum of its space-effects for all parts of that displacement; *i.e.*, the total work will still be represented by the integral in (38).

25. If we confine attention, in the first place, to motion in a straight line parallel to Ox, the quantity $\frac{1}{2}\,Mu^2$ is one-half the product of the mass and of the square of its resultant velocity. This quantity is termed the *kinetic energy* of the moving mass. Accordingly, in this case, we may express equation (38) by saying that the *work* done by the applied force is equal to the increase of kinetic energy.

26. In the general case of motion in three dimensions, we have, corresponding to (38), the additional equations

$$\int_0^1 Ydy = [\tfrac{1}{2}Mv^2]_1 - [\tfrac{1}{2}Mv^2]_0,$$

and

$$\int_0^1 Zdz = [\tfrac{1}{2}Mw^2]_1 - [\tfrac{1}{2}Mw^2]_0,$$

when Ox, Oy, Oz are a rectangular system of axes. Then u, v, w are the three perpendicular components of a resultant velocity q (say), and it follows from the vector law for velocities (§ 6) that

$$u^2+v^2+w^2=q^2.$$

Hence, by addition of the foregoing equations with (8), we deduce that, in a displacement of the mass M from the point (x_0, y_0, z_0) to (x_1, y_1, z_1),

$$\int_0^1 (Xdx+Ydy+Zdz) = [\tfrac{1}{2}Mq^2]_1 - [\tfrac{1}{2}Mq^2]_0, \tag{39}$$

and $[\frac{1}{2}Mq^2]$ is now, by our definition, the *kinetic energy* of the moving mass.

Equation (39) may be expressed by the same formula as (38), if we make a suitable extension (to cover motion in three dimensions) to our definition of "work." In general the displacement of a body will not be along the line of action of the force which acts upon it. Suppose then that the displacement is from A to B (fig. 9), and that AB is inclined at an angle θ to the line of action of the resultant force P; let BN be perpendicular to this line of action. If AB is indefinitely small, we may take P to remain constant, both in magnitude and direction, during the displacement from A to B; and if dx, dy, dz are the components of this very small displacement, and X, Y, Z the components of P, in the directions Ox, Oy, Oz, respectively, it may be shown that

$$X\ dx+Y\ dy+Z\ dz=PAN=PAB\ \cos\theta \tag{40}$$

According to the vector law, AN is the resolved part of the displacement AB in the direction of P. We take the product $(P{\cdot}AN)$ to be a measure of the work done by P in the displacement AB; *i.e.*, we now take as our generalized definition of "work" (*cf.* § 24) the product of the force and of the resolved part of the displacement in the direction of the force. With this definition, according to (40), the integral on the left of equation (39) measures the total work done in the displacement from (x_0, y_0, z_0) to (x_1, y_1, z_1); so we may assert, generally that in any displacement of a body, the work done by the applied force is equal to the increase in kinetic energy.

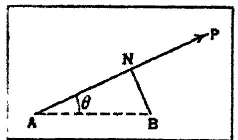


FIG. 9

27. Now let us imagine that the force on a mass M_A is due to interaction with a second mass M_B. Then if X is the component force on M_A, there will be, at the same instant, a force $-X$ acting on M_B. Let dx_A be the displacement of M_A in a very small interval of time, and dx_B the displacement of M_B in the same interval. According to § 24, we shall have

$X\,dx_A$ = change, during this interval, in the quantity $\frac{1}{2}M_A\,u_A{}^2$,

$-X\,dx_B$ = change, during this interval, in the quantity $\frac{1}{2}M_B\,u_B{}^2$,

and hence, by addition,

$$X(dx_A-dx_B) = \text{change, during the interval, in the quantity } \tfrac{1}{2}(M_Au_A{}^2+M_Bu_B{}^2) \tag{41}$$

Suppose, in the first place, that the motion of both masses is confined to the direction Ox. Then if M_A and M_B move through the *same* distance (so that $dx_A=dx_B$), equation (41) may be expressed in the statement that interaction does not affect the total kinetic energy of the two masses; and it is evident that this conclusion may be generalized for a system containing any number of masses. The total kinetic energy however will be altered by interaction if the distance between A and B does not remain constant during the displacement: *e.g.*, if a bullet be fired into a block of wood, the forward pressure on the wood is equal to the backward pressure on the bullet; but, since the bullet penetrates the wood, its forward displacement in any interval of time is less than that of the wood; so less work is done by the forward pressure than is done against the backward pressure, and the total kinetic energy of the wood and bullet is decreased as a consequence of the interaction.

Particles, and "Rigid Dynamics."—28. A similar conclusion holds for motion in general. The total kinetic energy of a system of masses will in general be changed as a result of interaction; but the total kinetic energy will not change, if the distance between any two masses remains constant, and if the forces due to their interaction act along the line which joins them.

We are here thinking of bodies so small that their masses may be imagined as concentrated in points. Such bodies are termed *particles*, and bodies of finite size are commonly treated, in dynamics, as made up of large numbers of particles (*cf.* § 53). We see from the foregoing discussion that special simplification will be possible if we assume that the distance between any two of the particles composing a body is invariable, *i.e.*, that the body is *rigid*; for then we can say that its kinetic energy, like its momentum, is unaffected by interaction between the constituent particles. This is the basic assumption of *rigid dynamics*.

Moment of Momentum.—29. We have defined the momentum of a body (§ 20) as the product of its mass and velocity. Let M be the mass of a particle at A (fig. 10), and let q, the resultant velocity, be along a line AB in the plane of the diagram. Let O be another point in the same plane, and let p denote the distance of O from the line AB. Then the quantity Mqp, *i.e.*, the product of the momentum of the particle and the distance of its line of action from O, is termed the *moment of momentum* of the

particle about O. It is usual to consider moment of momentum as positive when (as in fig. 10) the point O would be on the left hand of a man moving with the particle.

Let perpendicular axes Ox, Oy be taken through O, and let $x(=AM)$ and $y(=AN)$ be the coordinates of A, and u, v the components of the resultant velocity q, relative to these axes. Then it will be seen (fig. 10) that

$$\begin{aligned} M(xv-yu) &= Mq(x\sin\theta - y\cos\theta), \\ &= Mq(ML-MK), \qquad (42) \\ &= Mqp. \end{aligned}$$

The moment of momentum of the particle about O is accordingly measured by $M(xv-yu)$, and hence its rate of change (since M is constant) is measured by

$$\begin{aligned} M\frac{d}{dt}(xv-yu) &= M\left\{\left(x\frac{dv}{dt}+v\frac{dx}{dt}\right)-\left(y\frac{du}{dt}+u\frac{dy}{dt}\right)\right\} \\ &= M(xf_y - yf_x), \qquad (43) \end{aligned}$$

by (7), (8) and (12).

However (§ 15) the existence of component accelerations f_x, f_y implies the existence of component forces X, Y, where

$$X = Mf_x, \quad Y = Mf_y.$$

Hence, according to (43), the rate of change of moment of momentum is measured by $(xY-yX)$. If

$$xY - yX = 0 \qquad (44)$$

this rate of change is zero.

Now (44) will be satisfied, not only when no force is acting on the particle (so that $X=Y=0$), but also when

$$\frac{X}{Y} = \frac{X}{Y};$$

i.e., (according to the vector law), when the resultant force on the particle acts along the line OA. Hence, if a particle is subjected to forces whose resultant always acts through a fixed point O, its moment of momentum about O will remain unchanged.

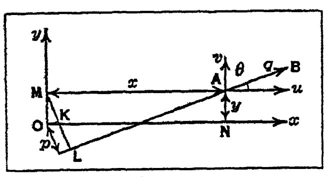


FIG. 10

30. In the general case we can show, as in (42), that $(xY-yX) = Pp'$, where P is the resultant force on the particle, and p' is the distance of O from the line of action of P. The product Pp' is termed the *moment* about O of the resultant applied force P. Thus we may express (43) by saying that the moment of the applied force about any point is equal to the rate of change of moment of momentum about that point.

Again, if the force P on a body A is due to interaction with a second body B, then by the third law of motion (§ 18) there must act, simultaneously, an equal and opposite force $(-P)$ on B. As in § 21, we may show that the total moment of momentum of two bodies is not affected by interaction, and we may generalize this result for any system of bodies: the resultant (or total) moment about any point of the external forces which act on a system is equal to the rate of change of the total moment of momentum of that system, about the same point; this is the *principle of angular momentum.*

ORBITS DESCRIBED ABOUT A CENTRE OF FORCE

31. The problem confronting Newton, for which he developed his system of dynamics, was to explain the motion of the heavenly bodies— the paths, or *orbits*, which they describe in relation to the earth. His explanation is based on the assumption of "universal gravitation"; *i.e.*, of mutual attraction between any two bodies, depending in intensity upon their masses and upon their distance apart.

If an attractive force of this kind acts between two bodies A and B, it will affect the motion of both. We have seen however (§ 23) that their *mass centre* will move with constant velocity in a straight line, notwithstanding the interaction between them, if (as we here assume to be the case) no other force is operative. Now in the case of two *particles* situated at points A and B, the mass centre lies in the line AB, *i.e.*, on the line of action of the forces of attraction. So to investigate the motion of either particle in relation to the mass centre, we need not consider the other particle; the first problem for discussion is the motion of a single particle A about a point O, where it is attracted to O with a force depending upon the distance OA. We call O the *centre of attraction.*

32. An argument similar to that of § 9 shows that the orbit will be confined to a single plane through O. Let v be the resultant velocity of the particle when its distance from the centre of attraction is r, and let p be the distance of O from AT (fig. 11), the instantaneous direction of this velocity. Then, since the force on the particle always acts through O, we know (§ 29) that the moment of momentum of the particle about O will not change; *i.e.*, since the mass is constant, we may write

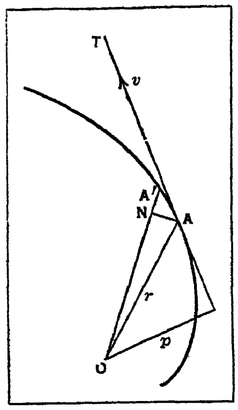


FIG. 11

$$pv = \text{const.} = h \text{ (say)}. \qquad (45)$$

33. Again, in a very small displacement from A to A' (fig. 11), if the distance from O is increased by a small quantity $A'N$ $(=dr)$, and if P is the force of attraction, then (§ 24) work of amount (Pdr) is done against P, and the increase in kinetic energy during this displacement is accordingly given by $(-Fdr)$. If m is the mass of the particle, it follows that in passing by any path from a point distant r_0 to a point distant r from O, the velocity will change from v_0 to v, where

$$\tfrac{1}{2}mv^2 - \tfrac{1}{2}mv_0^2 = -\int_{r_0}^{r} F dr. \qquad (46)$$

The force F depends, by assumption, solely on the distance r. So we may write

$$F = m\phi(r), \qquad (47)$$

where $\phi(r)$ is some function of r. Equation (46) may then be written in the form

$$v^2 - v_0^2 = -2\int_{r_0}^{r} \phi(r)dr, \qquad (48)$$

or

$$v^2 + 2\int^{r} \phi(r)dr = \text{const.},$$

where $\phi(r)$ is to be interpreted, from (47), as the acceleration imposed upon the particle, by the force of attraction. This relation, when $\phi(r)$ is known, gives v in terms of r: like (45), it must be satisfied at all points in the orbit.

34. Combining (45) and (48) we have

$$\frac{h^2}{p^2} + 2\int^{r}\phi(r)dr = \text{const.}, \qquad (49)$$

a relation between p and r which is independent of dynamical quantities, and serves to determine the *shape* of the orbit. When $\phi(r)$ is known, the integral can be evaluated, and then (49) gives the equation of the orbit in the *tangential-polar* form.

The Orbit for the "Inverse Square" Law.—35. Thus, if we take $\phi(r)$ to be given by Newton's *inverse square law of attraction;* viz.,

$$\phi(r) = \frac{\mu}{r^2}, \text{ where } \mu \text{ is constant}, \qquad (50)$$

equation (49) takes the form

$$\frac{h^2}{p^2} = \frac{2\mu}{r} + C. \qquad (51)$$

This may be recognized as the tangential-polar equation of a *conic* with respect to a *focus* as origin. The three forms of conic are the ellipse, the parabola and the hyperbola: for the ellipse the equation is

$$\frac{l}{p^2}=\frac{2}{r}-\frac{1}{a},$$

and for the hyperbola

$$\frac{l}{p^2}=\frac{2}{r}+\frac{1}{a},$$

where, in each case, l denotes the *semi-latus rectum* and a the length of the *semi-axis* containing the focus in question; in the parabola, a is infinitely great, and we have the equation

$$\frac{l}{p^2}=\frac{2}{r},$$

Comparing these equations with (51), we see that there is exact correspondence provided that

$$l=\frac{h^2}{\mu},\quad a=\mp\frac{\mu}{C}. \qquad (52)$$

Hence the orbit will be an ellipse, parabola or hyperbola according as C, in (51) is negative, zero, or positive. In any case the semi-latus rectum of the orbit will be given by the first of (52). A positive value of C implies a positive value of the constant on the right of (48), and hence, if we substitute from (50), a value of v^2 greater than $\frac{2\mu}{r}$. Thus, if at any point in an orbit

$$v=\sqrt{(2\mu/r)}=V(\text{say}), \qquad (53)$$

that orbit is a parabola; if $v<V$ it is an ellipse, and if $v>V$ it is a hyperbola. We see that V is the velocity which must be possessed by the particle in order that its orbit may go to an infinite distance from the centre of attraction; it is termed the *critical velocity* corresponding to the distance r.

Newton's Law of Gravitation.—36. We have assumed in the preceding paragraph that the attractive force on the particle varies inversely as the square of its distance from the centre of attraction. When the force is due to the attraction of a second particle, this is equivalent to assuming that the attraction varies inversely as the square of the distance between the two particles.

Newton's "law of universal gravitation" asserts that a mutual attraction, satisfying this relation, is exerted between every pair of particles in the material universe. If two particles have masses m, m', it asserts that the force of their mutual attraction, when their distance apart is r, will be

$$\frac{\gamma mm'}{r^2},$$

where γ is a universal constant, called the constant of gravitation.

That branch of mechanics known as the "*theory of attractions*" is concerned with the consequences of this law in regard to the attractions of bodies of finite extent; *i.e.*, bodies composed of a large number of particles. One result may be stated here: a spherical body (either solid or hollow), of which the density is the same for all points at the same distance from its centre, exerts the same attraction on any particle or body outside it as would be exerted by a particle of the same total mass, situated at its centre. Thus in calculating, *e.g.*, the motion of a planet under the attraction of the sun, we may replace each body by a particle of equal mass. The investigation of § 35 relates directly to this problem, if we assume (as is very nearly true) that the sun's mass is so large, in relation to that of the planet, that the centre of the sun can be identified with the mass-centre of the two, *i.e.*, with the *centre of attraction*. More elaborate investigations, by Newton and his successors, have taken account of the attractions of the planets on the sun and on one another: they have abundantly confirmed the accuracy of the inverse square law, by showing that it is able to explain the actual motions of the planets in minute detail.

STATICS

Statics treats of forces at rest and therefore in equilibrium. The second law of motion is: "*Change of motion is proportional to the moving force impressed and takes place in the direction in which the force acts.*" By change of motion, Newton meant *change in momentum* as his own explanation of the law indicates. He explains this law as follows: "If a force generate any motion, a double force will generate a double motion, a triple force, a triple motion, whether they be applied simultaneously and at once, or gradually and successively. This motion, if the body were already moving, is either added to the previous motion, if in the same direction, or subtracted from it, if directly opposed, or compounded with it if the two motions are inclined at an angle."

37. According to Newton's second law of motion, the possession by a mass M of an acceleration F in any direction implies that a force P, given by

$$P=MF,$$

is acting in that direction. As a deduction from this law, it was shown (§ 16) that forces can be resolved or compounded according to the vector law. Combining these results, we observe that a body can remain at rest (that is, it can have zero acceleration), either because it is entirely free from the action of force (§ 14), or because the forces which act upon it have no resultant, *i.e.*, neutralize one another when combined by the vector law. The former condition cannot be contemplated in a universe characterized by universal gravitation: the second is the concern of statics—the science of forces in balance, or *equilibrium*.

EQUILIBRIUM OF A PARTICLE

Polygon of Forces.—38. We start by considering a particle, *i.e.*, a body of infinitesimal size. Suppose first that two forces are acting, represented in direction and magnitude by lines OP_1, OP_2 (fig. 12) passing through O, the particle. According to the vector law, their resultant will be represented by OR_1, the diagonal of the parallelogram of which OP_1, OP_2 are the sides: it follows that the point R_1 could have been found by drawing OP_1 to represent the first force and P_1R_1 to represent the second.

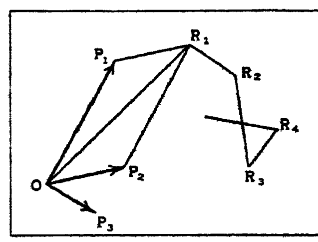


FIG. 12

If a third force acts in addition, represented by OP_3, the resultant of the three forces is the resultant of OP_3 and OR_1. By the same argument, it will be represented by OR_2, where R_1R_2 is drawn (parallel and equal to OP_3) to represent the third force. The process can be repeated for any number of forces: we obtain points such as R_3, R_4, . . . etc., and the successive resultants will be represented by OR_1, OR_2, OR_3 . . . etc. It is however a condition of equilibrium that the resultant of all the forces shall be zero; so we see that the last of the points obtained in this way must coincide with O. That is to say, if OP_1, P_2R_1, R_1R_2, . . . etc. are drawn to represent all the forces which act on a particle in equilibrium, these must be sides of a *closed* polygon, which is called the *polygon of forces*. The order in which the forces are taken is evidently immaterial, and the polygon is not necessarily confined to one plane.

In the special case of two forces, we see that R_1 must coincide with O, if the forces are to be in equilibrium. Clearly, this can only occur when the forces are equal and opposite, with the same line of action.

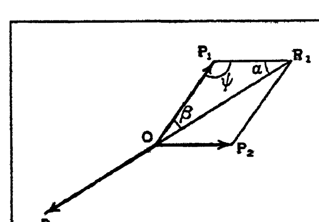


FIG. 13

Triangle of Forces.—39. If the particle is in equilibrium under three forces, represented by OP_1, OP_2, OP_3, the same argument shows that OP_3 must be equal and opposite to OR_1. In words, the three forces must be represented by the sides of a triangle (OP_1R_1) taken in order.

Lamy's Theorem.—40. Fig. 13 illustrates this case. We have, as just stated,

$$\frac{P_1}{OP_1}=\frac{P_2}{P_1R_1}=\frac{P_3}{R_1O}.$$

But, by a property of the triangle,

$$\frac{OP_1}{\sin\alpha} = \frac{P_1R_1}{\sin\beta} = \frac{R_1O}{\sin\gamma}.$$

Hence we deduce that each force is proportional to the size of the angle between the other two forces. This theorem is due to B. Lamy (1679).

BODIES OF FINITE SIZE

Transmissibility of Force.—41. Forces imposed upon the same particle are necessarily concurrent; *i.e.*, their lines of action must intersect at a common point. The same is not true of forces which act upon a body of finite size: to specify any such force completely, we must state not only its line of action, magnitude and sense, but also its point of application. It will be realized that actual bodies distort when forces are applied, and that definite particles, in consequence, alter their relative positions.

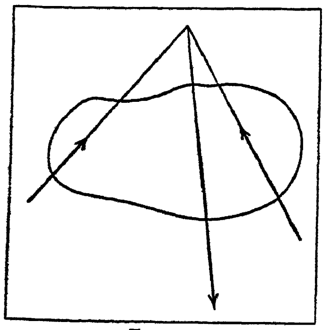


FIG. 14

On the other hand, the distortion is generally small, and for many purposes it may be neglected. Statics commonly treats of bodies as rigid, and it makes use of an assumption which can be regarded as intuitive, viz., that any point in a body, lying on the line of action of a force, may be regarded indifferently as the point of application. This is the *principle of transmissibility of force;* it enables us, in effect, to concentrate upon forces, without particular reference to the body upon which they act.

42. Thus, if *three* forces combine to maintain equilibrium in a body of any size, we may assert, quite generally, that they must be concurrent. This theorem will be seen to follow directly from the condition for two forces which was stated at the end of § 38: the third force must be equal and opposite to the resultant of the other two, and therefore it must act through their point of intersection. As fig. 14 indicates, the point at which three forces intersect will not necessarily fall within the body upon which they act.

Parallel Forces.—43. The principle of transmissibility of force can be employed to find the resultant of two *parallel* forces —a case which does not fall directly within the scope of the vector law. It is evident that the effect of a given system of forces will not be altered by the addition of two equal and opposite forces having the same line of action. If then P and Q (fig. 15) are the two parallel forces whose resultant is required, we may superpose two equal and opposite forces of magnitude S, acting, as

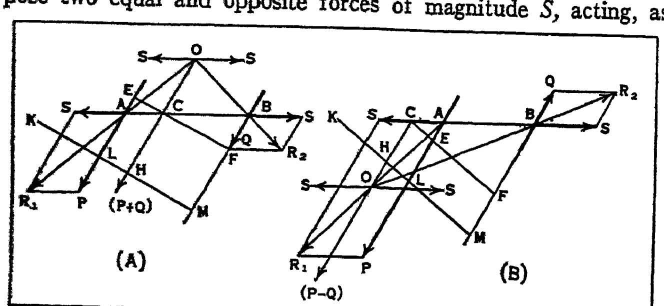


FIG. 15

shown, along a line AB which cuts the line of action of P and Q; and we may combine, according to the vector law, one of these forces with P and the other with Q.

The resultant of P and S is a force R_1, and the resultant of Q and S is a force R_2. In general, the lines of action of R_1 and R_2 will intersect, as shown, at some point O, and according to the principle of transmissibility this point may be regarded as the point of application both of R_1 and R_2. If we now replace R_1 by forces P and S, and R_2 by forces Q and S, acting through O as shown, the two forces S will again neutralize. So we are left, finally, with forces P and Q acting through O in a direction parallel to the original lines of action of P and Q; and it follows that OC is the line of action of the required resultant.

Two cases demand examination, shown in diagrams (A) and (B), respectively, of fig. 15. In the first case, P and Q have the same sense, and C lies between A and B: in the second, P and Q are opposite in sense, and C lies outside AB, on the side of the greater force P. In either case we have

$$\begin{aligned}\frac{CA}{CB} &= \frac{CA}{OC} \div \frac{CB}{OC},\\ &= \frac{S}{P} \div \frac{S}{Q} \text{ (by the vector law),} \qquad (54)\\ &= \frac{Q}{P}.\end{aligned}$$

The magnitude of the resultant force is evidently $(P+Q)$ in the first case and $(P-Q)$ in the second; its sense is in both cases that of P_1, *i.e.*, the greater of the forces P and Q.

Thus one problem is solved, except in the special case in which P and Q are equal in magnitude and opposite in sense. In this case, according to (54), the point C is an infinite distance from A and B, and the magnitude of the resultant is zero: in effect, we cannot find a single force which will replace a pair of equal and opposite parallel forces whose lines of action are not coincident. A pair of forces of this nature is said to constitute a *couple*.

Moments.—44. Equation (54) admits of interpretation in accordance with the concept, moment of a force, which was introduced in § 30. If we draw a line EF through C, perpendicular to the lines of action of P and Q, we have at once, from the figure,

$$\frac{CE}{CF} = \frac{CA}{CB}, \quad = \frac{Q}{P}, \text{ by (54).}$$

This equation may be written in the form

$$PCE = QCF, \qquad (55)$$

and in this form it may be expressed in the statement, that the moments of P and Q about C, according to the definition of § 30, are equal and *opposite; i.e.*, the resultant moment of P and Q about C is zero.

The forces P and Q evidently have the same moments about any other point H in OC, the line of action of their resultant. Conversely, if the resultant moment of two parallel forces about any two points is zero, their resultant must act along a line which passes through those two points, and is therefore definite. We might, in fact, have determined the resultant of P and Q in this way.

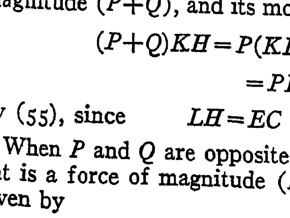


FIG. 16

45. Now consider the moment of the resultant force about any other point K in the plane of the forces. When the forces P and Q have the same sense (diagram A), their resultant is a force of magnitude $(P+Q)$, and its moment about K is given by

$$\begin{aligned}(P+Q)KH &= P(KL+LH)+Q(KM-HM)\\ &= PKL+QKM, \qquad (56)\end{aligned}$$

by (55), since $LH=EC$ and $HM=CF$.

When P and Q are opposite in sense (diagram B), their resultant is a force of magnitude $(P-Q)$, and its moment about K is given by

$$\begin{aligned}(P-Q)KH &= P(KL-HL)-Q(KM-HM),\\ &= PKL-QKM, \text{ by (55) again.} \qquad (57)\end{aligned}$$

46. In both cases we see that the sum of the moments of P and Q about K (taken with due regard to sign) is equal to the moment of their resultant about the same point. The same theorem is true of two forces which intersect (fig. 16). The moment of P about K is PKL, *i.e.*, it is measured by twice the area of the triangle KOP; and similarly, the moments of Q and R

are measured by twice the areas of the triangles KOQ and KOR respectively. Since, however, $QR=OP$, the triangle KOP is equal in area to the sum of the triangle OQR and KQR: therefore the sum of the triangles KOP, KOQ is equal in area to the triangle KOR; *i.e.*, the sum of the moments of P and Q about K is equal to the moment of their resultant R about the same point.

This theorem can be extended to any number of forces, whether parallel or intersecting. In the case of two parallel forces constituting a couple (§ 43), the total moment about any point in their plane has a constant value, given by the product of either force with the distance between their lines of action.

Centre of Gravity.—47. The total weight of a body (*i.e.*, the force exerted upon it by the attraction of the earth) is the resultant of forces exerted upon all the particles which go to form that body. When its dimensions are small in comparison with those of the earth, the force on each particle is proportional to its mass, and all the forces may be taken as parallel: under these conditions we may show that the weight of a rigid body acts always through a point fixed in relation to the body.

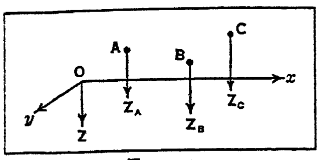


FIG. 17

Let Ox, Oy, Oz be three perpendicular axes fixed in relation to the body, and consider the components in the direction Oz of the forces which act upon three particles A, B, C, of mass M_A, M_B, M_C. Whatever be the direction of the resultant forces on the particles, these components also will be proportional to the respective masses; so we may take them to be given by

$$Z_A=kM_A,\quad Z_B=kM_B,\quad Z_C=kM_C.$$

where k is a constant; and if x_A, x_B, x_C are the distances of A, B, C from the plane yOz, the moments of Z_A, Z_B, Z_C about the axis Oy will be $Z_A\,x_A$, $Z_B\,x_B$, $Z_C\,x_C$. Therefore the resultant moment about Oy will be

$$k(M_Ax_A+M_Bx_B+M_Cx_C). \tag{58}$$

By a generalization of the theorems stated above, the resultant of Z_A, Z_B, Z_C will be a parallel force of magnitude

$$(Z_A+Z_B+Z_C)=k(M_A+M_B+M_C),$$

and its moment about Oy must be equal to (58). Therefore the distance from yOz of its line of action will be $\bar{x}$, where

$$k(M_A+M_B+M_C)\,\bar{x}=k(M_Ax_A+M_Bx_B+M_Cx_C).$$

Generalizing this result for any number of particles constituting a total mass $\overline{M}$, we obtain the formula (33) of § 23; and applying the same argument to moments about the axes Oz and Ox, we find that the resultant of all the forces on all the particles, *i.e.*, the total weight, will in every case pass through a point $(\bar{x}_x, \bar{y}_y, \bar{z}_z)$ which in that article was termed the *mass centre* of the system. In its present significance it is termed the *centre of gravity* of the system, *i.e.*, of the body which the particles compose.

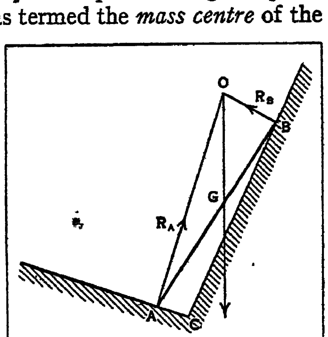


FIG. 18

Equilibrium Under Gravity.—48. The motion of centre of gravity—as a point, fixed in relation to any given body, through which its weight may be taken to act—enables us to bring many problems within range of the theorem stated in § 42. For example, suppose that we require to know the slope at which a heavy rod AB (fig. 18) can rest in equilibrium with its ends on two smooth plane surfaces CA, CB. Since the effect of gravitation may be represented by a single force through G, the centre of gravity of the rod, this is in effect a problem of equilibrium under three forces. We know that R_A and R_B, the forces exerted by the plane surfaces, must intersect in a point vertically above G; moreover, since these surfaces are smooth, R_A and R_B must be perpendicular to CA and CB respectively. Hence, when the position of G in AB is known, we have only to draw lines OA, OG, OB in three known directions, and to place AB so that it is divided by these lines into segments which have a definite ratio: when this condition is satisfied, AB has the required slope.

Catenaries.—49. Again, we may employ the theorem to calculate the curve in which a heavy chain AB (fig. 19) will hang in equilibrium under gravity, and the tensions which will be brought into play. Since the chain is flexible, the tension at every point will act along the tangent to the curve. Let T be the tension at any point P, and H the tension at the lowest point O. The portion of the chain which extends between O and P may be regarded as held in equilibrium by three forces; viz., the tensions T and H, acting in the directions CP, CO, as indicated, and the resultant weight of the portion OP. Since these three forces must be concurrent, the centre of gravity of the portion OP must lie in the vertical line through C; the triangle PCN (fig. 19) will be the triangle of forces (§ 39); and if W is the weight of the portion OP, we have

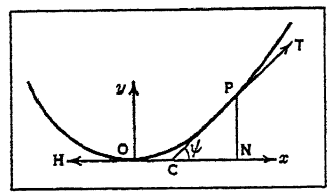


FIG. 19

$$\frac{W}{PN}=\frac{H}{CN}=\frac{T}{CP}. \tag{59}$$

Let Ox, Oy be drawn horizontally and vertically through O, and let s denote the length of the curve measured from O. Then we have, from (59),

$$W=H\tan\psi=H\frac{dy}{dx},$$

and hence

$$\frac{dW}{dx}=H\frac{d^2y}{dx^2}.$$

Now $\dfrac{dW}{dx}$, the rate at which the total weight W increases with the horizontal distance ON, is the weight of the chain per unit horizontal run. If w is the weight of the chain per unit length (this quantity may of course vary along the length of the chain) we have

$$\frac{dW}{dx}=w\frac{ds}{dx}=w\sqrt{\left[1+\left(\frac{dy}{dx}\right)^2\right]}.$$

So we have, finally, the relation

$$\frac{w}{H}=\frac{\dfrac{d^2y}{dx^2}}{\sqrt{\left\{1+\left(\dfrac{dy}{dx}\right)^2\right\}}}, \tag{60}$$

as a differential equation from which the form of the curve may be deduced when w and H are specified. When the curve has been found, the tension T at any point can be found from (59); for we have

$$T=H\sec\psi=H\frac{ds}{dx}.$$

50. When the weight per unit horizontal run is uniform—as will be very approximately true of a uniform wire stretched in a flat curve—the centre of gravity of OP must lie above the middle point of OH. Hence we shall have

$$CN=\tfrac{1}{2}x,$$

or, by (59)

$$Hy=\frac{W}{2}x.$$

Since W is now proportional to x, we see that y will be proportional to x^2; *i.e.*, the chain will hang in a parabola.

Solid Friction.—51. Reverting to the problem discussed in § 48, we observe that the forces exerted on the rod by the surfaces CA, CB will not necessarily have directions perpendicular to those surfaces, unless the possibility of frictional forces i

expressly excluded. Allowance for friction is commonly made on the basis of the empirical law propounded by C. A. Coulomb (1821), according to which the force exerted between two surfaces may be inclined to their common normal at any angle which does not exceed some definite value λ; this limiting angle λ, termed the *angle of friction,* depends upon the nature of the surfaces in contact, but is independent of the intensity of the reaction between them. On the basis of this law we may say, in the problem considered, that the rod can rest in any position (as shown, *e.g.*, in fig. 20), provided that a point D can be found, vertically above G, such that neither of the angles DBO, DAO exceeds λ, where AO, BO are perpendicular to CA, CB respectively.

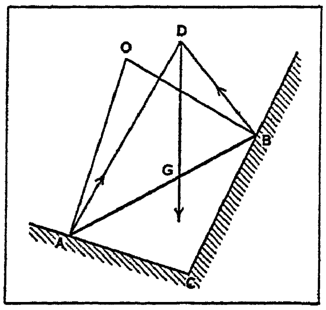


FIG. 20

52. Coulomb's law of friction may be stated in another way. If R is the normal pressure between two surfaces in contact, the resultant action is found by combining R with a tangential component S (due to friction); it will thus be inclined at an angle ϕ to the normal direction, where

$$\tan\phi = \frac{S}{R}.$$

Hence, if ϕ cannot exceed the angle of friction λ, it follows that the ratio S/R cannot exceed a definite limit, $\tan\lambda$, which is called the *coefficient of friction,* and is commonly denoted by the symbol μ. Thus, according to Coulomb's law, a tangential force will be exerted between two rough surfaces in contact, which cannot exceed a definite fraction μ of the normal pressure between them, but will assume, within these limits, any magnitude and direction that may be required to maintain equilibrium. As was shown by the preceding example, the exact nature of the forces which act to maintain equilibrium in a given position will generally be indeterminate.

DYNAMICS OF CONTINUOUS SYSTEMS

53. The purpose of this article is to explain, to a reader not previously conversant with mechanics, those basic concepts and principles of the science which he will require when reading other articles in this encyclopaedia, and in particular the article DYNAMICS.

54. Natural bodies, with which the general theory has to deal, are continuous or apparently continuous distributions of matter, either solid, fluid or gaseous. One way in which they may be treated is to conceive them as an aggregate of particles—large but finite in number, and separated by small but finite intervals—which act on one another with forces of direct attraction or repulsion. This is commonly known as *Boscovich's hypothesis* (R. G. Boscovich, a *Treatise on Natural Philosophy,* Venice, 1758): it enables us to formulate after the manner of §§ 22, 30, the principles of linear and angular momentum.

Principle of d'Alembert.—55. Another method of treatment is to assume a principle first stated by d'Alembert (J. le R. d'Alembert, *Traité de dynamique,* 1743). According to Newton's second law (§ 15) the possession of an acceleration F, in any direction, by a particle of mass M implies that a force of magnitude MF acts upon it in that direction. This force, which we may call the effective force, is the resultant of all the forces which act on the particle. When the particle forms part of a material "system," the latter forces may be divided into two classes: (1) the *external forces* acting from outside the system, and (2) the *internal forces* due to the reaction of other particles in the system. D'Alembert's principle assumes that the internal forces constitute by themselves a system in equilibrium, and hence, that the *effective forces* constitute a system which as a whole is statically equivalent to the system of external forces.

Accordingly we have, for any system, three equations of the type

$$\Sigma(m\ddot{x}) = \Sigma(X), \tag{61}$$

and three of the type

$$\Sigma(xm\ddot{y} - ym\ddot{x}) = \Sigma(xY - yX), \tag{62}$$

in which Σ denotes a summation embracing all the particles of the system. In these equations m denotes the mass of a typical particle, and x, y, z its coordinates referred to any rectangular system of axes, so that $m\ddot{x}$, $m\ddot{y}$, $m\ddot{z}$ are the components of the effective force on m; X, Y, Z are the components of the external force on this particle. Equation (61) is obtained by resolving parallel to Ox, and (62) by taking moments about Oz.

Writing (61) and (62) in the equivalent forms

$$\frac{d}{dt}\Sigma(m\dot{x}) = \Sigma(X) \tag{63}$$

$$\frac{d}{dt}\Sigma(xm\dot{y} - ym\dot{x}) = \Sigma(xY - yX) \tag{64}$$

we see that they express the principles of linear and angular momentum, which are thus shown to be derivable from either of the two fundamental assumptions just stated. It will be observed that neither principle is restricted to rigid bodies: the importance of assuming rigidity lies in the fact that it renders the six equations of types (63) and (64) sufficient in number to determine the motion of a body.

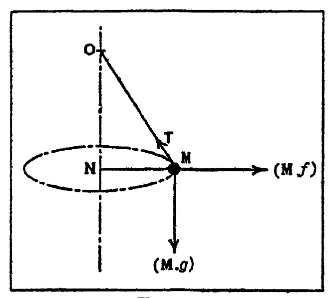


FIG. 21

56. An obviously equivalent statement of d'Alembert's principle is that the system of external forces is in equilibrium with the system of effective forces *reversed.* This concept enables us to treat problems in dynamics by the methods of statics. For example, in the problem of the conical pendulum (fig. 21) we have a mass M attached to a fixed point O by an inextensible string, and describing a circular path about a vertical axis through O. The circular motion can be shown to involve an acceleration of the mass along the radius MN, and if this acceleration has a constant value f we may take account of the motion by assuming a *reversed effective force,* of magnitude $M \cdot f$, to act as shown. Then we have, in effect, a problem in statics, since the reversed effective force must be in equilibrium with the external forces on M, viz., its weight $M \cdot g$ acting vertically and the force T imposed upon it by the tension of the string. (R. V. S.)

BIBLIOGRAPHY.—Text-books dealing with the elementary notions of mechanics, as outlined in this article, are very numerous: the reader may be referred to A. E. H. Love's *Theoretical Mechanics,* or to H. Lamb's *Statics, Dynamics* and *Higher Mechanics.* The last of these treatises deals with higher developments of the subject as outlined in the article DYNAMICS; E. T. Whittaker's *Treatise on Analytical Dynamics* may also be consulted. Philosophical aspects are treated in the first part of J. Ward's *Naturalism and Agnosticism.* For a short account of Newton's researches *cf.* S. Brodetsky, *Sir Isaac Newton.*

MECHANICVILLE, a city of Saratoga county, New York, U.S.A., on the State Barge canal and the west bank of the Hudson river, near the mouth of the Hoosick, 20 m. above Albany. It is served by the Boston and Maine (which has a large freight-classification yard here) and the Delaware and Hudson railways. Pop. (1920), 8,166; 7,924 in 1930. The city has abundant water-power, and manufactures brick, paper, paper boxes, shirts, knit goods, gloves and other articles. A dam provides power for the General Electric Company at Schenectady. The first settlement was made about 1680. The village was chartered by the county court in 1859, incorporated in 1870 and became a city in 1915.

MECHANISM is the general name for a theory which holds that natural phenomena can be and should be explained by reference to matter and motion and their laws. The term, however, is used in rather different senses in different contexts, according to the nature of the other view which it is intended to contradict. The principal antitheses are these: Mechanism *versus* Super-naturalism; Mechanism *versus* Teleology; Mech-

anism *versus* Vitalism; Mechanism *versus* Emergence. The enumeration follows more or less the historical order of the controversies which each pair of antithetic terms suggests. In the 17th century a great deal was written in favour of the "mechanical philosophy." "The tenets of mechanical philosophy," as Robert Boyle conceived it, consisted in explaining the physical phenomena of nature by means of "little bodies variously figured and moved." What the upholders of the "mechanical philosophy" were most concerned about was the elimination from science of such notions as "substantial forms," "occult qualities," "hypostatical principles," etc., which had long obstructed the path of natural knowledge. Boyle himself did not see any inconsistency in combining "mechanical" with teleological explanations or with the assumption that Nature has "designs." Spinoza, on the other hand, regarded the mechanical method of explanation as incompatible with the teleological and the supernatural. In view of the once prevalent proneness to explain natural phenomena teleologically, and teleologically only (which Voltaire still found it necessary to ridicule) the supporters of a mechanical, anti-teleological attitude in science no doubt rendered an important service. But the subsequent development of the biological sciences tended to show the inadequacy of a merely mechanical explanation of vital phenomena. While admitting the need of pursuing mechanical modes of explanation as far as possible, it has been felt with increasing urgency that something more is required to account for the facts of life than the laws of matter and motion. The opposition to biological mechanism, or mechanical biology, first took the form of what is known as Vitalism or the assumption that there is in each living organism a kind of entelechy (*q.v.*) or directive vital principle. This kind of vitalism was especially vindicated by H. Driesch. More recently Lloyd Morgan and others have advocated a theory of emergence (*q.v.*) in opposition not only to biological mechanism, but to the theory of exclusive mechanism even in chemistry and other physical sciences. In its application to biology, the doctrine of emergence has been called emergent vitalism in contrast to the vitalism of Driesch which is called substantial vitalism. *See* EMERGENCE; EVOLUTION AND MIND.

See also C. D. Broad, *The Mind and its Place in Nature* (1923); C. Lloyd Morgan, *Emergent Evolution* (1926). (A. Wo.)

MECHITHARISTS, a congregation of Armenian monks in communion with the Church of Rome. The founder, Mechithar, was born at Sebaste in Armenia, 1676. He formally joined the Latin Church, and in 1701, with sixteen companions, he formed a definitely religious institute of which he became the superior. Their Uniat propaganda encountered the opposition of the Armenians and they were compelled to move to the Morea, at that time Venetian territory, and there built a monastery, 1706. On the outbreak of hostilities between the Turks and Venetians they migrated to Venice, and the island of St. Lazzaro was bestowed on them, 1717. This has since been the headquarters of the congregation, and here Mechithar died in 1749, leaving his institute firmly established. The Mechitharists are numbered among the lesser orders affiliated to the Benedictines.

BIBLIOGRAPHY.—See *Vita del servo di Dio Mechitar* (Venice, 1901); E. Boré, *Saint-Lazare* (1835); Max Heimbucher, *Orden u. Kongregationen* (1907) I. § 37; and the articles in Wetzer u. Welte, *Kirchenlexicon* (ed. 2) Herzog, *Realencyklopädie* (ed. 3), and the *Catholic Encyclopaedia*. (E. C. B.)

MECHNIKOV, ILYA (1845–1916), Russian biologist, was born at Ivanovka, in Kharkov on May 15, 1845. At the age of 17 he entered the Kharkov university and two years later went to Germany. Returning to Russia in 1867, he became a *dozent* in zoology both at St. Petersburg and at Odessa, where in 1870 he was made professor of zoology and comparative anatomy. In 1882 he went to Messina and there began his studies on the nature and habits of microbes. Henceforth he devoted himself to pathological study and in 1888 went to Pasteur in Paris, who gave him a laboratory in the École Normale. By 1892 his views on the essential importance of phagocytosis were firmly established. In that year he published *The Comparative Pathology of Inflammation,* followed in 1901 by his chief work, *Immunity in Infectious Diseases* (Eng. trs. 1905), and a more popular treatise, *The Nature of Man* (1903, Eng. trs. 1904). In later years he made a special study of the bacteria infesting the alimentary canal of man. In 1908 he was awarded the Nobel Prize for medicine. He died in Paris July 16, 1916.

See *Life* by his wife, Olga Mechnikov (1920 Eng. trans. 1921).

MECKLENBURG, a territory in northern Germany, on the Baltic sea, divided into the republics of Mecklenburg-Schwerin and Mecklenburg-Strelitz.

Mecklenburg-Schwerin is bounded N. by the Baltic sea, W. by Ratzeburg and Schleswig-Holstein, S. by Brandenburg and Hanover, and E. by Pomerania and Mecklenburg-Strelitz, and possesses three small exclaves. It became a republic in 1918 and by the constitution of 1920 it is governed by a Landtag of 64 members. The state sends one member to the Reichsrat of the German Republic. For administrative purposes it is divided into 17 divisions, in addition to the four cities of Rostock, Schwerin, Wismar (the capital) and Güstrow. Its area is 5,068 sq.m. Pop. (1925) 674,045, about 95% of whom are Protestant.

Mecklenburg-Strelitz consists of two detached parts, the former duchy of Strelitz on the East of Mecklenburg-Schwerin, and the former principality of Ratzeburg on the West. The first is bounded by Mecklenburg-Schwerin, Pomerania and Brandenburg, the second by Mecklenburg-Schwerin, Lauenburg, and the territory of the free town of Lübeck. Their joint area is 1,131 sq.m. Pop. (1925) 110,269. The state was declared a republic in 1918 and by the constitution of 1923 it is now governed by the 35 members of the Landtag who choose an executive of two. It is represented in the Reichsrat by one member. The capital is Neu-Strelitz.

Industries.—Mecklenburg lies wholly within the great North-European plain, and its flat surface is interrupted only by a low range of morainic hills, which form the watershed between the Baltic sea and the Elbe. Its highest point, the Helpter Berg, is 587 ft. above sea-level. The coast-line is for the most part covered with dunes. The rivers are numerous and some are navigable, and the facilities for inland water traffic are increased by canals. As a result of glaciation lakes are numerous (about 400). The temperature varies from a January average of 32° F to a July average of 64° F and the annual rainfall is about 23 in. Although there are long stretches of marshy moorland along the coast, the soil is on the whole productive, about half the area being cultivated, while one-fifth is forested. Agriculture is by far the most important industry, and the chief crops are rye, wheat, potatoes and hay. Smaller areas are devoted to maize, sugar beet, pease, rape, hemp, flax, hops and tobacco. The pastures support herds of sheep, cattle and horses. Red deer, wild swine and various other game are found in the forests. The industrial establishments include a few iron-foundries, wool-spinning mills, machine factories, dye-works, tanneries, brick-fields, soap-works, breweries, limekilns and tar-boiling works, tobacco factories and mills of various kinds. Rostock, Warnemünde and Wismar are the principal commercial centres. The chief exports are grain and other agricultural produce, live stock and wood; the chief imports are colonial produce, iron and coal. Fishing is carried on extensively in the numerous inland lakes.

The peasantry of Mecklenburg retain traces of their Slavonic origin, especially in speech, but their peculiarities have been much modified by amalgamation with German colonists. The townspeople and nobility are almost wholly of Saxon strain. The slowness of the increase in population is chiefly accounted for by emigration.

HISTORY

The Teutonic peoples, who in the time of Tacitus occupied the region now known as Mecklenburg, were succeeded in the 6th century by some Slavonic tribes, one of these being the Obotrites, whose chief fortress was Michilenburg, the modern Mecklenburg, near Wismar; hence the name of the country. Though partly subdued by Charlemagne towards the close of the 8th century, they soon regained their independence, and the effective subjugation of Mecklenburg was made by Henry the Lion, duke of Saxony. The Obotrite prince Niklot was killed in battle

said to have destroyed Nineveh about 880 B.C., preserved in Diod., ii. 32, seq. and copied by many later authors) has no historical value whatever, although some of his names may be derived from local traditions. According to Herodotus, Phraortes, the son of Deioces, was the first who attacked Nineveh, but was defeated and slain; and when his son Cyaxares renewed the attack, his progress was interrupted by an invasion of the Scythians, who founded an empire in western Asia, which lasted 28 years. This invasion of Asia by the Scythians appears to have greatly shaken the Assyrian empire; from Jeremiah and Zephaniah we know that a great invasion of Syria and Palestine by northern barbarians really took place in 626 B.C. Some stories in Herodotus show the Scythian warriors in connection with Cyaxares and the Medes; so the probable explanation is that the Babylonian annals generally give the title "King of the hosts of the Manda" to the Median kings; Manda is an old word for the nomadic tribes of the north, which is also applied to the Cimmerian chieftains.

Until 1923 we knew practically nothing about the fall of the Assyrian empire. But in this year, a chronicle was discovered by Gadd (the "Fall of Nineveh") in the British Museum, which gives us the exact dates. From it we learn that Nabopolassar of Babylon and Cyaxares (Uvakishtar) of Media began the war against the Assyrians (who were supported by the Egyptians) in 616 B.C. In 612 the allies began the siege of Nineveh, which was stormed and destroyed. The last king, Siusharishkun, the Saracus of Berossus probably sought his death in the flames of his palace; but an offspring of this dynasty, Ashuruballit, still maintained the fragments of his kingdom for some years in Harran (Carrhae), until this town also was taken by the Medes.

The victors divided the provinces between themselves. Syria with Palestine and the south of Mesopotamia fell to the Chaldaean empire of Babylon; the Median king ruled over the greatest part of Iran, Assyria and northern Mesopotamia, Armenia and Cappadocia. His power was very dangerous to their neighbours, and the exiled Jews expected the destruction of Babylonia by the Medes (Isa. xiii., xiv., xxi.; Jerem. l. li.), and Nebuchadrezzar tried to secure his kingdom by great fortifications, canals and walls against the menace from the north. He succeeded in establishing a state of equilibrium for half a century, further secured by an intermarriage between the dynasties. When Cyaxares attacked Lydia, the kings of Cilicia and Babylon intervened and negotiated a peace in 585, by which the Halys was established as the boundary.

About the internal organization of the Median Empire we know only that the Greeks derive a great part of the ceremonial of the Persian court, the costume of the king, etc., from Media. But it is certain that the national union of the Median clans was the work of their kings; and probably the capital Ecbatana (*q.v.*) was created by them.

By the rebellion of Cyrus, king of Persia, against his suzerain Astyages, the son of Cyaxares, in 553, and his victory in 550, the Medes were subjected to the Persians. In the new empire they retained a prominent position; in honour and war they stood next to the Persians; the ceremonial of their court was adopted by the new sovereigns who in the summer months resided in Ecbatana, and many noble Medes were employed as officials, satraps and generals. After the assassination of the usurper Smerdis, a Mede Fravartish (Phraortes), who pretended to be of the race of Cyaxares, tried to restore the Median kingdom, but was defeated by the Persian generals and executed in Ecbatana (Darius in the Behistun inscr.). Another rebellion, in 409, against Darius II. (Xenophon, *Hellen.*, i. 2, 19) was of short duration. But the non-Aryan tribes of the north, especially the Cadusians, were always troublesome; many abortive expeditions of the later kings against them are mentioned.

Under the Persian rule the country was divided into two satrapies. The south, with Ecbatana and Rhagae (Rai), Media proper, or "Great Media," as it is often called, formed in Darius' organization the eleventh satrapy (Herodotus, iii. 92), together with the Paricanians and Orthocorybantians; the north, the district of Matiane (*see* above), together with the mountainous districts of the Zagros, and Assyria proper (east of the Tigris) was united with the Alarodians and Saspirians in eastern Armenia, and formed the 18th satrapy (Herod., iii. 94; cf. v. 49, 52, vii. 72). When the empire decayed and the Carduchi and other mountainous tribes made themselves independent, eastern Armenia became a special satrapy, while Assyria seems to have been united with Media; therefore Xenophon in the *Anabasis*, ii. 4, 27; iii. 5, 15; vii. 8, 25; cf. iii. 4, 8 sqq. always designates Assyria by the name of Media.

Alexander occupied Media in the summer of 330; in 328 he appointed as satrap Atropates, a former general of Darius (Arrian, iii. 8, 4, iv. 18, 3, vi. 29, 3), whose daughter was married to Perdiccas in 324 (Arrian, vii. 4, 5). In the partition of his empire southern Media was given to the Macedonian Peithon; but the north, which lay far off and was of little importance for the generals who fought for the inheritance of Alexander, was left to Atropates. While southern Media with Ecbatana passed to the rule of Antigonus, and afterwards (about 310) to Seleucus I., Atropates maintained himself in his satrapy and succeeded in founding an independent kingdom. Thus the partition of the country, which the Persian had introduced, became lasting; the north was named Atropatene after the founder of the dynasty, a name which is preserved in the modern Azerbaijan. The capital was Gazaca in the central plain, and the strong castle Phraaspa (Dio Cass., xlix. 26; Plut., *Anton.*, 38; Ptol., vi. 2, 10) or Vera (Strabo, xi. 523), probably identical with the great ruin Takhti Suleiman, with remains of Sassanid fire-altars and of a later palace. The kings had a strong and warlike army, especially cavalry (Polyb., v. 55; Strabo, xi. 253). Nevertheless, King Artabazanes was forced by Antiochus the Great in 220 to conclude a disadvantageous treaty (Polyb., v. 55), and in later times the rulers became in turn dependent on the Parthians, on Tigranes of Armenia and then Rome. Pompey defeated their King Darius (Appian, *Mithr.* 108), Antonius invaded Atropatene,—Augustus received the homage of their kings. In the time of Strabo (A.D. 17), the dynasty existed still (p. 523); in later times the country seems to have become a Parthian province.

Southern Media remained a province of the Seleucid empire for a century and a half, and Hellenism was introduced everywhere. "Media is surrounded everywhere by Greek towns, in pursuance of the plan of Alexander, which protect it against the neighbouring barbarians," says Polybius (x. 27). Only Ecbatana retained its old character. But Rhagae became a Greek town, Europus; and with it Strabo (xi. 524) names Laodicea, Apamea, Heraclea or Achais (*cf.* Plin., vi. 48). Most of them were founded by Seleucus I. and his son Antiochus I. In 221, the satrap Molon tried to make himself independent (there exist bronze coins with his name and the royal title), together with his brother Alexander, satrap of Persis, but they were defeated and killed by Antiochus the Great. In the same way, in 161, the Median satrap Timarchus took the diadem and conquered Babylonia; on his coins he calls himself "the great King Timarchus"; but this time again the legitimate king, Demetrius I., succeeded in subduing the rebellion, and Timarchus was slain. But with Demetrius I. the dissolution of the Seleucid empire begins, which was brought on chiefly by the intrigues of the Romans, and shortly afterwards, about 150, the Parthian king, Mithridates I. (*q.v.*), conquered Media (Justin, xli. 6). From this time Media remained subject to the Arsacids, who changed the name of Rhagae, or Europus, into Arsacia (Strabo, xi. 524), and divided the country into five small provinces (Isidorus Charac.). From the Arsacids or Parthians, it passed in A.D. 226 to the Sassanids, together with Atropatene. By this time the old tribes of Aryan Iran had lost their character and had been amalgamated into the one nation of the Iranians. The revival of Zoroastrianism, which was enforced everywhere by the Sassanids, completed this development. It was only then that Atropatene became a principal seat of fire-worship, with many fire-altars. Rhagae now became the most sacred city of the empire and the seat of the head of the Zoroastrian hierarchy; the Sassanid *Avesta* and the tradition of the Parsees therefore consider Rhagae as the home of the family of the Prophet. Henceforth the name of Media is used only as a geographical term and begins to disappear from the living language; in Persian traditions

it occurs under the modern form *Māh* (Armen. *Mai;* in Syriac the old name *Madai* is preserved; *cf.* Marquart, *Eranshahr,* 18, *seq.*).

For Mohammedan history *see* CALIPHATE; for later history SELJUKS and PERSIA. (ED. M.)

MEDIA, a borough of Pennsylvania, U.S.A., county seat of Delaware county, 8 m. W. of Philadelphia, on the Pennsylvania railway and Federal highway 1. It has a municipal airport. Pop. (1920) 4,109 (80% native white); and 5,372 in 1930. Media was founded by the Friends in 1682. There is still a large Quaker element in the population. The borough was incorporated in 1850.

MEDIAN, the point on a statistical scale of the distribution of cases, above which and below which lie exactly 50% of the cases. The median is thus a measure of "central tendency." It has the advantage over the arithmetical mean or "average" that it is not affected by unusually high or low values of the variable. For instance, given the values 3, 4, 5, 6, 7, 8, 100, the median is 6, and the arithmetic mean is 19. For some purposes the median value better describes the central tendency of such a series.

In a triangle, a line drawn from any vertex to the mid-point of the opposite side. The three medians of a triangle meet in a point which is two-thirds of the distance from each vertex to the mid-point of the opposite side. This point is the *centroid* of the triangle, and is its centre of gravity.

MEDIANT, a term in music signifying the note occupying the third degree of the diatonic scale (*e.g.,* E in the key of C), the name being derived from the fact that the note in question stands mid-way between the tonic (the first note) and the dominant (the fifth). (*See* HARMONY.)

MEDIATION, in international law the intervention of a third Power, on the invitation or with the consent of two other Powers, for the purpose of arranging differences before an appeal to arms or after war has broken out. In either case the mediating Power negotiates on behalf of the parties who invoke or accept its aid, but does not go further. Unlike an arbitrating Power the mediator limits his intervention to suggestion and advice. His action is liable to be arrested at any time at the will of either party unless otherwise agreed, in which case to arrest it prematurely would be a breach of good faith.

Of successful mediation in the strict sense there have been many instances: that of Great Britain, in 1825, between Portugal and Brazil; of France, in 1849–50, when differences arose between Great Britain and Greece; of the Great Powers, in 1868–69, when the relations of Greece and Turkey were strained to breaking-point by reason of the insurrection in Crete; of Pope Leo XIII., in 1885, between Germany and Spain in the matter of the Caroline islands. In these cases mediation averted war. The Austro-Prussian War of 1866, the war between Chile and Peru in 1882, that between Greece and Turkey in 1897, and that between Russia and Japan in 1905 are instances of wars brought to a close through the mediation of neutral Powers. Mediation has also been occasionally employed where differences have arisen as to the interpretation of treaties or as to the mode in which they ought to be carried out; as when Great Britain mediated between France and the United States with regard to the Treaty of Paris of July 4, 1830. In one case at least mediation has been successful after a proposal for arbitration had failed. In 1844, when war between Spain and Morocco was threatened by reason of the frequent raids by the inhabitants of the Rif on the Spanish settlement of Ceuta, Spain declined arbitration on the ground that her rights were too clear for argument. But both she and Morocco subsequently accepted joint mediation at the hands of Great Britain and France.

The cause of mediation was considerably advanced by the Declaration of Paris of 1856. The plenipotentiaries of Great Britain, France, Austria, Russia, Sardinia and Turkey recorded in a protocol, at the instance of Lord Clarendon, their joint wish that "States between which any misunderstanding might arise should, before appealing to arms, have recourse so far as circumstances might allow (*en tant que les circonstances l'admettraient*) to the good offices of a friendly Power." Article 8 of the Treaty of Paris, concluded in the same year, stipulated that "if there should arise between the Sublime Porte and one or more of the other signing Powers any misunderstanding which might endanger the maintenance of their relations, the Porte and each of such Powers, before having recourse to the use of force, shall afford the other contracting parties the opportunity of preventing such an extremity by means of mediation." These precedents (in which it will be seen that "good offices" and "mediation" are used interchangeably) were followed in the general act agreed to at the Conference held at Berlin in 1884–85, the object of which was to secure religious and commercial liberty and to limit warlike operations in the Congo basin.

A special form of mediation was adopted by The Hague Peace Conferences of 1899 and 1907. It was provided that, before an appeal to arms or during hostilities, a Power not a party to the dispute shall be entitled to offer good offices or mediation to the States at variance, and that the exercise of this right shall not be regarded by either of the parties in dispute as an unfriendly act. (M. H. C.; H. H. L. B.)

MEDIATIZATION, the process by which at the beginning of the 19th century, a number of German princes, hitherto sovereign as holding *immediately* of the emperor, were deprived of their sovereignty and *mediatized* by being placed under that of other sovereigns.

See August Wilhelm Heffter *Die Sonderrechte der Souveränen und der Mediatisirten, vormals reichsständischen Häuser Deutschlands* (1871).

MEDICAL AND SURGICAL SOCIETIES. The first meeting of the *Congrès Médical International* was held at Paris in 1867; a *Bulletin* has been issued annually since 1868, and the first Surgical Congress was held in Paris in 1885. The first *Congrès Périodique Internat. d'Ophthalmologie* took place at Brussels in 1857. The Royal Colleges of Physicians and of Surgeons of London, Edinburgh and Dublin do not come within our scope. The *Medical Society of London* (1773) is the oldest in the metropolis; it has issued *Memoirs* (1787–1805), *Transactions* (1810, etc.), and *Proceedings* (1872, etc.). The *Royal Society of Medicine* was formed, by Royal charter, in 1907 by the amalgamation of the following societies: *Roy. Med. and Chir. Soc.* (1805), *Pathological Soc.* (1846), *Epidemiological Soc.* (1850), *Odontol. Soc. of Gt. Britain* (1856), *Obstetrical Soc.* (1858), *Clinical Soc.* (1867), *Dermatological Soc. of London* (1882), *British Gynaecological Soc.* (1884), *Neurolog. Soc.* (1886), *British Laryngol. Rhinol. and Otological Assoc.* (1888), *Laryngol. Soc.* (1893), *Soc. of Anaesthetists* (1893), *Dermatol. Soc. of Gt. Brit. and Ireland* (1894), *Otological Soc.* (1899), *Soc. for Study of Diseases in Children* (1900), *British Electro-therapeutic Soc.* (1901) and the *Therapeutical Soc.* (1902). Most of these societies had separate *Transactions* or *Proceedings* which are now incorporated in the *Proc. Roy. Soc. Med.* Other British or London societies (past and present) include the *Abernethian Society* (1795), which issues *Proceedings; Anatomical Soc. of Gt. Brit. and Ireland* (1887); *British Dental Association* (1880), with a *Journal* (1880, etc.); *British Homoeopathic Association* (1859), with *Annals* (1860, etc.); *British Medical Association* (1832), which has more than forty home and colonial branches, and publishes *British Medical Journal* (1857, etc.); *Hahnemann Publishing Society* (1852), *Materia Medica* (1852, etc.); *Harveian Society* (1831); *Hunterian Society* (1819), *Trans.; Lister Institute* (incorp. 1891); *Medico-Legal Soc. of London, Trans.; Medico-Psycholog. Assn. of Gt. Britain and Ireland* (1841, incorp. 1895); *New Sydenham Society* (1858), which published *Biennial Retrospect* (1867, etc.), and translations and reprints of books and papers of value, succeeded the old *Sydenham Society* (1844–1858), which issued 40 vols.; *Ophthalmological Society* (1880), *Trans.; Pathological Society of Gt. Brit. and Ireland, Jour. of Pathology and Bacteriology; Pharmaceutical Society* (1841), with museum, *Pharmaceutical Journal* (1842, etc.); *Physiological Association* (1876), *Journ. of Physiology* (1878, etc.); *Brit. Psycholog. Soc., Brit. Jn. Med. Psychol.; Soc. for Study of Inebriety* (1884), *Brit. Jn. of Inebriety; Med. Off. Health Assn.* (1884), *Jn. of School Hygiene; Roy. Med. Psychol. Assn.* (1926), *Jn. of Mental*

Sci.; Roy. Soc. of Med. and Hyg., Trans.; Assn. Physicians Gt. Brit. and Ireland, Quarterly Jn. Med.; Röntgen Soc. now merged into the Institute of Radiology, *Journal; Royal Institute of Public Health* (1886, incorp. 1892), *Journ. Royal Sanitary Institute* (1876, incorp. 1888), the council of which appoints examiners, directs Parkes Museum, founded in 1876 in memory of Dr. E. A. Parkes; *Society of Medical Officers of Health* (1856), *Trans.* and *Public Health; Soc. of Public Analysts, Analyst.* The provincial societies are very numerous and include: Bradford, *Med. Chir. Soc.* (1863); Bristol, *Med. Chir. Soc.;* Cardiff, *Med. Soc.* (1870); Liverpool, *Sch. of Tropical Med.* (1898, incorp. 1905), *Memoirs;* Manchester, *Med. Soc.* (1848); Newcastle-upon-Tyne, *North. and Durham Med. Soc.* (1848). Dublin, *Roy. Acad. of Med. in Ireland* (1882), *Trans.* (1883, etc.); *Pharmac. Soc. of Ireland* (1875). Edinburgh, *Roy. Med. Soc.* (1737; charter 1778); *Harveian Soc.* (1752); *Medico-Chirurg. Soc.* (1821), *Trans.* (1824, etc.); and *Obstetrical Soc.* (1840). Aberdeen, *Med. Chir. Soc.* (1789). Glasgow, *Medico-Chirurg. Soc.* (1866), based upon *Med. Soc.* and *Med.-Chirurg. Soc.* (both 1814), joined by *Path. Soc.* in 1907.

AUSTRALIA: Melbourne, *Med. Soc. of Victoria, Austr. Med. Journ.* (1856, etc.). CANADA: Montreal, *Union Méd. du Canada, Revue* (1872, etc.); *Canada Med. Assoc., Trans.* (1877, etc.). INDIA: Bombay, *Med. and Physical Soc., Trans.* (1838, etc.). Calcutta, *Med. Soc., Trans.* (1883, etc.).

UNITED STATES: *Amer. Pub. Health Assoc., Reports* (1873, etc.); *Amer. Dental Assoc., Trans.* (1860, etc.); and *Amer. Inst. of Homoeop., Trans.* (1878, etc.). The headquarters of the *American Medical Association* (1847) are at Chicago; it publishes a *Journal.* The *American Surgical Association* (1880) unites at Washington every third year with the *Congress of American Physicians and Surgeons.* The State medical associations include those of Alabama, *Trans.* (1869, etc.); Georgia, *Trans.* (1873, etc.); Maine, *Trans.* (1853, etc.); Missouri, *Trans.* (1851, etc.); and South Carolina, *Trans.* The State medical societies include those of Arkansas, *Trans.* (1877, etc.); California, *Trans.* (1870, etc.); Illinois, *Trans.* (1851, etc.); Kansas, *Trans.* (1867, etc.); Michigan; *Trans.* (1869, etc.); Minnesota, *Trans.* (1874, etc.); Nebraska, *Trans.* (1869, etc.); New Jersey, *Trans.* (1859, etc.); Pennsylvania, *Trans.* (1851, etc.); Rhode Island, *Trans.* (1877, etc.); Texas, *Trans.* (1874); and Wisconsin, *Trans.* (1880, etc.). To these have to be added the following town associations. Albany, *Med. Soc., Journal* (1807, etc.). Baltimore, *Med. and Chirurg. Faculty of Maryland, Trans.* (1856, etc.). Boston, *Amer. Gynaecolog. Soc., Trans.* (1876, etc.); *Mass. Medico-Legal Soc., Trans.* (1878, etc.). Denver, *Acad. of Med.* (1903). New York, *Acad. of Med., Trans.* (1847, etc.) and *Bull.* (1860, etc.); *Med. Soc., Trans.* (1815, etc.); *Medico-Chirurg. Soc., Trans.* (1878, etc.); *Amer. Surg. Assoc., Trans.* (1883, etc.); *Medico-Legal Soc., Sanitarian* (1873, etc.); *Amer. Ophthalmolog. Soc., Trans.* (1865, etc.); *Path. Soc.* (1844), *Trans.* (1875–1879), *Proc.* (1888, etc.). Philadelphia, *Med. Soc., Trans.* (1850, etc.); *Obstet. Soc., Trans.* (1869, etc.); *Amer. Pharm. Assoc., Proc.; Patholog. Soc.* (1857), *Trans.* (1897, etc.); *Coll. of Physicians* (1787); *Amer. Soc. of Tropical Med.* (1903). Richmond, *Med. Soc., Trans.* (1871, etc.).

FRANCE: Besançon, *Soc. de Méd.* (1845), *Bull.* (1845, etc.). Bordeaux, *Soc. de Méd.* (1798), *Journ.* (1829, etc.); *Soc. de Pharm.* (1834), *Bull.* (1860, etc.); *Soc. de Méd. et de Chirurg.; Soc. d'Anat. et de Physiol.* (1879), *Bull.* (1880). Caen, *Soc. de Méd.* (1799; known by its present name since 1875), *Journal* (1829), *Mém.* (1869). Chambéry, *Soc. de Méd.* (1848), *Comptes rend.* (1848, etc.) and *Bull.* (1859, etc.). Grenoble, *Soc. de Méd.* Havre, *Soc. de Pharm.* (1858), *Mém.* Lille, *Soc. de Méd.* (1843), *Bull.* (1845, etc.) Lyons, *Soc. Nat. de Méd.* (1789), *Le Lyon méd.* (1869, etc.). Marseilles, *Soc. de Méd.* (1800), *Comptes rend.* (1826–1853) and *Le Mars. méd.* (1869, etc.); *Soc. Méd.-Chirurg.* (1872). Paris, *Soc. de Méd. Pratique* (1808), *Bull.; Acad. Nat. de Méd.* (1820); *Soc. Nat. de Chirurg.* (1843, reorganized 1859), *Mém.* (1847, etc.) and *Bull.* (1851, etc.); *Soc. Anat.* (1803), *Bull.* (1826, etc.); *Soc. Clinique, Bull.* (1877, etc.); *Soc. Méd. des Hôpitaux, Bull.* (1849, etc.); *Soc. Méd. Légale; Soc. de Pharm.* (1803), *Journ.* (1815, etc.); *Soc. de Thérapeutique; Soc. Fran. de Hygiène; Soc. Centr. de Méd. Vétérinaire* (1844), *Bull.; Assoc. Int. de l'Inst. Marey* (1898) (for examining physiological methods and apparatus), *Bull., Travaux.* Rouen, *Soc. de Méd.* (1821), *Union Méd.* (1861, etc.); *Soc. Libre des Pharmaciens* (1802), *Bull.* Toulouse, *Soc. de Méd.* (1801), *Bull.* and *Revue* (1867, etc.). Tours, *Soc. Méd.* (1801). GERMANY and AUSTRIA-HUNGARY: *Deutscher Ärztevereinsbund* (1872), *Verhandl.; Central Ver. d. Zahnärzte* (1859), *Mittheil.; D. Veterinärrath* (1874); *D. Apotheker-Ver.* (1820), *Archiv* (1822, etc.). Berlin, *Ver. f. Heilkunde* (1832), *Magazin* (1835, etc.); *Ges. f. Geburtshülfe u. Gynaekologie* (1876), *Ztschr.* (1877, etc.); *Ges. f. Heilkunde* (1855); *Berl. Med. Ges.* (1860), *Verhandl.* (1865, etc.); *Physiolog. Ges.* (1875), *Verhandl.* (1877, etc.); *D. Ver. f. Med. Statistik* (1868); *Ver. Homöop. Ärzte* (1871), *Ztschr.* (1882, etc.); *D. Ges. f. Chirurgie* (1872), *Verhandl.* Bonn, *Verband der Ärztl. Vereine* (1865). Breslau, *Ver. f. Physiolog. Heilkunde* (1848), *Ztschr.* (1850, etc.); *Verband d. Schles. Ärzte-Ver.* (1878). Cologne, *Rhein. Med.-Chirurg. Ver.* (1848), *Organ* (1852, etc.). Darmstadt, *Ärztl. Kreisver.* (1844). Dresden, *Ges. f. Natur- u. Heil-Kunde* (1818), *Jahresber.* (1848, etc.). Erlangen, *Physik.-Med. Soc.* (1808), *Sitzungsber.* (1870, etc.). Frankfort, *Arztl. Ver.* (1845), *Jahresber.* (1857, etc.). Hamburg, *Arztl. Ver.* (1816); *Deutsche Ges. für Gesch. der Medizin* (1901), *Mitteil.* Hanover, *Ver. Analyt. Chemiker* (1878). Heidelberg, *Ophthal. Ges.* (1857). Jena, *Med.-naturwissenschaftliche Ges.* (1854), *Zeitschr.* (1874, etc.). Königsberg, *Ver. f. wiss. Heilkunde* (1851). Leipzig, *Med. Ges.* (1829); *Ges. f. Geburtschülfe* (1854), *Mittheil.; Homöop. Central-Ver.* (1829); Magdeburg, *D. Chirurgen-Ver.* (1844), *Ztschr.* (1847, etc.). Munich, *Ärztl. Ver.* (1833), *Int.-Blatt* (1854, etc.). Strasburg, *Soc. de Méd.* (1842), *Mém.* (1850, etc.); *Soc. Vétérin.* (1864); *Medizinisch.-Naturwissenschaftlicher Ver.* (1873). Stuttgart, *Württemb. Ärztl. Ver.* (1831), *Corr.-Blatt* (1832, etc.); *Hahnemannia* (1868), *Mittheil.* (1873, etc.); *Apotheker-Ver.* (1822), *Pharm. Wochenblatt* (1861, etc.). Vienna, *K. k. Ges. der Ärzte, Ztschr.* (1844, etc.); *Ges. für innere Medizin u. Kinderheilkunde, Med. Wochenschrift.* Weimar, *Med.-naturwiss. Ver.* (1863). Würzburg, *Physikal.-med. Ges.* (1849), *Verhandl.* (1850, etc.). SWITZERLAND: Geneva, *Soc. Méd.* Zürich, *Soc. de Méd.; Schweiz. Apotheker-Ver.* ITALY: Bologna, *Soc. Med.-chirurg.* Genoa, *Accad. Med.-chirurg.* Milan, *Soc. Ital. d' Igiena.* Modena, *Soc. Med.-chirurg.* Naples, *Real Accad. Med.-chirurg.* Palermo, *R. Accad. delle Sc. Med.* (1649), *Atti* (1889, etc.). Rome, *R. Istit. Fisico-patologico.* Turin, *Accad. Real Med.-chirurg.* BELGIUM: Antwerp, *Soc. de Méd.* (1839), *Annales.* Brussels, *Acad. Roy. de Méd.* (1841), *Bull.* (1841, etc.) and *Mém.* (1843, etc.); *Soc. Roy. de Pharm.* (1845), *Bull.; Soc. d' Anat. Patholog.* (1846), *Annales; Soc. Belge de Méd. Homoeop.; Soc. Roy. des Sc. Méd. et Nat.* (1822), *Journal* (1842, etc.), *Annales* (1892, etc.), *Bulletin* (1843, etc.); *Inst. Solvay de Physiol.* (1894), with electro-physiological, chemical, embryological and other laboratories, and lecture hall. Ghent, *Soc. de Méd.* (1834), *Annales.* Liége, *Soc. Méd.-chirurg.* HOLLAND: Amsterdam, *Genootschap ter Bevordering der Genees- en Heel-Kunde, Verhandel.* (1841, etc.); *Nederl. Maatschappij ter Bevord. der Pharmacie.* Batavia (Java), *Geneeskundige Vereeniging.* DENMARK: Copenhagen, *K. Med. Selskab; Veterinaer Selskab.* NORWAY: Oslo, *Med. Selskab, Magazin* (1840, etc.). SWEDEN: Stockholm, *Farmaceutiska Inst.; Svenska Läkaresällskapet* (1808), *Handl.* (1813, etc.). Upsala, *Läkareförenig, Förhandl.* (1865, etc.). SPAIN: Madrid, *R. Acad. Med.* (1732). PORTUGAL: Lisbon, *Soc. de Sc. Med.* (1835), *Jornal* (1835, etc.); *Soc. Pharm. Lusitana.* RUSSIA: Dorpat, *Pharm. Soc.* Helsingfors, *Finska Läkaresällskapet* (1835), *Handl.* (1841). Moscow, *Phys.-med. Soc.* Riga, *Soc. of Practical Physicians.* Leningrad, *Soc. of Practical Physicians; Imp. Pharm. Soc.* Vilna, *Imp. Med. Soc.* (1805), *Protokoly.* Warsaw, *Med.-Chirurg. Soc.* Tomsk (Siberia), *Soc. of Naturalists and Physicians* (1889), *Protocol.* RUMANIA: Jassy, *Soc. of Naturalists and Physicians* (1830), *Buletinul.* GREECE: Athens, *Soc. Méd.* TURKEY: Constantinople, *Soc. Imp. de Méd.; Soc. de Pharm.* CENTRAL and SOUTH AMERICA: Buenos Aires, *Asoc. Med.* Caracas, *Escuela Med.* Guadalajara (Mexico), *Soc. Med.* Merida (Mexico), *Soc. Med.* Mexico, *Acad. de Med.; Soc. Med.* Monte Video, *Soc. de Med.* Rio de Janeiro, *Instituto*

Oswaldo Cruz, formerly *Instituto de Manguinhos* (for the promotion of experimental pathology); *Soc. Med. e Cirurgia*, Santiago, *Soc. Med.* JAPAN: Tokyo, *Soc. for Adv. of Med. Sc., Trans.* (1885, etc.).

New York Academy of Medicine.—This is an American association which was founded in 1847 to advance medical education, to aid the scientific development of its members and to make progress in all matters relating to public health. It has (1928) 1,690 fellows and 38 honorary fellows. The library is one of the largest in the United States and contains 150,256 volumes, 104,564 octavo pamphlets, 9,720 quarto pamphlets and subscribes to 1,570 current serials. It is open to the public daily as well as to its fellows (except Dec. 25 and July 4). The Bureau of Clinical Information, maintained by the Committee on Medical Education, offers detailed information regarding all medical activities in New York and other cities of the United States, Canada and in European centres. The Committee on Public Health Relations gathers and publishes pertinent information with regard to health activities of the municipal and voluntary social service agencies. The stated meetings of the academy and those of its various sections are open to physicians and medical students as well as to its fellows.

MEDICAL ARTICLES. Under the general subject of Medicine several subdivisions are included, viz., Anatomy, Pharmacology and Therapeutics, Pathology, Midwifery and Diseases of Women, Surgery, Medicine, Public Health, Tropical Medicine, Veterinary Medicine. In each instance a general article is given in which the scope of the subject is presented, but in addition so many special articles are included that they must be indicated in separate paragraphs.

Anatomical Articles.—In a general article on ANATOMY the subject is reviewed particularly from the superficial and artistic points of view and also in respect of the modifications introduced by X-ray examination during recent years. In addition to numerous smaller articles which are included on special subjects, the ALIMENTARY CANAL, ARTERIES, BRAIN, CONNECTIVE TISSUES, DUCTLESS GLANDS, EAR, EYE, HEART, JOINTS, LIVER, LYMPHATIC SYSTEM, MUSCULAR SYSTEM, NERVE, NERVOUS SYSTEM, REPRODUCTIVE SYSTEM, RESPIRATORY SYSTEM, SKELETON, SKIN AND EXOSKELETON, SKULL, SPINAL CORD, TEETH, URINARY SYSTEM and VEINS receive extended notice. Numerous illustrations are included and though the subjects are treated primarily from the human point of view subsections deal with the comparative anatomical and embryological aspects. Adequate bibliographies are given at the end of most of the articles.

Bacteriological Articles.—The main subject is treated under the headings of BACTERIA AND DISEASE, and in the articles on Bacteriology: FILTER PASSING VIRUSES, IMMUNITY, PHAGOCYTOSIS, SERUM THERAPY, VACCINE THERAPY. In addition all diseases of known or suspected dependence upon bacterial infection, *e.g.*, diphtheria, measles, food poisoning, carry some reference to the bacterial factor inculpated. In INFLAMMATION AND ITS SEQUELS a broad survey is given of the response of the body to bacterial and non-bacterial irritants and the points of similarity and of difference are contrasted. Closely akin to this group is that on PARASITIC DISEASES in which are described the characters and effects of various naked-eye and microscopic animal parasites affecting man and lower animals. An adequate bibliography is placed at the end of each article.

Pharmacological Articles.—General articles are those on PHARMACY, PHARMACOLOGY and PHARMACOPOEIA. In addition to shorter notices on the great majority of drugs found in the most important pharmacopoeias there are special articles of greater length on ANAESTHESIA AND ANAESTHETICS, ANTISEPTICS AND ASEPSIS, BALNEOTHERAPEUTICS, ELECTROTHERAPY, POISONS, RADIOTHERAPY, RADIUM THERAPY and SUNLIGHT TREATMENT. Important drugs like CALABAR BEAN, DIGITALIS, BELLA-DONNA, CINCHONA BARK, ALKALOIDS OF, OPIUM and the BARBITURIC ACID and SULPHONAL Group receive greater notice. The general principle is to indicate the botanical origin of a drug with a description of the special plant or its varieties from which the drug is obtained and this is followed by its chemistry so far as is known, its pharmacological action and its uses. In many instances a bibliography of recent work on the particular subject is appended.

Pathological Articles.—Some indication of the known or suspected pathology is given in the case of all diseases, but special articles of a pathological kind are contained in PATHOLOGY, ANAPHYLAXIS, ATROPHY, HYPERTROPHY, BLOOD TRANSFUSION, CANCER RESEARCH, HAEMORRHAGE, INFLAMMATION AND ITS SEQUELS, MONSTER, NEUROPATHOLOGY, PAIN (SIGNIFICANCE OF), SHOCK AND COLLAPSE, TUMOURS. In this connection a knowledge of the normal appearances is necessary and reference must be made to the various anatomical articles (*see* ANATOMICAL ARTICLES) as well as to those which deal with EPITHELIUM, ENDOTHELIUM, CONNECTIVE TISSUES, MUSCLE (STRUCTURE OF), GLANDS, etc. Shorter articles deal with ABSCESS, ALCOHOL (PATHOLOGICAL EFFECTS OF), ANKYLOSIS, AUTOPSY, BEDSORE, BLISTER, BUNION, CALCULI (with colour plate), CARBUNCLE, CORN, DILATATION, EMPYEMA, FROSTBITE, NAEVUS, NECROSIS, GANGRENE, ULCER, etc.

Midwifery and Diseases of Women.—The chief articles in this subsection are ABORTION, BIRTH CONTROL, EMBRYO, GYNAECOLOGY, MENSTRUATION, OBSTETRICS, PLACENTA, PUERPERAL FEVER. Shorter articles are on CAESAREAN SECTION, MENOPAUSE, OVARIOTOMY, TWILIGHT SLEEP.

Surgery.—Principle articles are on ABDOMEN (SURGERY OF), APPENDICITIS, BONES (DISEASES OF), BRAIN (SURGERY OF), CANCER, DENTISTRY, EAR, NOSE AND THROAT (DISEASES OF), HEART AND LUNG (SURGERY OF), HERNIA, INTESTINAL OBSTRUCTION, JOINTS (DISEASES AND INJURIES OF), MAMMARY GLAND (DISEASES OF), OPHTHALMOLOGY, ORTHOPAEDIC SURGERY, PERITONITIS, SEPSIS, SKULL (SURGERY OF), SPINAL COLUMN AND CORD (SURGERY OF), UROLOGY, VENEREAL DISEASES. Important shorter articles are on BLOOD LETTING, BURNS AND SCALDS, CLEFT PALATE AND HAIR LIP, CLUB-FOOT, FISTULA, FRACTURES, HAEMORRHOIDS, PHLEBITIS, REPRODUCTIVE SYSTEM (SURGERY OF), BLADDER AND PROSTATE (DISEASES OF), STOMACH (DISEASES OF), TETANUS, VARICOSE VEINS, WOUND. In addition numerous small articles of about a quarter page are given on subjects of surgical interest.

Medicine.—In this subsection is included the greater number of subjects contained in a single subsection. Besides important articles on MEDICINE (HISTORY OF), MEDICINE (GENERAL), MEDICAL EDUCATION, MEDICAL LEGISLATION, MEDICAL JURISPRUDENCE, MEDICAL RESEARCH, authoritative articles are presented on ALIMENTARY SYSTEM (DISEASES OF), ANAEMIA, CHILDREN (DISEASES OF), DIABETES, DIAGNOSIS, DIPHTHERIA, ENCEPHALITIS LETHARGICA, EPILEPSY, EPILEPTIC FIT, GOUT, HEART (DISEASES OF), HYDROPHOBIA, INFLUENZA, INSANITY, KIDNEY (DISEASES OF), LIVER AND GALL-BLADDER (DISEASES OF), MEASLES, METABOLIC DISEASES, PARALYSIS, PARANOIA, PARATYPHOID FEVERS, PNEUMONIA, PSYCHOSIS, PSYCHIATRY, RESPIRATORY SYSTEM (DISEASES OF), RHEUMATISM, SCARLET FEVER, SKIN DISEASES, SMALLPOX, TUBERCULOSIS, TYPHOID FEVER, TYPHUS FEVER. Shorter but also authoritative articles cover most of the diseases affecting man, *e.g.*, ANGINA PECTORIS, APOPLEXY, BLINDNESS (CAUSES OF), BRONCHITIS, CONVULSIONS, DEAF-MUTISM, DROPSY, DYSPEPSIA, GASTRIC AND DUODENAL ULCER, GOITRE, HOOK WORM, INSECT STINGS AND BITES, JAUNDICE, LARYNGITIS, LOCOMOTOR ATAXIA, MIGRAINE, NEURASTHENIA, RICKETS, ST. VITUS' DANCE, TONSILLITIS, WHOOPING COUGH.

Public Health.—Articles are presented on ABATTOIR, SLAUGHTER-HOUSE, ADULTERATION, AMBULANCE, CREMATION, DROWNING AND LIFE-SAVING, ENTOMOLOGY (MEDICAL), EPIDEMIOLOGY, FOOD (PURE), HOSPITALS, VACCINATION in addition to general articles on PREVENTIVE MEDICINE and PUBLIC HEALTH.

Tropical Medicine.—Longer articles are on CHOLERA, DYSENTERY, LEPROSY, MALARIA, PLAGUE, SLEEPING SICKNESS and YELLOW FEVER. Shorter articles include those on BERI-BERI, BILHARZIOSIS, BLACKWATER FEVER, DENGUE, KALA-AZAR, MALTA FEVER, SANDFLY FEVER, SPRUE, SUNSTROKE AND HEATSTROKE, YAWS.

Veterinary Medicine.—The articles included in this subsection are on ANTHRAX, DISTEMPER, FOOT AND MOUTH DISEASE, GLANDERS OR FARCY, ABORTION, CONTAGIOUS, PLEURO-PNEU-

MONIA, RINDER PEST, SWINE FEVER.

Miscellaneous Medical Articles.—Some 40 articles differing in length are given to subjects not easy to place in one of the foregoing sections and subsections. Such are those on ADOLESCENCE, AVIATION (MEDICAL ASPECTS OF), BLOODLESS SURGERY, CLIMATE IN THE TREATMENT OF DISEASE, DIET AND DIETETICS, DRUNKENNESS, HOMOEOPATHY, HYPNOTISM, INFANCY, INFANT CARE, MANIPULATIVE SURGERY, MINERAL WATERS, NURSING, PHOTOGRAPHY IN MEDICINE, PHRENOLOGY, PHYSICS IN MEDICINE, QUACKERY, RED CROSS, REJUVENATION, SEA-SICKNESS, SOMNAMBULISM, STAMMERING, STARVATION, VEGETARIANISM, VIVISECTION, ANIMAL EXPERIMENT, MEDICAL SERVICE, ARMY, MEDICAL SERVICE, NAVY, VITAMINS. In most instances a recent bibliography is appended to the articles and cross-references are numerous.

MEDICAL EDUCATION. A sound general education is necessary for the medical as for all other learned professions.

I. IN GREAT BRITAIN

In Great Britain before admission to a course of training a boy or girl is required to show in an examination of matriculation, character and standard that he or she has acquired a respectable knowledge of English, a language other than English, mathematics and some other school subjects of the candidate's own selection. Latin is no longer exacted by the General Medical Council (G.M.C.) although in certain universities it is compulsory for students who desire to obtain a medical degree.

The General Council of Medical Education and Registration does not determine directly the requirements of the various licensing bodies, but exercises a measure of control over the doctor's training by deciding the conditions precedent to registration, first as a medical student and finally as a qualified practitioner. Since 1922 the G.M.C. has required an examination in physics and chemistry be passed by him before registration. The gain is two-fold. His school work more efficiently prepares the boy for his profession, and more time is made available in the brief five years, which is the most that can be exacted as a minimum between registration as a student and registration as a qualified practitioner. The council also allows the student to pass the examination in biology immediately after registration. The curriculum recognized as medical carries the student through a succession of stages which merge insensibly one into the other, until his accumulated knowledge and steadily increasing skill justify the conferring upon him of a degree or diploma which admits him to all the responsibilities of medical practice. It is impossible to over-emphasize the statement that the several steps "merge." They are not stepping stones. No subject is left behind when the passing of an examination qualifies a student to approach the next. The examination tests his fitness to approach subject B whilst still carrying forward subject A.

Stages of the Education.—These stages may be defined as (1) The study of the structure of the body and of its behaviour in health, anatomy (*q.v.*) and physiology (*q.v.*), to which two years are assigned. (2) The study of the behaviour of the body when perturbed by abnormal conditions, by malformations, by injury (*see* PATHOLOGY), by the invasion of parasites (*see* PARASITOLOGY) ranging from ultra-microscopic "germs" (*see* FILTER-PASSING VIRUSES) to intestinal worms, an extension of physiology into the domain of disease. (3) The study of physiological changes which result from the administration of various chemical substances, "drugs," already anticipated by the study of the "drugs" which, in health, various organs pour into the circulation, internal secretions (*see* ENDOCRINOLOGY). (4) The study of the possibilities of modifying the behaviour of the body, when diseased, in a beneficial way by administration of drugs. (5) The proper management of the body in health, preventive medicine. (6) The care of the sick and of women in childbirth.

The Object of Medical Training.—With the exception of the changes already referred to, developments in medical education are rather in the manner of presenting knowledge than in the selection of subjects to be studied. When so much of value must be omitted, every subject included in the curriculum should be taught in the most practical way. It must be made a part of the practitioner's outfit, which he can never afford to lose. His knowledge of the anatomy of the living body must enable him to see its organs in their relation to one another as clearly as if it were transparent. In some degree, dissecting room work has given way to surface anatomy and the study of models and frozen sections; although training in the use of scalpel and forceps is still the only means of acquiring dexterity in the surgeon's craft. In physiology, during the first year, the student is in most schools given more practical work than formerly.

The greatest changes have been introduced in the third and fourth years of the curriculum. Physiology has been extended into pharmacology, an ever-growing body of exact knowledge derived from the study, with instruments of precision, of the effects produced upon guinea-pigs and rabbits by chemical compounds of which some, like caffeine and morphine, are vegetable products, whilst others, such as phenacetin, have been prepared synthetically in the laboratory for the express purpose of modifying the behaviour of the body. When used to correct disorders, these various chemical substances, with the apparatus which has been designed for the purpose of studying their effects, belong to the sphere of therapeutics (*q.v.*).

At about this stage in the student's training, bacteriology (*q.v.*), a science which is growing so rapidly as to be for the most part relatively new, claims his attention. The micro-organisms which cause disease present biological problems of the highest interest. Every medical man needs to be expert in the methods of making preparations for identification with the microscope (*see* MICROSCOPY), of using the various culture media and of cultivating the various organisms *in vitro*. And since the effects upon the fluids of the body which they induce can be recognized chemically, a new name, "biochemistry" (*q.v.*), is usually applied to the department of science in which ascertained facts are grouped together. To the physiologist and physician have been opened up the two provinces of serum and vaccine therapy and immunology (*see* IMMUNITY). Provision is made for teaching the principles of various kinds of drugless therapeutics, such as treatment with ultra-violet light (*see* HELIOTHERAPY) with radium and X-rays, or by massage, and the demonstration of the results obtained in special clinics.

Clinical Units.—The most notable modification in medical education made during recent years is the organization of clinical units. Physicians and surgeons still go round their wards at stated hours—usually in the early afternoon—followed by troops of students to whom they point out the features of each case, expound the nature of the malady and explain the reasons for the treatment adopted. But no longer, as formerly, is the student dependent upon "walking the wards," attending lectures and reading about the illnesses of which the cases he has seen are illustrations. The clinical unit is a far more efficient training centre. Its staff consists of a director and three or four assistants. Either the director himself or one of his assistants is a whole-time officer of the university. To the unit are assigned a number of beds—usually 60 or 70—in suitable wards with adequate laboratory accommodation in their near vicinity and an ample supply of apparatus for the examination of the patients and for testing their reactions. An out-patient department is included in the unit.

Students examine chemically and microscopically the blood and excreta. They make every kind of measurement, and as the wards are open throughout the day they have the opportunity of seeing how patients should be treated, nursed, and cared for in every respect. As the teachers of physiology, bacteriology, pharmacology and other subjects visit the clinic from time to time, the student learns under ideal conditions how all that he has been taught combines to fit him for his life-work, the care of the sick and their restoration as speedily as possible to health.

New and Old Systems Contrasted.—Until comparatively recent times students were required to attend a certain amount of hospital practice during their first two years, usually six months. This was a relic of the apprenticeship through which aspirants for admission to medical, as to legal and other profes-

sional guilds, were required to pass. In Britain, this tradition is obsolete at last. No longer is a student required, or even allowed, to listen to bedside disquisitions on maladies of which even the names may be unfamiliar, in terms which carry little meaning to his mind, or to watch the physical examination of organs of which he knows but vaguely the form and situation, and to hear of their perturbations before he knows how they function normally. Not until he knows how the body works in health is he shown how disease may disturb its harmony, or taught the remedial measures which should be adopted with a view to aiding nature to set it right. Too early contact with patients inevitably led to confused thinking and false inferences which had to be corrected by subsequent reading and observation and, it may be added, developed in the tyro a conviction that medical practice consists in "spotting" the disease and administering the drug which will "cure" it. The progressive opening-out of knowledge with the synchronous revelation of ignorance, which is the aim of the modern curriculum, avoids loss of time and secures the highest degree of qualification which the limited period of training allows.

Post-graduate and Specialist Work.—As a result of the careful allocation of his time the modern student finds that he has less opportunity than his forerunners of paying special attention to any branch which may attract him. Diseases of the eye, of the throat, of the ear, of the nervous and other organs, are treated with sufficient fullness for the equipment of general practitioners, but not with the thoroughness necessary to make specialists. The student who proposes to specialize must continue his studies after graduation. An increasing number of graduates who do not propose to devote themselves to a single specialty, but wish to make themselves proficient in particular branches of their work, such as gynaecology for example, defer going into practice, or return from time to time to a medical school in order to keep abreast with advances in knowledge and technique. Post-graduation courses are more numerous and better organized than they were in former days, but they are not yet, in Britain, as complete or as intensive as they might be.

II. IN OTHER COUNTRIES

Other Countries.—In most other countries, progress has followed much the same lines as in Britain. The arrangement of a logical sequence of studies and their integration in the curriculum have been the reformer's aim.

In Japan the sequence of studies is much the same as in Britain; but the minimal length of the purely medical curriculum is four years, following on a course in the preliminary sciences.

In China through a subsidiary board of the Rockefeller Foundation of New York, there has been established a modern medical school. The Rockefeller Foundation has furnished funds amounting to $8,000,000 to build and equip the Peking Union Medical college, and in addition it was in 1921 supporting the institution on the basis of a budget for the year amounting to $500,000. The China Medical Board also aids four other medical schools in China carried on by other organizations.

In Belgium the University of Brussels in 1921 planned a complete reorganization of its medical department. The city, the State and the university co-operated in maturing plans for a modern teaching hospital, and new, well-equipped laboratories on a single site.

In France the medical schools still adhere to the system which they regard as "natural." Their students are encouraged to attend clinics from the date of their inscription in the faculty, and the relegation of all lectures and laboratory work to the afternoons almost compels them to devote the mornings to attendance in the wards and out-patient departments.

Bibliography.—For detailed information concerning the existing system of medical education in Great Britain consult *Recent Advances in Medical Education in England,* a memorandum addressed to the Minister of Health by Sir George Newman, Chief Medical Officer; and *Medical Education, a Comparative Study,* by Abraham Flexner. (X.)

III. IN THE UNITED STATES

The U.S. Constitution provided no supervision over either medical education or medical practice but left this to the individual States which, with a few exceptions, have established no regulations, in either State Constitutions or laws. The lack of legal safeguards over the chartering of medical schools made it easy for any group of individuals to open them and to grant degrees whether or not they possessed the essential teachers, buildings, hospitals and other equipment. The result was a rapid multiplication of medical schools. The first medical school in the United States was organized in 1765 as the Medical school of the College of Philadelphia. In 1800, there were five medical schools in the United States for a population of 5,500,000 people. Thereafter, they increased much more rapidly than the population, reaching 162 in 1906, when there was one medical school to each half million people. The course of instruction consisted at first of two annual sessions of six months each, probably ample for the knowledge of medicine of that time. The student's best instruction, perhaps, was obtained by assisting his physician-preceptor in the care of patients and listening to his explanations.

At first, some of the university medical schools required a baccalaureate degree for admission but, through competition with the increasing number of schools, the requirement was reduced to a high school education. Nevertheless, the better schools attracted many students possessing a college training. Of the graduates of Harvard Medical school up to and including 1840, for example, 65% also held baccalaureate degrees. The medical schools, with some notable exceptions, were scantily equipped, had no hospitals, and few, if any, expert teachers. In the better schools, however, there were teachers who gained great repute because of their knowledge and skill, as well as their teaching ability, and a large proportion of students were attracted to these schools. Demands for improvement in medical education, however, were not lacking. With no legal supervision of the medical schools, that function was voluntarily assumed by the national organization of physicians. The American Medical association was established in 1847, its chief object being the "improvement of medical education in the United States." Investigations made on several occasions resulted in improvements by the better medical schools. In 1877, a medical practice law was enacted in Illinois creating a State board of health. Information was collected regarding all medical schools in the United States and Canada, and a list made of low grade medical schools from which recognition was withdrawn, forcing most of them to close. Under this board, also, in 1892 the medical course was increased from two to three, and in 1896 to four annual sessions of seven months each. Entrance requirements were raised, nominally, to a high school education. The reports of the Illinois State board of health contain the only reliable information regarding medical education during the 20 years prior to 1900.

A change of administration in Illinois in 1892, however, brought sweeping changes in the personnel of the board of health which resulted in a relaxation of the supervision over medical education and practice and in the adoption of several retrogressive measures. With the relaxation of the efficient supervision of medical education in Illinois, the numbers of inferior medical schools again increased until, in 1906, the United States had over half of the world's supply. Educationally, also, its medical schools suffered by comparison with those of other countries. In 1904, however, the American Medical association created a permanent committee whose duty was the improvement of medical education. Besides collecting and publishing statistics, two educational standards were prepared; one for immediate adoption suggesting a high school education, and another "ideal standard" requiring one and later two years of college work for admission, with a further requirement after graduation of a year's internship in a hospital. An annual conference was held to which representatives of universities, licensing boards, colleges and others were invited for the discussion of problems of medical education. Following an inspection, the medical schools were graded in classes A, B and C according to their degrees of excellence and a classification was published in 1910.

With so many medical schools and with educational requirements lower than those abroad, the need was for fewer but better medical schools. During the inspections, therefore, two or more

medical schools in any city were urged to unite and form one better equipped institution. Thus, the number of medical schools decreased from 162 in 1906, to 80 in 1923; but those requiring college work for admission increased from two to 74, and the graduates of these higher grade schools increased from 268 to 3,798. In 1910, the Carnegie Foundation for the Advancement of Teaching published its report following a second inspection of medical schools made jointly by representatives of the Foundation and the American Medical association. This report attracted attention to the need in medical schools, of improvements and financial support. The Foundation established no standards and no classifications, those being continued as a function of the Medical association. In 1914, one year of college work was required for admission, which in 1918 was increased to two years. Since 1918, therefore, all students in class A medical schools have obtained two or more years of college education, before entering medical schools, and over 65% of all graduates now obtain both baccalaureate and medical degrees. These higher qualifications are essential if students are to master the present highly technical medical curriculum.

Besides higher entrance requirements, medical schools have increased endowments, new buildings, better laboratories, better trained teachers, better dispensaries and hospitals and more efficient methods of instruction. Now, practically every student before graduation has been drilled in the examination and treatment of patients. Over 90% of graduates spend an additional year as interns in hospitals. Physicians must have a better training than was necessary before 1900. With the great increase of medical knowledge the discovery of the germ origin of diseases has resulted in the development of highly technical methods of treatment of great value if employed by well-trained physicians, but dangerous in unskilled hands. Surgery, formerly used mostly in emergencies, is now commonly employed. Serums, antitoxins, vaccines and the X-ray, wisely used, are saving thousands of lives, but may have serious results if carelessly employed. Because of these highly technical methods, hospitals have become more essential in the care of the sick and have increased both in numbers and size. Through the lack of legal control over hospitals, a voluntary supervision has been assumed by the medical profession. To be approved hospitals are required to possess staffs of competent and reputable physicians, the essential equipment and an efficient routine for the care of sick and injured people.

Bibliography.—Illinois State Board of Health, *Reports* (1880–94); *Journal A.M.A.*, Educational numbers, August each year (1903–28 incl.); U.S. Commission of Education, *Chapters on medical education* (1912–28). (N. P. C.)

MEDICAL JURISPRUDENCE deals with the relationships of law and medicine. A registered medical practitioner is one whose name appears on the register kept by the General Medical Council established under the Medical Acts of 1858 to 1886 to set up standards of professional knowledge, to keep a register of men and women who reach this standard and to deprive of their qualifications those whom the council finds guilty of "infamous conduct in a professional respect." This body is not to be confounded with the British Medical Association, a voluntary association comprising 64% of the medical men and women on the register.

The elements of medical jurisprudence form part of the curriculum of every examining body approved by the General Medical Council. The introductory part of this study treats of the doctor as witness, a medical man being in the nature of things often asked in a court of law to give his opinion as well as to testify as to facts. (*See* Evidence.) At the threshold of this subject stands the question of so-called medical privilege. (*See* Privilege.) Is a doctor bound to disclose in a court of law communications made to him by his patient? The law recognizes no such thing as medical privilege in the sense that there is legal privilege, nor is the reason far to seek. A medical man is consulted about questions which are or ought to be unconnected with the law; a patient does not ask a doctor to undertake his defence in a case before the courts. A medical witness appearing as such should never in any sense be an advocate and must not take sides, whether he be called for the plaintiff or for the defendant. Medical writers themselves hold this ideal up to the profession although in practice it is not always adhered to. Many medical men on graduation take, and all reputable medical men consider themselves bound by, the Hippocratic oath, the relevant part of which is as follows: "Whatsoever in connection with my professional practice or even outside of it I see or hear in the life of men *which ought not to be spoken of* I will not divulge." The italics are important. It is clear that it is required of medical men, as it is required of bankers, that they shall not gossip. When however the law requires it, it is clearly proper to divulge such matters; indeed it will be contempt of court to refuse to do so. On the other hand, it will not be proper to divulge certain matters under any other circumstances, for example, to the executive, who have not the authority, though they often assume it, of the judiciary. (*See* Constitutional Law.)

The notification of Infectious Diseases Act 1889 and many others show that medical privilege is no more recognized by statute law than it is by the common law. The list of acts of parliament which affect medical men is a long and formidable one. Not all of these, however, are considered as forming the subject matter of medical jurisprudence, the majority of them are considered to belong rather to the domain of public health (*q.v.*).

The precision required for elucidation of medico-legal problems will sometimes exceed and sometimes fall short of that required by science; that is to say, the law will at times be content with what may seem rough and ready methods, while at others it is necessary to decide between the diametrically opposed views of medical experts of equal eminence. Obviously the law, by its very nature conservative, must lag a little behind contemporary science, for the interests of justice require not theories nor even hypotheses but facts. The law's *routine* relations are rather with medicine as an art than medicine as a science. This fact is apt to be lost sight of when the so-called expert is extolled at the expense of the general practitioner whose very name denotes that he deals with the realities of life rather than with theories. For this reason medical practitioners enjoy a certain equality in the eyes of the law (nor have we any system as obtains in France where a panel of experts, called *médecins légistes* and consisting of pathologists, toxicologists, gynaecologists and alienists, is drawn up every year by the court). The certificate under the Lunacy Acts may be signed by any registered medical practitioner, although one of the two medical certificates required by s. 5(3) of the Mental Treatment Act 1930 in cases of "temporary treatment without certification" [sic] may be signed only by a practitioner of five years standing approved by the Board of Control. The coroner (*q.v.*) will in difficult cases of course prefer to have the services of a pathologist or of a toxicologist, that is, of men whose reading and practice specially qualify them for the determination of the causes of death, but no such persons are known to the law.

It is difficult to arrange in logical order the subjects falling within the purview of forensic medicine; but a more or less orderly arrangement may be made according to the nature of the court and the case before it. First in date and interest, if not in importance, is the institution, peculiar to the English-speaking peoples (under the common law), of the court of the coroner (*q.v.*) whose duty it is to enquire into all deaths of which the cause is unknown, deaths from violence (accidental or criminal) or in circumstances of suspicion in prisons, lunatic asylums, etc., or from certain notifiable diseases. It is strictly an enquiry and not a trial: there is no suit and there are no parties. The question is—how and by what manner X came by his death. In the great majority of cases death will be found to be due to natural causes, and the investigation of those cases in which the physician in attendance is unwilling or unable to give a death certificate forms the routine work of the pathologist. Some diseases, such as acute haemorrhagic pancreatitis, are almost never diagnosed *ante mortem*. Then again, in cases of sudden death, the physician will be chary of giving a certificate in a case that he has not been attending regularly. Although the coroner enquires into all cases of sud-

den death, he is not always bound to have an autopsy. Some writers, Taylor among them, urge that there should always be an autopsy. Some go further and say that all autopsies should be done by pathologists and not by an "ordinary" medical man. Before 1927 where a certificate was refused and there were no circumstances of suspicion, the publicity of an inquest seemed unnecessarily painful to relatives and not perhaps required by the interests of justice. A useful compromise is found in s. 21 the Coroners Amendment Act 1926 whereby, if there are no circumstances of suspicion and he is not otherwise bound to hold an inquest the coroner may, upon the report of a medical man whom he has instructed to make an autopsy, dispense with an inquest if he thinks fit.

Next in order of frequency will be fatal vehicle accidents which since 1927 must be taken with a jury. It might be thought that in some of these the actual physical cause of death was obvious, as where a man is decapitated by a train. But suppose a man had a stroke and fell under a train: only an autopsy could reveal this and avoid, say, a wrong verdict of suicide, the next commonest case before the coroner.

Last in order of frequency, but of great interest for forensic medicine, will be deaths in respect of which a crime (murder, infanticide, abortion, manslaughter) will be imputed to someone. The duplication of procedure which existed before 1927 has been wisely done away with by the act of 1926 and the coroner, when he learns that someone has been charged with a crime in respect of a body lying within his jurisdiction, adjourns his inquest until after the finding of the criminal court. It is upon the criminal courts that the weapons of forensic medicine have been whetted.

The study of murder (*q.v.*) has a peculiar fascination for many (not necessarily morbid) minds and a vast quantity of material has been collected on this subject. A medical man will usually be one of the first persons on the scene in such cases and it is his duty to note, not only the condition of the body, but also any surrounding circumstances that may be of use in elucidating the crime; for although it is no part of a doctor's business to play the detective, society expects him to take at least as much interest as any other of its members in the suppression of crime. Is an apparent case of suicide, for instance, really one of murder? Did a man found hanging in reality hang himself or was he in fact strangled and then hanged by his assailant?

Louis, a French medical jurist of the Eighteenth century, taught us how to distinguish such cases. A man is found shot or with his throat cut, and a razor or revolver, by him or actually in his hand; was it murder or suicide? These and a host of similar questions are answered in any standard work on forensic medicine. Reading, however, does not make the medico-legal expert. Most of the serious contributions to legal medicine have been made by men who have combined knowledge and experience with the ability to apply both these to an emergency. Some methods, however, have been worked out in the quiet of the laboratory. Of these the most striking is the precipitin test for blood. Blood may be detected by chemical, spectroscopic, microscopic and immunological methods. The first three detect blood but not necessarily human blood, nor was the chemical test (since improved) free from fallacies. The second has no biological specificity while the third enables one to distinguish the blood of the mammalia. The fourth, a veritable triumph of science, enables one to say definitely that the extract of blood-stains examined contains human blood. The stain is extracted with salt solution and added to the serum of a rabbit which has been injected at intervals with human blood: a precipitate will form if the blood is human but not otherwise. The test is done after it has been established by one of the other methods that the stain is blood. In the strictly biological sense the test is generic rather than specific and is given (in a less marked degree) by the anthropoid apes.

The time that has elapsed since death in any given case is an important question to which, in the absence of evidence, the answer cannot in the present state of our knowledge be given with scientific precision. Yet the careful observation of generations has worked out certain rules which allow of an approximation of a fair degree of accuracy. The average rate of cooling of the body is about one degree per hour, depending, however, somewhat on surrounding temperature and moisture, and even, at times, on the mode of death. Post-mortem rigidity comes on three to six hours after death, and lasts, on an average, 16 to 24 hours, while decomposition usually begins on the third day. These are some of the data that are relied on, but they are interpreted in practice with great caution.

If poisoning is suspected, the examiner, under direction of the coroner, sends the stomach and contents and pieces of the solid viscera in sealed jars to the analyst. The study of poisons and their detection is called toxicology. Needless to say the methods have been elaborated with great care, as they must be susceptible of the closest scrutiny.

The crime of infanticide (*q.v.*) is only seven years old in English law. Before that wilful killing of an infant as of any other human being was murder, but the unwillingness of juries to convict led to the Infanticide Act of 1922, whereby the killing of a newly-born child by its mother is made equivalent to manslaughter. Enquiries into the death of infants born alive are not infrequent. The questions for the opinion of the police surgeon, who usually performs the autopsy, will be: Was the child born alive? How long did it live? Was death due to violence, neglect or natural causes? The answers to these questions can be given with precision only by those who have experience of such cases and are acquainted with the fairly comprehensive body of knowledge already acquired—a body of knowledge elaborated, it must be remembered, under the jealous scrutiny of the courts of law when infanticide was murder.

Abortion in law means unlawful abortion, a criminal act, the penalty for which is provided by ss. 55, 58 and 59 of the Offences Against the Persons Act 1861. Abortion, however, means to medical men any artificial termination of pregnancy. There are several indications for the *lawful* termination of pregnancy and their common factor is the danger to the mother's life through the continuance of pregnancy; if the foetus is viable its life will, if possible, be preserved. In criminal abortion on the other hand, it is the mother's convenience that is studied and the act is aimed against and is intended to destroy the ovum or foetus. Lawful abortion will be marked by deliberation, consultation with professional brethren, and the asepsis of the operating theatre. Criminal abortion will be hurried, secret and often septic and unskilful.

Space does not allow the consideration of the numerous other offences against the person which are comprised in legal medicine. The various kinds of manslaughter need not detain us, but mention must be made of the increase in the number of convictions in recent years, due to the enormous development of motor transport. Where, *e.g.*, the driver was "drunk in charge" of a vehicle, criminal negligence will be hard to rebut. The criteria of drunkenness are a subject which is not purely medical. In this condition akin to insanity (*q.v.*) the factor of conduct looms so large that others besides medical men claim to be able to give an opinion. In the navy, *e.g.*, the criterion is: "Is the man fit for duty?" and it is the officer of the watch who applies it, unless the man asks to see the surgeon.

Turning now to civil causes, medical evidence will be required in inquisitions upon lunacy, sometimes in actions upon wills, in actions under Lord Campbell's Act, under the Workmen's Compensation Acts and in matrimonial causes. In connection with workmen's compensation the question of malingering has sometimes to be considered, a subject more familiar to medical men in countries which have adopted conscription. In divorce and in legitimacy cases the period of gestation will sometimes be an issue. After much learned argument there is now pretty general agreement that the period can, in exceptional cases, be as much as 300 days, which happens to be the figure fixed by the XII. Tables. (*See* ROMAN LAW.)

The fact that a medical man may be compelled to disclose in a court of law information obtained from a patient who has consulted him on the faith of the secrecy promised by the Venereal

Diseases Act would seem to make it desirable that medical privilege should be accorded, not indeed with regard to this particular matter alone but in all cases which concern neither fraud nor crime nor otherwise the public interest. (F. T. G.)

UNITED STATES

Medical Jurisprudence deals with the reciprocal relations of law and medicine, using the latter term in its broadest sense. The application of medical knowledge in legal trials is designated forensic medicine. In the United States, the practice of medicine is restricted to licensed physicians, the issuing of licences, as also the regulation of practice, being in the main the function of the individual States. Exceptions include particular Federal laws, such as the act regulating the use of narcotics, popularly known as the Harrison Act, and the act restricting the medicinal use of alcoholic medicinals, known as the Volstead Act. Closely allied is the Food and Drugs Act of 1906, legalizing drug standards.

In presenting evidence of service to a patient, the elements to be established are: the employment, the performance of the service and the value of the service. An original entry of the actual transactions is generally receivable in evidence and is a valuable record. The calling on or of a physician is generally accepted as evidence of employment. Unless there are definite circumstances indicating a contrary relation, the person treated and not the person calling the physician is liable.

By statutes differing in the various States, workmen receive compensation from employers when injured in the pursuit of their employment. The Workmen's Compensation Law of the State of New York provides that the employer must furnish the medical, surgical or other treatment which "the nature of the injury or the process of recovery may require." The employee is not entitled to recover from the employer for expenditures for such services unless, after request, the employer has refused or failed to provide promptly such treatment; nor is a claim of any attending physician valid unless within 20 days from the first treatment he furnish to the employer and to the industrial commissioner, on a prescribed form, a report of the injuries and treatment. The delay may be excused by the board. All fees are subject to regulation by the board and are limited to such charges as prevail in the community for similar treatment of injured persons of a like standard of living. Under this law a large portion of the cases treated is by physicians specializing in compensation work and in clinics of the insurance carriers. Physicians not on the preferred lists of the insurance companies continually experience difficulties over their bills.

The treatment of a patient obliges the physician to possess the ordinary knowledge of his profession and to exercise the ordinary skill. Failure to do so, including wilful neglect, renders him liable for malpractice. A mistake in judgment does not render him liable. Failure to take an X-ray, where the usual practice is to do so, has been construed by the courts as negligence. Wilful unlawful acts towards a patient constitute a second division of malpractice. A third includes acts forbidden by statute, such as the production of criminal abortion or the treatment of a patient while the physician is intoxicated.

Under the Hippocratic oath, physicians regard communications from patients as privileged. Under the English rule of law, the courts do not so recognize them, but in the United States communications are made privileged by statutes in the following States: Group I., in which the patient's consent is necessary for a disclosure: California, Colorado, Idaho, Iowa, Minnesota, Montana, Nebraska, Nevada, New York, North Dakota, Ohio, Oregon, South Dakota, Utah, Washington, Wyoming. Group II., in which the patient waives privilege, if he offers himself or his physician as a witness: Colorado, Kansas, Oklahoma, Oregon. Group III., in which the presiding judge of a superior court may compel disclosure if he deems it necessary to a proper administration of justice: North Carolina. Group IV., in which the statutes are silent on the subject of waiver: Indiana, Kansas, Michigan, Wisconsin. In the Federal courts, in trials at common law the laws of the respective States apply, except where otherwise provided; in a criminal prosecution the privilege secured by State statutes does not avail.

When a physician is called upon as a witness in court merely to relate facts which he has observed, including inferences and deductions which all men are accustomed to make, he is governed by the rules applicable to an ordinary witness. When called upon to explain or interpret facts by reason of his special knowledge, he becomes an expert witness. As an ordinary witness he is subject to subpoena. If the issue concerns a charity patient, the subpoena must be issued by the judge of the court, in some jurisdictions. It is optional with the physician whether he act as an expert witness. In the latter capacity, by reason of his employment by a particular litigant, he is confronted with the possibility of bias which should be avoided. There is criticism of the choice of experts by litigants and resulting conflicting views. To an extent such conflict is due to the relative stability of law with its consequent lagging behind contemporary medical knowledge; experts, especially alienists, thus frequently testifying from different points of view. General medicine, surgery, pathology and toxicology afford less basis for intelligent differences of opinion.

There is no right of property in a dead human body, but duties are imposed upon public officers and next of kin to protect the body from violation and to see that it is properly disposed of and subsequently protected. They may authorize a necropsy to the extent of ascertaining the cause of death. The coroner or other officer is authorized by statutory enactments, varying in detail in the different States, to order a necropsy and such further examination as may be required when, in the discharge of his official duties, it is deemed necessary in cases of sudden death or where there is suspicion that a crime has been committed. If a person dies in one locality and the body is transported to another, the officers where the body is located have jurisdiction.

(E. E. Sm.)

MEDICAL LEGISLATION, though of great antiquity, has only recently taken a prominent place in the statute books of civilized countries. In the last 20 years, statutes have been passed in many countries creating or reorganizing the central public health authority. The Ministry of Health for England and Wales created by the Act of 1919 took the place of the Local Government Board with all its powers and duties and, as regards public health, also those previously exercised by the Board of Education and other departments. Power was further created to transfer from the ministry duties which were not incidental to health.

Ministries of Health have also been established in Canada (1919), the Union of South Africa (1919), Poland (1919), New Zealand (1920), France (1920) and Rumania (1923). A Department of Public Health for the Commonwealth of Australia was created in 1921, and a General Directorate of Public Health in Spain, by a royal decree of 1922.

Zymotic Diseases.—In Australia, New Zealand and the Union of South Africa comprehensive regulations regarding the notification and control of infectious diseases were included; similar regulations were issued in Austria (1913), the Straits Settlements (1915), Peru (1916), Chile (1918), Sweden (1919), Brazil (1921) and Venezuela (1921). A Polish law of 1920 created the office of special commissioner for dealing with epidemics, and a French decree of 1920 instituted a mobile unit equipped with laboratories.

Vaccination.—By a law of 1914, vaccination against smallpox (*q.v.*) becomes compulsory in Siam whenever the health administrator deems it necessary; in the Straits Settlements (1915) it is compulsory, and re-vaccination also can be made compulsory in the face of danger; in France (1915) vaccination and re-vaccination can be made compulsory by decree, but (1918) vaccination is compulsory for state officials. Chile (1918) has compulsory vaccination in the first, 10th and 20th years of age; in Venezuela (1921) there is infant vaccination and re-vaccination every seven years, failure to comply barring from a large number of employments. In Poland (1919) there is compulsory vaccination for infants, and again at seven years. In Tunis (1922) vaccination against smallpox is compulsory, and also against typhoid, cholera and plague, if there is danger of an epidemic. Uruguay (1923) has compulsory vaccination in the first six months, and again in the 10th and 20th years. A Polish law of 1920 makes vaccination

against typhoid fever and cholera compulsory for doctors, nurses, employees at waterworks and for various others.

Tuberculosis.—Anti-tuberculosis legislation has been put into force in various directions. Tuberculosis schemes and the legislation involved are discussed in the article TUBERCULOSIS. The Milk and Dairies (Consolidation) Act, 1915, of Great Britain, provided, *inter alia,* for the registration of dairies and the inspection of dairies and herds; and prohibits the sale for human consumption of milk from a cow with tuberculosis or other specified diseases of the udder. The Milk (Special Designation) Order, 1922, of the British Ministry of Health instituted the licensing of classes of milk, namely certified, Grade A (tuberculin tested), Grade A (non-tuberculin tested) and pasteurized; and prohibited the sale of milk under a designation to which it is not entitled.

The British Public Health Act, 1925, section 62, authorizes a court of summary jurisdiction to order the removal to a suitable hospital or institution, of any person suffering from pulmonary tuberculosis in an infectious stage, when a source of danger to others, either from lack of proper accommodation or from failure to observe sanitary precautions. In Denmark, laws of 1912, 1918 and 1919 made compulsory the notification of pulmonary and laryngeal tuberculosis by the doctor in attendance.

A Japanese law of 1919 gives power to examine any person whose calling might make him a source of transmission, to forbid the exercise of a particular calling by such, and to forbid or restrict trading in old clothes, old books and other articles which might carry infection. In Denmark, compulsory isolation of infectious cases is also empowered with certain limitations; and laws of 1918 and 1919 provided for the use of public funds to support hospitals for tuberculosis, sanatoria and convalescent establishments. A French law of 1916 instituted public dispensaries for treatment and for giving instruction in anti-tuberculosis measures. A decree of 1920 laid down regulations for the establishment, working and supervision of sanatoria. An Italian royal decree, 1919, instituted a central anti-tuberculosis committee, and a Swedish royal decree, 1912, regulated subventions to hospitals for treating tuberculosis.

Venereal Diseases.—The English Venereal Diseases Act (1917) prohibits treatment by unqualified persons in areas to which it is applied, when gratuitous treatment has been provided and approved, and prohibits all kinds of advertisements of quack remedies for such diseases. In Sweden (1912) an affected person is obliged to obtain and complete medical treatment; the same applies to the Union of South Africa (1919), where it is also an offence for an infected person to follow certain employments, or to engage such a person in employment; and to Czechoslovakia, where an infectious person may also be removed compulsorily to hospital if necessary, and an examination by a doctor can be enforced where there is reason to suppose that a person is infected with such a disease. In the state of Rio Grande do Norte, Brazil, by a decree of 1921, a special service for the prevention of venereal diseases was created, and provision was made for action against charlatans and for diffusing information regarding modern methods of avoiding the contagion. In Italy, a royal decree (1923), approved of regulations for the prevention of venereal diseases, including the examination and treatment of prostitutes. A Danish law of 1922 obliges a person suffering from venereal disease, in a stage when it may be communicated or transmitted, to inform the other party to a proposed contract of marriage, and this party must be instructed by a doctor before contracting. The parties must make a declaration of freedom from such disease. The same procedure must be adopted if one of the parties suffers from epilepsy.

Housing.—The British Housing Act, 1925, *inter alia,* makes it a duty of the local authority and the medical officer of health to inspect houses, prohibits the erection of back-to-back houses, and gives power to close and demolish houses deemed unfit for human habitation. The Public Health Act, 1925, gives a local authority power to cleanse, disinfect or destroy articles infested with vermin in dwellings, and to oblige a landlord or tenant to cleanse the dwelling; powers are granted for cleansing of the person also. A Belgian law of 1919 instituted the National Society for Housing, amongst its powers being that of destroying unhealthy dwellings; a revising law of 1921 gave power to expropriate such houses and sites as are required. Similar powers were granted to authorities in France by a law of 1915. A law of 1922 codifies the laws relating to working-class dwellings.

Infant Welfare.—The British Notification of Births (Extension) Act, 1915, extended the act to areas in which it had not been adopted. A Belgian law of 1919 instituted the national work for infant welfare. In France a law of 1917 provided financial help for necessitous women in connection with child-birth, and when the mother nurses the child assistance continues for a period of 12 months. In Germany (1922) help is given to women in the same circumstances, insured and uninsured. An English Act of 1920 regulates the employment of children, young persons and women in industrial occupations; and a Peruvian law of the same year is a similar measure.

Food.—The English Public Health (Milk and Cream) Regulations, 1912, prohibited the addition of any preservatives to milk intended for sale for human consumption, any thickening to cream or preserved cream or any preservatives to cream with less than 35% of milk fat; the only permissible preservatives in cream intended for human consumption were boric acid, borax, a mixture of these, or hydrogen peroxide. By an order (1917) no more than 0·4% of boric acid might be added and the cream must be sold as preserved cream and labelled as unsuitable for infants and invalids. In 1925 the addition of boric acid was prohibited altogether. Public Health regulations, 1923, fixed the minimum percentage of milk fat in dried milk of various descriptions, and that of milk fat and total solids in condensed milks. Containers must declare the contents, and skimmed milk be labelled as unfit for babies.

Drugs.—Most countries have legislated to restrict the use of opium, cocaine and related substances. The English Therapeutic Substances Act, 1925, regulates the manufacture, sale and importation of serums, vaccines, salvarsan, insulin, etc. Other countries have legislated similarly. (R. Sc.)

UNITED STATES

U.S. Public Health Service.—This Federal activity originated in 1798, by an act providing medical relief to merchant seamen. The service was then known as the U.S. Marine Hospital Service. Legislation reorganizing the service and authorizing the appointment of a surgeon general was passed in 1870. In 1889 and in 1902 laws were passed effecting further reorganization and in the latter year the hygienic laboratory, established in 1887, was placed on a more effective basis and the name of the service changed to the U.S. Public Health and Marine Hospital Service. The service was further enlarged in 1912 and the name changed to the U.S. Public Health Service.

State Health Departments.—The health department of the District of Columbia was established in 1822. The establishment of State health departments was in the following chronological order: Louisiana (1855); Massachusetts (1869); California (1870); Minnesota and Virginia (1872); Michigan (1873); Maryland (1874); Alabama (1875); Wisconsin (1876); Illinois, Mississippi, New Jersey, North Carolina and Tennessee (1877); Connecticut, Kentucky, Rhode Island and South Carolina (1878); Delaware (1879); Iowa and New York (1880); Arkansas, Indiana, New Hampshire and West Virginia (1881); Missouri (1883); Kansas, Maine and Pennsylvania (1885); Ohio and Vermont (1886); Florida and North Dakota (1889); Oklahoma (1890); Nebraska and Washington (1891); Colorado and Nevada (1893); South Dakota (1895); Utah (1898); Montana and Wyoming (1901); Arizona, Georgia, Oregon and New Mexico (1903); Idaho (1907); Texas (1909).

Notifiable Diseases.—Michigan was the first State to pass legislation providing for a comprehensive system for notification of diseases (1883). Massachusetts followed in 1884. Modern legislation in the several States either specifies the diseases to be reported, designates that certain classes of diseases shall be reported, as "all contagious diseases," or confers on State health departments the right to promulgate regulations covering the subject. Requirements vary as to whom the report is to be made.

Vital Statistics.—Virginia, in 1632, passed a law requiring burials and christenings to be reported annually by a minister or warden from every parish. The Massachusetts Bay Colony, in 1639, adopted a requirement for recording births and deaths, and Massachusetts, in 1692, passed a law putting the registration of births and deaths on a definite basis. All States have such legislation. With respect to births, the usual requirement is that the attending physician, the midwife, or in their absence, the parents or head of the household shall report to a designated official information regarding the child and its parents. With respect to deaths, the usual requirement is that a certificate giving cause of death and certain other information shall be filed with a designated official and this filing is generally made a condition precedent to the issuance of a burial permit.

Venereal Diseases.—These diseases are made reportable in every State. With the exception of Maine, Massachusetts and Nevada, in all States compulsory examination and quarantine of suspects are authorized. The advertising of cures for gonorrhea, syphilis and chancroid is prohibited in 28 States (Alabama, California, Colorado, Idaho, Iowa, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Montana, Nebraska, Nevada, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, South Dakota, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin and Wyoming). The sale of such cures, except on a physician's prescription, is prohibited in 18 States (Alabama, Arizona, Colorado, Kentucky, Louisiana, Michigan, Missouri, Montana, Nebraska, New Hampshire, New York, North Carolina, Oklahoma, Oregon, South Carolina, Utah, Wisconsin and Wyoming). The right of venereally infected persons to marry is forbidden or restricted in 20 States (Alabama, Indiana, Louisiana, Maine [syphilis only], Michigan, Nebraska, New Hampshire [syphilis only], New Jersey, New York, North Carolina, North Dakota, Oklahoma, Oregon, Pennsylvania, Utah, Vermont, Virginia, Wisconsin and Wyoming).

Vaccination Against Smallpox.—A Federal act (1902) provides for the purity of vaccines, serums and analogous products. U.S. quarantine regulations require vaccination of persons entering the country from localities in foreign countries where smallpox prevails and of subordinates at quarantine stations.

Compulsory general vaccination is authorized in 13 States (Alabama, Connecticut, Georgia, Kansas, Kentucky, Massachusetts, Mississippi, North Carolina, Pennsylvania, South Carolina, Tennessee, Virginia, Wyoming) and the District of Columbia. Vaccination of school children may be required in 18 states (Arkansas, Connecticut, Georgia, Kentucky, Maryland, Massachusetts, New Jersey, New Hampshire, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, Virginia, West Virginia) and the District of Columbia. During the prevalence of smallpox, unvaccinated children may be excluded from school in ten other States (Iowa, Kansas, Louisiana, Maine, Minnesota, Montana, Nebraska, North Dakota, Washington and Wisconsin).

Tuberculosis.—Michigan, by State board of health regulation, was the first State to require tuberculosis to be reported (1893). The disease is now reportable in every State. Massachusetts (1895) established the first State tuberculosis sanatorium. New York and Ohio (1909) passed first county sanatoria laws. In 31 States, State hospitals or sanitoria have been established (Alabama, Arkansas, Florida, Georgia, Idaho, Indiana, Iowa, Kansas, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Rhode Island, South Dakota, Tennessee, Texas, Utah and Vermont). In 28 States, county hospitals or sanitoria have been established (Alabama, California, Arizona, Florida, Illinois, Indiana, Iowa, Kansas, Kentucky, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nevada, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, South Dakota, Tennessee, Texas, Vermont, Virginia, Washington and Wisconsin). In nine States municipal hospitals or sanatoria have been established (Alabama, Georgia, Illinois, Iowa, Kentucky, New York, New Jersey, North Carolina and Tennessee). In five States district hospitals or sanatoria have been established (Kentucky, Louisiana, Missouri, Ohio and Oklahoma). Some other types of legislation adopted have relation to spitting, examination of sputum of suspects, tuberculosis nurses, sanitation of premises, segregation of recalcitrant patients, establishing of clinics, educational measures, State commissions and safeguarding milk supplies.

Eugenical Sterilization.—These laws seek to prevent degenerate offspring by asexualizing certain socially unfit potential parents. They apply only to designated inmates of certain State institutions and have no application to the public at large. Indiana, in 1907, was first to enact this type of legislation, the law, however, being later declared unconstitutional. Twenty States have since passed such laws, the constitutionality of which has either been upheld or untested (California, Connecticut, Delaware, Idaho, Iowa, Kansas, Maine, Michigan, Minnesota, Mississippi, Montana, Nebraska, New Hampshire, North Dakota, Oregon, South Dakota, Utah, Virginia, Washington and Wisconsin). Other States are likely to follow this example.

Medical Practice Acts.—Virginia, in 1639, passed the first law regulating the practice of medicine. Massachusetts followed in 1649 and New York and New Jersey, in 1665. All States have since enacted this type of legislation. Modern medical practice acts provide for a system of licensing physicians, prescribe certain academic and professional qualifications and specify causes and means for the revocation of a licence.

Pure Foods and Drugs.—In 1906 the Federal Pure Food and Drugs Act was passed, a date marking the beginning of the general enactment and enforcement of such laws by the several States. Legislation prior to this date was uncertain of value or enforcement. The Federal act, which serves as a pattern for State legislation, makes it unlawful to ship in interstate commerce, to import or export, or to sell or manufacture in the District of Columbia "any article of food or drugs which is adulterated or misbranded" within the meaning of the act.

Narcotics.—Federal control legislation dates from 1909, when an act was passed prohibiting the importation and use of opium for other than medicinal purposes. This act was later amended to regulate imports and exports of opium, coca leaves, cocaine or any salt, derivative or preparation of such drugs (1922). In 1914, the Harrison Narcotic Act was passed by Congress which by a system of registering specified classes of legitimate users seeks to control the distribution and consumption of narcotic drugs. In 1929 an act was passed establishing two federal narcotic farms for the confinement and treatment of certain addicts.

Anti-narcotic State legislation dates from 1877 (Nevada). Every State has since adopted regulatory laws. The following of the more familiar narcotics are subject to the provisions of such laws: coca leaves, in 18 States; cocain, in 37; eucain, in 27; novocain, in 4; opium, in 47; morphin, in 36; heroin, in 30; codein, in 18; laudanum, in 1; cannabis sativa, in 10; cannabis indica, in 13; chloral hydrate, in 16.

Child Hygiene.—In 1912 the Children's Bureau was created by an act of Congress as a part of the Department of Labor. The date of establishment of the State agencies engaged in child-health work follow: Louisiana (1910); New York (1914); Kansas, Massachusetts and New Jersey (1915); Ohio (1916); Illinois, Indiana, Montana, Pennsylvania and Utah (1917); Florida, Kentucky and Virginia (1918); Alabama, Arizona, California, Colorado, Connecticut, Georgia, Idaho, Michigan, Missouri, North Carolina, Rhode Island, South Carolina, Texas, West Virginia and Wisconsin (1919); Maine and Mississippi (1920); District of Columbia, Nebraska, New Hampshire, New Mexico and Oregon (1921); Maryland, Minnesota (1922); Delaware, Iowa, North Dakota, South Dakota, Tennessee, Washington and Wyoming (1923). (J. W. Ho.)

MEDICAL RESEARCH. Progress in medical research since 1911 can be subdivided according to the branch of medical science into which it falls most naturally. An arbitrary classification, however, has the drawback that many subjects might be discussed equally well under other headings than those in which they are presented.

ANATOMY

First place in this section must be given to the collections of specimens illustrating war injuries and diseases that have been formed by certain museums, notably that of the Royal College of Surgeons of England. Extending to many thousand specimens these collections present a picture of the medical and surgical effects of war, in the widest sense, that has never been equalled. Other anatomical researches of note were upon the distribution of the absorbents from the lower intestine and upon the caeco-colic sphincter tract. The former offers explanation of many peculiarities of disease in this region and is of value surgically; the latter is a new conception, likens the tract in question to the stomach and supports this contention by numerous references to several species of lower animals.

PHYSIOLOGY

Hormones.—Bier found reason to believe that a chemical stimulus (hormone) secreted by the retina initiates the formation of the lens in the larva of the newt (*Molge*), and that a hormone formed from bone-marrow underlies repair of bone. From this he argued that repair in general is dependent upon special hormones formed at the seat of the injury according to the type of tissue needing repair.

Shock and Blood Transfusion.—A large amount of work has been done upon shock and allied conditions. Shock is of great complexity but sudden removal of large quantities of fluid (blood) with the resulting disturbance of the circulation is a fertile cause. (*See* Shock and Collapse.) In correspondence with this, treatment by transfusion (*see* Blood Transfusion) is of the greatest value and the methods of transfusion as well as the substances to be used were made the subject of numerous enquiries. Broadly speaking, for surgical shock and loss of blood by haemorrhage, injection of solutions of gum arabic are of great value, particularly if a small amount of glucose be added. Volume of injected fluid and rapidity of action are fundamental considerations, composition of the injected fluid is a matter upon which some latitude can be allowed, and use of blood is by no means obligatory. On the other hand, where transfusion is performed for anaemia (*q.v.*) due to disease, the character of the injected fluid is of first importance. Here, use of human blood is indicated and it is necessary, by careful examination of patient's blood and donor's blood, to ensure that they belong to blood groups not mutually antagonistic.

Muscle Tone.—Physiological research of unusual importance was carried out (Sherrington, Magnus and others) upon muscle tone in the decerebrated animal by means of which tendon and other reflexes received a clearer explanation and information was afforded upon many reflex postural responses to stimuli that appear to be voluntary. This line of research supplements experimental psychology, a branch of investigation that has made strides during the past two decades (*see* Psychology).

Respiration.—In the province of respiration, the relation of lactic acid and muscular exercise to the respiratory quotient has been investigated. Under exercise a lactic acid maximum of 0·3% in the muscles can be reached in about 30 sec., and this, or rather less, is the longest time that maximal exertions can be kept up. For these short maximal efforts there is reason to believe that carbohydrate alone is used by the muscles. Regulation of rhythmic respiration, from experiments carried out on cats, appears to depend upon the action of an inspiratory mechanism, the apneustic centre, at the level of the striae acusticae, an expiratory mechanism just below it, both of these centres being controlled by the pneumotaxic centre which is situated in the upper half of the pons. The actual stimulating agent is carbon dioxide.

Other Discoveries.—Very many subjects of enquiry must be passed over here, *e.g.*, discovery of rhythmic contractions of capillaries discovered by a special modification of the microscope; the behaviour of the spleen in poisoning by carbon monoxide; the action of lead upon red blood corpuscles; researches on bilirubin and urobilin and other pigments in relation to jaundice; on "buffering" of blood whereby the addition of a given amount of acid to blood is represented by a smaller change in reaction than would occur in simple watery solutions because of the existence of weak basic salts of carbonic and phosphoric acid, especially in the red corpuscles; and numerous investigations upon the action of insulin upon blood sugar and other constituents of the body as well as upon the interaction of insulin and other endocrine secretions.

Energy Expenditure. Of more general interest is a research carried out upon the energy expenditure in sewing with a machine and hemming by hand.. Careful measurements were made by means of the respiration calorimeter, but one most instructive result is that influenza exerts a depressant influence on energy output during rest when the patient has apparently recovered completely. In the case of the woman made the subject of measurement for five weeks after her apparent complete recovery, with the body weight returned to normal, energy expenditure was 4% lower than before the illness.

Tissue Culture (*q.v.*). Minute portions of chick and duck embryo heart have been cultivated in special glass cells. Under suitable conditions these portions of tissue live, grow and beat rhythmically in the culture medium for prolonged periods. If two portions of heart from the same species are placed in the same culture cell, each beats rhythmically at an independent rate until the masses fuse by growth, when the beats become synchronous. If in the experiment the two portions are chick and duck, fusion by growth may occur but independence of rhythmic contraction persists.

BIO-CHEMISTRY

Insulin.—Much of the research falling into this category is concerned with the minute physical chemistry of the cell and therefore is of a fundamental character though hardly suitable for analysis in this place. An important practical result of laboratory work consisted in a simplification of the method of preparing insulin (*q.v.*) whereby a larger amount of the material of a higher potency was prepared from a given amount of raw material in less time and at smaller cost. Insulin forms a picrate when freshly ground pancreas is mixed with solid picric acid. The insulin picrate is extracted by acetone. By this discovery the cost of insulin treatment of diabetics has been reduced to one-third or less.

Vitamins.—Perhaps the most striking subject upon which biochemical investigations have been conducted during recent years has been that associated with accessory food factors (vitamins, *q.v.*) and food deficiency diseases. Investigation of beri-beri (*q.v.*) a nutritional disease associated with various nervous and paralytic symptoms, which occurs in man and can be induced in pigeons by feeding exclusively on polished rice, showed that addition of a minute quantity of the milling was sufficient to prevent onset of the disease or cure it if in existence. Then followed investigations into the causation, prevention and cure of scurvy and enquiries into the factors underlying growth of the body generally or of special systems (*e.g.*, bone in rickets). It cannot be said with certainty that rickets depends exclusively upon absence of a special vitamin, for other factors, such as a sufficiency of calcium and phosphorus, are necessary. Moreover, sunlight, particularly the ultra-violet portion of the spectrum, is no less essential than due provision of the requisite vitamins for production of that normal growth of the body of which normal growth of bones is but a part. As a result of the entire series of investigations upon accessory food factors, it may be said that at the present time fat-soluble vitamin A and water-soluble vitamin B are regarded as being bound up with processes of growth and in addition there are anti-scorbutic and anti-beri-beri vitamins and one that is necessary for fertility (*see* Diet and Dietetics). These vitamins have been found in a great variety of animal and vegetable substances and the amounts present vary within wide limits. Their nature is unknown, and the most certain points in connection with them are the minuteness of quantity in which they are present and the potency of their activity. As to their origin the suggestion has been put forward on experimental grounds that they are compounds of high energy content produced by the influence of ultra-violet light, but this hypothesis cannot be regarded as proved except in the case of vitamin D (anti-rachitic).

DIAGNOSTICS

Radiology (*see* RADIOLOGY; RADIOTHERAPY; RADIUMTHERAPY).—On its diagnostic side, quite apart from the use of contrast meals and injections opaque to the rays, it is now possible to produce far better radiographs with exposures measured in fractions of a second than were possible at the beginning of the century with exposures lasting minutes. This is largely due to the employment of X-ray tubes in which the anticathode is a mass of tungsten, heated by an independent current. For treatment, in order to approximate the wave-length of rays emitted by the X-ray tube to the wave-length of the gamma rays of radium, apparatus has been produced with a voltage in the region of 200 kilovolts. So far this type of apparatus is employed chiefly in the treatment of cancer. During the routine examination of large numbers of cases various anatomical peculiarities have been observed and some hitherto unknown morbid processes in bone have been described. Radiology has also proved useful in study of the physiology and pathology of the heart and great blood-vessels, in pulmonary conditions, notably tuberculosis and bronchiectasis, in diagnosis of renal and biliary calculi, and it has been suggested as a means of diagnosis when perforation of a gastric or intestinal ulcer is suspected. The intentional injection of oxygen or air into the peritoneal cavity as an aid to radio-diagnosis has been employed somewhat extensively; it is stated to be devoid of risk and renders diagnosis of fluid or solid masses relatively easy. The use of radium (*see* CANCER; RADIUM) is confined chiefly to the treatment of cancer.

Therapeutic Use. Other forms of radiant energy, sunlight (heliotherapy), mercury-vapour quartz lamp, carbon arc, radiant heat, all of which depend upon the presence of ultra-violet light in the first instance and warmth in the second, are employed therapeutically to an increasing extent. A disadvantage under which X-ray and ultra-violet forms of treatment labour is the absence of a satisfactory standard of dose. Sabouraud's pastille is only reliable for "soft" radiation. The "skin erythema dose" is unsatisfactory because as used in France it is two and a half times as great as the "Hauterythemdosis" of the Germans. Even in German institutions the erythema dose varies between 285 R units and 1,120 R units (Martius).

Effects of Radiation. Numerous researches have been made on the effects of radiation, particularly the gamma rays of radium, upon cells and tissues of the animal body, plants, seeds, bacteria, protozoa. It has been shown that the cell in division is more vulnerable than the cell at rest and that there exists a wide range of radiosensibility amongst animal cells and tissues. Amongst the most radiosensitive are the lymphocytes. So far as composite tissues are concerned the intestinal mucosa is highly radiosensitive, exposure of the abdomen to unduly heavy dosage leading to excessive formation of mucus, mucoid degeneration, intestinal haemorrhage, paralysis of intestinal muscle, desquamation of large tracts of mucosa and death from toxic absorption. While there is universal agreement that, directly or indirectly, rays produce injurious effects upon cells there is doubt whether smaller doses do not stimulate the activity of cells.

PATHOLOGY

Histology.—Morbid histology has been in some measure at a standstill, although during the World War it was employed extensively in striving to unravel the pathology of trench nephritis, gas gangrene, gas poisoning and, indeed, of any novel pathological condition. Its most striking success was in reference to the mode of extension of gas gangrene from the seat of infection. The action of the toxin secreted by the infecting bacilli extends along the muscle bundles far in advance of the bacilli themselves, produces glassy changes of the muscle fibres correlated with a loss of contractility that can be demonstrated on the operation table and is a necessary precursor to advance of the bacilli themselves by multiplication. These observations were the prelude to a radical modification of the surgery of the condition and a definite improvement in results.

Bacteriology.—In bacteriology (*q.v.*) a useful step was taken by the Medical Research Council in forming the national collection of type cultures at the Lister Institute. Begun in 1920 it now contains more than 2,000 living strains of bacteria, protozoa and fungi, available for workers in widely different lines of research.

Experiments upon the conditions under which bacilli, particularly the sporing anaerobes of tetanus and gas gangrene, exert pathogenic activity showed that, if washed clear of toxin and inoculated without contaminating substances, they remained inert. Multiplication, followed by manifestation of the ordinary disease phenomena, occurred only if they were injected along with toxin (not necessarily their specific toxin) or with some solid particles such as lime or silica. In other experiments the presence of silica exerted an important influence on the multiplication of tubercle bacilli in the tissues.

Diphtheria.—Important observations were conducted in many countries upon the so-called Schick test as a means of diagnosing susceptibility to diphtheria (*see* INFECTIOUS FEVERS). If a minute quantity of diphtheria toxin, highly diluted, be injected intradermally in man, there occurs a patch of redness locally about 2 cm. in diameter in certain persons, whereas in others the injection is without effect. Heating of the toxin destroys its power of producing this effect. Further search indicated that in those persons who are negative, diphtheria antitoxin is present in the blood serum, whether naturally, or as the result of having passed through an attack of diphtheria, or of gradual immunization owing to the fact that the person is a diphtheria carrier. In Schick-positive persons there is absence of antitoxin and therefore the injected toxin is not neutralized and produces its pathological effect. Subsequent examination on a large scale showed that the reliability of the test was of a high order. The natural corollary is that during an epidemic all Schick-positive persons should receive a prophylactic treatment with diphtheria antitoxin. Later work showed that diphtheria "anatoxin," *i.e.*, toxin detoxicated by addition of formaldehyde and exposure to a temperature of 37° C for a few weeks, was equally efficacious in producing immunity.

Scarlatina.—By a similar process of reasoning the two Dicks in America introduced an intradermal diagnostic test for scarlatina, the toxin being derived from broth cultures of a variety of haemolytic streptococcus found in the throats of scarlatina patients and believed by some to be the cause of the disease. So far the Dick test is not on such firm ground as the Schick test. Nevertheless some authors have expressed their view that the test is of much value in determining susceptibility or insusceptibility to scarlatina and that an anti-scarlatinal serum prepared by means of the haemolytic streptococci is in many instances efficacious in immunizing the Dick-positive individual and rendering him negative on subsequent intradermal tests. A further extension of the principle has been applied in the case of tuberculosis (*q.v.*), but the work is still in its earlier stages and the time is not ripe for dogmatic statement.

New Diseases.—A hitherto unrecognized disease was described by McCoy in 1912 when investigating ground squirrels in Tulare county, Calif., that had been attacked by a plague-like disease not caused by *B. pestis.* Since that time it has been found widely in the United States and was definitely recognized as affecting man in 1914. Since 1914 tularaemia has occurred in at least nine laboratory workers engaged on investigations with *B. tularense.* The micro-organism is an exceedingly minute cocco-bacillus and it is believed that infection in man occurs by inhalation or by a blood-sucking fly. Transmission from rabbit to rabbit occurs by the rabbit louse and the rabbit tick, neither of which bites man.

During the war there occurred in Flanders amongst the men in the trenches a severe form of disease associated with jaundice and haemorrhage which was traced to a spirochaete similar to or identical with *Sp. icterohaemorrhagica,* which in Japan infects rats, and is transmitted by them to man. The same organism was found in the rats infesting the trenches.

Dental Caries.—A bacillus (*B. acidophilus odontolyticus*) has been isolated from carious teeth and in pure culture forms sufficient acid to dissolve the enamel. Undecayed teeth placed in such pure cultures for a period of weeks show loss of enamel at spots and local growth of the bacilli along the dental tubules. Micro-

scopically the appearance of this artificial caries is identical with that of natural caries.

Botulism.—Numerous papers have been published upon botulism, a form of severe food poisoning (*q.v.*) dependent upon an anaerobic bacillus (*B. botulinus*). The nervous system is profoundly attacked by the toxin, difficulty of vision, dilated pupils, ptosis and paralysis being among the earliest symptoms. The toxin differs from other toxins in being pathogenic when administered orally; it is absorbed in the stomach and upper duodenum. An antitoxic serum has been prepared and is useful in treatment. This form of food poisoning was originally associated with sausages but occurs in connection with a great variety of foods. Most of the recorded cases have occurred in America.

Syphilis.—In syphilis (*see* VENEREAL DISEASES), Brown and Pearce succeeded in transmitting the disease to rabbits by intratesticular inoculation and showed the close resemblance of the pathological and clinical manifestations to those met with in man. By a prolonged series of experiments on rabbits Pearce answered in the negative the long debated question whether yaws and syphilis are manifestations of a single disease. Much work has been done on the Wassermann reaction. All doubts are not set at rest nor is the behaviour of the reaction completely understood, but it has stood the test of time and is considered of great diagnostic value.

In the investigation of spirochaetal diseases caution in deduction from experiment is shown by the fact that spirochaete-like bodies are to be found in the lateral ventricles of normal monkeys, rabbits and guinea-pigs. Only after animals that had been injected long previously with material from disseminated sclerosis (which is regarded by most authorities as of syphilitic origin) had been found to present these bodies in their lateral ventricles, was their existence in normal animals also discovered.

Typhus.—In typhus and trench fevers minute parasites were discovered belonging to the group now named Rickettsia. For a short time the relation of the Rickettsia to the disease was in doubt, but largely owing to the work of Bacot, an eminent entomologist who contracted typhus during his investigations and died therefrom, it is now recognized that both diseases depend upon the presence of varieties of Rickettsia, and that these parasites are conveyed from patient to patient by body lice. One of the most delicate manipulative operations ever attempted, and actually carried out with brilliant success by Bacot, was the filling of the rectum and intestine of lice with Rickettsia-infected blood by means of a fine capillary glass tube.

Bacteriophage.—An interesting phenomenon called after D'Herelle, its discoverer, has attracted much attention. When working with certain cultures of intestinal bacteria D'Herelle observed that on occasions culture apparently failed, the broth remaining quite clear. Subsequently he found that addition of a minute quantity of one of these clear fluids to a culture tube, cloudy with growth, was followed by clarification of the latter; as little as one part in a million was sufficient. He considered that he had obtained evidence of a filter-passing "microbe bactériophage" and obtained the phenomenon by successive culture from intestinal contents, sewage, soil extracts. This clarifying power is a property of leucocytes, tears, nasal mucus, eggwhite and other substances.

From the first the filter-passing microbial explanation met with opposition, many authorities regarding the phenomenon as being due to the action of an autolytic enzyme, or a catalyst causing the micro-organisms to produce autolytic ferments. Later, Fleming described a somewhat similar phenomenon by means of a special micro-organism that he isolated (*M. lysodeikticus*). This organism in thick suspension is in a few minutes completely dissolved by tears in a 1–9,000 dilution and using it as an indicator he found evidence of the lytic principle in nearly all tissues of the body, but not in urine, cerebrospinal fluid or sweat. In the vegetable kingdom he found it in the turnip alone. It is doubtful whether there is a single lytic substance or more than one. The essential difference between this and D'Herelle's phenomenon is that the former cannot be transmitted in series. Fleming therefore speaks of it as a "lysozyme," and points out that some bacteria are sensitive to lysozyme action and others not, thus raising the speculation whether the pathogenicity of bacteria may be determined by the absence of lysozyme.

Filter-passing Viruses.—Since 1905 papers have appeared from time to time in medical literature on the "filter passer" or "filterable virus" (*see* FILTER-PASSING VIRUSES). A series of morbid conditions is now recognized with more or less certainty as being due to a virus so minute that it passes through the pores of a porcelain filter, or in some cases is beyond the lowest limits of microscopic vision. Of these diseases rabies, vaccinia and perhaps variola, are the best known. In lethargic encephalitis and herpes, evidence is tending in that direction but is not conclusive owing to the discovery that laboratory animals mainly used for this type of work (monkeys, rabbits) may under normal conditions present appearances in their brains that have been regarded as evidence of experimental transmission from man.

Dengue has been added to the list, while the so-called mosaic disease of the tobacco and tomato plants (*see* PLANTS: *Plant Pathology*) is stated to be due to a filterable virus, and distemper in dogs may show a like origin. In addition a transmissible filter-passing virus has been recognized in the rabbit; at first this virus was thought to be the cause of varicella but it is now recognized to be the cause of a naturally occurring infection of the rabbit.

Gye and Barnard have described and photographed by means of ultra-violet light, respectively, a filterable virus derived from certain malignant tumours, following in this direction the pioneer work of Rous on chicken sarcoma. (*See* CANCER RESEARCH.) Finally, in the opinion of some authorities the cause of influenza (*see* INFLUENZA) is not Pfeiffer's *B. influenza*, this being merely a usual concomitant, but is in reality a filter-passing virus that has not yet been determined with certainty.

OBSTETRICS AND GYNAECOLOGY

Eclampsia.—The exact pathology of eclampsia has not yet been solved. Obata, as the result of injecting mice with extracts of human eclamptic placenta, considers that it is an intoxication by placental poisons made possible by a weakening in its normal capacity of neutralization on the part of the maternal blood. Treatment of the condition on conservative lines has recently gained ground against more radical measures, and control of convulsions by hypnotics with venesection and administration of oxygen have replaced operative procedures. Under these conditions mortality has been reduced by more than 50%.

Fibroids.—The chief direction in which change of view is taking place among gynaecologists is that of the treatment of uterine fibroids. The old method of curetting has given place in large measure to hysterectomy, which in turn may be destined to give place to radiological treatment in a large proportion of cases. In several important gynaecological clinics on the Continent surgical treatment of uterine fibroids is the exception in an uncomplicated case.

MEDICINE

Anaemia.—In pernicious anaemia (*q.v.*) it has been shown that one of the cardinal features is an increase in the mean diameter of the red cells which is independent of the degree of the anaemia and persists through the course of the disease. On the other hand anisocytosis increases with the anaemia. In the remissions which occur naturally or after splenectomy, though the haemoglobin may rise there is little change in the diameter of the red cells. In treatment transfusion has been found of little value, but benefit has resulted in some cases from removal of a portion of the bone marrow from the tibia. Apparently removal of some of the bone marrow acts as a stimulus to regeneration of marrow and therewith of the blood cells that are needed by the body. Recently great success has followed administration of liver or of a non-protein substance derived from liver (*see* ANAEMIA). Purpura is described as being of two varieties (1) that which is dependent upon destruction of blood platelets; (2) that which occurs in anaphylactic conditions and is due to direct injury of blood vessels. In the platelet variety a blood platelet antiserum has been prepared and is of therapeutic value.

Heart Diseases.—Diseases of the heart and great blood-vessels have been studied by the electrocardiograph, and numerous conditions, particularly heart block and those in which the nervous mechanism of the heart beat is concerned, have been investigated. Systematic examination of recruits in whom cardiac symptoms developed during early training resulted in a clearer perception of those abnormalities of heart action which were transient and of little importance as distinguished from those which were significant of disease.

Cerebrospinal Meningitis.—Cerebrospinal meningitis (*q.v.*) and lethargic encephalitis (*q.v.*) have received much attention. In cerebrospinal meningitis it has been shown that three, possibly four, different types of meningococcus occur and that antiserum treatment to be successful must be homologous. Epidemics could usually be traced to a carrier and the chance of their occurrence was greater where men were confined in a relatively narrow space, *e.g.*, barracks. A special method of treating carriers by means of inhaling chloramine-T was instituted with some success. In the case of lethargic encephalitis, it appears probable that the cause will be found to be a filter-passing virus.

Herpes.—In the case of herpes in rabbits and herpes in man, including herpes zoster, it has been found possible to transmit keratitis and some other special conditions from animal to animal and man to animal by means of a filter-passing virus. When this has occurred microscopical appearances are found in the nervous system apparently identical with those met with in lethargic encephalitis. The whole question, therefore, is in an unsettled condition.

Liver Cirrhosis.—An interesting observation is that a form of progressive degeneration of the lenticular nucleus occurs which is associated with hepatic cirrhosis. Since its first description by Wilson in 1912 over 70 cases have been described but the pathological agent remains completely unknown, though there are indications that the liver is the seat of the primary pathological process. Clinically the symptoms are chiefly cerebral and the hepatic cirrhosis which is so constantly found at autopsy is usually latent.

General Paralysis of the Insane.—In the case of general paralysis of the insane, a form of treatment that has been advocated is inoculation with benign tertian malaria which is then treated with quinine. Maniacal and early cases have been found to respond to this treatment best. Intelligence, articulation, writing and equilibrium improve markedly, but defects of character and manners remain. Some cases may even be able to return to responsible duties. Advanced cases merely remain stationary. The idea underlying this treatment is that the malarial parasites stimulate the body to the formation of spirochaetal anti-substances.

Respiratory Diseases.—In the province of respiratory diseases, gas poisoning necessitated urgent investigation from the commencement of 1915. An intense oedema was produced which blocked the finer air passages and in its minor degrees led to a widespread bronchopneumonia. Variations were met with as the nature of the gas used was changed, but from the respiratory point of view at least the phenomena were fairly constant. In pneumonia, experimental work on monkeys showed that four types of pneumococcus occur and do not protect against one another.

Asthma. Work on asthma has shown that in a large proportion of cases, if not in all, the disease is of an anaphylactic nature, an intense reaction being produced in the bronchial mucous membrane of a person sensitized to some particular substance of protein origin. Determination of the particular substance in any individual case may be lengthy, but if it be determined there is a possibility of successful treatment by gradual immunization.

Tuberculosis. In tuberculosis (*q.v.*) two important methods of treatment have been suggested. In one, an endeavour has been made to increase the antagonizing cells in the body by repeated irradiation of the spleen. This organ is a storehouse for lymphocytes and it is known that the lymphocytic content of the blood can be raised by repeated small doses of X-rays. The method has not as yet a great following. The other method is by administration of a gold salt [$Au\ (S_2O_3)_2Na_3$] named "sanocrysin" by Möllgard, originator of the method. The underlying idea is not purely chemotherapeutical for it is held that the poisonous action of the organisms killed *in vivo* by chemical means is neutralized by an antiserum. The experimental work was carried out in Denmark and has been confirmed and extended in England. Careful selection of cases must be made when applying sanocrysin to man as the reaction in pulmonary tuberculosis may be very severe, but with due precautions great benefit may accrue.

Diabetes.—In the case of diseases of endocrine origin the outstanding example of advance is afforded by the insulin (*q.v.*) treatment of diabetes (*q.v.*). The pathology of the condition was fairly well known, but the great achievement of Banting and his collaborators was that they succeeded in isolating the material in sufficient quantity for therapeutic purposes. Numerous researches have been undertaken in the endeavour to simplify the treatment, but it still remains necessary for insulin to be injected intravenously and repeatedly in severe diabetes.

Goitre.—The relation of iodine to endemic and to exophthalmic goitre (*q.v.*) has been investigated. A close relation between the cellular condition of the thyroid and the amount of iodine has been demonstrated, and it is held that relative or absolute deficiency of iodine is the immediate cause of simple goitre however this deficiency may be occasioned. Treatment by internal administration of iodine has met with much success. Success has also been claimed for radiological treatment and for surgery in cases in which iodine and other medical treatment has failed.

Paratyphoid.—Description has been given of a paratyphoid epizootic in a flock of sheep with a consequent human epidemic of paratyphoid (40–50 severe cases with four deaths) that occurred in the Essen district. *B. paratyphosus B.* was isolated from the sheep's flesh and from the patients' stools. It was not here a case of mutton from healthy sheep being contaminated, but the sheep suffered during life from the same disease as the human beings.

A peculiar disease developed in July 1924 among the fisher folk of the Frisches Haff, the great freshwater lagoon of East Prussia. Many suggestions were put forward as to its aetiology, but finally it was traced to arsenic freely contained in the waste water of two cellulose factories which was pouring into the Haff in large quantities.

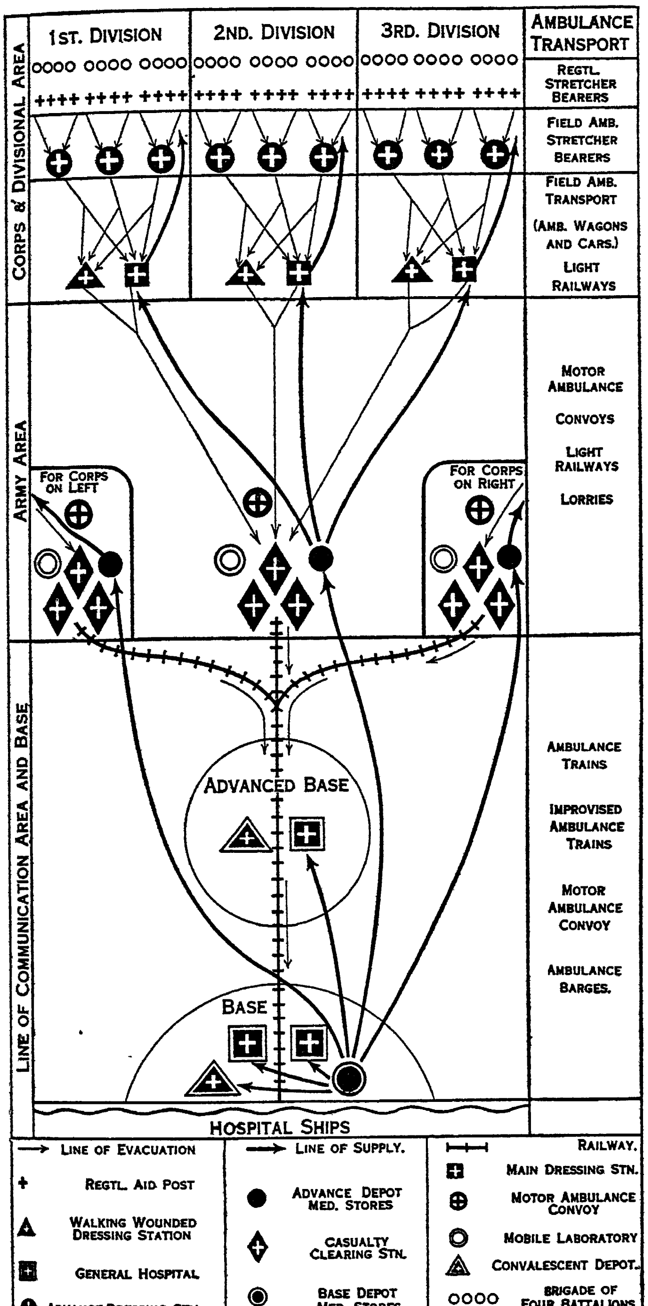
Racial Blood Indices.—On the basis of observed peculiarities of group II. and group III. red blood cells, another research would group mankind according to their racial blood index (*see* Races of Mankind). Analysis of the large amount of material accumulated since 1919 suggests that so far as blood groups are concerned races fall into six divisions strikingly different in type. These six divisions are European, Intermediate, Hunan, Indo-Manchurian, Afro-South-Asiatic and Pacific-American. No better indication could be given, than this last example, of the wide range covered by medical research.

Yellow Fever.—In concluding this article, a warning must be given that owing to the fluidity of knowledge, statements which appear to be fully justified at one time may seem doubtful a little later. An example of this is the case of yellow fever (*q.v.*). The cause of this disease was, on apparently adequate grounds, regarded as leptospira, but very recently grave doubt has been thrown on the point and it is suggested that the patients, from whom the original deduction was made, were subjects of a dual affection. From this it is argued that the leptospira, known to be the cause of the second, unsuspected disease, does not account for the yellow fever itself, the cause of which would therefore still remain unknown. (W. S. L.-B.)

MEDICAL SERVICE, ARMY. An Army Medical Service (Fr., *service de santé;* Ger., *Sanitätsdienst;* It., *servizio sanitario;* Jap., *eisei kimmu*) is an indispensable technical branch of the military organisation. On its efficiency the man-power of an army to a great extent depends. Its duties include the care of sick and wounded, the prevention of disease and the preservation of health, the medical examination of recruits, the invaliding of men unfit for further service, the supply of medical and surgical material, the administration of military hospitals and the command, education and training of a personnel for all these purposes. In time of war the collection, evacuation and distribution of battle casualties and the strategical and tactical employment of a variety of medical

units for these duties are additional functions of an army medical service.

Administration.—The army medical service of the British forces is administered by a director-general in the adjutant-general's branch of the War Office, with a staff for personnel and mobilisation services, for preparation of statistical reports and consideration of professional questions, and for the supply of medical and surgical material, together with two new directorates



BY COURTESY OF H.M. STATIONERY OFFICE

DIAGRAM OF THE ORGANIZATION OF ARMY MEDICAL SERVICES FROM A CORPS FRONT OF THREE DIVISIONS TO A SEA BASE

of hygiene and pathology which were instituted after the World War in consequence of the lessons of the War and of the scientific advances in the domain of medical research. The director-general also administers the nursing services and the Army Dental Corps, the former through a matron-in-chief and the latter through an Assistant-Director-General (for the Dental Service), at the War Office. He is represented in commands at home and overseas by deputy directors and assistant directors with deputy assistant directors for hygiene and pathology. A similar form of administration exists in other armies. In the United States the surgeon-general controls not only the medical, dental, nursing, medical administrative and sanitary corps, but also the veterinary corps.

Advisory Boards are composed of military and civil members and are associated with the British Army medical administration. They meet from time to time at the War Office for consideration of general professional policy, questions of hygiene and of pathological research, nursing services and the co-operation of voluntary aid in war.

Personnel.—The estimated peace establishment of the Royal Army Medical Corps is approximately 850 officers and 3,800 other ranks. They serve in all stations at home and overseas where there are British troops, including India. Their work there is supplemented by assistant-surgeons of the Indian Medical Dept., formerly the Indian subordinate medical department, and by natives of an Indian Hospital Corps, formerly the army hospital corps and army bearer corps, who with soldiers trained for hospital duties from combatant regiments formed the subordinate staff of British military hospitals in India before the War. A separate body of officers, the Indian medical service and sub-assistant-surgeons of the Indian Medical Dept. served until the World War with Indian regiments and in regimental hospitals under much the same conditions as the British regimental medical services of earlier days. Since the World War, station hospitals for Indian troops have been instituted.

The Army Dental Corps, with an establishment of 144 Dental officers is estimated to provide one dental officer for every 600 recruits and one for every 3,000 trained troops. It is a joint service for the Army and the Royal Air Force. (*See* DENTISTRY.)

Queen Alexandra's Imperial Military Nursing Service (Q.A. I.M.N.S.) has an establishment of 582 nurses. They serve in the larger military and families hospitals at home and overseas.

Territorial Army Royal Army Medical Corps.—The personnel is organised in peace to provide a regimental service, one field ambulance for each division of the Territorial Army, three general hospitals and fifteen Field Hygiene Sections organised for peace training into four Field Hygiene Companies. These are field service units and form a cadre for the training of the R.A.M.C. (T.A.). Previous to the World War the Territorial Force had three field ambulances, one casualty clearing station and one sanitary section for each division, together with 23 general hospitals. The reduction therefore in Territorial Army R.A.M.C. units since the War has been considerable. An establishment of 2,000 other ranks is organised to provide trained personnel to staff military hospitals in England on the outbreak of war when the regular Royal Army Medical Corps personnel is withdrawn, and to furnish reinforcements for an expeditionary force. The number of medical officers (1924) was 939, of dentists 155, of nurses 675 and of veterinary officers 124. In continental armies with conscript service the fixed establishments for medical services cannot be computed for purpose of comparison on the same basis as those of the British and American voluntary armies.

Training.—Officers of the R.A.M.C. attend preliminary and post-graduate courses at the Royal Army Medical College, and military training with the men at the R.A.M.C. Depôt at Aldershot, where there is also an army school of hygiene. In America, an army medical centre was opened in 1923, at Washington, District of Columbia. It consists of the Walter Reed general hospital and schools for the training of the medical, dental, nursing and veterinary corps. There is also a medical field service school at Carlisle, Pennsylvania, and a school of aviation medicine at San Antonio, Texas. In Italy, there is an army medical school at Florence, and in France, at Lyons, in addition to the post-graduate school at the Val-de-Grâce, for student candidates.

In the British Army, military hospitals and small depôt hospitals are established in all commands. In America and its insular possessions there are garrison hospitals and seven large general hospitals, similar to some of the larger military hospitals in England. In continental armies there are also garrison hospitals, but in France, military sections of the civil hospitals take their place to a great extent. In some continental armies most of the medical and surgical material is or was prepared in army medical laboratories and factories. In Great Britain and America it is distributed

from army medical stores, that for the British Army being at Woolwich.

War Organisation.—A regimental medical service, field ambulances, casualty clearing stations, general hospitals, convalescent depôts, advanced and base depôts of medical stores, motor ambulance convoys, ambulance trains, hospital ships, field hygiene sections and mobile hygiene, bacteriological, X-ray and dental laboratories come into being for service with a British Expeditionary Force on the outbreak of war; there are equivalent units in other armies under different names and organisations. To complete their personnel on mobilisation the medical and nursing reserves are called up. For this purpose there is a regular reserve of R.A.M.C. retired officers and men liable to be recalled to service, a supplementary reserve of officers, a military hospital reserve of the St. John Ambulance Brigade, the Territorial Army R.A.M.C. and the Voluntary Aid Detachments (under T.A. County Assn.) of the British Red Cross Society, the St. John and the St. Andrew Ambulance Associations. There are also important reserves of Queen Alexandra's Imperial Military Nursing Service and the Territorial Army Nursing Service. But in a great war, practically the whole of the country's medical resources may be enrolled within the limits of age. In the World War, the peace establishment of the R.A.M.C. thus expanded to 15,000 officers and 120,000 ranks; while in the United States Army the medical service (veterinary excluded) expanded to 38,140 officers and 264,181 other ranks. A similar vast expansion occurred in nursing personnel (21,480 nurses, U.S.A.), and in the number of medical units. Military hospital beds, for example, reached a total of 637,746 for the British forces and 407,914 for those of the United States.

The various units are distributed in the war zone, from front to base, in divisional, corps, army, and lines of communication areas of command, according to the nature of the functions for which they are organised. The regimental medical service consists of an officer of the R.A.M.C. with 21 men of the regiment as stretcher bearers and 16 as sanitary detachment. In battle, a regimental aid post (Fr., *poste de secours;* Ger., *Truppenverbandplatz;* It., *posto di medicazione*), to which they collect the wounded, is established. Each division has three field ambulances (the equivalent of the medical regiment of a U.S.A. division, the *groupe sanitaire divisionnaire* of the French, and the *Sanitätsbattalion* of the German organisations). A field ambulance is composed of a headquarters and two companies, the headquarters being destined to form a main dressing station and each company an advanced dressing station. With a cavalry division there are two Cavalry Field Ambulances, each consisting of a headquarters and one company.

In battle, the Field Ambulance opens an advanced dressing station at a point to which its wheeled ambulance transport can be brought, and a main dressing station further back. The company removes the wounded from the regimental aid posts to the advanced dressing station, and the transport brings them from there to the main dressing station. The motor ambulance convoys (Fr., *section sanitaire auto*), composed of 75 motor ambulance cars each and with one convoy to each corps, bring the wounded from the main dressing stations to the casualty clearing stations (U.S.A., evacuation hospital; Fr., *hôpital d'évacuation;* Ger., *Kriegslazarett*), which are established in the proportion of one to each division, at or near railways and at the head of the lines of communication. From there, when fit to travel, the sick and wounded are taken in ambulance trains to the general hospitals, which are units of 1,000 or less beds placed at sea bases or other convenient centres. Hospital ships transfer the patients to home ports, whence they are distributed to hospitals throughout the country. Such is the normal system of collection, evacuation and distribution of sick and wounded in a war zone. It is liable to modification according to circumstances and the nature of the terrain, especially as regards methods of transport by road, rail, river, canal or air. It worked well in the World War, where the test was severe. During the battles of the Somme, for example, the British field ambulances collected 316,073 wounded between July 1 and Nov. 30, 1916, including 26,675 in the first 24 hours; 304,285 were transferred to the base hospitals, and on one day, July 6, 10,112 arrived in hospital ships at Southampton and Dover.

The mobile laboratories and advanced depôts of medical stores are usually placed with or near the casualty clearing stations. For sanitary duties a Field Hygiene section, of one officer and 27 men, is allotted to each division and base, and sanitary squads of five men each to small posts, such as railheads. Their influence and that of medical research had remarkable results during the World War in preventing disease. Enteric and typhus fever, the scourge of armies in past wars, became negligible quantities in the British and American forces, and fatal gangrene of wounds and trench fever, for long a cause of much inefficiency, were brought under control. Indeed, the two outstanding features of the army medical service of the present day are its power of controlling disease and its power of systematically, rapidly and effectually bringing battle casualties under life-saving surgical and hospital treatment. In this beneficent work it is assisted by voluntary aid organisations. Amongst all civilised nations there are national Red Cross societies (*see* RED CROSS) organised as auxiliaries of their army medical services in time of war. They are of special value in distributing voluntary gifts and comforts, such as are not supplied through official sources, to the various hospitals in the home territory and in the war zone, in organising auxiliary hospitals and in various other activities. Those recognised by their governments, together with the whole of the personnel and units of the medical services of armies, are protected and become the recipients of special privileges under the Geneva Convention of 1906, should they fall into the power of the enemy during war. (W. G. MA.)

MEDICAL SERVICE, NAVY. In the British navy, medical requirements at the present day are provided for by a special department of the Admiralty which is placed under the administration of the medical director general,—an officer selected from the list of surgeon rear-admirals. As head of his department, he is responsible to the Board of Admiralty for the efficiency both in regard to the personnel and material of all medical details; he superintends the professional and administrative details of naval medical establishments and the practice of medical officers, and further advises the Board on all questions of "disability assessments" arising from invaliding and claims for compensation.

Conditions of Service.—Until the outbreak of the World War, officers of the Royal Naval Medical Service were entered by competitive examination, but since the conclusion of peace—owing to the lack of applicants—these examinations have not been resumed, and for the time being medical officers are entered for temporary service, engaging for three years, with the option of turning over to the permanent service if they are considered suitable, but it is anticipated that the recently innovated facilities for post-graduate study, together with the extra pay for officers who specialize, will attract a sufficiently large number of young medical men to enable entry by examination to be resumed. Particulars concerning the conditions of service, etc., are published in the official Navy List or can be obtained by application to the medical department of the Admiralty.

Since 1919 the ranks held by medical officers have been approximated to those held by the executive branch, and are:—on entry, surgeon lieutenant; after six years satisfactory service, surgeon lieutenant-commander; and after a further period of six years surgeon commander, provided the necessary professional examination has been passed. The more senior ranks of surgeon captain and surgeon rear-admiral are reached by selection.

Except the smallest, all British men-o'-war carry a medical officer, battleships and certain cruisers having two. Apart from his purely medical and surgical duties, it is regarded as an important function of the medical officer to protect the health of the ship's company, and to suggest to his commanding officer any measures considered necessary for this purpose. He must make himself acquainted with the conditions of health prevailing in the ports which his ship is likely to visit, and veto the introduction into the ship of any water or food which could possibly carry disease. It is also his duty to give instruction in "first aid" and "personal hygiene," especially in regard to the dangers arising from venereal disease and the abuse of alcohol.

Equipment and Hospitals.—The special accommodation

which is allocated for the sick in all H.M. ships is termed the sick bay. This place—in spite of the fact that all serious cases are, for their own comfort transferred to hospital on the earliest occasion—is fully equipped for the comfort of patients and for all medical and surgical contingencies. For the general safety of wounded in action, spaces are reserved in the most protected parts of the ship, these spaces are designated "medical distributing stations." Each of the principal naval ports has a naval hospital. These establishments conform in every way to the most modern and scientifically conceived requirements of medicine, surgery and hygiene.

Afloat, the nursing is carried out by the sick berth nursing staff, a highly trained and efficient body of men. They also carry out nursing duties in the naval hospitals, but in addition in these establishments there are lady nurses belonging to Queen Alexandra's Royal Naval Nursing Service.

The Royal Naval Dental Service was inaugurated in 1920 and is supervised by a dental officer of surgeon captain's rank, attached to the staff of the medical director general.

The World War.—Except under abnormal climatic conditions, and during the epidemics of influenza, the health of the navy was remarkably good during the World War. This satisfactory state of affairs can be attributed to: (*a*) The careful supervision of the personnel by the medical officers and the strict quarantine precautions enforced. (*b*) The care exercised concerning food, water and victualling arrangements, both in ships and establishments. (*c*) Preventive inoculation against enteric fever. (*d*) The comparative isolation of the fleets lessening the chance of venereal infection and the abuse of alcohol. (*e*) Lectures given to the men on personal hygiene. (*f*) Measures taken to lessen the monotony of ship life in war time.

As compared with land warfare, the number of men killed outright in action was striking, and this, combined with the number of deaths from immersion, made the ratio of killed to wounded far higher in the British Navy than in the Army. For instance, at Jutland, out of 6,688 casualties there were 6,014 either killed or drowned. The higher proportion of fatal wounds was due to the condition of modern naval warfare—explosion of large shells in closed compartments. In comparison with the wounds in the trenches, where the clothing and skin were ingrained with filth, wounds in the Navy were less disposed to become septic.

Other Navies.—The organization in other navies is similar to that in the British.

Medical Officers of the French Navy—instead of being selected from candidates qualified in the ordinary way, as is the practice in the British, Italian and Japanese navies—are professionally educated at special naval medical colleges, and subsequently hold purely professional titles of rank. Italian naval medical officers, in common with other non-executive officers of that navy, hold military, in contradistinction to naval rank. The medical organization in the Japanese navy is almost identical with the British. The medical and dental officers are admitted to the corps after passing satisfactory examinations and as vacancies occur. Above the rank of lieutenant-commander, promotion is by selection and examination. (G. L. B.)

United States.—In July 1928 the Medical Service of the U.S. navy consisted of: the Medical Corps; Dental Corps; Hospital Corps; and Nurse Corps (female). The Medical Corps was composed of 4 rear-admirals, 82 captains, 91 commanders, 268 lieutenant commanders, 218 lieutenants and 168 junior grade lieutenants. Medical officers appointed immediately following graduation are given one year's rotating internship, upon the completion of which they are subject to detail to posts of duty afloat or ashore. The Dental Corps consisted of 14 commanders, 68 lieutenant commanders, 66 lieutenants and 20 lieutenants (junior grade). Medical and dental officers are admitted to the corps after passing satisfactory examinations and as vacancies occur. Above the rank of lieutenant commander promotion to each grade is by selection and examination. Opportunity is given to officers of the Medical and Dental Corps to take "refresher" courses from time to time at the Naval Medical school, where problems concerning submarines, aviation and other aspects of navy life may be studied. Medical officers showing aptitude for specialties in medicine are given graduate instruction in their specialties at appropriate medical schools.

The health and hygiene of the navy personnel are entrusted to the medical and dental officers of the service. Fully equipped hospital ships with an efficient personnel and skilled medical officers, including specialists, accompany all large fleets. The Medical Corps of the naval reserve force is composed of officers taken from civilian life and from ex-naval medical officers, appointed and promoted pursuant to law and in accordance with regulations. They may receive a certain amount of training each year and are subject to call in an emergency so declared by the president.

The Hospital Corps consists of chief pharmacists (commissioned officers), pharmacists (warrant officers), chief pharmacist's mates, pharmacist's mates, first, second and third class (petty officers) and hospital apprentices (non-rated enlisted men). Vacancies are filled by promotion from lower ratings. Chief pharmacists and pharmacists are concerned largely with administration of naval hospitals and dispensaries. Many of these officers become expert chemists, accountants, X-ray technicians, etc. The enlisted men are trained as male nurses, and several each year are given special instruction for qualification as technicians in the following branches: bacteriology, pathology, medical zoology, chemistry, X-ray, electrocardiography, dentistry, aviation medicine and embalming.

The Nurse Corps (female) consists of the superintendent of the Nurse Corps (female), chief nurses and nurses. The members of the Nurse Corps are employed principally at naval hospitals, naval dispensaries and on board hospital ships.

The surgical instruments, dressings, medicines and laboratory equipment are supplied in great part from the navy medical supply depot in Brooklyn, N.Y., and from the medical supply depots in Mare island, Calif., and Canacao, P.I. Naval medical service is provided for officers and enlisted men, active or retired, afloat or ashore. Of the commissioned officers of the Medical Corps of the U.S. navy 3,093 served in the World War, together with 24,587 enlisted men in the Hospital Corps. The entire U.S. naval medical service is directed by the surgeon general of the U.S. navy, who is appointed by the president, from the Naval Medical Corps, for a term of four years, after which he may be reappointed. This duty carries with it the rank of rear-admiral, "upper nine," which corresponds to that of major-general, U.S. army. (J. C. Pr.)

MEDICI, the name of a famous Italian family. Legend declared that the house was founded by Perseus, and that Benvenuto Cellini's bronze Perseus holding on high the head of Medusa was executed and placed in the Loggia dei Lanzi at Florence to symbolize the victory of the Medici over the republic. The name appears in Florentine chronicles as early as the close of the 12th century.

Early Bearers of the Name.—The first of the family to be a distinct figure in history was Salvestro dei Medici, who, in 1378, was the real leader in the revolt of the Ciompi (wool-carders). The lesser gilds had gained some ground by this riot, and Salvestro dei Medici the great popularity at which he had aimed.

Giovanni.—Giovanni, son of Averardo Bicci dei Medici (1360–1429), may be considered the actual founder of Medicean greatness. He realized an immense fortune by trade—establishing banks in Italy and abroad, which in his successor's hands became the most efficient engines of political power. The Council of Constance (1414–1418) enabled Giovanni dei Medici to realize enormous profits. Like his ancestor Salvestro, he was a constant supporter of the lesser gilds in Florence. Historians record his frequent resistance to the Albizzi when they sought to oppress the people with heavier taxation, and his endeavours to cause the chief weight to fall upon the rich. For this he gained a great reputation. Giovanni dei Medici died in 1429 leaving two sons, Cosimo (1389–1464) and Lorenzo (1395–1440). From the former proceeded the branch that ruled for many generations over the nominal republic of Florence, and gave to Italy the popes Leo X. and Clement VII. On the extinction of this elder line in the 16th century, the younger branch derived from Lorenzo, Cosimo's

brother, for two centuries supplied grand-dukes to Tuscany.

Cosimo.—Cosimo, surnamed Cosimo the Elder, and honoured after his death by the title of *pater patriae,* first succeeded in solving the problem of becoming absolute ruler of a republic keenly jealous of its liberty, without holding any fixed office, without suppressing any previous form of government, and always preserving the appearance and demeanour of a private citizen. Born in 1389, he was forty when his father died. He showed much taste and an earnest love both for letters and art. But he was devoted to business to the day of his death, and like his forefathers gained wealth through his friendly relations with the papal court. He inherited the leadership of the opposition to the then dominant party of the greater gilds headed by Rinaldo degli Albizzi, Palla Strozzi and Niccolò da Uzzano.

Cosimo was generous in lending and even giving money when it suited his political ends. He is said to have fomented the war with Lucca, and to have made money out of it. When the fortune of war turned against Florence, Cosimo turned on the Albizzi and their friends who were mainly responsible for its conduct. The Albizzi vowed revenge. A general assembly of the people was convoked and a *balia* chosen, which changed the government and sent Cosimo into exile at Padua.

Finally, on Sept. 1, 1434, a signory was elected in Florence composed of his friends, and his recall was decreed. Rinaldo degli Albizzi determined to oppose it by force, but his attempt failed, and he left Florence never to return. For three centuries, dating from that moment, the whole history of Florence was connected with that of the house of Medici.

Cosimo secured himself by exiling the most powerful citizens to all parts of Italy. It was impossible for Cosimo openly to assume the position of tyrant of Florence, nor was it worth his while to become gonfalonier, since the term of office lasted only two months. He attained his object by securing the control of the magistracy, whose members were appointed for a five year term.

Cosimo's Patronage of Art.—Without the title of prince, this merchant showed royal generosity in his expenditure for the promotion of letters and the fine arts. Besides his palace in the city, he constructed noble villas at Careggi, Fiesole and other places. He built the basilica of Fiesole, and that of St. Lorenzo in Florence, and enlarged the church and monastery of St. Mark. Even in distant Jerusalem he endowed a hospice for the use of pilgrims. He was the patron of Donatello, Brunelleschi, Ghiberti, Luca della Robbia, and many others. Cosimo purchased many Greek and Latin manuscripts; he opened the first public library at St. Mark's at his own expense, and founded another in the abbey of Fiesole. The Greek refugees from Constantinople found a constant welcome in his palace. During the Council of Florence (1439–1442), Gemistus Pletho spoke to him with enthusiasm of the Platonic philosophy. Cosimo was so deeply attracted by the theme that he decided to have the young Marsilio Ficino (*q.v.*) trained in philosophy and Greek learning in order to make a Latin translation of the complete works of Plato. Through Ficino he founded that Platonic academy which led to such important results in the history of Italian philosophy and letters. On Aug. 1, 1464, Cosimo died at the age of seventy-five, while engaged in listening to one of Plato's dialogues.

Cosimo was succeeded by his son Piero "the Gouty," who quelled a plot against his leadership, and maintained his authority for five years, mainly through the prestige inherited from Cosimo. He died on Dec. 3, 1469, leaving two sons, Lorenzo (1449–1492) and Giuliano (1453–1478).

Lorenzo.—The younger, the gentler and less ambitious of the two, was quickly removed from the world. Lorenzo seized the reins of state with a firm grasp. In literary talent he was superior to Cosimo, but as a financier was inferior. In politics he had nobler conceptions and higher ambitions, but he was more easily carried away by his passions, less prudent in his revenge, and more disposed to tyranny. Lorenzo's policy, although prosecuted with less caution, was still the old astute policy initiated by Cosimo.

Among his worst enemies were the powerful clan of the Pazzi. They were on the point of inheriting the large property of Giovanni Borromeo when Lorenzo hurriedly caused a law to be passed that altered the right of succession. The hatred of the Pazzi was thereby exasperated to fury. There ensued a desperate quarrel with Pope Sixtus IV. Consequently the Pazzi and Archbishop Salviati, another enemy of Lorenzo, aided by the nephews of the pontiff, determined to destroy the Medici. On April 26, 1478, while Giuliano and Lorenzo were attending high mass in the cathedral of Florence, the former was mortally stabbed by conspirators, but the latter was able to beat back his assailants and escape into the sacristy. Lorenzo wreaked cruel vengeance upon his foes. Several of the Pazzi and their followers were hanged from the palace windows; others were hacked to pieces, dragged through the streets, and cast into the Arno, while others were condemned to death or sent into exile. The pope had excommunicated Lorenzo, put Florence under an interdict, and, with the help of the Neapolitan king, made war against the republic. Lorenzo went to Naples, to the court of King Ferdinand of Aragon, and secured an honourable peace, which soon led to a reconciliation with Sixtus.

Thus at last Lorenzo found himself complete master of Florence. But, as the *balia* changed every five years, it was always requisite to secure a new magistracy favourable to his aims. In 1480 Lorenzo compassed the institution of a new council of seventy, which was practically a permanent *balia* with extended powers, which not only elected the chief magistrates, but had also the administration of numerous state affairs. This permanent council of devoted adherents once formed, his security was firmly established. By this means, the chroniclers tell us, "liberty was buried," but the chief affairs of the state were always conducted by intelligent and experienced men, who promoted the public prosperity. Florence was still called a republic; the old institutions were still preserved, if only in name. Lorenzo was absolute lord of all, and virtually a tyrant.

His immorality was scandalous; he kept an army of spies; he frequently meddled in the citizens' most private affairs, and exalted men of the lowest condition to important offices of the state. Yet, as Guicciardini remarks, "If Florence was to have a tyrant, she could never have found a better or more pleasant one." In fact all industry, commerce and public works made enormous progress. The civil equality of modern states, which was quite unknown to the middle ages, was more developed in Florence than in any other city of the world. Even the condition of the peasantry was far more prosperous than elsewhere. Lorenzo's authority was very great throughout the whole of Italy. He was on the friendliest terms with Pope Innocent VIII., from whom he obtained the exaltation of his son Giovanni to the cardinalate at the age of fourteen. This boy-cardinal was afterwards Pope Leo X. From the moment of the decease of Sixtus IV., the union of Florence and Rome became the basis of Lorenzo's foreign policy.

The palace of Lorenzo was the school and resort of illustrious men. Within its walls were trained the two young Medici afterwards known to the world as Leo X. and Clement VII. Ficino, Poliziano, Pico della Mirandola and all members of the Platonic academy were its constant habitués. It was here that Pulci gave readings of his *Morgante,* and Michelangelo essayed the first strokes of his chisel. Lorenzo's intellectual powers were of exceptional strength and versatility. He could speak with equal fluency on painting, sculpture, music, philosophy and poetry.

But his crowning superiority over every other Maecenas known to history lay in his active participation in the intellectual labours that he promoted. He was an elegant prose writer, and a poet of real originality. It is Lorenzo's lasting glory to have been the initiator of the movement for the revival of the national literature in the mother tongue. He died on April 8, 1492.

Pietro.—Lorenzo left three sons—Pietro (1471–1503), Giovanni (1475–1521) and Giuliano (1479–1516). He was succeeded by Pietro, whose rule lasted but for two years. He fomented the hatred between Lodovico Sforza and Ferdinand of Naples, which hastened the coming of the French under Charles VIII., and the renewal of foreign invasions. When the French approached the frontiers of Tuscany, Pietro, crazed with fear,

accepted terms equally humiliating to himself and the state. The enraged citizens decreed his deposition, and he fled to Venice. He was drowned at Garigliano in 1503.

Cardinal Giovanni (Leo X.), Giuliano, Lorenzo.—A republican government was maintained in Florence from 1494 to 1512, and the city remained faithful to its alliance with the French, who were all-powerful in Italy Cardinal Giovanni, the head of the family, resided in Rome, playing the patron to a circle of litterati, artists and friends, and waiting for better days. The battle of Ravenna wrought the downfall of the fortunes of France in Italy, and led to the rise of those of Spain, whose troops entered Florence to destroy the republic and reinstate the Medici. Pietro had left a young son, Lorenzo (1492–1519), who was afterwards duke of Urbino. In 1513 Cardinal Giovanni was elected pope, and assumed the name of Leo X. (*q.v.*). Meanwhile his kinsmen continued to govern Florence by means of a *balia.* And thus, being masters of the whole of central Italy, the Medici enjoyed great authority throughout the country. This was the moment when Niccolò Machiavelli (*q.v.*), in his treatise *The Prince,* counselled them to accomplish the unity of Italy

Giuliano dei Medici had died during Leo's reign, in 1516, without having ever done anything worthy of record. He was the husband of Philiberta of Savoy, was duke of Nemours, and left a natural son, Ippolito dei Medici (1511–1535), who afterwards became a cardinal. Lorenzo was invested by his kinsman, Leo X., with the duchy of Urbino, after expelling on false pretences its legitimate lord, Francesco Maria della Rovere. This prince, however, soon returned to Urbino, where he was joyously welcomed by his subjects, and Lorenzo regained possession only by a war of several months, in which he was wounded. In 1519 he also died, worn out by disease and excess. By his marriage with Madeleine de la Tour d'Auvergne, he had one daughter, Caterina dei Medici (1519–1589) (*see* Catherine de' Medici), married in 1533 to Henry, duke of Orleans, afterwards king of France. Lorenzo also left a natural son named Alessandro. Thus the only three surviving representatives of the chief branch of the Medici, Cardinal Giulio, Ippolito and Alessandro were all of illegitimate birth, and left no legitimate heirs.

Cardinal Giulio (Clement VII.).—Cardinal Giulio (*see* Clement VII.), who had laboured successfully for the reinstatement of his family in Florence in 1512, had been long attached to the person of Leo X. as his trusted factotum and companion. When Giuliano and Lorenzo died, the pope appointed the cardinal to the government of Florence. When, after the death of Leo X. and the very brief pontificate of Adrian VI., he was elected pope (1523) under the name of Clement VII., he entrusted the government of Florence to Cardinal Silvio Passerini conjointly with Alessandro and Ippolito, who were still young.

Giovanni delle Bande Nere.—The younger branch of the Medici, descended from Lorenzo, brother to Cosimo the elder, now emerged from obscurity. In fact the most valiant captain of the papal forces was Giovanni dei Medici, afterwards known by the name of Giovanni delle Bande Nere. His father was Giovanni, son of Pier Francesco, who was the son of Lorenzo, the brother of Cosimo dei Medici. The youthful Giovanni was the only leader who opposed a determined resistance to the imperial forces. He was seriously wounded at Pavia when fighting on the French side. On his recovery he joined the army of the League. When the imperial troops were struggling through the marshes of Mantua, surrounded on every side, and without stores or ammunition, Giovanni attacked them with a small body of men. One of the first shots fired by the enemy injured him so fatally that he died a few days after. He was married to Maria Salviati, by whom he had one son, Cosimo (1519–1574), who became the first grand duke of Tuscany, and indeed the founder of the grand duchy and the new dynasty.

Duke Alessandro.—Meanwhile the imperial army had sacked Rome, and Clement VII. had signed a treaty of alliance with the emperor (1529), who sent an army to besiege Florence and restore the Medici, whom the people had expelled in 1527 on the re-establishment of the republic. After an heroic defence, the city was forced to surrender (1530). Ippolito being a cardinal, Alessandro was chosen as the new ruler of Florence.

By imperial patent Duke Alessandro (he was duke of Città di Penna) was nominated head of the republic. No previous ruler of the city had enjoyed hereditary power confirmed by imperial patent, and such power was incompatible with the existence of a republic. A new council was formed of two hundred citizens elected for life, forty-eight of which number were to constitute a senate. Alessandro, as duke of the republic, filled the post of gonfalonier, and carried on the government with the assistance of three senators, changed every three months, who took the place of the suppressed signory. The duke's chief advisers and the contrivers of all these arrangements were Baccio Valori, Francesco Vettori and above all Francesco Guicciardini—men, especially the latter two, of lofty political gifts and extensive influence. When the leading Florentine families realized not only that the republic was destroyed, but that they were reduced to equality with those whom they had hitherto regarded as their inferiors and subjects, their rage was indescribable, and hardly a day passed without the departure of influential citizens who were resolved to overthrow their new ruler. They found a leader in Cardinal Ippolito dei Medici, who was then in Rome.

Cardinal Ippolito.—In 1534 the principal Florentine exiles were despatched to Charles V. with complaints of Alessandro's tyranny. Ippolito represented his own willingness to carry on the government of Florence in a more equitable manner, and promised the emperor a large sum of money. He set out to meet Charles in Tunis, but on Aug. 10, 1535, died suddenly at Itri, poisoned, it is supposed, by order of Alessandro. On the emperor's return from Africa, the exiles presented themselves to him in Naples. Duke Alessandro, being cited to appear, came to Naples accompanied by Francesco Guicciardini, who by speaking in his defence, tarnished his illustrious name. Alessandro rose higher than before in the imperial favour, married Margaret of Austria, the natural daughter of Charles, and returned to Florence with increased power. Alessandro now indulged unchecked in the lowest excesses of tyranny, and gave way to increased libertinism.

Lorenzino.—His constant associate in this disgraceful routine was his distant kinsman Lorenzo, generally known as Lorenzino dei Medici. On Jan. 5, 1537, Lorenzino led the duke to his own lodging, and left him there, promising shortly to return with the wife of Leonardo Ginori. Alessandro fell asleep on the couch while awaiting Lorenzino's return. Before long the latter came accompanied by a desperado known as the Scoronconcolo, who aided him in murdering the sleeper. They placed the body in a bed, hid it beneath the clothes, and, Lorenzino having attached a paper to it bearing the words, *Vincit amor patriae, laudumque immensa cupido,* they both fled to Venice. In that city Lorenzino was assassinated some ten years later, in 1548, at the age of thirty-two, by order of Alessandro's successor. He wrote an *Apologia,* in which he defended himself with great skill and eloquence, saying that he had been urged to the deed solely by love of liberty. By Alessandro's death the elder branch of the Medici became extinct.

Cosimo I.—Cardinal Cybo convoked the council of forty-eight to decide upon a successor. Guicciardini and other leading citizens favoured the choice of Cosimo, the son of Giovanni delle Bande Nere. He was already in Florence, was aged seventeen, was keen-witted and aspiring, strong and handsome in person, heir to the enormous wealth of the Medici, and, by the terms of the imperial patent, was Alessandro's lawful successor. Charles V. approved the nomination of Cosimo, who without delay seized the reins of government with a firm grasp.

Meanwhile the exiles assembled their forces at Mirandola. They had about four thousand infantry and three hundred horse; among them were members of all the principal Florentine families; and their leaders were Bernardo Salviati and Piero Strozzi. They entered Tuscany towards the end of July 1537. Cosimo ordered Alessandro Vitelli to collect the best German, Spanish and Italian infantry at his disposal, and attack the enemy. Alessandro Vitelli re-entered Florence with his victorious army and his fettered captives. Cosimo had achieved his first triumph.

On four mornings in succession four of the prisoners, all mem-

bers of great families, were beheaded. Then the duke saw fit to stay the executions. Baccio Valori, however, and his son and nephew were beheaded on Aug. 20 in the courtyard of the Bargello. Filippo Strozzi still survived, but, later, on Dec. 18, he was found dead in his prison, with a blood-stained sword by his side, and a slip of paper bearing these words: *Exoriare aliquis nostris ex ossibus ultor.*

The young prince's cold-blooded massacre of his captives cast an enduring shadow upon his reign and dynasty. But it was henceforward plain to all that he was a man of stern resolve, who went straight to his end without scruples. He was regarded by many as the incarnation of Machiavelli's *Prince*. Guicciardini, who still pretended to act as mentor, withdrew from public life and when he died in 1540, it was immediately rumoured that the duke had caused him to be poisoned. This shows the estimation in which Cosimo was now held. He punished with death all who dared to resist his will. By 1540 sentence of death had been pronounced against 430 contumacious fugitives, and during his reign 140 men and six women actually ascended the scaffold, without counting those who perished in foreign lands by the daggers of his assassins.

Cosimo bore a special grudge against the neighbouring republics of Siena and Lucca. Siena was an old and formidable foe to Florence, and had always given protection to the Florentine exiles. It was now very reluctantly submitting to the presence of a Spanish garrison, and, being stimulated by promises of prompt and efficacious assistance from France, rose in rebellion and expelled the Spaniards in 1552. Cosimo instantly wrote to the emperor, asking leave to attack Siena, and begged for troops. He then began negotiations with Henry II. of France, and, by thus arousing the imperial jealousy, obtained a contingent of German and Spanish infantry. Siena was besieged for fifteen months, and its inhabitants made a most heroic resistance, even women and children helping on the walls. But finally the Sienese were obliged to capitulate on honourable terms that were shamelessly violated.

In 1559 Cosimo also captured Montalcino, and thus formed the grand-duchy of Tuscany, but he continued to govern the new state—*i.e.* Siena and its territories—separately from the old. His rule was intelligent, skilful and despotic; but his enormous expenses drove him to excessive exactions in money. Hence, notwithstanding the genius of its founder, the grand-duchy held from the first the elements of its future decay. Cosimo preferred to confer office upon men of humble origin in order to have pliable tools, but he also liked to be surrounded by a courtier aristocracy on the Spanish and French pattern. Cosimo was no Maecenas; nevertheless he restored the Pisan university, enlarged that of Siena, had the public records classified, and executed public works like the Santa Trinità bridge. During the great inundations of 1557 he turned his whole energy to the relief of the sufferers.

In 1539 he had married Eleonora of Toledo, daughter of the viceroy of Naples, by whom he had several children. Two died in 1562, and their mother died shortly afterwards. It was said that one of these boys, Don Garcia, had murdered the other, and then been killed by the enraged father. Indeed, Cosimo was further accused of having put his own wife to death but neither rumour had any foundation. Worn by the cares of state and self-indulgence, Cosimo, in 1564, resigned the government to his eldest son, who was to act as his lieutenant, since he wished to have power to resume the sceptre on any emergency. In 1570, by the advice of Pope Pius V., he married Camilla Martelli, a young lady of whom he had been long enamoured. In 1574 he died, at the age of 54 years and ten months, after a reign of 37 years, leaving three sons and one daughter besides natural children. These sons were Francesco, his successor, who was already at the head of the government, Cardinal Ferdinand, and Piero.

Francesco I.—Francesco I., born in 1541, began to govern as his father's lieutenant in 1564, and was married in 1565 to the archduchess Giovanna of Austria. He was suspicious, false and despotic. Holding every one aloof, he carried on the government with the assistance of a few devoted ministers. He cast himself like a vassal at Austria's feet. He reaped his reward by obtaining from Maximilian II. the title of grand-duke, for which Cosimo had never been able to win the imperial sanction, but he forfeited all independence. Towards Philip II. he showed even greater submissiveness, supplying him with large sums of money wrung from his overtaxed people. His love of science and letters was the only Medicean virtue that he possessed. He had an absolute passion for chemistry, and passed much of his time in his laboratory. Francesco was a slave to his passions, and was led by them to scandalous excesses and deeds of bloodshed.

In 1576 Isabella dei Medici, Francesco's sister, was strangled in her nuptial bed by her husband, Paolo Giordano Orsini, whom she had betrayed. Piero dei Medici, Francesco's brother, murdered his wife Eleonora of Toledo from the same motive. Still louder scandal was caused by the duke's passion for the famous Bianca Cappello, a Venetian of noble birth, who had eloped with and married a young Florentine named Pietro Buonaventuri. Francesco nominated her husband to a post at court. Upon this, Buonaventuri behaved with so much insolence, even to the nobility, that one evening he was found murdered in the street. After the death of the grand-duchess in 1578 he married Bianca. The grand-duke died at his villa of Poggio a Caiano on Oct. 18, 1587, and the next day Bianca also expired. Rumour asserted that she had prepared a poisoned tart for the cardinal, and that, when he suspiciously insisted on the grand-duke tasting it first, Bianca desperately swallowed a slice and followed her husband to the tomb.

Such was the life of Francesco dei Medici, and all that can be said in his praise is that he gave liberal encouragement to a few artists, including Giovanni Bologna (*q.v.*). He was the founder of the Uffizi gallery, of the Medici theatre, and the villa of Pratolino; and during his reign the Della Cruscan academy was instituted.

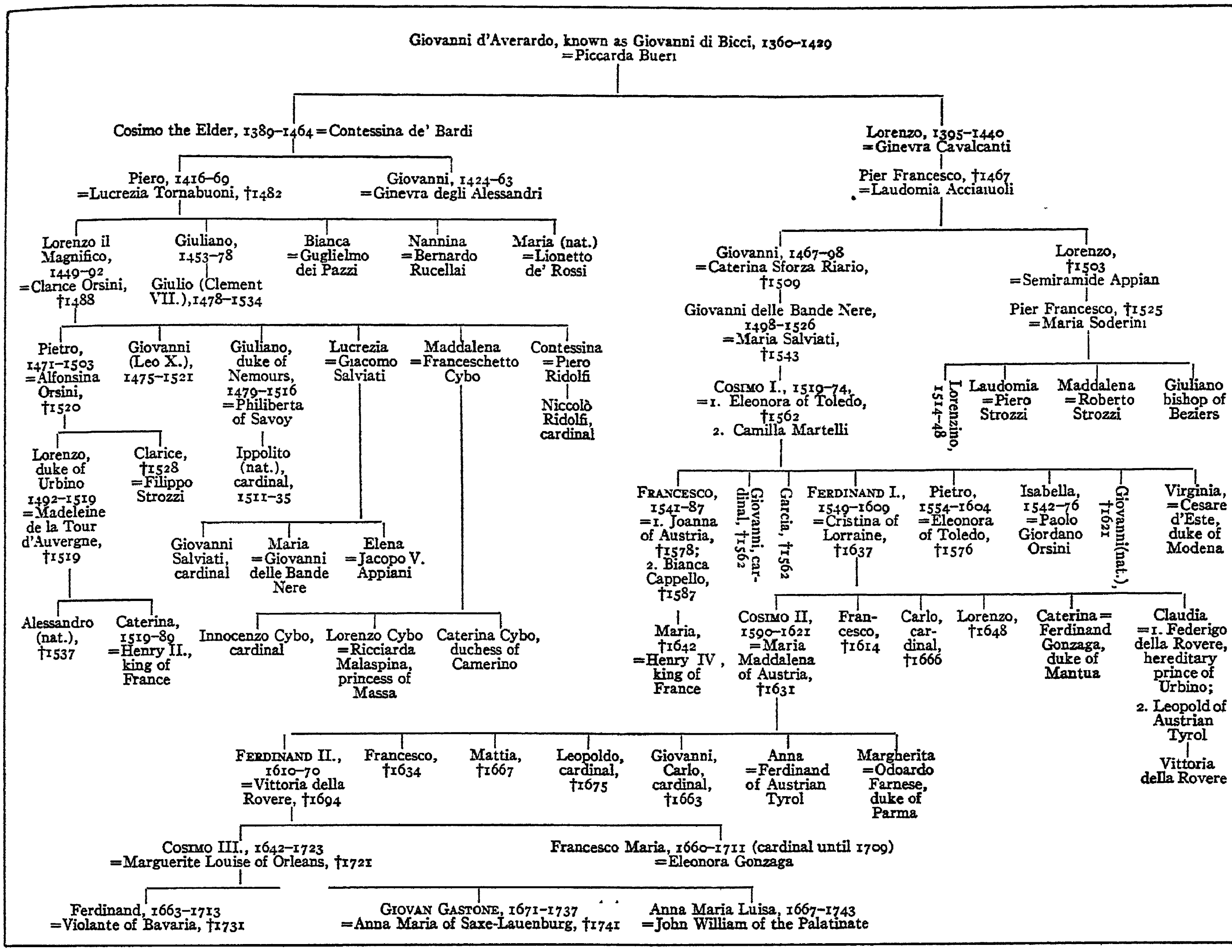
Ferdinand I.—Ferdinand I. was thirty-eight years of age when, in 1587, he succeeded his brother on the throne. A cardinal from the age of fourteen, he had never taken holy orders. He was the founder of the Villa Medici at Rome, and the purchaser of many priceless works of art, such as the Niobe group and many other statues afterwards transported by him to Florence. After his accession he retained the cardinal's purple until the time of his marriage.

He re-established the administration of justice, and sedulously attended to the business of the state. Tuscany revived under his rule, and regained the independence and political dignity that his brother had sacrificed to love of ease and personal indulgence. He ensured the prosperity of Leghorn, by an edict enjoining toleration towards Jews and heretics, which led to the settlement of many foreigners in that city. He improved the harbour and established canal communication with Pisa, and carried out many works of public utility in the duchy. He retained the reprehensible custom of trading on his own account, keeping banks in many cities of Europe. In foreign policy he sought emancipation from Spain.

During this grand-duke's reign the Tuscan navy was notably increased, and did itself much honour on the Mediterranean. The war-galleys of the knights of St. Stephen were despatched to the coast of Barbary to attack Bona, the headquarters of the corsairs, and they captured the town with much dash and bravery. In the following year (1608) the same galleys achieved their most brilliant victory in the archipelago over the stronger fleet of the Turks, by taking nine of their vessels, seven hundred prisoners, and jewels of the value of 2,000,000 ducats.

Cosimo II.—Ferdinand I. died in 1609, leaving four sons, of whom the eldest, Cosimo II., succeeded to the throne at the age of nineteen. Like his predecessors, Cosimo II. studied to promote the prosperity of Leghorn, and he deserves honour for abandoning all commerce on his own account. He was fond of luxury, spent freely on public festivities and detested trouble. Tuscany was apparently tranquil and prosperous; but the decay of which the seeds were sown under Cosimo I. and Ferdinand I. became before long beyond all hope of remedy. Cosimo II. protected Galileo Galilei. He recalled him to Florence in 1610, and nominated him court mathematician and philosopher. Cosimo died in February

GENEALOGICAL TABLE OF THE MEDICI



1621. His mother, Cristina of Lorraine, and his wife, Maddalena of Austria, had been nominated regents and guardians to his eldest son Ferdinand II., a boy of ten.

Ferdinand II.—In 1627 Ferdinand II., then aged seventeen, chose to assume the government; but he decided on sharing his power with the regents and his brothers. When Florence and Tuscany were ravaged by the plague in 1630, he showed admirable courage and carried out many useful measures. But he was entirely subservient to Rome. On the death in 1631 of the last duke of Urbino, the pope was allowed to seize the duchy without the slightest opposition on the part of Tuscany. Ecclesiastics usurped the functions of the state; and the ancient laws of the republic, together with the regulations decreed by Cosimo I. as a check upon similar abuses, were allowed to become obsolete. On the extinction of the line of the Gonzagas at Mantua in 1627, war broke out between France on the one side and Spain, Germany and Savoy on the other. The grand duke, uncertain of his policy, trimmed his sails according to events. Fortunately peace was re-established in 1631. Mantua and Monferrato fell to the duke of Nevers, as France had always desired. But Europe was again in arms for the Thirty Years' War. Urban VIII. wished to aggrandize his nephews, the Barberini, by wresting Castro and Ronciglione from Odoardo Farnese, duke of Parma and brother-in-law to Ferdinand. Farnese marched his army through Tuscany into the territories of the pope. The grand-duke was drawn into the war to defend his own state and his kinsman. By means of the French intervention, peace was made in 1644. But the pope resigned none of his ecclesiastical pretensions in Tuscany. The septuagenarian Galileo was obliged to appear before the Inquisition in Rome, which treated him with infamous cruelty.

Like his predecessors, Ferdinand II. gave liberal patronage to science and letters. His brother Leopold, who had been trained by Galileo Galilei was one of the founders of the celebrated academy *Del Cimento,* which took for its motto the words *Provando e riprovando,* and followed the experimental method of Galileo. Formed in 1657, it was dissolved in 1667.

Cosimo III.—Cosimo III. succeeded his father in 1670. He was weak, vain, bigoted and hypocritical. His wife, Louise of Orléans, niece of Louis XIV., being enamoured of duke Charles of Lorraine, was very reluctant to come to Italy. After the birth of her third child, Giovan Gastone, her hatred for her husband increased almost to madness and she returned to France. In Cosimo's reign the wretchedness of the people increased, and the insufficient revenues of the state were spent on clerical endowments.

Cosimo's eldest son Ferdinand died childless in 1713. The pleasure-loving Giovan Gastone was married to Anna Maria of Saxe-Lauenburg, widow of a German prince, a wealthy, coarse woman wholly immersed in domestic occupations. After living with her for some time in a Bohemian village, Giovan Gastone withdrew to France, and ruined his health by his excesses. After a brief return to Bohemia he finally separated from his wife, by whom he had no family. Thus the dynasty was doomed to extinction. Cosimo had a passing idea of reconstituting the Florentine republic, but, this design being discountenanced by the European powers, he determined to transfer the succession, after the death of Giovan Gastone, to his sister Anna Maria Louisa, who in fact survived him. For this purpose he proposed to annul the patent of Charles V., but the powers objected to this arrangement also, and

by the treaty of 1718 the quadruple alliance of Germany, France, England and Holland decided that Parma and Tuscany should descend to the Spanish Infante Don Carlos. The grand-duke made energetic but fruitless protests.

Giovan Gastone.—Cosimo III. had passed his eightieth year at the time of his decease in October 1723, and was succeeded by his son Giovan Gastone, then aged fifty-three. The new sovereign was in bad health, worn out by dissipation, and had neither ambition nor aptitude for rule. His throne was already at the disposal of foreign powers, and his only thought on ascending it was to regain strength enough to pass the remainder of his days in enjoyment. And when, after prolonged opposition, he had resigned himself to accept Don Carlos as his successor, the latter led a Spanish army to the conquest of Naples, an event afterwards leading to the peace of 1735, by which the Tuscan succession was transferred to Francesco II., duke of Lorraine, and husband of Maria Theresa. Giovan Gastone was obliged to submit. Spain withdrew her garrisons from Tuscany, and Austrian soldiers took their place and swore fealty to the grand-duke on Feb. 5, 1737. He expired on July 9 of the same year. Such was the end of the younger branch of the Medici, which had found Tuscany a prosperous country, where art, letters, commerce, industry and agriculture flourished, and left her poor and decayed in all ways, drained by taxation, and oppressed by laws contrary to every principle of sound economy, downtrodden by the clergy, and burdened by a weak and vicious aristocracy.

BIBLIOGRAPHY.—A. Fabroni, *Laurentii Medicei magnifici vita* (2 vols. Pisa, 1784) and *Magni Cosimi Medicei vita* (2 vols., Pisa, 1789); J. Galluzzi, *Storia del granducato di Toscana sotto il governo di casa Medici* (5 vols., Florence, 1787); W. Roscoe, *Life of Leo X.* (1846) and *Life of Lorenzo de Medici* (new ed. 1872); A. von Reumont, *Geschichte Toscanas seit der Ende des florent. freiestaats* (2 vols. Gotha, 1876); G. Capponi, *Storia della republica di Firenze* (Florence, 1875); B. Buser, *Lorenzo de' Medici als italienischer Staatsmann* (Leipzig, 1879) and *Die Beziehungen der Mediceer zu Frankreich* (1879); P. Villari, *Storia di Savonarola* (Florence, 1887) and *Machiavelli* (1878–83); F. T. Perrens, *Histoire de Florence* (1888); E. Armstrong, *Lorenzo de' Medici* (1896); E. Robiony, *Gli ultimi Medici* (Florence, 1905); E. L. S. Horsburgh, *Lorenzo the Magnificent* (1908); J. Ross, *Lives of the Medici from their Letters* (1910); S. Brinton, *Golden Age of the Medicis* (1927). *See* also FLORENCE and TUSCANY. (P. V.; X.)

MEDICINE (*see* also MEDICINE, GENERAL; MEDICAL RESEARCH), the department of knowledge and practice dealing with disease and its treatment in man and domestic animals. In a more limited sense it implies that branch of the whole which is contrasted with surgery. Medicine regards the normal in health as a base line against which disease can be evaluated and its standard of attainment in all its branches in any age bears a close relation to the general mental development of the nation producing its practitioners. Medical knowledge, therefore, moves on parallel lines with the development of education. But this is not all. The history of medicine teaches that, measured by modern standards, in many ancient states medical knowledge was limited and inexact at a time when civilization, art and letters were at their highest. It was not until about the middle of the 19th century, when there occurred in Europe a notable awakening of interest in all branches of Natural Science, that Medicine can be said to have attained any like degree of development, since when its development has steadily continued until to-day it has grown so extensive that its ramifications are manifestly beyond the powers of any single individual to grasp. It covers medicine in the limited sense, surgery, midwifery, and numerous subdivisions in these main groups. It includes pathology, which deals with the "how" and "why" of disease; pharmacology, which is concerned with the action of drugs; physiology, which deals with normal processes in normal animals; and anatomy, which investigates their structure and organization as revealed alike to the naked eye and by microscopic examination. It has links with biology, chemistry, physics, meteorology, geology, ethnology; indeed, it draws where it can from all branches of knowledge. Even its terminology is constructed—unhappily, not always on blameless lines—from the classical languages, and in its acquirement of information it needs to be conversant with most written tongues. Its range is co-terminous with human and animal life. (W. S. L.-B.)

MEDICINE, GENERAL. Since 1910 the progress of medicine has been much influenced by the four years of the war, which, while interfering with steady research, brought with it urgent problems, caused diseases previously rare or unrecognised to become matters of common knowledge, and produced epidemics on an enormous scale, thereby calling forth much investigation and new knowledge.

Influence of the World War.—Trench fever and a special form of kidney affection, called trench nephritis, were practically new diseases; and the serious condition of epidemic (lethargic) encephalitis (*q.v.*), though it may have existed previously, for the first time became common and was recognised during the war. Certain industrial forms of poisoning, namely of trinitrotoluene among munition workers, and of tetrachlorethane among aeroplane makers, were temporarily in evidence, and an impetus was given to research into the conditions modifying efficient performance of labour. Deficient diet caused scurvy, especially in 'Iraq, and other "deficiency diseases" came into evidence, especially in central Europe. Cerebrospinal ("spotted") fever became for the first time epidemic in Great Britain (*see* SPINAL MENINGITIS); as a result of the depressing conditions and the lowered bodily resistance, influenza (*q.v.*) became pandemic all over the world in 1918–19; and a fatal form of infective heart disease (*endocarditis lenta*) became much more frequent in discharged soldiers. A form of infective jaundice (*spirochaetosis icterohaemorrhagica*), formerly known as Weil's disease, became prevalent in Flanders, and its true nature, namely, an infection with an animal microbe, akin to that of yellow fever (*q.v.*) (*Leptospira icteroides*), was found in Europe to be identical with that described in Japan in 1914. Paratyphoid fevers (*see* PARATYPHOID FEVERS) A and B, though of course known before, became much more familiar during and after the war, and it may be noted that the distinction between the forms of enteric fever known as typhoid and paratyphoid was not recognised in the Boer War (1899–1902), when the disease exacted a relatively heavier toll than in the World War, when the troops were eventually extensively protected by T.A.B. vaccination. Dysentery (*q.v.*), as in past wars, became prominent, as did malaria (*q.v.*) in the eastern areas of the campaign. The influence of a Sanitary Corps in the prevention of disease among the Allied Armies was a noticeable feature (*see* MEDICAL SERVICE, ARMY). Much progress has also been made in the prevention of tropical diseases. (*See* THERAPEUTICS and TROPICAL MEDICINE.)

Mental Diseases.—The war provided a tremendous field for the observation of the mental perturbations commonly designated as "shell shock," due to the physical effects of long-continued bombardment, mental strain and anxiety, repression or the active forgetting of terrifying experiences, and of fear. Incidentally it gave an opportunity for testing the opinion of the more advanced followers of Sigmund Freud of Vienna, who, on the assumption that the sexual instinct is stronger than those of self-preservation and of the herd, have increasingly tended to refer mental symptoms akin to those of shell shock to the conflict resulting when some sexual experience had, in obedience to the conventional influences, been repressed and thus removed out of the zone of consciousness. The value of Freud's contribution to morbid psychology (*see* PSYCHOANALYSIS) in the conception of mental conflict resulting from the active forgetting or repression of unpleasant experiences is undoubted, but to refer them mainly to sexual causes was shown by war experience to be too narrow a view, and the treatment by psychoanalysis and interpretation of dreams, and the patient's "associations" aroused much opposition. On the other hand curative measures on psycho-therapeutic lines, such as sympathetic analysis, re-education and occupational therapy, met with success and approval. (*See* PSYCHIATRY, PSYCHOSES, PSYCHOTHERAPY.)

Orthopaedic Surgery (*q.v.*) also made great advances as the result of the numerous cases of injury during the war, and remedial gymnastics and exercises have thus been of great use in furthering recovery in such cases.

Preventive Medicine (*q.v.*).—The prolongation of life and diminution of infant mortality in Great Britain have both im-

proved by about 50% in the last half century, and in the United States of America the average age at death has advanced from 40 in 1855 to 58 years at the present time. This has coincided with improved conditions of hygiene and environment, and has stimulated active measures in the prevention of disease—the ideal of medicine. The establishment in 1919 of the Ministry of Health in Great Britain was a far-seeing advance for the improvement of the national health and the prevention of disease (*see* THERAPEUTICS). In America regular periodic examination of healthy, or supposedly healthy, persons has been begun, and the statistical experience of life-assurance companies has already proved that this practice exerts a beneficial effect on the mortality of those adopting this course. The prevention of disease has been greatly assisted by the Rockefeller Foundation in New York, which has undertaken a world-wide campaign with this object on very broad lines through its International Health Board, its Division of Medical Education and its China Medical Board. In 1913 the Rockefeller Sanitary Commission, founded in 1909 for the eradication of hookworm disease (*q.v.*), was incorporated as the International Health Commission (called the International Health Board after 1916) of the then recently established Rockefeller Foundation, and since then has carried out campaigns against yellow fever (*q.v.*) in South America, which have practically exterminated it and incidentally led to Noguchi's discovery of the cause (*Leptospira icteroides*) of the disease, against malaria (*q.v.*) and tuberculosis (*q.v.*) (see also THERAPEUTICS). In connection with the National Insurance Act (1911) the Medical Research Committee (now Council) was created, and research workers have been financed and an enormous impetus given to the advancement of medicine and so to the diminution of disease.

The special conditions bearing on health in factories and industries, particularly the dangerous trades, have attracted specialised attention, particularly in America, where a School of Industrial Medicine has been instituted in connection with Harvard University.

Insanity.—The prevention of insanity by early treatment in psychiatric clinics, usually attached to general hospitals and often part of the neurological department, has been an important step in the prevention of mental disorder (*see* PSYCHIATRY). It is connected with the social service and after-care movements. In 1908 the American Council of Mental Hygiene was founded, in 1918 a similar council was started in Canada, in 1920 the French League of Mental Hygiene was inaugurated and in 1922 the British National Council for Mental Hygiene was established. Evidence of the awakening interest in health of the public at large since the war is also shown by the Society for the Prevention of Venereal Disease, the League of Health and the British Empire Cancer Campaign.

Comparative Medicine.—The increase of experimental research has been followed by the study of comparative medicine and pathology, whereby human and veterinary medicine may mutually help and benefit each other; an institute for research in the pathology of animal diseases and a professorship were established at Cambridge in 1923, and the study of experimental epidemics has been undertaken in laboratories at the Rockefeller Institute, New York, and at Manchester.

Statistical Methods.—Biological, anthropological and statistical methods are now being more formally utilized in medicine than in the past, and exact measurements and skilled calculations are being employed. An individual's constitution, or "the aggregate of hereditary characters, influenced more or less by environment, which determines his reaction to the stress of environment" (G. Draper), was present to the mind of Hippocrates and others, but the rise of bacteriology diverted attention from the internal to the external factors of disease.

Applied Physiology.—Applied physiology was extensively developed and utilised during the war, for example in aviation, the transfusion treatment of surgical shock and haemorrhage, and the relief of gassing, and has advantageously been continued since on other lines, such as ventilation, the effects of sunlight and ultra-violet rays on bacteria, infections, general health and rickets (*see* PUBLIC HEALTH). Following on the established value of open-air treatment of tuberculosis and other infections, the beneficial influence on bodily resistance induced by sunlight (heliotherapy) and ultra-violet rays has been utilised. Heliotherapy (*q.v.*), practised for 20 years at Leysin by Rollier in surgical tuberculosis, has been adopted in Great Britain. Sunlight prevents and cures rickets, and its relation to the anti-rachitic vitamin D is an addition to knowledge, possibly of potential importance in connection with other "deficiency diseases." Ultra-violet rays act on a complex alcohol, cholesterol, present widely in the body and skin, in such a way as to confer on it the anti-rachitic action of the vitamin; they also raise the amount of calcium, iron, iodine and phosphorus in the blood, increase its bactericidal power and accelerate the healing of wounds. The tungsten-arc and mercuric-vapour arc lamps are employed to provide artificial ultra-violet rays. Diathermy or the application of a special form of intensive heat has been employed in cancer, pneumonia and other infections. (*See* ELECTROTHERAPY; SUNLIGHT TREATMENT; VITAMINS.)

Biochemistry.—Closely associated with applied physiology, of which it is really a part, biochemistry (*q.v.*) has developed out of physiological chemistry and has risen rapidly to an authoritative position. At Cambridge the Sir William Dunn trustees have built and equipped a fine institute and endowed the professorship held by Sir Gowland Hopkins, who has 40 advanced students carrying out research under his direction. The Rockefeller Foundation, New York, has provided similar laboratories at Oxford and University College, London.

Metabolism.—Biochemistry is specially concerned with the changes always going on in the body and described by the name metabolism. The basal metabolism means the average minimal chemical changes compatible with life taking place in the body during complete rest and when food is not being digested and absorbed, and corresponds with the minimal heat-production 18 hours after a meal of a mixed dietary—the working expenses, so to speak, of the resting body. This is estimated directly by measuring by respiratory calorimeters the heat evolved, or indirectly, and more easily in practice, by chemical analysis of the respiratory exchange, and has been shown to be remarkably constant in normal conditions. In disease the metabolic rate may be altered; for example, in myxoedema it is lowered and all the vital processes are on a lower plane; whereas in fever and exophthalmic goitre it is accelerated. In the last-named disease the condition of the patient can be judged by the degree of increase in the metabolic rate.

Vitamins.—The recognition of the accessory food factors or vitamins (*q.v.*) has opened a new chapter in nutrition and in the causation and prevention of disease. They are present in food in minute quantities, which greatly contrast with their power, and are essential for health, growth, especially of bone and teeth, and in other ways. New knowledge of the effects of their absence and of the (deficiency) diseases thus caused has accumulated, but more may be anticipated. The vitamins each have their special actions; one prevents scurvy (anti-scorbutic), others rickets (anti-rachitic or vitamin D), beri-beri or polyneuritis (anti-neuritic), and recently, it would appear, one is essential for normal reproduction, the absence of which, at least in female rats, produces sterility. Starvation, partial or complete, and an unbalanced diet entail a corresponding degree of avitaminosis and deficiency disease; war or famine oedema, which resembles the "wet" form of beri-beri, has been ascribed to a diet largely composed of cereal and deficient in protein food.

Blood-chemistry.—With improved technique, chemical examination of the blood for non-protein nitrogen (in kidney disease), sugar and gases, cholesterol, calcium, phosphates, chlorides and bilirubin has become a method of clinical laboratory routine and essential for correct diagnosis and treatment. Much work has been done on the hydrogen ion concentration of the blood and the conditions of (1) acidosis, or diminution in the alkali reserve of the blood, which occurs in two forms, ketosis, as in diabetes mellitus, and another due to retention of phosphates, as in renal disease, and (2) of alkalosis or alkalaemia in which the alkalinity of the blood is increased, as in forced breathing when carbonic acid gas is removed in unusually large quantities from the lungs. Alkalosis has, like a fall in the calcium salts and the poisonous effect of

guanidine, been thought to cause a convulsive state—tetany, which forms part of the condition called spasmophilia seen in children.

Bacteriology (*q.v.*) has revealed the organism responsible for a number of diseases and so opened the way to specific treatment and the prevention of the infection. In the case of scarlet fever (*see* INFECTIOUS FEVERS), ascribed to haemolytic streptococci, G. F. and G. H. Dick have elaborated a test (the Dick test), analogous to the Schick test in diphtheria, whereby those susceptible to the disease can be detected and so artificially protected against it by an antitoxin. The recognition of tularaemia (due to a coccobacillus), a disease of rodents and transmitted to man by the bite of the horse fly, and of melioidosis also a disease of rodents and due to the *Bacterium whitmori*, in which the exact method of its transmission to man is uncertain, bear on the desirability of the closer correlation of the human with veterinary medicine. Invisible viruses or ultra-microscopic organisms, also called filter-passers (*see* FILTER-PASSING VIRUSES), because they are so minute that they pass through the fine pores of a Chamberland or other filter, have attracted much attention and many diseases in man and animals are with a fair degree of certainty or probability ascribed to their agency.

Bacteriophage.—D'Hérelle described a phenomenon, previously noted by Twort in 1915, often known by D'Hérelle's name, which he interpreted as the existence of an ultra-microscopic virus which lives as a parasite upon living bacteria and leads to their destruction and solution. The general opinion about the active substance responsible for these changes in bacterial cultures, and called by D'Hérelle the *microbe bacteriophage*, is that it is not an ultra-microscopic virus, but an enzyme or ferment produced by the undoubted bacteria themselves.

Protozoan infections (*see* PROTOZOA) are the cause of a number of diseases, such as yellow fever (*Leptospira icteroides*), a form of infective jaundice (*Spirochaeta icterohaemorrhagica*), rat-bite fever (*Spirochaeta morsus-muris*), and seven-day fever in Japan (*Leptospira hebdomadis*), and probably sandfly fever (*q.v.*) (a *Leptospira* resembling that of yellow fever). Thus their prevention and the employment of curative antitoxins has been rendered possible.

Immunity (*q.v.*).—After a fever the individual usually becomes immune and protected against another attack; this is acquired immunity; the blood of such a person contains antibodies which antagonise the cause of that disease, and advantage has been taken of this to inject the blood serum of patients convalescent from measles into persons who have not had the disease so as to render them immune.

Anaphylaxis (*q.v.*).—The reverse of immunity is hypersensitiveness (anaphylaxis, allergy) which is shown by idiosyncrasies and forms the underlying factor in asthma and other diseases spoken of as "toxic idiopathies;" the substances responsible for the symptoms can be detected by skin tests and the appropriate treatment thus employed. Protein shock therapy is also employed for asthma and chronic arthritis. The importance of "focal infection" such as dental disease (*see* DENTISTRY), is now much more fully recognized. (*See* THERAPEUTICS.)

Exact studies upon the chemical activities of bacteria now in progress are beginning to throw light on the actions of toxins and the chemical factors involved in immunity reactions.

Radiology (*q.v.*).—In radiology there has been a steady advance in the methods of diagnosis and treatment; technique has been elaborated and special methods have been introduced. Substances opaque to X-rays have been employed in various directions; thus lipiodol has been injected into the bronchial tubes to demonstrate dilatation of their lumen, into the spinal column to show the position of tumours, and even into the uterus to detect pregnancy. The condition of the gall bladder and the presence of gall stones can be made evident by organic compounds of iodine and bromine (tetra-iodo-phenol-phthalein and tetra-brom-phenol-phthalein), which after being taken by the mouth are excreted in the bile and show up under X-rays (cholecystography). Injection of air into the peritoneal cavity enables a clearer X-ray picture of the abdominal viscera to be obtained. The skiagrams of the jaws, showing the presence or absence of infection of the apices of the teeth and of the skull, showing the condition of the sella turcica, have facilitated the detection of focal sepsis and of pituitary disease respectively. The improvement of technique has made advances in treatment possible. By intensive X-ray exposures, following the Erlangen practice, the remedial therapy of deep-seated malignant growths has been pursued. The radium treatment of cancer in positions where the radium (*q.v.*) can be brought into close contact with the growth, is now carried out with increasing frequency, and team work in this treatment of cancer of the uterus has been adopted in a number of hospitals. Side by side with advances in treatment the effect of X-rays on the tissue cells has been investigated experimentally; the results have a very definite bearing on the methods and dosage employed in treatment, for the destructive changes induced in the cells may give rise to grave symptoms and even death. It appears that X-rays and the gamma rays of radium may set up secondary radiations in the tissues and so cause severe changes.

Diseases of Function.—Functional disorder and the investigation of the early stages of disease, before the physical signs of gross structural changes appear, have attracted increasing attention and are intimately wrapped up with the prevention of disease. The first manifestation of disease is commonly disorder of function, which shows itself by symptoms unaccompanied by any structural change. Clinical observation was specially directed to the detection of the earliest signs of disease by the late Sir James Mackenzie, who in 1919 started team work in this direction at the St. Andrews Institute for Clinical Research, where laboratory tests were fully utilised as an aid to the careful analysis of the patient's symptoms in an intense search for a real understanding of the familiar manifestations of undue fatigue, malaise, shortness of breath on exertion and pain. Tests for disorder of function—some physical, as in disorders of the circulatory and respiratory organs, others chemical, such as examination of the blood and the ability of the organ to excrete coloured dyes, for example, phenol-sulphone-phthalein, as in disease of the kidney and the liver, others psychological, as in nervous disorder—have recently been much elaborated and multiplied, and bid fair to facilitate more accurate and early diagnosis and treatment on scientific lines.

Psychology (*q.v.*).—Experimental psychology, once regarded as an academic pursuit, has been the means of great economic saving in industry, and the results of research work and tests have led to the introduction of rest pauses and other modifications, with the result of an increased output of work on the one hand and benefit to the worker on the other. The Industrial Fatigue Research Board was set up during the war, and The National Institute of Industrial Psychology, established in Great Britain after the war, ensures continued practical guidance for employers and employed. (See INDUSTRIAL PSYCHOLOGY.)

Endocrinology (*q.v.*). *Ductless Glands*.—The part played by the ductless or endocrine glands in the production of disease has attracted increasing discussion, especially on the questions (1) of the endocrine balance, meaning thereby that when one gland is disordered the equilibrium which normally exists between them as a whole is upset, and (2) of the effects of disease of more than one of these glands—pluriglandular disorder. This last problem has on the one hand, from the difficulty of positive proof, aroused scepticism as to its existence, and on the other hand stimulated exploitation of commercial preparations of combined glandular extracts, the activity of which, as regards some of the constituents, is open to serious doubt. The outstanding advance in the medicinal use of endocrine preparations, and indeed in therapeutics generally, is the introduction of insulin (*q.v.*) for the treatment of diabetes mellitus (*q.v.*). (*See* THERAPEUTICS.)

The use of the endocrine preparations proved to be active is passing out of the qualitative stage into the further one in which they are being so standardised that the proper dose can be administered; this has been done for insulin, adrenalin, thyroid and parathyroid extracts. The interstitial cells of the testis ("interstitial gland") have attracted much research in connection with their influence on the secondary sex characters and in insanity. Experimental ligature of the duct of the testis (vasectomy) increases

the prominence of the interstitial gland and is followed by rejuvenation (Steinach), and with this object the operation has been often performed on men, as has grafting of testes of men or chimpanzees (Voronoff). (*See* REJUVENATION.)

Cardiology and Circulatory Organs.—The work of the late Sir James Mackenzie and Sir Thomas Lewis has so revolutionised our knowledge of the heart that there is a new cardiology (*see* HEART, DISEASES OF). By the electrocardiograph, which is specially valuable in showing the condition of the heart muscle, Lewis showed that the extreme irregularity of the heart in cardiac failure, called by Mackenzie nodal rhythm, is due to auricular fibrillation, a circus movement instead of the normal contraction; it is in this condition that digitalis is of value. By means of the graphic methods the irregularities of the heart have been classified.

Angina Pectoris.—Cardiac murmurs have been shown not necessarily to be of grave importance, and much work has been done on angina pectoris. The symptoms—status anginosa—of sudden obstruction of the coronary arteries which supply the heart have been defined, and the cause of angina pectoris has been referred to the failure of the heart muscle (Mackenzie), and to disease of the first part of the aorta (Allbutt); in accordance with the last view operative division or removal of its nerves has been practised and found to relieve the pain, but not otherwise to affect the disease. Bullets embedded in the heart-wall have been removed, and a contracted (mitral) valve has been remedied by surgical measures. (*See* HEART AND LUNG SURGERY.)

Blood-pressure.—The existence of high blood-pressure without kidney disease or hyperpiesia (Allbutt) has been established, and it has been suggested that table salt and, probably with more reason, guanidine raise, and that hepatic extract lowers blood-pressure. The state of the capillaries—microscopic vessels—their power to contract, and their influence on blood-pressure have been investigated and much new knowledge has been acquired. The prevention of rheumatic heart disease and the responsibility of tonsils and other sites of focal infection have received considerable attention both in Great Britain and in America.

New Methods.—Numerous advances and improvements in technique have taken place, such as the following:

Bronchoscopy.—In diseases of the lungs the trial of new methods of treatment has gone on, such as specific or chemical remedies, and the production of artificial pneumothorax (*q.v.*) (*see* THERAPEUTICS). As the presence of adhesions inside the chest interferes with the production of a curative pneumothorax, they have been divided by a cautery, the process being watched through a hollow tube, illuminated by electric light, passed into the chest (Jacobaeus' thoracoscopy). Bronchoscopy for the detection and removal of foreign bodies from the air-passages has, in the hands of Chevalier Jackson, become a fine art; the importance of an early removal of these bodies before they have set up destructive changes in the lungs, which in the past have proved obscurely fatal, has now been fully recognized. In the abdomen a method, laparoscopy or coelioscopy, by which the contents can be seen by an arrangement similar to that of thoracoscopy, has been employed; but neither of these difficult methods is likely to come into general use.

Fractional Test Meals.—The adoption of fractional test meals as a more exact method of determining the constitution and variations of the constituents of the gastric contents has, thanks to Rehfuss, superseded the single examination made one hour after a test meal. Absence of hydrochloric acid, a normal constituent of the gastric juice, has been shown to favour the onset of pernicious anaemia (*see* ANAEMIA). Aspiration of the bile by a duodenal tube, after Oddi's sphincter, which closes the lower end of the common bile duct, has been relaxed by a spray of magnesium sulphate, enables a microscopical, chemical and bacteriological examination of the bile to be made, and also does good by drainage in cases of infection and inflammation of the biliary tract.

Tests for Hepatic Efficiency.—The search for tests to estimate the functional capacity, or the way the liver is doing its work, has been carried on with energy, and a number of tests for the individual functions have been introduced; but no one test for them as a whole is satisfactory, and another difficulty is that the liver, like the heart and other organs, has a great reserve, so that it can, although much damaged, discharge its functions so well that tests do not reveal any failure of the compensated condition; this is especially true in chronic disease. By means of a blood test—the Hijmans van den Bergh reaction—obstructive jaundice can be distinguished from other forms.

Neurology.—The physiology and pathology of the nervous system has steadily progressed; the researches into the factors presiding over equilibrium and posture have yielded valuable information; disease of the extra-pyramidal system has attracted attention; acute infections of the nervous system, acute poliomyelitis, encephalitis epidemica ("sleeping sickness") and cerebrospinal fever were more prominent in the conditions of war than before; much valuable scientific research into the methods of actions of poisons on the nervous system has been carried out.

Other Changes. *Panel Practice.*—The conditions of medical practice in Great Britain were profoundly modified by the introduction, as the result of Mr. Lloyd George's National Insurance Act (1911), of the "Panel system," whereby 15,000,000 insured persons are now looked after by practitioners paid at a yearly rate of a sum which has averaged about ten shillings a year, paid partly by insurance contributions and partly by the state; this enormous undertaking is part of National Insurance and is under the control of the Ministry of Health. No one medical man is now allowed to have more than 3,500 persons on his panel. At the time of its initiation the panel system met with great opposition from the medical profession, but this collapsed, and on the whole the system works well, and is certainly an improvement on the old system of clubs. (*See* NATIONAL INSURANCE, HEALTH.)

Diplomas in Special Subjects.—The enormous advances in medicine have made specialism necessary and inevitable, and as evidence of the general recognition of this need diplomas in these special subjects are granted by the universities and licensing bodies. The General Medical Council in 1922 revised the regulations for one of the oldest diplomas, that of Public Health (D.P.H.), and ordained that two years, instead of one year as formerly, must elapse from the date of a candidate's obtaining a registrable qualification in medicine, surgery and midwifery before his admission to Part II. of the examination for diplomas in sanitary science, public health or state medicine. There are diplomas in psychological medicine, in tropical medicine and hygiene, in ophthalmic medicine and surgery and in laryngology and otology, and since the war the universities of Cambridge and Liverpool have given diplomas in radiology. (*See* MEDICAL EDUCATION.)

Group Medicine.—The specialization of medicine and the elaboration of technique prevent any one man from being master of the whole field of medicine, and accordingly there has been a tendency for men to combine in team work or group medicine, especially in America. A group of men expert in their own lines may work together or under a general physician or surgeon who, in consultation with them, correlates the collected evidence and comes to a final decision on the whole matter. These diagnostic clinics, which are exemplified by the Mayo Clinic, Rochester, Minn., are commoner in America than in Great Britain. They should have the advantage, from the patient's point of view, of providing for a fixed inclusive fee all the special examinations that may be necessary at a lower cost than in ordinary practice would be required for such a number of tests.

BIBLIOGRAPHY.—*See* bibliographies to the articles referred to in the text; also Sir T. C. Allbutt and Sir H. D. Rolleston (editors), *A System of Medicine,* 9 vol., various dates. (H. R.)

MEDICINE, HISTORY OF. This subject falls naturally into two divisions: I. Ancient Medicine; II. Modern Medicine.

I. ANCIENT MEDICINE

The first records of a rational or scientific medical system are Greek.

Greek Medicine.—Greek medicine was exhibited in its pure form from about 500 B.C. till the rise of the Roman empire. Its chief development was on the Mediterranean littoral of Asia Minor. Other important centres were Athens and the Greek

colonies in Sicily and Italy. This Greek system of medicine had various roots.

(1) The submerged civilization of the conquered Minoan folk. It is probable that the cult of the serpent constantly associated with Aesculapius was of Minoan origin. It is also probable that certain ideas of the Greeks on sanitation were derived from the Minoans.

(2) From Mesopotamia the Greeks drew some of their more superstitious beliefs, as well as some, at least, of their scientific method. The Mesopotamian peoples had for ages laid up a great treasury of observation, notably of astronomical data often applied to astrological ends, and of anatomy derived from the entrails of animals used in divination. Working on these records, the Greeks erected a scientific method which appears as a prominent feature in their intellectual life. Moreover, there was in Mesopotamia a standardization of medical procedure which the Greeks were quick to adopt. From Mesopotamia, too, came the demoniac theories important in later Greek medicine, as in the New Testament.

(3) From Egypt came many drugs used by the Greek physicians. The basis of Greek medical ethics can be traced to Egypt. Some practical devices of Greek medicine, such as the forms of certain surgical instruments, were Egyptian. The Egyptians deified an historic physician Imhotep exactly as the Greeks deified the historic Asklepios, *i.e.*, Aesculapius.

(4) Persian and Indian sources contributed something to Greek medicine. As to the amount and the character of these contributions, we are not yet in a position to speak with definiteness.

The Hippocratic Collection.—The Greeks of western Asia Minor, thus drawing material from many sources, developed near the end of the 7th century B.C., a philosophical system out of which the whole of their science was a natural growth. Factors in this development were the medical schools of Cos, where Hippocrates was born, and of the opposite peninsula, Cnidus. These were in active operation by the 6th century B.C. By the middle of the 5th century they were important elements in Greek life. Much of the *Hippocratic Collection,* which contains the earliest as well as the best Greek medical writings that have survived, was put together in the 4th century B.C., though its final recension is much later.

To the question: "Which of these works is by Hippocrates?" no definite answer can be given. There is no work which we can state with confidence to be by the Father of Medicine. The books of the *Collection,* of which there are about 100, are by a number of authors of different schools, holding various and often contradictory views, living in widely separate parts of the Greek world and writing at dates separated, in extreme cases, by perhaps five or six centuries. Of the finest books of this collection we can only say that they contain nothing inconsistent with a Hippocratic origin, that their ethical standard accords with the Hippocratic ideal, and that they are the work of physicians of great intellectual power and experience. If we ask what is known about Hippocrates himself, and seek information rather than entertainment, our answer will be almost as meagre. (*See* HIPPOCRATES.)

The Hippocratic Oath.—No part of the *Hippocratic Collection* is more impressive than the famous passage known as the *Hippocratic Oath.* The recension that has come down to us is much later than Hippocrates, though passages in it may be even earlier. There is perhaps some suggestion of the oath in Egyptian papyri of the second millennium B.C. The late date of the oath by no means removes its interest as an ethical monument. No passage better reflects the spirit of the Hippocratic physicians:

> I will look upon him who shall have taught me this Art even as one of my parents. I will share my substance with him, and I will supply his necessities, if he be in need. I will regard his offspring even as my own brethren, and I will teach them this Art, if they would learn it, without fee or covenant. I will impart this Art by precept, by lecture and by every mode of teaching, not only to my own sons but to the sons of him who has taught me, and to disciples bound by covenant and oath, according to the Law of Medicine.
>
> The regimen I adopt shall be for the benefit of my patients according to my ability and judgment, and not for their hurt or for any wrong. I will give no deadly drug to any, though it be asked of me, nor will I counsel such, and especially I will not aid a woman to procure abortion. Whatsoever house I enter, there will I go for the benefit of the sick, refraining from all wrongdoing or corruption, and especially from any act of seduction, of male or female, of bond or free. Whatsoever things I see or hear concerning the life of men, in my attendance on the sick or even apart therefrom, which ought not to be noised abroad, I will keep silence thereon, counting such things to be as sacred secrets.

The treatise of the *Hippocratic Collection On wounds of the head* has always drawn attention as bespeaking especial ingenuity and experience. The description of trephining is of peculiar interest, because the practice was known in prehistoric times, and is still found among savage and semi-civilized peoples. (*See* MEDICINE: *Prescientific.*) The process recommended for cases of fracture of the skull and injury to the underlying structures resembles, in many details, the modern surgical procedure. Another important surgical treatise of the *Collection* is that *On Fractures and Dislocations.*

In the *Hippocratic Collection* the physician attends cases of every type. He is no "specialist." But the mass of his practice lay with cases to which instrumental treatment was inapplicable. In these he tended to adopt the "expectant" line of treatment. Realizing that the tendency of the body is to recover, he contented himself with "waiting on nature." This does not imply that he was helpless, for much could be done by nursing, regimen and diet to aid the patient in that conflict which he alone must fight. For the conduct of that great battle wise and useful directions are recorded. But believing in *the healing power of nature*—the phrase is characteristically Hippocratic—the physician was not eager to administer drugs.

The Hippocratic Writings.—The *Aphorisms* is the most famous book with which the name of Hippocrates is linked, and it is as likely as any of the *Collection* to be by Hippocrates himself. It consists of a series of very brief generalizations. Many have been confirmed by the experience of later ages. Some have become popular proverbs. The style suggests an aged physician reflecting on the experience of a lifetime. A few extracts will give a good idea of the book.

> Life is short and Art is long; the Crisis is fleeting, Experiment risky, Decision difficult. Not only must the physician be ready to do his duty, but the patient, the attendants, and external circumstances must conduce to the cure.
>
> Old persons bear fasting most easily, next adults, and young people yet less; least of all children, and of these least again those who are particularly lively.
>
> When sleep puts an end to delirium, it is a good sign.
>
> Weariness without cause indicates disease.
>
> To eat heartily after a long illness without putting on flesh is a bad portent.
>
> Food or drink slightly inferior in itself, but more pleasant, should be preferred to that better itself, but less pleasant.
>
> The old have fewer illnesses than the young, but if any become chronic with them, they generally carry it with them to the grave.
>
> Convulsions supervening on a wound are deadly.
>
> Phthisis comes on mostly from 18 to 35 years of age.
>
> Apoplexy is commonest between the ages of 40 and 60.
>
> If you give the same nutrient to a patient in a fever and to a person in health, the patient's disease is aggravated by what adds strength to the healthy man.

The chief clinical achievement of the *Hippocratic Collection* lies in the descriptions of actual cases. These are not only without parallel during nearly 2,000 years, but are models of what succinct clinical records should be. They are clear and short, give all the leading features and yet show no attempt to prejudge the importance of any particular feature. It is a reflex of the spirit of honesty in which the Hippocratic physicians worked that in the majority of the cases they record that death ensued.

Immense importance is attached by the Hippocratic writings to the art of "Prognosis," that is of predicting the course which the disease will take. The work to which the title *Prognostics* is attached represents a very lofty standard of practice. Very famous is the description in it of the signs of impending death to which the name of *Hippocratic facies* has become commonly attached. It is imitated by Shakespeare in his description of the death of Falstaff in *Henry V.*:

> You should observe thus in acute diseases; first the countenance of

the patient, if it be like those of persons in health, and especially if it be like itself, for this is best of all. But the opposite are the worst; such as these—a sharp nose; hollow eyes; collapsed temples; the ears cold, contracted, and their lobes turned out; the skin about the forehead rough, stretched and parched; the colour of the face greenish, dusky livid or leaden. If the countenance be such at the beginning of the disease, and if this cannot be accounted for by the symptoms, and if the symptoms do not subside in a day and a night, be it known for certain that the end is at hand.

In the 4th century B.C. medicine emerges as a definite part of the scientific consciousness. During that century there lived and worked one whose thought has stamped itself on the whole subsequent course of the biological and medical sciences. Aristotle (384–322 B.C.) (*q.v.*) was the great codifier of ancient science.

Aristotle.—The views of Aristotle have had a vast influence in determining the direction of medical thought. For more than 2,000 years Aristotelian philosophy, in more or less corrupted form, constituted the main intellectual food of mankind. Without some knowledge of the biological verdicts of Aristotle, it is impossible to understand the course subsequently taken by rational medicine. The influence of Aristotle is specially evident in certain basic biological conceptions. (*See* BIOLOGY: *History*.) There is one aspect of Aristotelian science, however, to which we must specially refer. Aristotle, following more ancient writers, held that there were four primary and opposite fundamental qualities—the *hot* and the *cold*, the *wet* and the *dry*. These met in binary combination to constitute the four essences of existences which enter in varying proportions into the constitution of all matter. The four essences, or to give them their usual name, elements, were earth, air, fire and water. Thus, water was wet and cold, fire hot and dry, and so forth. With this theory later writers combined the somewhat similar Hippocratic doctrine which held that the body was composed of the four "humours" or liquids: blood, phlegm, black bile (melancholy), and yellow bile (choler). Excess or defect of one or other humour gave rise to disease. Hence the so-called "humoral pathology" and the doctrine of the "temperaments" or proportional mixing of the humours which still has its analogues in modern medicine.

The Alexandrian School.—Soon after the death of Aristotle in 322 B.C., a great medical school was founded at Alexandria. The two earliest medical teachers at that school were also the greatest —Herophilus of Chalcedon, who flourished about 300 B.C., and his slightly younger contemporary Erasistratus of Chios. Herophilus may be regarded as the father of anatomy, Erasistratus as the father of physiology.

Herophilus was the first to dissect the human body in public. He recognized the brain as the central organ of the nervous system and the seat of the intelligence. He extended the knowledge of the parts of the brain, certain of which still bear titles translated from those given by him. He was the first to grasp the nature of the nerves, which he distinguished as motor and sensory, though he did not separate them clearly from tendons. He also made the first clear distinction between arteries and veins.

In the Alexandrian period there flourished that view of the structure of the world known as *atomic*. It was associated with the Epicurean philosophy. (*See* EPICURUS.) Atomism had reactions on medicine at Alexandria, where its leading exponent was Erasistratus of Chios.

Erasistratus of Chios.—Erasistratus professed himself a "rationalist," but had nevertheless to invoke the idea of "Nature" as an external power, shaping the ends to which the body acts in order to explain its workings. This is in contrast with Aristotle's view of the "soul" as an *entelechy*, an innate and inherent factor. (*See* ARISTOTLE.) To make physiology intelligible, he added a conception, *Pneumatism*, found also among older thinkers. Pneumatism is the belief that life is associated with a subtle vapour, a *pneuma* or spirit, which permeates the organism and causes its movements. This vapour is held to have some affinities with the air we breathe. Pneumatism is, in fact, primarily an attempt to explain the phenomena of respiration; it passes on to attempt the explanation of the nature of life and, indeed, of all existence. It is a theory of great historical importance.

Erasistratus observed that every organ is formed of a threefold system of "vessels," veins, arteries and nerves, dividing indefinitely. These, plaited together, he believed, make up the tissues. Blood and two kinds of pneuma are the essential sources of nourishment and movement. The blood is carried by veins. Air is taken in by the lungs and passes to the heart, where it becomes changed into a peculiar pneuma, the vital spirit, which is sent to the various parts of the body by the arteries. It is carried to the brain, and there further changed to a second kind of pneuma, the animal spirit. This in turn is conveyed to the parts of the body by the nerves. It is the prime cause of movement.

In the brain Erasistratus observed the convolutions, noted that they were more elaborate in man than in animals, and associated this complexity with higher intelligence. He distinguished between cerebrum and cerebellum, described the cerebral ventricles and considered that they were filled with *animal spirit*. He had a clear view of the action of muscles in producing movement and regarded their shortenings as due to distension by *animal spirit*.

Erasistratus regarded excess of blood or plethora as the chief cause of disease. Among such diseases are coughing of blood, epilepsy, pneumonia, tonsillitis, etc. Most of these could be treated by diminishing the local supply of blood. In treatment Erasistratus concentrated on plethora, which he treated primarily by starvation. Among his contemporaries blood-letting was habitually applied to almost every condition. Erasistratus employed it rarely, and his successors banned it altogether. He was consistently opposed to violent remedies, among his favourite therapeutic measures being regulated exercise, diet and the vapour bath.

After the first generation, the activity of the Alexandrian medical school flagged. With the absorption of Egypt into the empire, Alexandria ceased to have great scientific importance.

Medicine Under the Roman Empire.—The original native Roman medical system was that of a people of low culture. Its aspect was changed by the advent of Greek science. Yet, notwithstanding the large field that the western empire provided, and the wide acceptance of Greek medicine by the upper classes, it is remarkable that the Latin-speaking peoples produced no eminent physician. At first, medical education at Rome was a private matter. The earliest scientific teacher was the Greek Asclepiades of Bithynia (d. *c.* 40 B.C.) a contemporary of Lucretius and, like him, an Epicurean. Asclepiades ridiculed the Hippocratic attitude of relying on the "healing power of nature" as a mere "meditation on death," and urged active measures that the cure might be "seemly, swift and sure." His school at Rome continued after him. At first it was the mere personal following of the physician, who took pupils and apprentices on his visits.

Later such groups combined to form colleges where problems of the art were debated. As Rome became a centre of medical instruction, subsidiary centres were established in other towns, first in Italy, then in the provinces. These secondary schools produced few whose writings have survived. They were largely training places for the army surgeons. That class seldom had scientific interests, though Dioscorides, one of the most prominent physicians of antiquity, who has deeply influenced the modern pharmacopoeia, served in the army under Nero. (*See* DIOSCORIDES.)

The earliest scientific medical work in Latin is the *De re Medica* of Celsus, prepared about A.D. 30, and in many ways the most readable and well-arranged ancient medical work. It is, however, not original, but a compilation from the Greek. The ethical tone is high and the general line of treatment sensible and humane (*see* CELSUS). An idea of the surgical instruments in use in his time can be obtained from those recovered from Pompeii.

Latin writers on architecture give much attention to the orientation, position and drainage of buildings. Sanitation was from an early date a feature of Roman life. Rome was already provided with *cloacae*, or subterranean sewers in the age of the Tarquins (6th century B.C.). The *Cloaca Maxima* itself, still the main drain of Rome, dates back to that period. The finest monuments to the Roman care for the public health are the 14 great aqueducts which supplied the city with 300,000,000gal. of water daily. No

modern city is better equipped.

Public Medical Service.—Under the early empire a definite public medical service was constituted. Physicians were appointed to the various towns and institutions. The Roman medical system was at its best in connection with the army. There was an adequate supply of military medical attendants who were well organized. The defect of the system was the absence of any elastic scheme for ranking medical officers, and the complete subordination of the medical to the combatant officer.

The greatest contribution of Rome to medicine is the hospital system the organization of which is connected with the military system. It had become the custom to expose sick and worn-out slaves in a temple to Aesculapius on an island of the Tiber. The emperor, Claudius (A.D. 41–54) decreed that if such slaves recovered, they need not return to the control of their masters. Thus, the island became a form of hospital for the sick poor. Later there were established *valetudinaria*, "infirmaries," for such persons. This development early affected military life. At first, sick soldiers on service were sent home for treatment. As the frontiers expanded military hospitals were founded at strategic points. From this the foundation of similar institutions for the imperial officials and their families in the provincial towns was no great step. The idea passed to Christian times, and the pious foundations of the middle ages are traceable to the Roman *valetudinaria*. These mediaeval hospitals for the sick must be distinguished from the even more numerous "spitals" for travellers and pilgrims, which may be traced to the rest-houses along the strategic roads of the Empire.

Galen.—Galen of Pergamum (A.D. 130–200) not only provided the final medical synthesis of antiquity, but also the effective scientific medical knowledge of Europe for 13 centuries. (*See* GALEN.) He developed a very characteristic physiological scheme which remained in vogue until destroyed by the researches of Harvey in the 17th century. It supposes three types of so-called spirits associated with three types of the activity of living things. These were the *natural spirits* formed in the liver and distributed by the veins; the *vital spirits* formed in the heart and distributed by the arteries; and the *animal spirits* formed in the brain and distributed by the nerves. The animal spirits were especially associated with the higher functions of sensation and motion. The scheme presupposed minute pores in the septum of the heart, through which venous blood charged with natural spirits passed from the right ventricle into the left where it became charged with vital spirits. Arterial blood charged with vital spirits became converted to animal spirits in the brain and was thence distributed by the nerves. Galen's system, fanciful as it seems now, was, in fact, an admirable working hypothesis, based on much experimental evidence.

Galen had no effective successor. Mediaeval medicine may be summed up as a corrupted version of Galenism. To some extent a purer tradition was revived for the West by translations of Arabic works. From the point of view of cultural contacts, the history of mediaeval medicine is of great interest, but has little value for the history of scientific medicine. Practical anatomy was revived in the later 13th century, and had an able exponent in the early part of the 14th century in Mondino da Luzzi (d. 1328). The true scientific tradition does not reappear, however, till the 16th century.

II. MODERN MEDICINE

The Dawn of Modern Medicine.—The factors that produced the progressive medicine of the 16th century were excessively complex. Among them were certainly the invention of printing, the enlargement of the world by exploration, the revived knowledge of Greek, the questioning that arose through religious differences. All affected medicine along with other studies of the day. There are, however, two factors which affected medicine in a manner different from all other subjects. One of these was the devastation caused by the epidemics of the time. The second was the advent of a school of art which studied the human body in detail and, therefore, demanded a knowledge of human anatomy. The main exponent of this method on the scientific as well as on the artistic side was *Leonardo da Vinci* (1452–1518) (*q.v.*). The modern father of anatomy, Andreas Vesalius (1514–64) was no unworthy successor of Leonardo.

The great anatomical work of Vesalius appeared in 1543. Vesalius initiated a period of exuberant scientific activity at Padua which long remained the centre of scientific medicine in Europe. From him descend a dynasty of important teachers who carried on the Vesalian tradition there. Even more important was the influence that he exerted through his great book. This immediately transformed the practice of surgery. Of that art the leading exponent of the new school was the French surgeon, Ambroise Paré (1517–90).

Internal medicine lagged behind surgery. The anatomical reforms of Vesalius were unaccompanied by any commensurate advance in physiological knowledge, without which there can be no science of internal medicine. The practice of the physicians thus remained largely mediaeval, and the ruling idea was still the old humoral pathology.

Lines of Advance.—There are, however, four respects in which the physician's art improved during the 16th and first half of the 17th centuries.

(1) There was some improvement in the ancient medical texts. More reliable translations, notably of the Hippocratic works, became available. These formed a substitute for the old translations from the Arabic that had been the main source of the knowledge of Hippocrates and Galen in the middle ages.

(2) Exploration and the formation of settlements in new land brought new drugs upon the market. These were often a mixed blessing, for some were useless, others dangerous. Nevertheless several important drugs were introduced, especially from America. Among them were ipecacuanha, quinine and, by no means least tobacco. The last was for long used as a narcotic. Moreover there was a corresponding advance in botany. The beautiful herbals of the time exercised, by the accuracy of their execution an exemplary influence on the development of medical science.

(3) There was advance in the knowledge of infectious disease. A rational theory of infection was set forth in 1546 by Girolamo Fracastoro (1483–1553) (*q.v.*) of Verona. He regarded infection as the passage from the infector to the infected of minute bodies, having the power of multiplication. The conception bears a superficial resemblance to the modern germ theory of disease. An important contribution to the conception of epidemics was also made by the French physician, Guillaume de Baillou (1538–1616) who re-introduced the Hippocratic idea of "epidemic constitution," *i.e.*, that particular seasons and particular years are of their nature subject to particular diseases. The idea was developed by the English physician, Thomas Sydenham (1624–89) (*q.v.*) and still has value.

(4) Fracastoro, de Baillou and Sydenham all made additions to the knowledge of particular infectious conditions; Fracastoro to syphilis and typhus; de Baillou to whooping cough and rheumatism; Sydenham to gout and to measles and many other diseases. Thus arose an exact body of teaching concerning these conditions which was the necessary prelude to the introduction of effective preventive measures at a later date.

The natural history of disease was a subject which Sydenham (*q.v.*) pursued with the greatest vigour and with life-long devotion. None before him had set himself to consider all the actual cases of disease that lay before him as a subject of scientific description and analysis. This was the great achievement of the "English Hippocrates." He set well on its way the conception of infectious conditions as specific entities, a conception which has since been illuminated by the germ theory of disease.

To one infectious disease, syphilis, we must refer more particularly. During the middle ages there had smouldered in various districts an obscure disease known most frequently as *lepra*. Towards the end of the 15th century this disease broke out in epidemic form all over Europe, causing great destruction of life. It received various titles, such as "the pox," "the French disease," "the Spanish disorder." Only tardily was it recognized that it was of venereal origin. In 1530, on the suggestion of Fracastoro, it received the cognomen *syphilis*. From the time of its recognition,

syphilis has been pursued by a portentous mass of confused literature. Alarm, misunderstanding, religious feeling, false modesty, wilful misrepresentation, and the change in type of the disease itself, have all contributed their quota of obscurantism and fable to a naturally difficult subject. Fracastoro did something to bring order out of the confusion.

The Rise of Physiology.—The later 16th and the earlier 17th centuries are marked by great activity in experimental physical science. The manner of working of physical phenomena was reduced to mathematical rules, based on measurement. This had a strong reaction on medicine. The first to apply these principles to medical matters was Sanctorius (1561–1636), a professor at Padua. He described a thermometer—though an extremely defective one—for comparing the temperatures of different persons and an apparatus for comparing pulse rates. He also sought to compare the weight of the body at different times and in different circumstances. In doing this he demonstrated that the body loses weight by mere exposure, a process which he ascribed to "insensible perspiration." He thus laid the foundations of the study of metabolism.

Another important professor was Jerome Fabricius of Aquapendente, who taught at Padua for over 50 years, from 1565 till his death at 82 in 1619. He was the founder of modern embryology and the author of the first illustrated work on that subject. He investigated the valves of the veins and observed that their mouths are always directed towards the heart. He failed to draw any important conclusion from this fact and the real importance of Fabricius is not so much as an investigator, but as a teacher. He was the master of the discoverer of the circulation of the blood, William Harvey (1578–1657) (*q.v.*).

Harvey and Boyle.—Knowledge of the circulation of the blood has been the basis of the whole of modern physiology, and with it of the whole of modern rational medicine. The blood, it was seen, is a carrier always going round and round on the same beat. What it carries, and why, how and where it takes up its loads, and how, where and why it parts with them, are questions the answering of which has been the main task of physiology in the centuries that have followed. As each question has obtained a more rational answer, so medicine has made a step toward becoming a true science. Thus the work of Harvey lies at the back of every important medical advance.

In the second half of the 17th century there were two important scientific movements destined between them to develop yet further the conception of the workings of the body of which Harvey had made a beginning. These were the movement for the microscopical examination or analysis of the tissues (*see* BIOLOGY, HISTORY OF) and the movement from alchemy to chemistry. (*See* CHEMISTRY, HISTORY OF.)

The revelations of the early microscopists showed at once an unexpected complexity of all the parts, and an unexpected resemblance of apparently diverse parts. Thus, the structure of the body came to be subjected to a process that we may call "microscopic analysis." After the first half of the 17th century, few improvements were made in the microscope until modern times, and the progress of microscopic analysis lay dormant. With the advance in the construction of the microscope in the 19th century, the method was taken up again with triumphant results.

During the 16th and the first half of the 17th centuries anatomy and physiology had put on their modern dress. Chemical knowledge, however, remained peculiarly backward. Advances had been made in technical processes, but theoretical chemistry was in the hands of the class of dupes who, since the middle ages, had been seeking the Philosopher's Stone. The old theory of the four elements, earth, air, fire and water formed an ill basis for experiment. The great defect of this ancient view of matter was that it contained no definite conception of the nature of a *pure substance*. The main agent in changing the alchemical to the chemical outlook, was Robert Boyle (1629–91) (*q.v.*). Under him chemical study was freed from the mystic factor and, moreover, loosed from the chains which bound it to medicine, to the disadvantage of both. A fine exponent of this new spirit was John Mayow (1645–79) (*q.v.*) whose short life prevented him from fulfilling all his early promise. He was the first to recognize clearly that there is in the air a substance or principle concerned at once with combustion, respiration, and the conversion of venous into arterial blood. In this sense he was the discoverer of oxygen.

Descartes and Other Theorists.—The great advances in the physical and biological sciences instituted during the 16th and 17th century left the old medical theories derelict. Numerous fresh theories arose. The more important can be classed under the headings iatrophysics, iatrochemistry and vitalism.

The physical discoveries of the time and the demonstrations of Sanctorius, Harvey and others, gave an impetus to the attempt to explain the animal body on mechanical grounds. One of the earliest and most impressive exponents of physiological theory along these lines was the French philosopher, René Descartes (1596–1650) (*q.v.*). His posthumous book *De homine* (1662) is the first modern text-book of physiology. Descartes had no extensive practical knowledge of the subject. On theoretical grounds he sets forth a very complicated model of animal structure. Subsequent investigation failed to confirm his findings. For a time, however, it attracted many followers. A strong point in his theory is the great stress laid upon the nervous system, and on its power of co-ordinating the different bodily activities.

Borelli, Sylvius and Stahl.—More lasting was the achievement of the eminent Italian mathematician, Giovanni Alphonso Borelli (1608–79). Stirred, like Descartes, by the success of the physicists in giving mathematical expression to mechanical events, Borelli attempted to do the same for the animal body. In this he was very successful. That department of physiology which treats of muscular movement on mechanical principles was effectively founded and largely developed by him.

Just as some explained animal activity on a mechanical basis, so others resorted to chemical interpretation. Of these iatrochemists, the most prominent was Franciscus Sylvius (1614–72), noted professor of medicine at Leyden. That progressive university was the seat of the first university laboratory, built at the instigation of Sylvius.

Sylvius devoted much attention to the study of salts and attained to the idea of chemical affinity—an important advance. Well abreast of the anatomical knowledge of his day, and accepting the broader lines of mechanistic advance in biology, such as the circulation of the blood and the mechanics of muscular motion, Sylvius sought to interpret other activities in chemical terms. His position and abilities as a teacher gave his views wide currency and he and his pupils occupy a large part of the field of medical theory until well into the 18th century. By this school almost all forms of vital activity were expressed in terms of "acid and alkali" and of "fermentation." The latter process was assumed to be of a chemical order. The school of Sylvius and its successors added considerably to the knowledge of physiological processes, notably by examining the digestive fluids, such as saliva, gastric juice, and the secretion of the pancreas.

A third school of medical theorists arose under the German chemist and physician, George Ernest Stahl (1660–1734) (*q.v.*). His was that view of the nature of the organism which goes under the term vitalism. Though expressed by him in obscure and mystical language, it is, in effect, a return to the Aristotelian position and a denial of the view of Descartes. To Descartes the animal body was a machine. To Stahl the word machine expressed exactly what the animal body was not. The phenomena characteristic of the living body are, he considered, not governed by physical and chemical laws, but by laws of a wholly different kind, those of the "sensitive soul." The sensitive soul of Stahl is, in its ultimate analysis, similar to the *psyche* of Aristotle. Stahl held that the immediate instruments, the natural slaves of this sensitive soul, were chemical processes.

The language and the theories of the iatrophysicists, the iatrochemists and the vitalists of the 17th and 18th centuries, have long been discarded by men of science in their original form. Nevertheless, they represent three attitudes to the activities of living things which have present and current meaning. Each seems

to present some aspect of truth. Whether some physiological thinker will combine all three aspects into one coherent whole, it is for the future to decide. In this sense the foundations of modern rational medicine may be said to have been laid by Borelli, Sylvius and Stahl.

Boerhaave.—The 18th century dawned with the refreshing breeze of Newtonian philosophy blowing through it. During the previous 200 years there had been an immense amount of new and fruitful research along diverse lines. The new generation was bewildered with the mass and novelty of the material. Thus there is a period of pause and consolidation for the introduction of unitary conceptions into the mass of accumulated material. It was, moreover, a period of consolidation not only of ideas but also of teaching. These tasks at first turned men's minds away from the accumulation of further knowledge. The first half of the 18th century thus exhibits something of a gap in the progress of research. The medical field is largely filled by two great figures, Boerhaave and Haller.

Hermann Boerhaave (1668–1738) was the first great clinical or "bedside" teacher. (*See* BOERHAAVE.) Until the 17th century there was no systematic clinical teaching. The universities gave medical degrees on the basis of a spoken "disputation." No contact with the patient was demanded. The first effective attempt to change this was at Leyden, where clinical teaching was instituted about 1636. Hermann Boerhaave was first appointed as a teacher at Leyden in 1701. At once the medical school attained a reputation which rapidly came to surpass even that of Padua. Boerhaave was a man of wide culture. To him, more than to any other man, we owe the modern method of medical instruction, especially in the English-speaking schools. Through his pupils he was the real founder of the Edinburgh Medical school, and through it of the best medical teaching in the English-speaking countries of the world.

Albrecht von Haller.—The only figure in the 18th century whose influence is comparable to that of Boerhaave is his pupil, the Swiss, Albrecht von Haller (1708–77) one of the most accomplished men of all time. (*See* HALLER, ALBRECHT VON.)

Haller's great *Elements of the Physiology of the Human Body* (1759–66), marks the modernization of the subject of which it treats. He did work on the mechanics of respiration, on the formation of bone, on the development of the embryo, and on the action of the digestive juices. His most permanent contributions, however, are not so much contributions to knowledge as contributions to thought. Notable among these are his conceptions of the nature of living substance and of the action of the nervous system. These are still integral parts of physiological doctrine.

During the 17th century the favourite doctrine of nervous action supposed the existence of a nervous fluid. This, it was held, passed down the nerves to inflate or extend the muscle fibres. Inflation was supposed to shorten the fibres and so the muscle came to contract. An exquisite experiment made by Swammerdam, about 1665 with a nerve-muscle preparation, had, in fact, disproved this, but the experiment remained unpublished till 1736. So the matter stood till Haller's time.

Haller concentrated on an investigation of the muscle fibres. A muscle-fibre, he pointed out, had in itself a tendency to shorten with any stimulus, and afterwards to expand again to its normal length. This capacity for contraction, Haller, following a predecessor, called *irritability*. He recognized the existence of "irritability" as an element in the movement of the viscera, and notably of the heart and of the intestines. The feature of "irritability" is that a very slight stimulus produces a movement altogether out of proportion to itself, and continues to do this repeatedly so long as the fibre remains alive.

But besides the force inherent in a muscle-fibre, Haller showed that there was another force which comes to it from without, is carried from the central nervous system by the nerves and is the power by which muscles are normally called into action. This force, like that of irritability, is independent of the will, and like it can be called into action after the death of the animal. Haller thus distinguished the inherent muscular force from the extrinsic nerve force.

Haller next turned to consider sensation. He showed that the tissues are not, in themselves, capable of sensation, but that the nerves are the sole channels or instruments of this process. He showed how all the nerves are gathered together into the brain, and believed that they tended to its central part. Throughout his discussion Haller never falters in his display of the rational spirit. He develops no mystical or obscure themes, and although his view of the nature of soul may lack clarity, he separates such conceptions sharply from those which he is able to deduce from actual experience.

One of the ablest physiologists of the 18th century was an English country parson, the Rev. Stephen Hales (1677–1761). (*See* HALES, REV. STEPHEN.) By temper a biologist, he had received a training in mathematics and physics. With this ideal equipment, he proceeded to investigate the dynamics of the circulation. His method consisted in applying the principle of the pressure gauge or manometer to living things. By tying tubes into the arteries and veins of animals, he measured blood-pressure. He thus laid the foundation of an important mode of studying disease. He computed the circulation rate and estimated the actual velocity of the blood in veins, arteries and capillary vessels. He made a very important contribution by showing that the capillary vessels are liable to constriction and dilatation, a knowledge that has become of primary importance to the practising physician. He began to explore that wonderful mechanism of the heart by which the organ adjusts itself to its needs of output. He exhibited his versatility by important contributions to many other departments as, for instance, his discoveries on respiration, his improvements in ventilation, and his campaign for temperance.

Réaumur, Spallanzani and Prout.—Following up the work of Sylvius and his school some progress was made in the knowledge of the digestive processes. The French naturalist, René Antoine de Réaumur (1683–1757), remembered for his thermometer (1731), made experiments on gastric digestion in birds (1752). He succeeded in obtaining gastric juice in a pure state and was able to demonstrate its power to dissolve food substance in a test-tube kept at body temperature. This was important since many believed that the process was induced mechanically by the muscles of the stomach wall. Réaumur thus gave the deathblow to the iatrophysical conception of digestion.

The investigation of gastric digestion was now pursued by a versatile Italian, the abbé Lazaro Spallanzani (1729–99), who showed that the churning action is an aid, but not an essential to the process of digestion (1782). He proved that digestion was not of the nature of putrefaction and differed essentially from the fermentation of wine. Spallanzani thus improved on the view of Sylvius and took a step towards that solution of the natures of putrefaction, fermentation, and digestion which was finally provided by Pasteur. He showed that the gastric juice was secreted by the stomach itself, and not introduced into it from other organs. He observed that it curdled milk and so began our knowledge of a separate ferment, that contained in rennet. Spallanzani's results showed that gastric juice had a solvent power *sui generis*, and that this was of a different order from putrefaction or vinous fermentation.

This phase of digestive physiology was closed by the English physician, William Prout (1785–1850), who demonstrated in 1823 the existence of free hydrochloric acid in the stomach. He showed that the presence of this acid was necessary for gastric digestion, but that the actual process of solution of food was the work of another agent. The matter was at last brought into the range of medical practice by an American army surgeon, William Beaumont (1785–1853) who, in the ten years ending 1833, had the opportunity to investigate gastric juice in a man who, having been shot in the stomach, had a permanent gastric fistula, through which the gastric juice could be obtained and the living gastric membrane examined at will.

Galvani, Black and Priestley.—A new department of physiology was opened by the extension of the knowledge of electric phenomena to the living body. Luigi Galvani (1737–98)

of Bologna, while investigating the susceptibility of nerves to irritation, showed that nervous action could be induced by electrical phenomena (1791). He was, as a matter of fact, producing an electrical current. Many thought at the time that a new kind of electricity of specially animal origin had been produced and they called it "galvanism." Alessandro Volta (1745–1827) of Pavia, deviser of the "Voltaic pile" was able to demonstrate (1800) that galvanism is without any essential animal relationship and that a muscle can be thrown into continuous contraction by repeating electric stimulations. Humbug and misunderstanding in connection with the electrical relations of living tissues were rife, and it was not till after the period we are now considering that electricity came to take a place in rational medicine. The change came with E. du Bois Reymond (1818–96) from 1843 onwards.

During the second half of the 18th century, important advances were made in the knowledge of respiration on the basis of the work of the Scottish chemist, Joseph Black (1728–99). Black was aware that chalk, when heated, is transformed into quicklime, thereby losing its power of effervescing with acids but gaining the power of absorbing water. As expressed to-day the changes are:

$$(1)\ CaCO_3 = CaO + CO_2$$
$$(2)\ CaO + H_2O = Ca(OH)_2.$$

The first achievement of Black was to show that in the process of heating to quicklime the chalk lost weight. This was a blow at the phlogiston theory, for it had been supposed that quicklime consisted of chalk *plus* phlogiston. Black now showed that if slaked lime $Ca(OH)_2$ be treated with a mild alkali, such as carbonate of sodium, it changes back to the state in which it was before heating, in fact into chalk, while the mild alkali is converted into a caustic alkali. As we now express it:

$$(3)\ Ca(OH)_2 + Na_2CO_3 = CaCO_3 + 2NaOH.$$

Black's triumph consisted essentially in showing that reactions (1) and (3) were indefinitely reversible and that the same amount of $CaCO_3$ could always be extracted from (3) as was put into (1). The substance given off by the chalk in (1) and absorbed by it in (3) he named "fixed air." We now call it *carbon dioxide*. The conversion of caustic lime into ordinary chalk by exposure, $CaO + CO_2 = CaCO_3$, proved this "fixed air" to be a normal constituent of the atmosphere.

The next advance in the knowledge of the air was made by the English Unitarian divine, Joseph Priestley (1733–1804). He showed that growing green plants would make respired air again respirable, and that they gave off a respirable gas. In 1774 he actually prepared oxygen by heating certain oxides, but was still hampered by the phlogiston theory. The real passage to the modern point of view was made by the French chemist, Lavoisier (1743–94). By quantitative investigation of the changes during breathing, burning and calcination, he discovered the true composition of respired air, and showed how both carbon dioxide and water are normal products of breathing. The modern physiological study of respiration dates from Lavoisier.

Morbid Anatomy and Clinical Medicine.—During the earlier 18th century there were published several accounts of groups of cases of post-mortem appearances connected with particular diseases. Boerhaave regularly attended post-mortem examinations. No general pathological principles were elicited. The theories of disease were still mainly speculative. This gap was bridged by Giovanni Battista Morgagni (1682–1771). He was professor at Padua for 56 years and during this time performed an enormous number of post-mortem examinations. In his 79th year, there emerged from his vast experience his work *On the Seats and Causes of Disease*. Its leading feature is the way in which actual cases are recorded. The life history of the patient, the history of his disease, the events in connection with his final illness and manner of death are all recounted with care. The condition of the organs at the post-mortem examination is minutely described and an attempt made to explain the symptoms as the result of the lesions. Morgagni introduced the "anatomical concept" into the study of disease. It is the main element in modern diagnosis.

The work of Morgagni was worthily continued by the Scot, Matthew Baillie (1761–1823), a successful London practitioner, who followed a convenient method in arranging his work by organs instead of symptoms, as Morgagni had done. The task of naked eye pathological anatomy, effectively begun by Morgagni, was effectively completed by Karl Rokitansky of Vienna (1804–78).

The great teachers of the earlier 18th century, though better equipped as regards knowledge than their predecessors, had hardly any better apparatus for diagnosis than the ancients. The first efficient clinical instrument of precision to merit clinical adoption was the "pulse watch." Sir John Floyer (1649–1734), an English provincial physician, introduced in 1707 an instrument constructed to go for just one minute. Attempts were also made to introduce a thermometer into practice, but the construction of suitable instruments proved impossible. Both these ideas gained final admission to practice during the 19th century.

Two clinical advances of first-class importance, the methods of percussion and auscultation were, however, introduced during the later 18th and early 19th centuries.

Percussion is of great value to the physician as a means of outlining the position of internal organs, especially those of the chest. It was invented (1761) by Leopold Auenbrugger (1722–1809), a Viennese physician. Like the thermometer, it was slow in entering practice.

Even more important than the introduction of percussion was the invention and adaptation of the stethoscope by the Breton physician, R. T. H. Laënnec (1781–1826). (*See* LAËNNEC.) Laënnec's instrument was first described by him in 1819. It was of the uni-tubular type, and at first a mere roll of paper.

Surgery and Obstetrics.—During the 18th century few new principles were introduced into surgery. Nevertheless the improvements in normal and pathological anatomy had their effects in surgical technique, so that operations could be performed that had seldom before been attempted. Even the greatest surgeon of the century, John Hunter (1728–93) (*q.v.*) introduced no fundamental new surgical principles. The main clinical improvements of the century, apart from operative technique, were probably those connected with the treatment of syphilis and the treatment of women in labour.

Syphilis, as has been already indicated, had existed in Europe in the later middle ages, but was then confused with leprosy and other conditions. Its treatment by mercury was practised at least as early as the 15th century, as an inheritance from the Arabian physicians. During the 16th and 17th centuries, various other remedies were tried. In the 18th century the experience of generations returned again to mercury.

The second advance was in the treatment and care of women in labour. Scientific obstetric works were produced, especially in France, in the second half of the 17th century. The obstetric forceps, for long a family secret, became widely known in the 18th century. For long there was great objection by pregnant women to treatment by medical men. The midwives were mostly ignorant, dirty and unskilful, and the resulting loss of life enormous. The objection to the "man midwife" was only gradually overcome, but his advent was attended by a great fall in maternal mortality. One of the ablest and most successful of the obstetric physicians was William Hunter (1718–83) (*q.v.*), the brother of John Hunter. Numerous lying-in hospitals were founded in England and elsewhere in his time.

John Hunter.—A new spirit was introduced into surgery by John Hunter. As an investigator his powers were superb, but he was handicapped at every turn by literary incoherence. Nevertheless, with him surgery begins to appear at last as a real science, and not as a mere applied art. Hunter brought to bear on the subject a mind stored with ideas drawn from comparative anatomy and pathology.

Technical advances are connected with Hunter's name, but his real scientific importance is as a pioneer in the making and ordering of museums. His monument is the Hunterian museum in London, based on his specimens of which many still survive. Natural history museums, as now constituted in all civilized

countries, have been influenced, if they have not been derived, from that which he literally gave his life's blood to found.

Beginning of Vital Statistics.—The mathematical manner of the presenting of collective medical data was first appreciated by the versatile English physician and inventor, Sir William Petty (1623–87) (*see* PETTY), the "father of Political Economy." In 1662 and on many subsequent occasions he joined a friend, John Graunt, in issuing *Natural and Political Observations upon the Bills of Mortality* of London. He endeavoured to deduce population, death-rates, disease prevalence and other matters of vital statistics from the crude figures of the day.

In 1761, a Prussian clergyman, J. P. Süssmilch (1707–82), produced a theological work, *The Divine Ordinance manifested in the Human Race through Birth, Death and Propagation.* Its object was to exhibit God's design in the constant numerical relationships of vital statistics. The work is of great historic and scientific importance. It was based upon a vast mass of statistics and showed significant advance in method. From the time of its publication, statistical studies advanced rapidly.

Statistical science was placed on a firm foundation by the Belgian astronomer, Lambert Quetelet (1796–1874). His principal work, *On Man and on the Development of his Faculties, an Essay on Social Physics,* contains his statistical researches on the development of the physical and intellectual qualities of man and on the "average man" both physically and intellectually considered. In his treatise of 1848 *On the Social System and the Laws which govern it,* he shows how the numbers representing the individual qualities of man may be grouped round the numbers referring to the average man in a way corresponding to the principles of the theory of probabilities.

Military, Naval and Prison Medicine.—During the 18th century the only sick of whom statistics were available were soldiers, sailors and prisoners. Thus the most important movements in preventive medicine, both in England and elsewhere, were initiated by naval and military surgeons.

The experience and position as chief medical officer of the British army of Sir John Pringle (1707–82) enabled him to get many of his reforms generally accepted. He was among the first to see the importance of ordinary putrefactive processes in the production of disease, and quite the first to apply these principles in hospitals and camps. He identified the deadly "gaol fever" or typhus with "hospital fever," and laid down rules for the hygiene of camps.

The Scottish physician, James Lind (1716–94) had a long naval experience. In an important work on scurvy (1753), then a very common and fatal disease at sea, he demonstrated how it might be prevented by fresh fruit or lemon juice. Fresh water had always been difficult to obtain on sea voyages. Lind arranged for sea water to be distilled for the purpose. He introduced rules for the prevention of typhus on ships, and made great improvements in naval hygiene. His essay of 1757, *On the most effectual means of preserving the Health of Seamen,* is very important. He also wrote an *Essay on Diseases of Europeans in Hot Climates,* which opened the campaign for the conquest of the tropics for the white man. Captain James Cook (1728–79), the explorer, adopted Lind's principles and established a record in a voyage to the South Seas.

Public Health Improvements.—The advent of the new system of labour in the 18th century had important reactions on public health. The system began and has been most pronounced in England, but it has now spread to all civilized countries. With the growth of towns and increased population there was an increased demand for food. The country became better cultivated and better drained, and there were many improvements in agriculture. Certain diseases began to diminish, and notably malaria, essentially a disease of undrained and ill-cultivated lands.

The improvement of hygienic conditions in the towns began in England soon after the middle of the 18th century. Westminster obtained an Improvement Act in 1762, Birmingham in 1765, the City of London in 1766, Manchester in 1776, and most of the other provincial towns soon followed. As a result of such acts noisome streams, which were but open drains, were covered in, streets were paved and lighted, and sewers improved. There were still many glaring defects of sanitation, including much which would horrify us now.

The improvement of such conditions as these could only be made by state action. This was clearly perceived by the social philosopher, Jeremy Bentham (1748–1832) (*q.v.*). The efficient agents in convincing the public that factors which influence the health of the country must be the concern of the legislature were two disciples of Bentham, the 19th-century reformers, Thomas Southwood Smith (1788–1861) (*q.v.*) and Edwin Chadwick (1800–90) (*q.v.*).

Rise of Hospitals.—An important hospital and dispensary movement arose about the middle of the 18th century. Many great hospitals both in England and in Continental countries were then either founded or rebuilt. The London hospital was rebuilt in 1752; St. Bartholomew's in 1730–53. Between 1700 and 1825 no fewer than 154 hospitals and dispensaries were founded in the British Isles. Though defective from the modern point of view, yet under the influence of the sanitarians, such as Hales, Pringle and Lind, these were far better equipped and better ventilated than institutions constructed at the beginning of the 18th century. The industrious Howard gives a very complete picture of them, and one that is more favourable than might have been expected. The main defect was the nursing. This was better in the lying-in hospitals, where the services of a higher type of woman were available, and where ladies served on the management. The general state of the hospitals remained almost stationary from the mid-18th century until transformed by the changes in surgery and nursing in the second half of the 19th century.

Inoculation and Vaccination.—During the 18th century smallpox was never absent from this country. From time to time the disease became epidemic. The outbreaks, often grave and fatal, varied greatly in virulence. Infection with a mild form would lead to protection from a graver. In the East a method of direct inoculation of the disease from a patient suffering from a slight attack was widely in vogue from an early date. The practice attracted little attention in Europe until Lady Mary Wortley Montagu (1689–1762) studied it at Constantinople. It was then soon taken up in England, and became recognized on the Continent.

The efforts of Lady Mary were reflected on the other side of the Atlantic. The Puritan leaders, Increase Mather (1639–1723) (*q.v.*) and Cotton Mather (1663–1728) (*q.v.*), turning from their exploits against witches, ardently urged the operation. In England the learned Dr. Richard Mead (1673–1754) (*q.v.*), who exercised very great influence on the medical world in his day, published in 1747 a work in which he supported the practice. It spread widely and rapidly. The operation was largely in the hands of specialists who were not always medical men.

Such was the state of affairs when the country practitioner, Edward Jenner (1749–1823) (*q.v.*), came upon the scene. In 1796 he demonstrated that the condition known as cowpox or *vaccinia* gave immunity to smallpox. From that time "vaccination" with cowpox has taken the place of the old method of inoculating with smallpox.

The discovery of vaccination is a mere trifle compared to the train of new work and new thought that was ultimately opened by the study of immunity to disease of which that established by vaccination is a special instance. The work of Pasteur, Lister and Koch, and the main part of the modern therapeutical movement, are based on the study of the type of phenomena to which Jenner drew attention.

General Tendencies of Modern Medicine.—During the 19th century medicine has developed along lines which separate it from that of the previous period. On the one hand there has been an ever-increasing tendency to adopt into medicine methods and knowledge derived from the special sciences. On the other hand there has been no less marked a tendency for medical practice and tradition to split up into discrete departments or so-called "specialities." These tendencies have brought unquestionable drawbacks along with manifest and admitted gains. It has become more and more difficult to survey the field as a whole,

not so much because of increase of knowledge—this is a difficulty countered by improved methods of bibliography and abstraction—as because of the artificial divisions and distinctions between the various departments. Moreover, regarded from the point of view of the medical man, it has become more difficult for the specialist to consider the condition of the patient apart from the diseased organ on which he is concentrating. Thus, that precious and indefinable quality of judgment has become doubly valuable to the practitioner of medicine in circumstances which render its exercise more difficult.

The system of medical specialization so characteristic of our age, though begun in England, spread to the Continent and affected no school more profoundly than that at Vienna. This seat of learning was long the main place of pilgrimage for English-speaking medical men who desired to continue their studies abroad. The high development of specialism at Vienna, which began soon after the middle of the 19th century, reacted in its turn on the English schools. This specialism has tended to take on a peculiar form in England, owing to the fact that the profession of medicine there has remained almost entirely unendowed. In England even the most scientific exponents of medicine have, till quite recently, always been forced to make their livelihood in practice. In medicine the existence of a specialty has thus often depended not so much on the direction and extent in the acquisition of new knowledge, as on the increasing demand for a very high degree of technical manipulative skill.

Moreover, the medicine of the 19th century, in so far as it is more scientific, differs from that of the older period in that it is more clearly founded upon physiological investigation. Thus physiology has become the natural introduction to medical study, as has been recognized in the medical curriculum. Therefore, to render intelligible any discussion of the medical thought of the last century, it is necessary to examine the physiological developments which have influenced that thought most deeply.

Morphology and Physiology.—The general character of physiological development during the modern period may be described as "synthetic." The study has become synthetic because physiologists have come to study organs, not so much in and for themselves as in relation to other organs. This increasing synthetic tendency has, to some extent, mitigated the evils of increasing scientific specialization.

By the beginning of the 19th century the knowledge of the naked eye structure of the human body had been pushed well nigh as far as possible. Subsequent progress, in so far as it has taken the direction of morphology, the pure study of form, has been in the departments, firstly, of comparative anatomy, in which the leading figure was that of Georges Cuvier (1769–1832) (*q.v.*) in France, followed by Richard Owen (1804–92) (*q.v.*) and Thomas Henry Huxley (1825–95) (*q.v.*) in England, by Karl Gegenbaur (1826–1903) (*q.v.*) in Germany, and by E. D. Cope (1840–97) in America; secondly, of development or embryology, a movement which was led by Karl Ernst von Baer (1792–1876) (*q.v.*) and Wilhelm His (1831–1904) in Germany, Francis Maitland Balfour (1851–82) (*q.v.*) in England, and C. S. Minot (1852–1914) in America. The general character of the work of these men is considered under separate articles. (*See* COMPARATIVE ANATOMY and EMBRYOLOGY.)

Far more important in its effect on medicine than the morphological movement has been the great impulse given to physiological progress by a series of very great teachers. Most of the more prominent of these in the earlier part of the modern period were Germans. France has taken a secondary place with the isolated but superb genius of Claude Bernard. The English-speaking world did not come to occupy an important position in the history of modern physiology until the last quarter of the 19th century, though at an earlier period she produced Sir Charles Bell (1774–1842) (*q.v.*) and Marshall Hall (1790–1857). Since the latter part of the 19th century England has come to occupy the main field with Michael Foster (1836–1907), Gaskell (1849–1914), Schäfer (1850–), Gowland Hopkins (1861–), Sherrington (1861–), Bayliss (1863–1924) and Starling (1866–1927).

Müller, Liebig, Ludwig and Bernard.—The foundations of German physiology were laid by Johannes Müller (1801–58) (*q.v.*), Justus von Liebig (1803–73) (*q.v.*) and Karl Ludwig (1816–95) (*q.v.*). These three men may be regarded as typifying the application of the comparative, the chemical and the physical methods to physiological investigation. They were all great teachers, and the course of modern physiology as a separate science and discipline has been their work through their numerous pupils. Claude Bernard (1813–78) (*q.v.*), perhaps more brilliant than any of them, has exerted his influence rather through his writings than personally.

Müller's text-book of physiology, which began to appear in 1834, marks the starting-point of physiology as a normal introduction to medicine. Not only did Müller's work sum up all the knowledge of the day, but it brought before the reader many new points of view. Foremost of these was the "Law of Specific Nerve Energies," according to which each sense nerve, however stimulated, gives rise to the particular sensation that is associated with it and to no other, and conversely the same stimulus, applied to different sense organs, produces a sensation which accords with the organ stimulated. Thus, sensation is a specific attribute. This implies that the things of the external world are not, in themselves, discernible by us, but are known only by the way they act on the senses, acting in different ways on different senses. This conclusion is not only of physiological importance but is fundamental for our view of the validity of scientific method itself.

Justus von Liebig, of Giessen, was and long remained the dictator of the chemical view of life. He did more than any other man to introduce laboratory teaching into medicine. The many scientific advances that he initiated are considered under his name, but we may note, first, his method for detecting and measuring urea, a substance regularly formed in the course of the bodily processes; secondly, his introduction, along with his colleague Wöhler (1800–82), of the conception of the "radicle" as a chemical group capable of forming an unchanging constituent through a series of compounds; thirdly, his doctrine that animal heat is the result of combustion and is not "innate"; and fourthly, his teaching that plants derive their carbon and nitrogen from the carbon dioxide and ammonia in the atmosphere, and that these compounds are returned to the atmosphere by the plants in the process of putrefaction, thus producing a sort of circulation in nature.

Claude Bernard, the greatest physiological experimenter that has ever lived, did more than any other physiologist to create the view of the body as a machine in which all the parts are interdependent. In the course of his researches on the action of the liver, he showed that the body could build up very complex chemical substances as well as break them down. He did pioneer work in elucidating the digestive functions, and in explaining the regulation of the blood supply.

Karl Ludwig, who had more pupils than any other of the great physiologists, published most of his work in their names. He was very ingenious as a deviser of physical apparatus, and was very well equipped in physics and chemistry. He was responsible for introducing graphic methods into science in general, and into physiology in particular. In doing this he was particularly fortunate in adapting the device of the kymograph, which had been originally introduced by Thomas Young in 1807. Ludwig applied himself to every branch of physiology. He was a mechanist and he is important in this connection because of his success in showing that glandular activity can be brought under the law of conservation of energy.

Investigation of the Nervous System.—Important fundamental work in physiology was done by Charles Bell (1774–1842) (*q.v.*) and Marshall Hall (1790–1857) (*q.v.*). Bell demonstrated the specific sensory (afferent) character of the dorsal spinal roots and the motor (efferent) character of the ventral spinal roots, a fact which forms the basis of the physiology of the nervous system. Marshall Hall established (1833) the difference between volitional action and unconscious reflex, and, indeed, effectively introduced the conception of reflex action to the scientific world. Since Hall's time there has been a great

extension of the conception of reflexes. The nervous system (*q.v.*) is integrated under higher and higher centres, till at last the highest centres of the brain are reached. A knowledge of this mechanism is essential for the theory and practice of medicine.

In connection with this process of integration comes the important question of the localization of the functions of the brain. This idea was developed in the first third of the 19th century by the Viennese workers, Franz Joseph Gall (1757–1828) and Johan Caspar Spurzheim (1776–1832) who ultimately developed into phrenological quacks. Later a number of observers—Paul Broca (1824–80) (*q.v.*), Hughlings Jackson (1834–1911) (*q.v.*) and David Ferrier (1843–1928) (*q.v.*) among them—studied the parts of the cortex specially connected with movement. Many operations previously regarded as involving complex mental processes, such as speech, reading, writing, drawing, etc., have been represented as depending on simple nervous relationships. Centres for the initiation of these operations have been described. Of late there has been reaction from this mechanical conception of the brain as an organ of the mind, especially under the leadership of Henry Head (b. 1861). The older school has, however, achieved striking clinical successes, especially at the hands of Jean Marie Charcot (1825–93) (*q.v.*) and his school. (*See* BRAIN: NEUROPATHOLOGY.)

Cellular Pathology.—The doctrine of the essential cellular nature of living things had been established by 1840. (*See* BIOLOGY: *History*.) Soon the conception of protoplasm as the physical basis of life, and the general structure of the cell, including the nucleus as an essential structure, came into clear view. The study of tissues—histology—was raised to the status of an independent science by the Swiss, Albrecht von Kölliker (1817–1905) (*q.v.*), a pupil of Johannes Müller (*q.v.*). Kölliker wrote the first textbook of histology in 1850.

A very important influence on medical thought was that of Rudolf Virchow (1821–1902) (*q.v.*). His great achievement was the extension of the cell theory into the analysis of diseased tissues. In his work *Cellular Pathology*, first published in 1858, he analysed diseased tissues from the point of view of cell formation and cell structure. Important sections of the science of cellular pathology were explored so well by Virchow that they have been little extended by his successors. He initiated the familiar idea that the body may be regarded as a "cell state in which every cell is a citizen." Disease is often but civil war. The white blood corpuscles, which have the power of engulfing and rendering innocuous bacteria and other foreign bodies, have been compared to police or scavengers. Some of these ideas had been adumbrated by A. V. Waller (1816–70) and were further developed by the Russian biologist working in Paris, Elie Metschnikoff (1845–1916) and by the English worker, Almroth Wright (b. 1861).

Since Kölliker and Virchow, the study of the intimate structure and workings of the cells themselves, as distinct from the tissues, has become a separate science, *cytology* (*q.v.*), which has been further extended to the study of cells in disease *cyto-pathology*. Among the major developments of *cyto-pathology* is the study of abnormal new growths, among which cancer (*q.v.*) takes a leading place. Apart from these special developments, there has been an extensive and intensive exploration of the microscopic appearances of diseased organs. This exploration has been illuminated by our knowledge of the nature and action of the micro-organisms of disease, and has been guided by experimental methods of producing disease in animals, a procedure which has become of increasingly greater importance since the days of Pasteur and Koch.

From this period, synchronous with the rise of bacteriology, we must leave the history of medicine which, from now onwards, passes within the range of special articles on various medical subjects to which the reader is referred.

BIBLIOGRAPHY.—General: *Mitteilungen z. Geschichte d. Medizin u. d. Naturwissenschaften* from 1902; *Isis* from 1913; F. H. Garrison, *Introduction to the History of Medicine* (1928); C. Singer, *Short History of Medicine* (1928).

Ancient Medicine: C. Singer, *Greek Medicine and Greek Biology* (1921); G. Sarton, *Introduction to the History of Science* (1927); W. H. S. Jones and E. T. Withington, *Hippocrates with an English Translation* (1922–28).

Mediaeval Medicine: M. Neuburger, *History of Medicine* (1916–21); C. Singer, *From Magic to Science* (1928); *Fasciculo di Medicina* (1925).

Special Departments of Medicine: C. Singer, *Evolution of Anatomy* and *Discovery of the Circulation of the Blood* (1922); M. Foster, *History of Physiology* (1901); M. Neuburger, *Die historische Entwicklung d. exp. Gehirn u. Rückenmarksphysiologie* (1897); E. Gurlt, *Geschichte d. Chirurgie* (1898); P. Lecène, *L'Evolution de la chirurgie* (1923); H Fasbender, *Geschichte d. Geburtshilfe* (1906); H. Schelenz, *Geschichte d. Pharmazie* (1904); J. Hirschberg, *Geschichte d. Augenheilkunde* (1908–18). (C. SI.)

MEDINA, JOSÉ TORIBIO (1852–), scholar, author and bibliographer, was born in Santiago de Chile on Oct. 21, 1852. After an excellent education, he received his degree of advocate at the university in Santiago in 1873, but such time as he could spare from the practice of his profession he consistently gave to literature and the study of American history. In 1875 he was appointed first secretary of legation in Lima, went to the United States in the following year and spent the next two years travelling in the United States and Europe, where he made a careful study of documents relating to the history of Chile. Shortly after his return to Chile he made a dangerous journey into Araucania in 1879 to gather materials for a work on *Los Aborígenes de Chile*, to be the first volume of a complete history of Chile which he had projected. In 1881, upon the conclusion of the War of the Pacific, in which he served as auditor of the reserves in Tarapacá, he went to Spain as first secretary of the newly established legation in Madrid where he was able to make extensive researches into the archives of the Indies in Seville and Simancas. When he returned to Chile in 1886 he set up his own printing press, from which and its successors he sent out a great number of books. In addition to his own works, Medina has edited numerous others relating to the whole range of discovery, exploration, history and geography in all the Americas, particularly Chile.

His labours in the entire field of Hispanic-American bibliography have been stupendous, a list of his works would exceed 300 titles, among them: *Historia de la literatura colonial en Chile* (1878); *Biblioteca americana* (1888); *Colección de documentos* (30 vol. 1888); *Historiadores de Chile* (33 vol.); *Biblioteca hispano-americana* (1898–1907); *Los Tribunales del Santo Oficio en América; La imprenta en Río de la Plata* (1892), *en Santiago de Chile* (1891), *en Lima* (1904–07), *en México* (1907–12); *La Araucana* (1910), a monumental edition in five folio volumes unlikely ever to be superseded; *El descubrimiento del Océano Pacífico* (1920); *Cervantes en las letras chilenas* (1923).

See W. B. Parker, *Chileans of To-Day* (Santiago de Chile, 1920). (W. B. P.)

MEDINA, or rather **EL-MEDINA** (the city), or MEDINAT RASUL ALLAH (the city of the apostle of God), a town of Arabia, about 820 m. by rail S.S.E. of Damascus, the refuge of Mohammed on his emigration from Mecca, and a renowned place of Muslim pilgrimage, consecrated by the possession of his tomb. The name Medina goes back to the Koran (*sur.* xxxiii. 60); the old name was Yathrib, the Lathrippa of Ptolemy and Iathrippa of Stephanus Byzantius.

Medina stands in a mountain basin on the uptilted western edge of the ancient plateau mass of Arabia. To the west the land falls abruptly to the Red sea coastlands, while southward the plain extends unbroken to the horizon. The most important mountain groups surrounding Medina are Jebel Ohod, the scene of the famous battle (*see* MOHAMMED), Jebel Thowr, Jebel 'Ayr and Jebel Salà. A number of torrent courses descend from the mountains, and converge in the neighbourhood of the town, to unite farther west at a place called Zaghaba, whence they descend to the sea through the "mountains of the Tehama"—the rough country between Medina and its port, Yanbua. The convergence of torrent-courses in the neighbourhood of Medina makes it one of the best-watered spots in northern Arabia. The city lies close to one of the great volcanic centres of the peninsula, which was in violent eruption as late as A.D. 1266. Volcanic activity has tended to confine the underground water, which can be reached at any point of the oasis by sinking deep wells. Nearly all the houses in Medina have their own wells, and good drinking water is supplied to the city from a spring near the village of Kuba, 4 m. to the south. The volcanic soil, although impaired in some places by salt, has given a tradition of fertility to the

city from the days of the Prophet. Thus situated, Medina was originally a city of agriculturists, unlike Mecca, which is a city of merchants. The latter was a haram, or sanctuary, before the time of Mohammed, but Medina became a sanctuary only at the Prophet's command.

We first hear of the oasis held by Jews, among whom emigrants from Yemen afterwards settled. From the time of the emigration of Mohammed (A.D. 622) till the Omayyads removed the seat of empire from Medina to Damascus, the town became prominent as the capital of the new power that so rapidly changed the fate of the East. Its fall was not less rapid and complete, and since the battle of Harra and the sack of the city in 683 it has never regained political importance. (*See* CALIPHATE.) Mohammed invested the country round Medina with an inviolable character like that of the haram round Mecca; but this provision has never been observed with strictness. After the fall of the caliphs, who maintained a governor in Medina, the native amīrs enjoyed a fluctuating measure of independence, interrupted by the aggressions of the sherīfs of Mecca, or controlled by an intermittent Egyptian protectorate. The Turks, after the conquest of Egypt, held Medina for a time with a firmer hand; but their rule grew weak, and was almost nominal long before the Wahhābīs first took the city in 1804. A Turko-Egyptian force re-took it in 1812, and the Turks remained in effective control until the revival of the Wahhābī movement under the Ibn Sa'ud, from 1912 onwards, increased their difficulties. Turkish rule ceased during the World War, and El Husain, the Hashimite king of the Hijaz, revolted against them. He later came into conflict with Ibn Sa'ud. Medina was in the hands of the Hashimite Government up to 1924, when it was besieged for 15 months and ultimately fell to Ibn Sa'ud (*q.v.*).

The city proper is surrounded by a high, strong wall, with towers and nine gates forming an irregular oval running to a kind of angle at the north-west, where stands a fort built by the Turkish Sultan Selîm in A.D. 1532. A second wall, less massive than the inner one, extends from near the Bakiâ cemetery, where 10,000 of the Prophet's companions are said to be buried, to the fort at the north-west end. The space between the outer and inner walls is occupied by various suburbs of the city, and is also a resting place for the desert caravans. The oldest quarter of the city is at the eastern end, that is between the great mosque and Bab el Bakiâ. This is a region of small houses and tortuous streets. The glory of Medina, and the only important building, is the mosque of the Prophet, in the eastern part of the city, a spacious enclosed court between 400 and 500 ft. in length from north to south, and two-thirds as much in breadth. The minarets and the lofty dome above the sacred graves are imposing features; but the circuit is hemmed in by houses or narrow lanes, and is not remarkable, except for the principal gate (Bab es-Salam) at the southern end of the west front, facing the sacred graves, which is richly inlaid with marbles and fine tiles, and adorned with golden inscriptions. This gate leads into a deep portico, with ten rows of pillars, running along the southern wall. Near the farther end of the portico, but not adjoining the walls, is a sort of doorless house or chamber hung with rich curtains, which is supposed to contain the graves of Mohammed, Abu Nekr and Omar. To the north of this is a smaller chamber of the same kind, draped in black, which is said to represent the tomb of Fatima. Both are enclosed with an iron railing, so closely interwoven with brass wire-work that a glimpse of the so-called tombs can only be got through certain apertures, where intercessory prayer is addressed to the Prophet, and pious salutations are paid to the other saints. The portico in front of the railing is paved with marble, and in the eastern part with mosaic, laid with rich carpets; the southern wall is clothed with marble, pierced with windows of good stained glass, and the great railing has a striking aspect; but an air of tawdriness is imparted by the painting of the columns, especially in the space between the tomb and the pulpit, which has received, in accordance with a tradition of the Prophet, the name of the Garden (*rauḍa*), and is decorated with barbaric attempts to carry out this idea in colour. The throng of visitors passing along the south wall from the Bab es-Salam to salute the tombs, is separated from the Garden by an iron railing. Within the court are the well of the Prophet, and some palm trees said to have been planted by Fatima.

The original mosque was a low building of brick, roofed with palm branches, and much smaller than the present structure. The wooden pulpit from which Mohammed preached appears to have stood on the same place with the present pulpit, in the middle of the south portico. The dwelling of the Prophet and the huts of his women adjoined the mosque. Mohammed died in the hut of Ayesha, and was buried where he died; Abu Bekr and Omar were afterwards buried beside him. In A.D. 711 the mosque, which had previously been enlarged by Omar and Othman, was entirely reconstructed on a grander scale, and in Byzantine style, by Greek and Coptic artificers at the command of the caliph Walid, and under the direction of Omar Ibn Abd-al-Aziz. The enlarged plan included the huts above named, which were pulled down. Thus the place of the Prophet's burial was brought within the mosque; but the recorded discontent of the city at this step shows that the feeling which regards the tomb as the great glory of the mosque, and the pilgrimage to it as the most meritorious that can be undertaken, except that to Mecca, was still quite unknown. It is not even certain what was done at this time to mark off the graves. Ibn 'Abd Rabbih, in the beginning of the 10th century (*'Iḳd,* Cairo ed., iii. 366), describes the enclosure as a hexagonal wall, rising within three cubits of the ceiling of the portico, clothed in marble for more than a man's height, and above that height daubed with the unguent called *khalūk*. This may be supplemented from Iṣtakhrī, who calls it a lofty house without a door. That there are no gravestones or visible tombs within is certain from what is recorded of occasions when the place was opened up for repairs. Ibn Jubair (p. 193 *seq.*) and Samhūdī speak of a small casket adorned with silver, fixed in the eastern wall, which was supposed to be opposite the head of the Prophet, while a silver nail in the south wall indicated the point to which the corpse faced, and from which the salutation of the worshippers was to be addressed (Burton misquotes). The smaller chamber of Fatima is comparatively modern. In the time of Ibn Jubair and of Ibn Batuta (unless the latter, as is so often the case, is merely copying his predecessor) there was only a small marble trough north of the rauḍa (or grave) which "is said to be the house of Fatima or her grave, but God only knows." It is more probable that Fatima was burried in the Baḳī, where her tomb was also shown in the 12th century (Ibn Jubair, pp. 198 *seq.*).

The mosque was again extended by the caliph Mahdi (A.D. 781) and was burned down in 1256. Of its appearance before the fire we have two authentic accounts by Ibn 'Abd Rabbih early in the 10th century, and by Ibn Jubair, who visited it in 1184. The old mosque had a much finer and more regular appearance than the present one; the interior walls were richly adorned with marble and mosaic arabesques of trees and the like, and the outer walls with stone marquetry; the pillars of the south portico were in white plaster with gilt capitals, the other pillars were of marble. Ibn 'Abd Rabbih speaks of 18 gates, of which, in Ibn Jubair's time, as at present, all but four were walled up. There were then three minarets. After the fire which took place just at the time of the fall of the caliphate, the mosque long lay in a miserable condition. Its repair was due chiefly to the Egyptian sultans, especially to Kāit Bey, whose restoration after a second fire in 1481 amounted almost to a complete reconstruction. Of the old building nothing seems to have remained but some of the columns and part of the walls. The minarets have also been rebuilt and two new ones added. The great dome above the tomb, the railing round it, and the pulpit, all date from Ḳāit Bey's restoration.

The principal street in the city is the one running from the Egyptian gate to the mosque entrance at Bab es-Salam. It is known as Es Sûk, and is the market street. The vegetable and cattle market are held just outside the inner wall, near the Bâb-esh-Shûna, while the grain market is held lower down, near the Egyptian gate. In 1908 a railway line was completed from Damascus to Medina. This increased considerably the prosperity of the city, and many wealthy residents from Turkish lands came here to live. At the height of the Turkish rule the city had pos-

sibly some 70,000 or more inhabitants, but the unrest in the country since 1912, and particularly the 15 months siege of Medina, had depleted this number to almost 6,000 in 1927. Much of the cultivated land in the neighbourhood of the city has been abandoned for similar reasons. In times of prosperity the volcanic soil among the surrounding hills grew thousands of palms, and beneath their shade were grown cereals, particularly wheat and barley, and also fruits. Many of the fields show evidence of deep digging and removal of the surface soil, so as to utilize the richer soils beneath. The date trade is very important, and has links with Egypt, Syria and India. Medina was at one time a great centre for Mohammedan theological students. About 3 m. from the Syrian gate, on the west of the city, is a large wireless telegraph station, placed beneath the old Turkish fort.

Bibliography.—Medina has been described from personal observation by Burckhardt (1815) and Burton (1853), and by the Arab geographers, Bakrī and Yāqūt. Besides Ibn 'Abd Rabbih and Ibn Jubair, Samhūdī wrote a history of the region. An extract is published by Wüstenfeld in the Göttingen *Abhandlungen*, vol. ix. (1861). It deals with the period down to the 15th century. *See* also C. M. Doughty, *Travels in Arabia Deserta*, vol. ii.; Eldon Rutter, *The Holy Cities of Arabia*, vol. ii. (1928).

MEDINA, a village of Orleans county, New York, U.S.A., 40 m. N.E. of Buffalo, on Oak Orchard creek, the State Barge canal and the New York Central railroad. Pop. (1920), 6,011 (84% native white); 1930 (Federal census) 6,071. It is surrounded by apple, peach, cherry and pear orchards and vegetable gardens, and there are quarries of the valuable Medina sandstone. Hydroelectric power is developed from falls in the creek, and at a large storage dam built in 1902. The village has large cold-storage warehouses, fruit evaporators, vinegar and pickling plants, flour mills, foundries, furniture factories and various other manufacturing industries. The village was incorporated in 1832.

MEDINA SIDONIA, DON ALONSO PEREZ DE GUZMAN EL BUENO, 7th Duke of (1550–1615), commander-in-chief of the Spanish Armada, was born Sept. 10, 1550. His father, Don Juan Claros de Guzman, died in 1555, and Don Alonso became duke, and on the death of his grandfather in 1559, master of one of the greatest fortunes in Europe. The family of Guzman first appears in the 10th century, and the branch to which the dukes of Medina Sidonia belonged was founded by Alonso Perez de Guzman (1256–1309), *El Bueno* "the stout-hearted," so called for allowing his son to be killed rather than surrender Tarifa (1296). The duchy of Medina Sidonia was conferred on his descendant, Juan Alonso de Guzman, count of Niebla in 1445. The titles and grandeeship passed in accordance with Castilian law, by marriage of a daughter and heiress in 1777, to the marquess of Villafranca, and have since remained in that house. The 7th duke married Ana de Silva y Mendoza, daughter of the prince of Eboli. Though he bore the name of *El Bueno,* he was a man of mean spirit. Appointed to the command of the Armada on the death (Feb. 9, 1588) of the marquess de Santa Cruz (*q.v.*), he sought to move Philip II. (who forced him to go out) by piteous declarations that he had neither experience nor capacity, and was always sick at sea. His conduct of the Armada justified his plea. He was even accused of cowardice, and was completely broken by the sufferings of the campaign. He retained his posts of "admiral of the ocean" and captain-general of Andalusia in spite of the contempt openly expressed for him by the whole nation. In 1596 his sloth and timidity lost Cadiz to the English. He was held up to ridicule by Cervantes in a sonnet. Yet the royal favour continued unmerited and unabated even under the successor of Philip II. In 1606 the duke's obstinacy and folly caused the loss of a squadron which was destroyed near Gibraltar by the Dutch. He died in 1615.

See C. Fernández Duro, *La Armada invéncible* (Madrid, 1884).

MEDINA SIDONIA, a town of southern Spain, in the province of Cadiz 21 m. by road E.S.E. of Cadiz. Pop. (1920), 13,416. Medina Sidonia is built on an isolated hill surrounded by a cultivated plain. It contains a fine Gothic church, several convents, and the ancestral palace of the dukes of Medina Sidonia. Medina Sidonia is doubtfully identified with the *Asido* of Pliny. Under the Visigoths the place was erected into a bishopric (Assidonia); in the beginning of the 8th century it was taken by Tariq. In the time of Idrisi (12th century) the province of *Shadūna* or *Shidona* included among other towns Seville and Carmona; later Arab geographers place Shadūna in the province of Seville.

MEDIOLANUM, the chief ancient city in Gallia Transpadana (mod. Milan, *q.v.*), Italy. The name is Celtic. The Romans defeated the Insubres in 225–222 B.C., and stormed Mediolanum itself in the latter year. Its inhabitants rebelled in the Hannibalic War, but were reduced to obedience in 196 B.C. In Strabo's time it was on an equality to Verona, but smaller than Patavium, but later increased. At the end of the 3rd century it became the seat of the governor of Aemilia and Liguria (which then included Gallia Transpadana also, thus consisting of the 9th and 11th regions of Augustus), and at the end of the 4th, of the governor of Liguria only, Aemilia having one of its own thenceforth. From Diocletian's time onwards the *praefectus praetorio* and the imperial vicar of Italy also had their seat here: and it became one of the principal mints of the empire. The emperors of the West resided at Mediolanum during the 4th century, until Honorius in 402 transferred his court to Ravenna. Its many inscriptions indicate a strong Celtic character in the population. Procopius speaks of it as the first city of the West, after Rome, and says that when it was captured by the Goths in 539, 300,000 of the inhabitants were killed. Roads radiated to Comum, to the foot of Ticinum, to Laus Pompeia and thence to Placentia and Cremona, and to Bergomum. None of these roads had an individual name, so far as we know. To its secular power corresponds the independent position which its Church took in the time of St. Ambrose (*q.v.*), bishop of Milan in 374–397, who founded the church which bears his name, and here baptized St. Augustine in A.D. 384, and whose rite is still in use throughout the diocese. The Huns invaded it under Attila (452), the Heruli under Odoacer (476) and the Goths under Theodoric (493). When Belisarius was sent by Justinian to recover Italy, Datius, archbishop of Milan, joined him, and the Goths were expelled from the city. Uraia, nephew of Vitigis the Goth, destroyed the whole of Milan in 539. Narses, in his campaigns against the Goths, had invited the Lombards to his aid; under Alboin, their king, they soon mastered north Italy, entering Milan in 569, but Pavia became the Lombard capital.

Of Roman remains little is seen above ground, but the plan of the city, which was rectangular, may be traced in the centre of the modern town and one of the round towers of its walls still exists. Close to the Torre del Carrobio remains of an ancient bridge and (possibly) of the walls of Maximian were found; and many remains of ancient buildings, including a theatre, have been discovered below ground-level. The objects found are preserved in the archaeological museum in the Castello Sforzesco. (*See* Milan.)

MEDITERRANEAN SEA. The Mediterranean is all that remains of a great ocean which at an early geological epoch encircled half the globe along a line of latitude. This ocean, already diminished in area, retreated after Oligocene times from the Iranian plateau, Turkistan, Asia Minor and the region of the north-west Alps. Next the plains of eastern Europe were lost, then the Aralo-Caspian region, southern Russia and finally the valley of the Danube. The "Mediterranean region" as a geographical unit includes all this area; the Black sea and the Sea of Marmora are within its submerged portion, and the climate of the whole is controlled by the oceanic influences of the Mediterranean sea. E. Suess, to whom the above description is due, finds that the Mediterranean forms no exception to the rule in affording no evidence of elevation or depression within historic times; but it is noteworthy that its present basin is remarkable in Europe for its volcanic and seismic activity. Submarine earthquakes are in some parts sufficiently frequent and violent as seriously to interfere with the working of telegraph cables. We divide, with E. Suess, the Mediterranean basin into four physical regions: (1) The western Mediterranean, from Gibraltar to Malta and Sicily, enclosed by the Apennines, the mountains of northern Africa, and of southern and south-eastern Spain (*Cordillère bétique*). (2) The Adriatic, occupying the space between the Apennines and the Dinaric group. (3) A part surrounded by the fragments of the Dinaro-

Taurus arch, especially by Crete and Cyprus. This includes the Aegean and the Black sea. These three parts belong strictly to Eurasia. (4) The part of the coastal region of Indo-Africa, terraced downwards in successive horizontal planes from the Shot, reaching the sea in the Little Syrte and continuing to the southern depressions of Syria, bounds the north of this area as the Sicily-Roman basin with the Levant basin in (2) and (3) above. Malta and Gozo are the only islands of the Mediterranean which can be associated with this section. Murray estimated (1888) the total surface of the Mediterranean drainage area, with which must be included the Black sea, at 7,600,300 sq.km., of which 48% are Eurasian and 52% are African. The principal rivers entering the Mediterranean directly are the Nile from Africa, and the Po, Rhone and Ebro from Europe.

The physical divisions of the Mediterranean given above hold good in describing the form of the sea-bed. The western Mediterranean, opened in the west by the Strait of Gibraltar (14 km. wide and 400 metres deep), is cut off in the east by a bank crossing the narrow strait between Sicily and Cape Bon, usually known as the Adventure Bank, on which the depth is nowhere 400 metres.

Between the Balearic islands and Corsica and Sardinia, the Mediterranean has an even floor of from 2,700–3,000 metres in depth. The greatest depth in this area is found off the south-west corner of Sardinia, with 3,151 metres. The Tyrrhenian sea is level in the north, but in the south, and between Sicily and Naples, has deep holes (3,731 metres). The Adriatic is the shallowest part of the Mediterranean, being, for the most part, less than 200 metres in depth, only reaching a depth of 1,200–1,300 metres in its southern part, west of Cattaro. The waters between Sicily and the Peloponnesus are the deepest of all the Mediterranean, having a depth of more than 4,000 metres. This area was sounded in 1891 by the Austrian Expedition boat "Pola" in 35° 45′ N., 21° 46′ E., 70 km. S.W. from Cape Matapan, and a depth of 4,400 metres was found. The slope of the ocean bed is steep here, but it is steeper still off the island of Sapienza, near Navarino; in this place, 13 km. from land, a depth of 3,150 metres was found. The depth of the Ionian sea is divided from that of the Levant basin by an undersea bank stretching north-easterly from Barka in North Africa to Crete, and for the most part the depth is less than 2,000 metres. Cyprus is tied to the Asiatic continent by the depth-line of 1,000 metres, although in the east and south-east from Rhodes, the sea is from 3,000–3,500 metres deep. In the Aegean sea, only north of Crete and south-east of the Chalcidian peninsula is the sea more than 1,000 metres deep.

According to the latest reckoning (E. Kossinna, 1921), the areas and mean depths of the four parts of the Mediterranean are:

	Area Sq.km.	Mean depth metres
Western Mediterranean	821,300	1,615
Adriatic sea	132,000	242
Aegean and Black sea	649,300	958
South-eastern Mediterranean	1,363,300	1,656
Total	2,965,900	1,429

Of this 2,965,900 sq.km. representing the whole area of the Mediterranean, the following percentages show the depths:

	%
0– 200 metres	22·2
200–1,000 „	21·5
1,000–2,000 „	17·9
2,000–3,000 „	29·7
Over 3,000 „	8·7

The total volume of the basin is calculated as 4,238,000 cu.km. (E. Kossinna, 1921).

Deposits.—A very great part of the bottom of the Mediterranean is covered with blue muds, frequently with a yellow upper layer containing 50–60% of carbonate of lime, chiefly shells of pelagic Foraminifera. In many parts, particularly in the eastern basin south of Crete, in depths varying between 300 and 3,000 metres, hard calcareous crusts from ½ in. to 3 in. in thickness are met with. Their origin is not yet explained. The fine mud of the Nile, which is directed in a northerly and north-easterly direction by the off-shore currents, should go still further north to the deeps off the Syrian coast; it is very poor in chalk content.

Temperature.—In any month of the year the superficial temperature of the Mediterranean is highest in the south-east towards the Levant, and lowest in the Gulf of Lions, the north Adriatic and in the north of the Aegean sea. Thus we observe a temperature of 12–13° C in February at the Riviera, at Port Said 17° C; in August, Riviera 20–24° and Port Said 27°. Below a level of 200 metres the waters seem to hold an even temperature, independent of the depth, of about 13° C in the western basin and about 14° in the eastern. In these "homothermic" deep layers, the salt-content is likewise constant, namely, 33·4‰ in the western area and 38·7–38·8‰ in the eastern. In the upper levels of the sea eastward from Gibraltar along the Algerian coast, there is only about 36·4–36·8‰ of salt content; here, with the surface currents coming into the sea from the ocean, is also Atlantic water weak in salt. A second area with little salt-content in the upper waters is the north Adriatic. In all other parts of the Mediterranean, the upper waters are rich in salt, with over 38‰ in the Levant basin over 39‰, while in the dry and hot summer period, evaporation is considerable.

Circulation.—There is little definite circulation of surface water within the Mediterranean itself. In the straits joining it with the Atlantic and the Black sea the fresher surface waters of these seas flow inwards to assist in making good the loss by evaporation at the surface of the Mediterranean, and in both cases dense water makes its way outwards along the bottom of the channels, the outflowing currents being less in volume and delivery than the inflowing. Elsewhere local surface currents are developed, either drifts due to the direct action of the winds, or streams produced by wind action heaping water up against the land; but these nowhere rise to the dignity of a distinct current system.

Climate.—The Mediterranean exerts a considerable influence on the climate of the lands whose shores it washes. In the winter months areas of low atmospheric pressure are formed over the individual basins, and over European lands and North Africa areas of high atmospheric pressure are formed. From these causes spring the annual cyclonal depressions from west to east in the Mediterranean; they bring with the changing winds the winter-rains of this zone. But in summer there is, with a moderately high barometer, a proportionate fall in atmospheric pressure from north-west to south-east, and steady, dry, northwest-north-north-easterly winds blow below a cloudless sky; this is the *Etesien* of the ancient Greeks. In Malta there is an annual rainfall of 517 mm., of which 445 mm. fall during the period October to March, leaving 72 mm. only for the months April–September; June and July are entirely dry months. The Mediterranean has characteristic winds, *e.g.*, the hot and dry Sirocco (*q.v.*) of Sicily (particularly in the early months), the hot and humid Sirocco of the Adriatic (in winter), both blowing from the south-east and south. There is the Bora, a cold wind in the territories of Istria and Dalmatia. The Mistral comes from the north (from the estuary of the Rhone). The Gulf of Lions (and, in general, the whole of the north-western part of the Mediterranean) is notorious for its terrible winter storms.

The air-temperature is usually, in winter, between 10° and 12° C, reaching, however, in the height of summer (in July and August) tropical heat, viz., 25° to 27° C.

Bibliography.—J. Murray u. E. Philippi, *Die Grundproben der deutschen Tiefsee-Expedition* (Jena, 1908); Joh. Schmidt, *Danish Oceanograph-Expeditions (1908–10) to the Mediterranean*, vol. i (Copenhagen, 1912); G. Schott, "Die Gewässer des Mittelmeeres," *Annalen der Hydrographie*, 1915; J. Hann, *Handbuch der Klimatologie*, 2nd ed. vol. iii. (Stuttgart, 1897). (G. Sc.)

POLITICAL DEVELOPMENT

The period 1910–27 was one of great changes in the lands round the Mediterranean Sea, particularly in the south and east. The essence of these changes was that large areas which had been really or nominally Turkish were divided up among other Powers,

and Turkey became virtually limited to Asia Minor.

In 1910 the Sultan of Turkey was suzerain of the area extending from the Gulf of Gabes to that of Alexandretta, and owned also the island of Cyprus. In 1927 Tripoli was Italian; Egypt was an independent kingdom; the mandated territories of Palestine and Syria were attached to Britain and France respectively, and Cyprus was a British colony. The changes in the European littoral of the Aegean Sea had also been great. In 1910 Greece was a small state, though Greeks were widely distributed around the shores of the Aegean. Crete was still Turkish, as was the whole of Thrace, together with the region vaguely called Macedonia. In 1927 Crete was Greek, and Turkey had also lost the whole of Macedonia and all but the eastern part of Thrace. In other words, Greece in 1927 included almost the whole of the European littoral of the Aegean, and to her previously existing ports had been added that of Salonika.

In 1910 Turkey held in the Epirus area a frontage on the Ionian Sea and had also a wide window on the Adriatic. The extension of Greece to the north and the establishment of the separate state of Albania were territorial changes which preceded the outbreak of the World War; but that war resulted in other changes of even greater importance. Prior to its outbreak, Austria-Hungary, which had annexed Bosnia-Hercegovina from Turkey in 1908, held the eastern coast of the Adriatic, from the edge of the very narrow strip which was Montenegrin to beyond the Isonzo. The Peace Treaties gave the greater part of the littoral to the Serb-Croat-Slovene State, and the smaller part to Italy, and left a cause of discord between the two, touching the fate of the port of Fiume. This was settled by agreement in 1924, when Fiume became Italian, and the adjacent Port Baross, Yugoslav. In the west, save for agreements in the case of Morocco, there were no territorial changes: a certain amount of political equilibrium had been reached there long prior to the period under consideration. But France, Italy and, to a minor extent, Spain made definite attempts to establish themselves more firmly on the shores of the Mediterranean.

Spanish Policy.—Spanish action was limited to a coastal belt in Morocco. In 1912, the year in which the French protectorate was accepted by the Sultan of Morocco, France and Spain reached an agreement as to the limits of their respective zones within that country. Spanish attempts to make occupation effective in their own zone were probably influenced primarily by the French advance: other influences were the loss of the remnants of the former colonial empire of Spain and the continuous emigration to Algeria, which had acquired a large Spanish element in its population. The convention of 1923 between Great Britain, Spain and France in regard to Tangier, then placed under a régime of permanent neutrality, indicated the growing importance of France in the western basin of the Mediterranean.

French Policy.—Other signs were not wanting of the new orientation of French policy. As contrasted with Italy and even with Spain, there is in France no surplus population seeking new lands for settlement. Thus the fact that the North African territories, particularly Algeria, give opportunities for European colonization is not of much direct importance to that country. On the other hand, there is great need of man-power, particularly for the army. Though the territories of the Mediterranean littoral are not densely peopled, they do form a recruiting ground, and Algeria, Tunisia and Morocco all furnish divisions to the French army. But these lands are but the margin of a vast area which, interrupted politically only by smaller *enclaves*, and physically by the Sahara desert, now extends to the Gulf of Guinea and, further eastward, to far beyond the equator. Parts of this area contain a virile coloured population, whose members make good soldiers. In this connection it may be noted that Senegalese regiments have formed a part of the French army since 1911, and that in 1919 the coloured element in the army was greatly increased. It is thus essential that facilities for transverse traffic between the French and the North African coast opposite should exist in peace, and that so far as possible the safety of the routes should be assured in time of war. These considerations have increased the significance of the Mediterranean ports. Bizerta, Algiers and Oran became important naval stations and submarine bases, and the French made great efforts to develop and strengthen all the ports on this littoral, as centres of trans-Mediterranean traffic. This emphasis on cross-routes is not only significant in itself, but is something entirely modern. Previously, as is well shown by the long-drawn-out row of British stations at Gibraltar, Malta and Aden, the Mediterranean was primarily of importance as a longitudinal thoroughfare. With the establishment of an independent kingdom in Egypt, and the changes just noted, it is obvious both that Great Britain's position in the Mediterranean has been weakened, and that a new set of traffic routes is being superimposed on the old.

Italian Policy.—Italian policy in the Mediterranean area since the war has been influenced by somewhat different motives. Italy has a steadily increasing population and the emigration laws in the United States restricted one of the pre-war outlets for the surplus. Thus Italian policy has been directed towards the discovery of new areas of possible settlement, and has led to efforts to develop Tripoli, obtained from Turkey in 1912. In the eastern part of the Adriatic, by the acquisition of the peninsula of Istria, with the ports of Trieste, Pola and Fiume, and of Zara and the island of Lagosta, Italy obtained both complete protection for the eastern coast of the peninsula and opened up possibilities of notable commercial developments. The extension of Italian influence in Albania was particularly noteworthy.

The New States.—The collapse of the Ottoman empire led to the rise in the eastern Mediterranean of states which were either new, as the kingdom of Egypt, Yugoslavia and the much smaller state of Albania, or like Turkey and Greece, had undergone such radical modification—territorial, political and ethnical—as to be to all intents and purposes new. Such states were for the most part characterized by a strongly nationalistic spirit which retarded economic recovery from the effects of the war. By 1926, however, signs of a changed outlook were apparent, particularly in Asia Minor, where Turkey strove to restore the industries ruined by the disappearance of the Christian population, and to extend the railway system with European aid.

This summary account makes it clear that political developments took place in the period 1910–27 with a rapidity all the more startling in view of the long antecedent period of complete or partial stagnation. But cumulative economic changes had been going on for a long period of time. In particular, the increased production of cereals for export in central and eastern Europe, and the discovery and working of oil-fields alike along the Carpathian border and in the Caspian region, gave to outlets to the eastern Mediterranean an importance which they did not possess in earlier times, and made readjustments inevitable. The Mediterranean Sea was no longer what the opening of the Suez Canal and the associated growth of European influence in the Far East had made it—primarily a thoroughfare for world commerce. It was becoming also an important outlet for the developing lands adjacent to its southern and eastern shores.

Present strategic conditions in the Mediterranean region are discussed in D. H. Cole's *Imperial Military Geography* (1925). *See* also M. I. Newbigin, *Geographical Aspects of Balkan Problems* (1915); I. Bowman, *The New World: Problems in Political Geography* (1925); E. W. P. Newman, *The Mediterranean and its Problems* (1927).

(M. I. N.)

MEDIUM, the word originally used by spiritualists to denote a person acting as intermediary between the spirit world and ordinary humanity. It now means a person by or through whom "supernormal" phenomena are produced, whether the supposed ultimate cause of the phenomena is spiritistic or not. But the word is often given a more restricted sense so as to include only those who habitually produce "physical" phenomena or give trance-communications.

See Psychical Research, Spiritualism, Trance.

Bibliography.—For a general account of the earlier mediums *see* Podmore's *Modern Spiritualism:* those who find this too critical for their taste may prefer Sir A. Conan Doyle's *History of Spiritualism.* For D. D. Home, Crookes' *Researches in the Phenomena of Spiritualism,* and Lord Dunraven's *Experiences in Spiritualism with D. D. Home* (reprinted by the S.P.R. in 1924) are important: for Stainton Moses, A. W. Trethewy's *The Controls of Stainton Moses;* and for

Eusapia Paladino, S.P.R. *Proceedings*, vol. xxiii. For favourable reports on modern mediums numerous books by Schrenck-Notzing, Geley, Crawford, etc.: for the other side, part I. of *Der Okkultismus in Urkunden*. The *Proceedings* of the S.P.R. are indispensable.

MEDJIDIE or **MEJIDIE** (mĕj-ĭd′ē-ā), a military and knightly order of the Turkish empire, and also a silver Turkish coin, worth twenty piastres. The coin was first struck in 1844, and the order was instituted in 1852 by the Sultan Abd-ul-Mejid, whose name was therefore given to them.

MEDLAR, *Mespilus germanica*, a tree of the tribe Pomeae of the family Rosaceae, closely allied to the genus *Pyrus*, in which it is sometimes included; it is a native of Europe from Holland southwards, and of western Asia. It occurs in hedges, etc., in middle and south England, as a small, much-branched, deciduous, spinous tree, but is not indigenous. The medlar was well known to the ancients. The well-known fruit is globular, but depressed above, with leafy persistent sepals, and contains stones of a hemispherical shape. It is not fit to eat until it begins to decay and becomes "bletted," when it has an agreeable acid and somewhat astringent flavour. Several varieties are known in cultivation. The fruit should be gathered in November, on a dry day, and laid out upon shelves. It becomes "bletted" and fit for use in two or three weeks. The Japanese medlar is *Eriobotrya japonica* (*see* LOQUAT), a genus of the same tribe of Rosaceae.

MÉDOC, a district in France adjoining the left bank of the Gironde from Blanquefort (N. of Bordeaux) to the mouth of the Gironde. It is about 50 m. long, and between 6 and 7 m. broad. It is formed by a number of low hills, which separate the Landes from the Gironde, and is traversed only by small streams; the Gironde itself is muddy, and often wrapped in fog. Large areas of its soil are occupied by vineyards, the products of which give the finest vintages of Bordeaux. (*See* WINE.)

MÉDOC WINES. The Médoc is a strip of undulating land, some six miles wide and about fifty miles long, along the left bank of the river Gironde, the vineyards of which produce about ten million gallons of red wine on an average, every year, and a very much smaller quantity of white wine.

No wine is entitled to the name Médoc except the wine made from grapes grown in the Médoc. There are, in the Médoc, some seventy wine-producing parishes, the most famous of which are those of St. Estèphe, Pauillac, St. Julien, St. Laurent, Margaux, Cantenac.

No wine is entitled to the name of any other parish but that of its birth. In each parish there are various estates where vines are cultivated under more or less particularly favourable conditions as regards soil, sub-soil, aspect, etc. The sixty best estates or châteaux of the Médoc, have been officially classified in five classes according to excellence. Thus Médoc is the name of any nondescript wine from any part of the whole district of Médoc. St. Julien, Margaux, St. Estèphe, etc., are the names of any wine from any part of these particular parishes. Château Margaux, Château Lafite and all the other châteaux are names belonging to the wine made at any of these particular estates, and no wine may be sold under the name of Château Margaux, Château Lafite or any named estate unless it be the produce of the château or estate named. (*See* CLARET, WINE.) (A. L. S.)

MEDUSA, a technical name for a jelly-fish. Jelly-fish are not all alike in structure, and do not all belong to the same group of animals. The majority belong to the classes Hydrozoa and Scyphozoa of that larger group known as the Coelenterata; the remainder belong to the Ctenophora. The true jelly-fish medusa is defined in the article COELENTERATA.

MEDUSA (mythological): *see* GORGON.

MEDWALL, HENRY (*fl.* 1490), the earliest known writer of an English secular play, is said on good authority to have been well-born. The date of his birth and the circumstances of his youth and education are unknown. The earliest reference to him is in Cardinal Morton's Register at Lambeth in the year 1490. On Aug. 28, 1492, he was admitted to the rectory of Bulyngham in the English marches of Calais. It was not till Feb. 27, 1500–01 that he appears to have been granted letters of protection enabling him to go overseas, and a few months later he resigned. No later reference to him is known and it is surmised that he did not long survive his patron, Cardinal Morton, who died in 1500.

Morton had appointed him his chaplain and it was for the entertainment of the cardinal and his guests that Medwall exercised his remarkable dramatic gifts. His reputation as a playwright has suffered from a story apparently invented by J. P. Collier, who stated that at Richmond in 1513 a moral interlude by Medwall, *The Fynding of Truth*, was performed but was not liked and that the king departed before the end to his chamber. There is no trace of the document on which the story is supposed to rest. Medwall did, however, write a morality play called *Nature*, in two parts and containing 22 characters. It is preserved in a single copy (printed by William Rastell) in the British Museum, and is a favourable example of the allegorical play. In it Medwall displays his talent for realistic dialogue and his skill as a versifier.

It is, however, as the author of *Fulgens and Lucres*, the first known secular play in English, that Medwall has a distinctive place in the history of the drama. The play was supposed to have been lost, except for a fragment, but a copy printed by John Rastell was found in 1919 in Lord Mostyn's library and passed, at the sale of his books, to the late Henry E. Huntington of California. Its source is a neo-Latin *declamatio* by Bonaccorso of Pistoja, *de Vera Nobilitate*, telling how Fulgentius, a Roman senator, had a daughter Lucretia who had two suitors, Publius Cornelius, well-born, rich and idle, and Gaius Flaminius, of humble birth but virtuous. Each pleads his case, but there is no decision. In the play, Lucres decides in favour of Flaminius, as the more truly "noble" of the two. Medwall also adds a comic underplot, in which the servants of the suitors are rivals for the favours of her handmaid. By virtue of this play Medwall stands at the head of the long line of English playwrights.

See A. W. Reed, *Early Tudor Drama* (1926); *Fulgens and Lucres* edit. by F. S. Boas and A. W. Reed (1926) and *Nature*, ed. by A. Brandl in *Quellen des weltlichen Dramas in England* (1898). (F. S. B.)

MEDWAY, a river in the south-east of England. It rises in the Forest ridges, in Sussex, and flows east to the county boundary, which it forms. Entering Kent near Ashurst, it continues north-east to its mouth. The river passes Tonbridge, receiving the Eden, and later the Teise and Beult, all these streams watering the Weald (*q.v.*) to the south of the North Downs, which the Medway breaches in a beautiful valley generally much narrower than the upper valley. Maidstone stands in this gap. Below Maidstone the valley forms a perfect basin, the hills descending upon it above Rochester. Below this city the river enters a broad, winding estuary, passing Chatham, and at Sheerness joining the Thames, so that the Medway may be considered a tributary, and its drainage area of 680 sq.m. reckoned as part of that of the greater river. The length of the Medway is about 60 m. The estuary is navigable for sea-going vessels drawing 24 ft. up to Rochester Bridge.

MEEANEE or **MIANI,** a village in Sind, India, on the Indus, 6m. N. of Hyderabad. It is famous as the scene of the battle in which Sir Charles Napier, with only 2,800 men, broke the power of the mirs of Sind on Feb. 17, 1843. The result of this victory was the conquest and annexation of Sind. The anniversary is kept up with special honour by the Cheshire Regiment (The 22nd Foot) as their chief celebration of the year.

MEEK, FIELDING BRADFORD (1817–1876), American geologist and palaeontologist, the son of a lawyer, was born at Madison, Indiana, December 10, 1817. In early life he was in business as a merchant, but his leisure hours were devoted to collecting fossils and studying the rocks of the neighbourhood of Madison. Being unsuccessful in business he turned his whole attention to science, and in 1848 he gained employment on the U.S. geological survey in Iowa, and subsequently in Wisconsin and Minnesota. In 1852 he became assistant to Professor James Hall at Albany, and worked at palaeontology with him until 1858. Meanwhile in 1853 he accompanied Dr. F. V. Hayden in an exploration of the "Bad Lands" of Dakota, and brought back valuable collections of fossils In 1858 he went to Washington, where he devoted his time to the palaeontological work of the

U.S. geological and geographical surveys, his work bearing "the stamp of the most faithful and conscientious research," and raising him to the highest rank as a palaeontologist. Besides many separate contributions to science, he prepared with W. M. Gabb (1839–78), two volumes on the palaeontology of California (1864–69), and also a *Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country* (1876). He died at Washington December 22, 1876.

MEERANE, a town in Saxony, 9 m. N. of Zwickau and 37 m. S. of Leipzig by rail. Pop. (1925) 24,094. It contains a mediaeval church. It is one of the most important industrial centres of Germany for the manufacture of woollen and mixed cloths, and in these products has a large export trade. There are also extensive dyeworks, tanneries and machine factories.

MEERSCHAUM, a German word designating a soft white mineral sometimes found floating on the Black sea, and rather suggestive of sea-foam (*Meerschaum*), whence also the French name for the same substance, *écume de mer*. It was termed by E. F. Glocker sepiolite, in allusion to its remote resemblance to the "bone" of the sepia or cuttle-fish. Meerschaum is of an opaque white, grey or cream colour, breaking with a conchoidal or fine earthy fracture, and occasionally, though rarely, fibrous in texture. It can be readily scratched with the nail, its hardness being about 2 on Mohs' scale. The specific gravity varies from 0·988 to 1·279, but the porosity of the mineral may lead to error. Meerschaum is a hydrous magnesium silicate, with the formula $H_4Mg_2Si_3O_{10}$, or $Mg_2Si_3O_8{\cdot}2H_2O$.

Most of the meerschaum of commerce is obtained from Asia Minor, chiefly from the plain of Eski-Shehr, on the Haidar Pasha-Angora railway; where it occurs in irregular nodular masses, in alluvial deposits, which are extensively worked for its extraction. The mineral is associated with magnesite (magnesium carbonate), the primitive source of both minerals being serpentine. When first extracted the meerschaum is soft, but it hardens on exposure to the sun or when dried in a warm room. Meerschaum is found also, though less abundantly, in Greece, as at Thebes, and in the islands of Euboea and Samos; it occurs also in serpentine at Hrubschitz near Kromau in Moravia. It is found to a limited extent at certain localities in France, Spain and Morocco. In the United States it occurs in serpentine in Pennsylvania (as at Nottingham, Chester county) and in South Carolina and Utah.

Meerschaum has occasionally been used as a substitute for soap and fuller's earth, and it is said also as a building material; but its chief use is for tobacco-pipes and cigarette-holders. The natural nodules are first scraped to remove the red earthy matrix, then dried, again scraped and polished with wax. The rudely shaped masses thus prepared are sent from the East to Vienna and other manufacturing centres, where they are turned and carved, smoothed and finally polished. Imitations are made in plaster of Paris and other preparations.

The soft white earthy mineral from Långbanshyttan, in Vermland, Sweden, known as aphrodite (ἀφρός, foam), is closely related to meerschaum. It may be noted that meerschaum has sometimes been called magnesite (*q.v.*).

MEERUT, a city, district and division of British India, in the United Provinces. The city (pop. [1921], 122,609), lies south of the cantonments, and although dating back to the days of the Buddhist emperor Asoka (*c.* 250 B.C.) Meerut owes its modern importance to its selection by the British government as the site of a great military station. In 1805 it is mentioned as "a ruined, depopulated town." The cantonment was established in 1806, and the population rose to 29,014 in 1847, and 82,035 in 1853. It has accommodation for horse and field artillery, British and native cavalry and infantry, and boasts of the finest "Mall" in India. It was here that the first outbreak of the Mutiny of 1857 took place. (*See* INDIAN MUTINY.)

The DISTRICT OF MEERUT forms part of the upper Doab, or tract between the Ganges and the Jumna, extending from river to river. Area, 2,298 sq.m. Though well wooded in places and abundantly supplied with mango groves, it has but few patches of jungle or waste land, being almost one continuous expanse of careful and prosperous tillage. Its fertility is largely due to the system of irrigation canals. The Eastern Jumna canal runs through the whole length of the district, and supplies the rich tract between the Jumna and the Hindan. The main branch of the Ganges canal passes across the centre of the plateau in a sweeping curve and waters the midland tract. The Anūpshahr branch supplies irrigation to the Ganges slope, and the Agra canal passes through the southern corner of Loni pargana from the Hindan to the Jumna. The Burh Ganga, or ancient bed of the Ganges, lies at some distance from the modern stream; and on its bank stood the abandoned city of Hastinapur, the legendary capital of the Pandavas at the period of the *Mahābhārata*.

The comparatively high latitude and elevated position of Meerut make it one of the healthiest districts in the plains of India. The average temperature varies from 57° F in January to 87° in June. The rainfall is small, less than 30 in. annually. The population in 1921 was 1,499,074. The principal crops are wheat, pulse, millet, sugar-cane, cotton and indigo, but this last crop has declined of late years almost to extinction.

The authentic history of the district begins with the Muslim invasions. The town was taken by Kutb-ud-din in 1191, and all the Hindu temples turned into mosques. In 1398 Tīmūr captured the fort of Loni after a desperate resistance, and put all his Hindu prisoners to death. He then proceeded to Delhi, and after his memorable sack of that city returned to Meerut, captured the town, and put the male inhabitants to the sword. After the death of Aurangzeb the country was exposed to alternate Sikh and Mahrattā invasions. From 1707 till 1775 it was the scene of perpetual strife, and was only rescued from anarchy by the exertions of the military adventurer Walter Reinhardt, afterwards the husband of the celebrated Begum Samru, who established himself at Sardhāna in the north, and ruled a large estate. The southern tract, however, remained in its anarchic condition under Mahrattā exactions until the fall of Delhi in 1803, when the whole of the country between the Jumna and the Ganges was ceded by Sindhia to the British. It was formed into a separate district in 1818.

The DIVISION OF MEERUT comprises the northern portion of the Doab. It consists of the five districts of Dehra Dun, Saharanpur, Muzaffarnagar, Meerut and Bulandshahr. Area, 9,181 sq.m.; pop. (1921), 4,509,572.

MEETING. Public meetings may be either those of statutory bodies or assemblies of persons called together for social, political or other purposes. In the case of statutory bodies, by-laws usually fix the quorum necessary to constitute a legal meeting. That of limited companies may be either by reference to the capital held or by a fixed quorum or one in proportion to the number of shareholders. It has been held that in the case of a company it takes at least two persons to constitute a meeting (*Sharp* v. *Daws,* 1886, 2 Q.B.D. 26). In the case of public meetings for social, political or other purposes no quorum is necessary. They may be held, if they are for a lawful purpose, in any place, on any day and at any hour, provided they satisfy certain statutory provisions or by-laws made under the authority of a statute for the safety of persons attending such meetings. If, however, a meeting is held in the street and it causes an obstruction those convening the meeting may be proceeded against for obstructing the highway. The control of a meeting and the subjects to be discussed are entirely within the discretion of those convening it, and whether the meeting is open to the public without payment, or subject to a charge or to membership of a specified body or society, those present are there merely by virtue of a licence of the conveners, which may be revoked at any time. The person whose licence is revoked may be requested to withdraw from the meeting, and on refusal may be ejected with such force as is necessary. If he employs violence to those removing him he commits a breach of the peace for which he may be given into custody. The Public Meeting Act 1908 enacted that any person who at a lawful public meeting acts in a disorderly manner for the purpose of preventing the transaction of the business for which the meeting was called together shall be guilty of an offence. (*See* also ELECTION LAW.) Any person who incites another to commit the offence is equally guilty. A public meeting is usually controlled by a chairman, who may be appointed by

the conveners or elected by the meeting itself. On the chairman falls the duty of preserving order, of calling on persons to speak, deciding points of order, of putting questions to the meeting for decision, and declaring the result and other incidental matters. (*See* PARLIAMENTARY PROCEDURE.)

In England it is illegal, by the Seditious Meetings Act 1817, to hold a public meeting in the open air within 1m. of Westminster Hall during the sitting of parliament.

See C. P. Blackwell's *Law of Meeting* and the article COMPANY.

MEGACYCLE is a million cycles. This term is used in radio work as a contraction for "megacycle per second."

MEGALOPOLIS, an ancient city of Arcadia, Greece, in a plain about 20 m. S.W. of Tegea, on both banks of the Helisson, about 2½ m. above its junction with the Alpheus. It was founded by the Theban general Epaminondas in 370 B.C., as a bulwark for the southern Arcadians against Sparta, and as the seat of the Arcadian Federal Diet. The builders were protected by a Theban force, and directed by ten native oecists (official "founders"), who drew inhabitants from all parts of Arcadia, but especially from Maenalia and Parrhasia. Forty townships are mentioned by Pausanias (viii. 27, 3–5) as having been incorporated in it. It was 50 stadia in circumference, and was surrounded with strong walls. Its territory was the largest in Arcadia, extending northward 24 m. The city was adorned with many handsome buildings. Its temples contained ancient statues brought from the incorporated towns. After the departure of Epaminondas, Lycomedes of Mantineia succeeded in drawing the Arcadian federation away from its alliance with Thebes, and it was consequently obliged to make common cause with Athens. Its attempt to use the treasures of Olympia led to dissensions, and in the battle of Mantineia (362) one-half of the Arcadians fought on the side of the Spartans, the other on that of the Thebans. After this battle many inhabitants of Megalopolis sought to return to their former homes, and it was only by the assistance of three thousand Thebans under Pammenes that they were prevented. In 353, when Thebes was preoccupied with the Sacred War, the Spartans attacked Megalopolis; but with Theban help the city was rescued. It was at this crisis that a Megalopolitan appeal to Athens, occasioned the oration of Demosthenes, *On the people of Megalopolis.* The Spartans now concluded peace with Megalopolis and acknowledged its autonomy. But their hostility did not cease, and Megalopolis entered into friendly relations with Philip of Macedon. Twenty years later, when the Spartans and their allies rebelled against Macedon, Megalopolis, loyal to its allegiance, stood a long siege. After the death of Alexander, it was governed by native tyrants. In the war between Cassander and Polyperchon it supplied 15,000 men to the former and was besieged by the latter. In 234 B.C. Lydiades, the last tyrant of Megalopolis, resigned, and the city joined the Achaean League, earning again the hatred of Sparta. In 222 Cleomenes plundered it, but in the next year its inhabitants were reinstated by Philopoemen, a native of the city. After this, it sank into insignificance and in the time of Pausanias it was in ruins. Its only great men were Philopoemen and Polybius the historian. Lycartas, the father of the latter, may be accounted a third. In the time of Pausanias, the city was mostly in ruins.

The site was excavated by the British School at Athens in 1890–1892. The description of Pausanias tallies closely with the reality. The town was divided into two approximately equal parts by the river Helisson, which flows through it from east to west. The line of the walls may be traced, partly by remains, partly by the contours it must have followed, and confirms the estimate of Polybius that they had a circuit of 50 stades, or about 5½ miles. The foundations, formerly supposed to belong to a bridge, are substructures of the precinct of Zeus Soter. The buildings north of the river were municipal, grouped round the square agora. The portico of Philip, on the N., was 300 ft. long, with three rows of columns running its whole length, and a projecting wing at either end. East of it stood the municipal offices (Archeia). At the south-west is the precinct of Zeus Soter, surrounded by a double colonnade, with a small temple on the west and an entrance on the east. In the midst was a substructure either for an altar or for the great group of Zeus and Megalopolis. North of this the Stoa Myropolis formed the E. boundary. These buildings were of various dates, but harmonious plan. On the S. bank of the river were the chief federal buildings, the theatre (noted by Pausanias as the largest in Greece), and the Thersilion or parliament hall; the great portico of the Thersilion facing the orchestra of the theatre. In consequence, the plan of the theatre is abnormal, for the portico, which has its base about 4 ft. 6 in. above the level of the orchestra, was too lofty for a proscenium; yet, a proscenium of the ordinary type would hide the lower part of the columns. Such a proscenium was actually erected later; but beneath it were foundations for a wooden proscenium, probably erected only when required. Later, steps were added, from the portico to the orchestra. The theatre was probably used, as at Athens, for political assemblies; but the adjoining Thersilion provided cover for the "ten thousand" in wet weather. It is unique in plan, its floor sloping up towards all sides like a theatre, with roof-columns set radially so as to obscure as little as possible the view from the centre.

See Society for the Promotion of Hellenic Studies, *Excavations at Megalopolis* (1892); W. Dörpfeld, *Das griechische Theater;* O. Puchstein, *Griechische Bühne;* Pauly-Wissowa, *s.v.*

MEGALOSAURUS, an extinct carnivorous bipedal reptile from the lower Jurassic rocks of west Europe. *Allosaurus* from the Jurassic of Colorado is allied and much better known. Both belong to the Theropodous division of the Dinosaurs (*q.v.*). The animal was from 15 to 20 ft. long with formidable teeth, strong hind limbs and long heavy tail.

MEGAPODE, the name given to a small family of birds confined to the Australian region and notable for their habit of burying their eggs in the ground or in mounds of earth, decaying vegetation, etc., which they scratch up, and leaving them there to hatch. This mound-making habit is communal. The young actually fly from the moment of hatching, a unique feature. The commonest form is the East Australian brush-turkey (*Catheturus lathami*), about the size of a hen-turkey. The South and West Australian mallee-bird or "native pheasant" (*Lipoa ocellata*) has shorter tarsi and toes and lacks the bare head of the last. Another form (*Megacephalon maleo*) inhabits the Celebes. It has a helmet-like protuberance on the back of the bare head. The genus *Megapodius* ranges from Samoa to the New Hebrides, North Australia and New Guinea. The birds are about the size of small fowls, generally crested, with short tails and enormous feet. They are shy, terrestrial birds, but have a powerful flight.

See A. R. Wallace, *Geogr. Distr. Animals* and *Malay Archipelago.*

MEGARA, an ancient Greek town on the Saronic gulf, between Attica and Corinth. Its district, Μεγαρίς or ἡ Μεγαρική, is bounded by Attica, Boeotia, Corinth, and the two gulfs, Mount Geraneia extending across the country from east to west, forms a barrier between continental Greece and the Peloponnesus. The shortest passage of this range is along the eastern side of the mountains, through the celebrated Scironian rocks, where Theseus destroyed the robber Sciron. The only lowland was the White Plain, in which was the city, Megara. The modern town occupies two low hills within the ancient site; it is the chief town of the eparchy of Megaris; pop. (1920) 9,531. Its Easter dances attract visitors. There are remains of the aqueduct made by the architect Eupalinus for the tyrant Theagenes.

History.—In prehistoric days Megara had intercourse with the southern Aegean. The early inhabitants were extirpated in the Dorian migration, for in historic times the city had a homogeneous Dorian population. Favoured by its proximity to two great waterways and by its two ports, Nisaea on the Saronic and Pegae on the Corinthian Gulf, Megara took a prominent part in commerce from the 8th century. Its trade was with Sicily, where Megarian colonies were established at Hybla (Megara Hyblaea) and Selinus, and with the Black sea, in which region the Megarians were pioneers of Greek commerce. In the Sea of Marmora they had to face the competition of the Samians and of Miletus; but on the Bosporus they established themselves by means of settlements at Chalcedon (675 B.C.) and Byzantium (658 B.C.). In the Black sea they exploited the shores of Pontus and Scythia. Their chief colonies were Astacus and Heracleia in Bithynia, and another Heracleia in the Crimea. Later this trade dwindled in

face of the commercial activity of Miletus, and that of Athens on the Hellespont. Megarian commerce in Sicily was supplanted by Corinth and Corcyra.

Megara's economic development entailed a change in political power. The land-holding aristocracy began to lose its grip upon the community of artizans. A short tyranny followed. The power of the nobles was broken in a war with Athens, in which Megara lost the island of Salamis (about 570 B.C.; *see* SOLON); after a period of democracy the constitution was fixed as an oligarchy of a moderate type. During the Persian wars the state, which joined the Peloponnesian League, could muster 3,000 hoplites. But the expansion of Athens ruined the commerce of Megara. In 459 an attack by Corinth induced the people to summon the aid of the Athenians, who secured Megara in battle and by the construction of long walls between the capital and its port Nisaea. In 445 the Megarians massacred their Athenian garrison. The Athenians retaliated by placing an embargo upon Megarian trade throughout their empire (432), and in the Peloponnesian War, reduced their neighbours to misery by blockade and devastations. In 424 they nearly captured Megara, in collusion with a democratic party within the town, and secured Nisaea, which they held until 410. In the 4th century Megara recovered some measure of prosperity, but played an insignificant part in politics, and finally was incorporated in the Achaean League (*q.v.*). Megara suffered severely in the civil war of 48 B.C. It maintained itself as a place of some size in subsequent centuries, but was depopulated by the Venetians in A.D. 1500. The inhabitants of the modern village are mostly of Albanian origin.

BIBLIOGRAPHY.—B. V. Head, *Historia numorum* (Oxford, 1887), pp. 329–330; F. Cauer, *Parteien und Politiker in Megara und Athen* (Stuttgart, 1890), pp. 1–44; R. Delbrück and K. G. Vollmöller, "Das Brunnerhaus des Theagenes," in *Mitteil. d. deutsch. Inst. Athen.* XXV. (1900). Ancient authorities are Strabo ix.; Theognis; Thucydides; Aristophanes, *Acharnians.*

MEGARA HYBLAEA (*see* also HYBLA), an ancient city on east coast of Sicily, 12 m. N.N.W. of Syracuse, founded in 728 B.C. by Megarean colonists. A hundred years later it founded Selinus. It was destroyed by Gelon about 481 B.C. In the Athenian expedition against Syracuse (415–413) Lamachus proposed (it being then deserted) to make it the Athenian base of operations; but his advice was not taken, and in the next spring the Syracusans fortified it. In 309 it was still fortified; and Marcellus captured it in 214. Excavations led to the discovery in 1891 of the north part of the western town wall, which in one section served also as an embankment against floods, of an extensive necropolis, about 1000 tombs of which have been explored, and of a deposit of votive objects from a temple which had been built over the ditch enclosing a late Neolithic village of the Stentinello period. The harbour lay to the north. (T. A.)

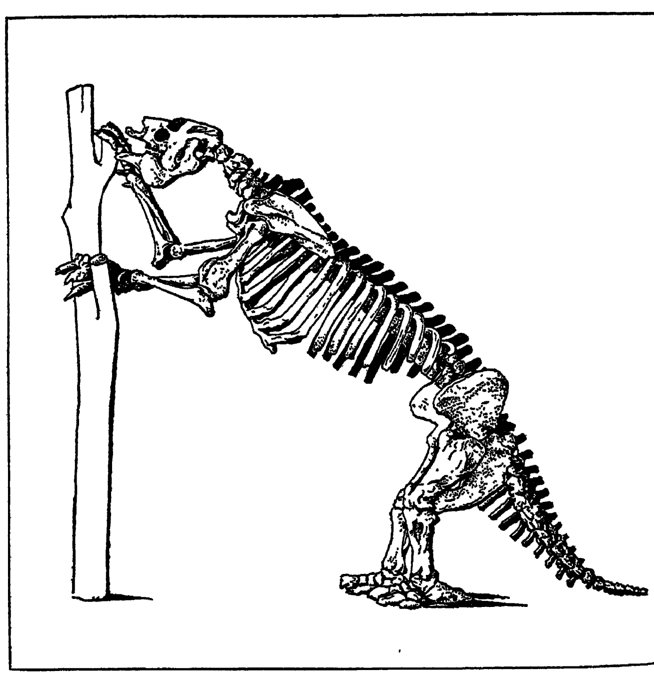
MEGARIAN SCHOOL OF PHILOSOPHY. This school was founded by Euclides of Megara, one of the pupils of Socrates. Two main elements went to make up the Megarian doctrine. Like the Cynics and the Cyrenaics, Euclides started from the Socratic principle that virtue is knowledge. But into combination with this he brought the Eleatic doctrine of Unity. Perceiving the difficulty of the Socratic dictum he endeavoured to give to the word "knowledge" a definite content by divorcing it absolutely from the sphere of sense and experience, and confining it to a sort of transcendental dialectic or logic. The Eleatic unity is Goodness, and is beyond the sphere of sensible apprehension. This goodness, therefore, alone exists; matter, motion, growth and decay are figments of the senses; they have no existence for Reason. "Whatever is, is!" Knowledge is of ideas and is in conformity with the necessary laws of thought. Hence Plato in the *Sophist* describes the Megarians as "the friends of ideas." Yet the Megarians were by no means in agreement with the Platonic idealism. For they held that ideas, though eternal and immovable, have neither life nor action nor movement.

This dialectic, initiated by Euclides, became more and more opposed to the testimony of experience; in the hands of Eubulides and Alexinus it degenerated into hairsplitting, mainly in the form of the *reductio ad absurdum.* The strength of these men lay in destructive criticism rather than in construction: as dialecticians they were successful, but they contributed little to ethical speculation. They spent their energy in attacking Plato and Aristotle, and hence earned the opprobrious epithet of *Eristic.* They used their dialectic subtlety to disprove the possibility of motion and decay; unity is the negation of change, increase and decrease, birth and death. None the less, in ancient times they received great respect owing to their intellectual pre-eminence. Cicero (*Academics,* ii. 42) describes their doctrine as a "nobilis disciplina," and identifies them with Parmenides and Zeno of Elea. But their most immediate influence was upon the Stoics (*q.v.*), whose founder, Zeno of Citium, studied under Stilpo. This sage, a man of striking and attractive personality, succeeded in fusing the Megarian dialectic with Cynic naturalism. The result of the combination was in fact a juxtaposition rather than a compound; it is manifestly impossible to find an organic connection between a practical code like Cynicism and the transcendental logic of the Megarians. But it served as a powerful stimulus to Zeno, who by descent was imbued with oriental mysticism.

For bibliographical information about the Megarians, *see* EUCLID; EUBULIDES; DIODORUS CRONUS; STILPO. *See* also ELEATIC SCHOOL; CYNICS; STOICS; and, for the connection between the Megarians and the Eretrians, MENEDEMUS and PHAEDO. Also Zeller, *Socrates and the Socratic Schools;* Mallet, *Histoire de l'école de Mégare* (Paris, 1845); Ritter, *Über die Philosophie der meg. Schule;* Prantl, *Geschichte der Logik,* i. 32; Henne, *L'école de Mégare* (Paris, 1843); Gomperz, *Greek Thinkers* (Eng. trans., 1905), ii. 170 *seq.*

MEGARON, the principal hall of the ancient Greek palace, situated in the andron or men's quarter. Examples exist at Tiryns and Mycenae (*c.* 1200 B.C.).

MEGATHERIUM, the largest of the ground-sloths, an extinct group of edentate mammals related to the modern tree-sloths. It is best known from skeletons obtained in Argentina, and equalled the elephant in bulk but was of very different proportions, with short and massive hind limbs, heavy tail, long,



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE SKELETON OF THE MEGATHERIUM, AN ENORMOUS EXTINCT MAMMAL WHICH EXISTED DURING THE PLEISTOCENE AGE

slender loose-jointed fore limbs and large powerful claws on fore and hind foot. The head has a rather long muzzle, apparently heavy and fleshy, no front teeth, and the cheek teeth, five above and four below on each side of the jaw, are square prisms, rootless and wearing on the crown into two cross crests. Various species of *Megatherium* have been found in Pleistocene formations all over South America and in North America as far north as Texas and New Jersey. The ancestry of the family is found in the Tertiary of South America. *Megalonyx* and its allies form, according to Stock, a separate group of the sub-family Meg-

atheriidae distinguished by teeth of oval or rounded cross-section and by more primitive characters in the feet. *Megalonyx* has a pair of tusk-like teeth in front, much as in the two-toed sloth (*Choloepus*), and was about as large as an ox. A smaller genus, *Nothrotherium*, lacks the tusk-like front teeth. Both these genera are chiefly known from North America, but are also recorded from South America. Allied, mostly smaller, genera inhabited the larger West Indian islands during the Pleistocene.

(W. D. M.)

MEGHNA, a river of India. It forms, in the lower part of its course, the great estuary of the Bengal delta, which conveys to the sea the main body of the waters of the Ganges and the Brahmaputra. The united waters, turbid and of great depth, are sometimes split into half a dozen channels by sand-banks, sometimes spread into a wide sheet of water. The river enters the sea by four principal mouths, enclosing three large islands. It is navigable by native boats and river steamers all the year; but the navigation is difficult and sometimes dangerous on account of shifting sand-banks and snags, and boisterous weather when the monsoon is blowing. The most favourable season is between November and February. Alluvion and diluvion are constantly taking place, especially along the seaboard. The regular rise of the tide is from 10 to 18 ft., and at springs the sea rushes up in a dangerous bore. It is greatest at the time of the biennial equinoxes, when navigation is sometimes impeded for days together. A still greater danger is the "storm wave" which occasionally sweeps up the Meghna under a cyclone.

MEGIDDO, BATTLES OF, 1918. This is the name usually given to the brilliantly conceived operations whereby Allenby (*q.v.*) broke the Turkish front in Palestine on Sept. 19, 1918, and completed his success by surrounding and rounding up the bulk of the Turkish forces in the next few days. This decisive victory was followed by a pursuit to Damascus and then to Aleppo, which ended with the capitulation of Turkey. For an account of this plan and its execution, *see* PALESTINE, OPERATIONS IN.

MEGIS: *see* CASTE.

MEHADIA, a market town of western Rumania, in the county of Severin, on the railway from Timisoara to Orsova. Pop. (1928), 3,800. The town is the site of the ancient Roman colony *Ad Mediam*, and contains Roman remains. In a narrow rocky ravine nearby in the valley of the Cerna are the famous Hercules Baths (the Roman Thermae or Fontes Herculis), which after falling into disuse, have been again frequented since 1735. There are 22 hot springs, of which nine are in use, the most powerful being the Hercules spring. The springs are all strongly impregnated with salts of sulphur, iodine, bromine and chlorine, and their average temperature is 70° to 145° F.

MEHEMET ALI: *see* MOHAMMED ALI.

MEHIDPUR or **MAHIDPUR,** a town of India, in Indore state of Central India, on the right bank of the Sipra, 24 m. N. of Ujjain. Pop. (1921), 7,062. Though of some antiquity and frequented by Hindu pilgrims, it is best known for the battle fought in the neighbourhood on the 20th of December, 1817, in which Sir John Malcolm defeated the army of Holkar. The result was the Treaty of Mandasor and the pacification of Malwa. There was some sharp fighting here during the Mutiny.

MEHTA, SIR PHEROZESHAH MERWANJI, K.C.I.E. (1845–1915), Indian municipal reformer, was the son of a Bombay merchant. Educated at the Elphinstone college, he was the first Parsee M.A. of Bombay university. He read law at Lincoln's Inn, and was the first Parsee to be called to the English Bar (1868). With Dadabhai Naoroji he founded the organization which grew into the East India Association. Returning to Bombay he rapidly made a name as an advocate. Appointed in 1869 as Justice of the Peace, he served on the new Bombay Corporation from 1872 till his death. He also served for over 30 years on the Bombay legislature. For the last few months of his life he was vice-chancellor of Bombay university. He died in Bombay on Nov. 5, 1915.

See H. P. Mody, *Sir Pherozeshah Mehta*, 2 vol. (1921); also *Rise and Growth of Bombay Municipal Government* (1913), by his most intimate co-worker, Sir Dinshah Edalji Wacha.

MÉHUL, ÉTIENNE HENRI (or ÉTIENNE NICOLAS) (1763–1817), French composer, was born at Givet, Ardennes, on June 24, 1763, of poor parents, and the boy made his way in music with great difficulties. He received much kindness and help from Gluck, but it was only after wearisome disappointments and delays that his *Euphrosine et Coradin* was performed at the Opéra Comique in 1790. His opera of *Stratonice* was also received with enthusiasm in 1792. After several unsuccessful operas, his *Adrien* appeared, and added much to his fame, which was further increased by his three best works, *Le Jeune Henri*, *Uthal* and *Joseph*, in which Méhul's powerful genius is seen at its best. *Uthal* was written for an orchestra without violins. Méhul became one of the four inspectors of the Paris Conservatoire. After writing forty-two operas, besides a number of songs for the festivals of the republic, cantatas, and orchestral pieces of various kinds, his health gave way and he died on Oct. 18, 1817 in Paris. In the sincerity and nobility of his inspiration Méhul showed himself a worthy successor of Gluck.

See Lives by Pougin (1889), Viellard (1859), and Quatremère de Quincey (1818).

MEIDERICH, a town of Germany, since 1905 incorporated with Duisburg, 2½ m. by rail N.E. of Ruhrort, whose river harbour is in great part within its confines. It is first mentioned in 874. Iron and steel works, coal-mines, saw-mills, brickworks, and machine-shops furnish the principal occupations of the inhabitants.

MEIEROVICS, ZIGFRIDS (1887–1925), Latvian statesman, was born on Jan. 24 (O.S.) 1887, the son of a country doctor in Courland, and was educated at the Riga Polytechnic. He first worked in an insurance company and afterwards in an agrarian bank. In Nov. 1918 he became the first foreign minister of independent Latvia and, as delegate to the Peace Conference, he secured Latvia's de jure recognition by the Powers, and, later, her admission to the League of Nations. From 1918 until his death he held office almost continuously as foreign minister and was twice prime minister (1921–23 and 1923–24). He was a delegate to the Genoa Conference (1922). He was killed in a motor accident on Aug. 22, 1925. Meierovics was perhaps the most statesmanlike and the most influential of contemporary Baltic statesmen. He recognized the real problems facing the Baltic States in the years immediately following the World War with probably greater facility and clarity than any of his colleagues in leadership. His foreign policy was based on the conviction that the common interests of Estonia, Latvia and Lithuania demanded co-operation between all the three states.

MEIGHEN, ARTHUR (1874–   ), Canadian statesman, was born at Anderson, in the county of Perth, Ontario, on June 16, 1874, the son of Joseph and Mary Meighen. He was educated at St. Mary's collegiate institute and at Toronto university, and became a barrister-at-law. He married in 1904 Jessie Isabel Cox, daughter of the late Charles Cox of Granby, Quebec. His political career began in 1908 when he was elected to the House of Commons as the Conservative member for Portage la Prairie in the province of Manitoba. In 1913 he became solicitor-general in the Government of Sir Robert Borden; and in Oct. 1917 secretary of state and minister of mines. Later he became minister of the interior. In 1918 he accompanied the Canadian prime minister to England to attend the Imperial Conference, and on Sir Robert Borden's retirement Meighen became prime minister and secretary of state for external affairs on July 10, 1920. In June 1921 he attended the conference of prime ministers in London. Meighen held the office of prime minister until the general elections in 1921, when the Conservative party was defeated; he then became the leader of the Opposition, and for four years was a vigorous opponent of the Liberal Government. He supported the disarmament resolution introduced by the prime minister, Mackenzie King.

The Military Service Act, under which conscription was enforced in 1917, was largely, in so far as its legal preparation was concerned, the work of Meighen, and the vigour with which he supported it in parliament drew upon him the hostility of all those opposed to that measure. As the sentiment against conscription was especially strong in Quebec, the feeling against him

in that province was intense, and prevented the policy of his party from receiving the due consideration of the electors. Meighen consistently repelled the personal attacks made upon him as the enemy of the French Canadians, but without much success. In the elections of 1925 the Conservatives, under the leadership of Meighen, were overwhelmingly victorious in Ontario and the maritime provinces, but with a practically solid Quebec against him it was impossible to obtain a majority, and the Government remained in the hands of the Liberals. In June 1926, on the resignation of Mackenzie King, Meighen took office as premier, but his Government was immediately defeated and a general election took place.

The adoption by the United States of protection, as well as the great industrial development of that country, placed Canada, in Meighen's view, at a disadvantage. He therefore strongly advocated protection for his own country, in order to prevent the United States from capturing the home markets. He was convinced also of the necessity for preserving the natural resources of Canada, particularly the almost unlimited water power so envied by the bordering states, as well as the products of the forests. He resisted all attempts made by the United States to secure for their territories electrical power generated from watercourses in Canada. Meighen made constant efforts to bring about a fusion of the diverse elements in the Canadian population. He was made a member of the Imperial privy council in Oct. 1920.

(A. G. D.)

MEIJI TENNO (Mutsu Hito), Tenno, or Emperor of Japan (1852–1912), was born on Nov. 3, 1852, succeeded his father, Komei Tenno, the former emperor, in Jan. 1867, and was crowned at Osaka on Oct. 31, 1868. The country was then in a ferment owing to the concessions which had been granted to foreigners by the preceding shōgun Iyemochi, who in 1854 concluded a treaty with Commodore Perry by which it was agreed that certain ports should be open to foreign trade.

This convention gave offence to the more conservative daimios, and on their initiative the mikado suddenly decided, in the face of strong opposition, to abolish the shogunate. The reigning shōgun, Keiki, yielded to the decree, but it was only by force of arms that the new order was imposed. The main object of those who had advocated the change was a reversion to the primitive condition of affairs, when the will of the mikado was absolute and when the presence in Japan of the hated foreigner was unknown.

But the reactionary party was not to be allowed to monopolize revolutions. The powerful daimios of Satsuma and Chōshū suddenly declared themselves to be in favour of opening the country to foreign intercourse, and of adopting far-reaching reforms. With this movement Meiji Tenno was cordially in agreement, and he invited foreign representatives to an audience on March 23, 1868. As Sir Harry Parkes, the British minister, was on his way to this assembly, he was attacked by samurai. The outrage was regarded by the emperor and his ministers as a reflection on their honour, and they made reparation. Meanwhile, the emperor, with his advisers, was maturing a political constitution providing for the assumption by the emperor of direct personal rule. As a step in this direction, Meiji Tenno transferred his capital from Kiōtō to Yedo, the former seat of the shōguns' government, and marked the event by renaming the city Tōkyō.

In the same year Meiji Tenno took oath to institute certain reforms, including the establishment of a deliberative assembly. He was supported by the majority of the daimios, who in a supreme moment of patriotism surrendered their estates and privileges to their sovereign. This was the death-knell of the feudalism which had existed for centuries, and gave Meiji Tenno a free hand. A centralized bureaucracy arose, and the nation rapidly progressed. Torture was abolished (1873), and a judicial code, adapted from the Code Napoléon, was authorized. The first railway—from Yokohama to Tōkyō—was opened in 1872; the European calendar was adopted, and English was introduced into school curriculums. In all these reforms Meiji Tenno took a leading part.

There was opposition to such sweeping changes between 1876 and 1884. Three serious rebellions took place in the provinces. These the emperor suppressed; and simultaneously he inflicted a check on the empire of China. As the Chinese government declared itself unable to punish Formosan pirates for outrages committed on Japanese ships (1874), Meiji Tenno landed a force on the island, chastised the bandits, and remained in possession of certain districts until the compensation was paid. The unparalleled advances made by the new government were now held to justify a demand for the revision of the foreign treaties, and negotiations were opened. They failed, and the consequent disappointment gave rise to a strong anti-foreign reaction. Foreigners were assaulted and even the Russian cesarevich, afterwards the Tsar Nicholas II., was attacked in the streets of Tōkyō. A renewed attempt to revise the treaties in 1894 was more successful, and in that year Great Britain concluded a revised treaty with Japan. Other nations followed, and by 1901 all those obnoxious clauses suggestive of political inferiority had disappeared from the treaties. In the same year (1894) war broke out with China. Meiji Tenno reviewed the troops as they left Japan for Korea and Manchuria, and personally distributed rewards to those who had won distinction. In the war with Russia, 1904–5, the same was the case, and it was to the virtues of their emperor that his generals ascribed the Japanese victories.

In his wise patriotism, as in all matters, Meiji Tenno always placed himself in the van of his countrymen. He led them out of feudalism, and lived to see his country advanced to the first rank of nations; and he was the first Oriental sovereign to form an offensive and defensive alliance with a first-rate European power. In 1869 Meiji Tenno married Princess Haru, daughter of Ichijō Tadaka, a noble of the first rank. He had one son and several daughters. Mutsu Hito adopted the epithet of Meiji, or "Enlightened Peace," as the *nengo* or title of his reign. Thus the year 1901, according to the Japanese calendar, was the 34th year of Meiji. He died at Tōkyō on July 30, 1912. He was posthumously styled the Emperor Meïji Tenno, according to the custom of Japan. He was succeeded by his son, Yoshihito.

MEIKTILA, a district in the Mandalay division of Burma. The district lies in the dry zone, but it includes also a strip of the wetter forested Shan hills on the east. Except for this portion it is a slightly undulating plain, with stretches of dark "cotton" soil, but suffering from a low rainfall which is also uncertain. The climate is healthy except in the eastern tracts, though the heat of April, as in Mandalay, is severe—the thermometer rising in the afternoons to over 100° F from March to June. The chief agricultural products are rice (grown on land irrigated by streams from the Shan hills), sesamum, cotton, ground nuts, peas, maize, millet and gram. In the heart of the district is an interesting lake. It is artificial, and according to Burmese legend was begun 2,400 years ago by the grandfather of Gautama Buddha. It is 7 m. long, averages half a mile broad, and covers an area of 3½ sq.miles. With the Minhla and other connected lakes it irrigates a large extent of country.

The area of the district is 2,287 sq.m., and the population (1921), 289,897. The vast majority of the population is Burmese Buddhist. The headquarters town, Meiktila, stands on the banks of the lake, which supplies good drinking water. Pop. (1921), 8,868. A branch railway connects it at Thazi station with the Rangoon-Mandalay line, and continues westward to its terminus on the Irrawaddy at Myingyan. From Thazi, the Shan States railway ascends the hills to the hill-station of Kalaw and the surface of the plateau.

MEINEKE, JOHANN ALBRECHT FRIEDRICH AUGUST (1790–1870), German classical scholar, was born at Soest in Westphalia on Dec. 8, 1790, and died at Berlin on Dec. 12, 1870. He was director of the Joachimsthal gymnasium. His work was mainly done on editing the comic dramatists and the Alexandrine poets.

See monographs by F. Ranke (1871), H. Sauppe (1872), and E. Förstemann in *Allgemeine deutsche Biographie*, xxi. (1885); also Sandys, *Hist. Class. Schol.* (1908), iii. 117.

MEININGEN, a town in the republic of Thuringia, Germany, situated on the right bank of the Werra, 40 m. S. of Eisenach by rail. Pop. (1925) 18,343. Meiningen, which was subject to the bish-

ops of Würzburg (1000–1542), came into the possession of the duke of Saxony in 1583. At the partition of 1660 it fell to the share of Saxe-Altenburg, and in 1680 became the capital of Saxe-Meiningen. The chief building is the Elisabethenburg, or the old ducal palace, containing several collections; it was built mainly about 1680, although part of it is much older. Other buildings are the Henneberger Haus with a collection of antiquities, and the town church, with twin towers, built by the emperor Henry II. in the 11th century. It manufactures chemicals, paper, pottery and machines and has breweries and iron foundries.

MEÏR, Jewish rabbi of the 2nd century, was born in Asia Minor and according to legend was a descendant of the family of Nero. He was the most notable of the disciples of Aqiba (*q.v.*), and after the Hadrianic repressions of A.D. 135 was instrumental in refounding the Palestinian schools at Usha. Among his teachers was also Elisha ben Abuya (*q.v.*), and Meïr continued his devotion to Elisha after the latter's apostasy. He is said to have visited Rome to rescue his wife's sister. His wife, Beruriah, a daughter of the martyr Ḥananiah ben Teradion, is often cited in the Talmud as an exemplar of generosity and faith. Meïr himself was the author of many famous sayings. His wisdom was proverbial, and to him was in particular assigned an intimate acquaintance with fables, and he is reported to have known 300 Fox-Fables. "With the death of Rabbi Meïr," says the Mishnah (*Sota* ix. 15), "Fabulists ceased to be." Meïr contributed largely to the material from which finally emerged the Mishnah. His dialectic skill was excessive, and it was said jestingly of him that he could give 150 reasons to prove a thing clean, and as many more to prove it unclean. His balanced judgment fitted him to carry on Aqiba's work, sifting and arranging the oral traditions, and thus preparing the ground for the Mishnaic Code. Meïr left Palestine some time before his death, owing to disagreements between him and the Patriarch. He died in Asia Minor, but his love for the Holy Land remained dominant to the last. "Bury me," he said, "by the shore, so that the sea which washes the land of my fathers may touch also my bones."

See Bacher, *Agada der Tannaiten*, vol. II. ch. i.; Graetz, *History of the Jews* (Eng. trans.), vol. II. ch. xvi.; *Jewish Encyclopedia* (whence some of the above cited sayings are quoted), viii. 432–435. On Meïr's place in the history of the fable, *see* J. Jacobs, *The Fables of Aesop*, i. cxi., etc. (*See* Index *s.v.*)

MEIRINGEN, the principal village on the Hasle (or the upper Aar) valley in the Swiss canton of Bern. It is situated on the bank of the Aar and is exposed to the south wind (or *Föhn*), and has several times been in great part destroyed by fire (1632, 1879 and 1891). It has 2,996 inhabitants, all German-speaking and Protestants. The village and valley belonged to the emperor, who in 1234 gave the advowson to the Knights of St. Lazarus, by whom it was sold in 1272 to the Austin Canons of Interlaken, on the suppression of whom in 1528 it passed to the state. In 1310 the emperor mortgaged the valley to the lords of Weissenburg, who sold it in 1334 to the town of Bern. The parish church of the 11th century was buried in the beginning of the 14th century by the Alpbach. In 1915 by excavation the ancient church was found underneath the present church. Above the church are the ruins of the mediaeval castle of Resti. Meiringen is frequented by travellers in summer, as it is the meeting-point of many routes: from Interlaken by the lake of Brienz and Brienz, from Lucerne by the Brünig railway (28 m.) and from the upper Valais by the Grimsel Pass (7,100 ft.).

MEIR OF ROTHENBURG (*c.* 1215–1293), German rabbi and poet, was born in Worms *c.* 1215. He played a great part in organizing the Jewish communal life of the middle ages. In 1286 for some unknown reason he was thrown into prison in Alsace, where he remained until his death in 1293. His friends offered to find a ransom, but he declined the suggestion, fearing that the precedent would lead to extortion in other cases. He wrote glosses to the Talmud (*tosaphot*) and many *Responsa* of the utmost value for historical research. Through his disciples Asher ben Yeḥiel and Mordecai ben Hillel, Meir exercised much influence on subsequent developments of Judaism. He was also a liturgical poet. One of his finest elegies is translated in Nina Davis's *Songs of Exile*.

See L. Ginzberg, *Jewish Encyclopedia*, viii. 437–440.

MEISSEN. The mark of Meissen was originally a district centring round the castle of Meissen or Misnia on the Middle Elbe, which was built about 920 by the German king Henry I., the Fowler, as a defence against the Slavs. After the death of Gero, margrave of the Saxon east mark, in 965, his territory was divided into five marks, one of which was called Meissen. In 985 the emperor Otto III. bestowed the office of margrave upon Ekkard I., margrave of Merseburg, and the district comprising the marks of Meissen, Merseburg and Zeitz was generally known as the mark of Meissen. When Ekkard II. died (1046) it was divided, and Meissen proper was given successively to William and Otto, counts of Weimar, and Egbert II., count of Brunswick. Egbert was a rival of the emperor Henry IV. and died under the imperial ban in 1089, when Meissen was bestowed upon Henry I., count of Wettin, but when in turn his son Henry II. died without issue in 1123 Meissen was given by the emperor Henry V. to Hermann II., count of Wintzenburg; but Henry I.'s second cousin Conrad eventually obtained possession of Meissen in 1130. Conrad, called the Great, extended the boundaries of Meissen before abdicating in 1156 in favour of his son Otto, known as the Rich. Otto appointed his younger son Dietrich as his successor and was attacked and taken prisoner by his elder son Albert; but, after obtaining his release by order of the emperor Frederick I., he had only just renewed the war when he died in 1190. During his reign silver mines were opened in the Harz mountains, towns were founded, roads were made, and the general condition of the country was improved. Otto was succeeded by his son Albert, called the Proud, who was engaged in warfare with his brother Dietrich until his death in 1195. As Albert left no children, Meissen was seized by the emperor Henry VI. as a vacant fief of the empire; but Dietrich, called the Oppressed, secured the mark after Henry's death in 1197. Dietrich married Jutta, daughter of Hermann I., landgrave of Thuringia, and was succeeded in 1221 by his infant son Henry, surnamed the Illustrious; who on arriving at maturity obtained as reward for supporting the emperor Frederick II. against the pope a promise to succeed his uncle, Henry Raspe IV., as landgrave of Thuringia. In 1243 Henry's son Albert was betrothed to Margaret, daughter of Frederick II.; and Pleissnerland, a district west of Meissen, was added to his possessions. Having gained Thuringia and the Saxon palatinate on his uncle's death in 1247, he granted sections of his lands to his three sons in 1265, but retained Meissen. A series of family feuds followed.

Eventually, Albert's son Frederick obtained possession of the greater part of the mark, and was invested with it by the German king Henry VII. in 1310. During these years the part of Meissen around Dresden had been in the possession of Frederick, youngest son of the margrave Henry the Illustrious, and when he died in 1316 it came to his nephew Frederick. About 1312 Frederick, who had become involved in a dispute with Waldemar, margrave of Brandenburg, over the possession of lower Lusatia, was taken prisoner. Surrendering lower Lusatia he was released, but it was only after Waldemar's death in 1319 that he obtained undisputed possession of Meissen. Frederick, who was surnamed the Peaceful, died in 1323 and was followed as margrave by his son Frederick II., called the Grave, who added several counties to his inheritance. From this latter Frederick's death in 1349 until 1381 the lands of the family were ruled by his three sons jointly; but after the death of his eldest son Frederick III. in 1381 a division was made by which Meissen fell to his youngest son William I. In 1407 William was succeeded by his nephew Frederick, called the Warlike, who in 1423 received from the emperor Sigismund the electoral duchy of Saxe-Wittenberg. The mark then became merged in the duchy of Saxony.

See F. W. Tittmann, *Geschichte Heinrichs des erlauchten Markgrafen zu Meissen* (Dresden, 1845–46); C. F. von Posern-Klett, *Zur Geschichte der Verfassung der Markgrafschaft Meissen im 13. Jahrhundert* (Leipzig, 1863); O. Posse, *Die Markgrafen von Meissen und das Haus Wettin* (Leipzig, 1881). *See* also *Urkunden der Markgrafen von Meissen und Landgrafen von Thüringen*, edit. by E. G. Gersdorf (Leipzig, 1864); and H. B. Meyer, *Hof- und Zentralverwaltung der Wettiner* (Leipzig, 1902).

MEISSEN, a town of Germany, in the republic of Saxony, on both banks of the Elbe. 15 m. N.W. from Dresden, on the railway to Leipzig via Döbeln. Pop. (1925), 41,516. Meissen was founded about 920 by Henry the Fowler and from 968 to 1581 was the seat of a line of bishops, who ranked as princes of the empire. The town suffered greatly during the various wars of religion. Cölln on the right bank of the Elbe was incorporated with Meissen in 1901. The old town lies on the left bank of the river, between the streams Meisse and Triebisch. Most of its streets are narrow and uneven. The cathedral, one of the finest early Gothic buildings in Germany, stands on the Schlossberg, above the town. It is said to have been founded by the emperor Otto the Great, but the present building was begun in the 13th century and was completed about 1450. A restoration, including the rebuilding of the two towers, was carried out in 1903–08. Adjoining the cathedral is the castle, dating from 1471–83, but restored about 1676, and after 1860. The convent of St. Afra, which stood on the Afraberg, was suppressed by Duke Maurice in 1543, and was by him converted into a school (the Fürsten Schule), one of the most renowned classical schools in Germany, which counts Lessing and Gellert among its former pupils. Other public buildings of interest are the town-hall, built in 1479 and restored in 1875; and the Franciscan church now used as a museum of objects connected with the history of Meissen. Since 1710 Meissen has been the seat of the manufacture of Dresden china. Meissen also contains iron foundries, factories for making earthenware stoves, pottery, glass, pianos, explosives and matches, sugar refineries, breweries and jute works. A considerable trade is carried on in the wine produced in the surrounding vineyards.

MEISSONIER, JEAN LOUIS ERNEST (1815–1891), French painter, was born at Lyons on the 21st of February 1815. He studied in Léon Cogniet's studio. He paid short visits to Rome and to Switzerland, and exhibited in the Salon of 1831 a picture then called "Les Bourgeois Flamands" ("Dutch Burghers"), but also known as "The Visit to the Burgomaster" (at Hertford House, London, with fifteen other examples of this painter). It was the first attempt in France in the particular *genre* which was destined to make Meissonier famous: microscopic painting—miniature in oils. Working hard for daily bread at illustrations for the publishers—Curmer, Hetzel and Dubocher—he also exhibited at the Salon of 1836 the "Chess Player" and the "Errand Boy." He then exhibited with much success the "Game of Chess" (1841), the "Young Man playing the 'Cello" (1842), "The Painter in his Studio" (1843), "The Guard Room," the "Young Man looking at Drawings," the "Game of Piquet" (1845), and the "Game of Bowls"—works which show the finish and certainty of his technique, and assured his success.

Meissonier worked with elaborate care and a scrupulous observation of nature. Some of his works, as for instance his "1807," were ten years in course of execution. He exhibited continuously henceforward, and obtained high prices. His "Cuirassiers," now at Chantilly, was bought from the artist for £10,000, sold at Brussels for £11,000, and finally resold for £16,000. He died in Paris on Jan. 21, 1891.

See Alexandre, *Histoire de la peinture militaire en France* (Paris, 1891); Laurens, *Notice sur Meissonier* (Paris, 1892); Gréard, *Meissonier* (Paris and London, 1897); T. G. Dumas, *Maîtres modernes* (Paris, 1884); Ch. Formentin, *Meissonier, sa vie—son oeuvre* (Paris, 1901); J. W. Mollett, *Illustrated Biographies of Modern Artists: Meissonier* (London, 1882).

MEISSONIER, JUSTE AURÈLE (1693–1750), French goldsmith, sculptor, painter, architect and furniture designer, was born at Turin, but worked in Paris, where he died. His Italian origin and training were probably responsible for the extravagance of his decorative style. Rarely does he leave a foot or two of undecorated space; and because he carried the Baroque style of his day to its extreme he acquired a vast popularity. He not only built houses, but decorated their internal walls; designed the furniture and the candlesticks, the silver and the decanters for the table; and was as ready to produce a snuff-box as a watch case or a sword hilt. His work in gold and silver-plate was often graceful and sometimes bold and original. He was least successful in furniture, where his floral and rocaille motives were overdone. He was appointed by Louis XV. *Dessinateur de la chambre et du cabinet du roi;* designer *pour les pompes funèbres et galantes* and *Orfèvre du roi.*

Knowledge of his work is to be found in his own books of design: *Livre d'ornements en trente pièces; Livre d'orfèvrerie d'église en six pièces,* and *Ornements de la carte chronologique.*

MEISTERSINGER, the name given to the German lyric poets belonging to the artisan and trading classes in the 14th, 15th and 16th centuries. They professed to carry on the traditions of the mediaeval Minnesingers (*q.v.*), regarding as the founders of their gild 12 of the greater poets of the Middle High-German period. They cultivated their art in so-called Meistersinger schools, the oldest of which is said to have been established at Mainz early in the 14th century. In that century there were such schools at Mainz, Strasbourg, Frankfurt, Würzburg, Zürich and Prague; in the 15th at Augsburg and Nuremberg, the last becoming in the following century, with Hans Sachs, the most famous of all.

Each gild numbered various classes of members, ranging from beginners, or *Schüler* and *Schulfreunde,* to *Meister,* a *Meister* being a poet who was not merely able to write new verses to existing melodies but had himself invented a new melody. The poem was technically known as a *Bar* or *Gesetz,* the melody as a *Ton* or *Weis.* The rules of the art were set down in the so-called *Tabulatur* or law-book of the gild. The meetings took place either in the Rathaus, or town hall, or, when they were held—as was usually the case—on Sunday, in the church; and three times a year singing competitions were instituted. At such competitions or *Schulsingen* judges were appointed, the so-called *Merker,* who criticized the competitors and noted their offences against the rules of the *Tabulatur.*

The literary value of the Meistersinger poetry was hardly in proportion to the large part it played in the life of the German towns of the 15th and 16th centuries. To these plain burghers poetry was a mechanical art that could be learned by diligent application, and the prizes they had to bestow were the rewards of ingenuity, not of genius or inspiration. Consequently we find an extraordinary development of strophic forms corresponding to the many new "tones" which it was the duty of every Meistersinger to invent. The verses were adapted to the musical strophes by a merely mechanical counting of syllables, regardless of rhythm or even sense. But the Meistersinger poetry, if not great or even real poetry, held—especially with a genuine poet like Hans Sachs—promise for the future. It reflected without exaggeration or literary veneer the faith of the German burgher, his blunt good sense and honesty of purpose. The Meistergesang reached its highest point in the 16th century; and it can hardly be said to have outlived that epoch, although the traditions of the Meistersinger schools lingered much longer in south German towns.

Bibliography.—Specimens of Meistersinger poetry will be found in various collections, such as J. J. Görres, *Altdeutsche Volks- und Meisterlieder* (1817); K. Bartsch, *Meisterlieder der Kolmarer Handschrift* (1862). Of our older sources of information the most important are Adam Puschmann, *Gründlicher Bericht des deutschen Meistergesangs* (1571; reprinted 1888), and J. C. Wagenseil, *Von der Meistersinger holdseligen Kunst* (Altdorf, 1697). *See* further O. Lyon, *Minne- und Meistergesang* (1882); K. Mey, *Der Meistergesang in Geschichte und Kunst* (2nd ed., 1901); W. Nagel, *Studien zur Geschichte der Meistersänger* (1909). The Meistersingers have been immortalized by Richard Wagner in his music drama, *Die Meistersinger von Nürnberg* (1868), which gives an excellent idea of the pedantic procedure of their schools. (J. G. R.)

MEITHEI, the principal tribe inhabiting the valley of Manipur in Assam; probably of mixed origin and related to the Kuki and Naga tribes, the Ao in particular, also probably to the Syntengs and Kacharis. They have a culture probably Shan in origin, though never Buddhist, and Hinduized in the first half of the 18th century A.D. They are great rice-growers, fishermen and horse-breeders; polo and hockey are national games and boat-racing an annual pastime. The head of the people is a Maharaja, under whom is a judicial body known as the Chirap court; the State is divided into administrative areas called *lam,* each with central and village officials. The ancient civil and military organization

was by functional divisions like that of the Ahoms. There are seven patrilineal exogamous clans, and marriage into the mother's clan is forbidden for one generation. Head-hunting was practised until Hinduism became general, before which the Meithei were meat-eaters and buried their dead. They now burn them and have an institution called *singlup*—a sort of burial club for ensuring the provision of wood for the cremation of contributors. In spite of the Hindu religion animistic beliefs and practices are strong. *Maiba* and *maibi*—Medicine-men and -women—are numerous and popular; forms of ancestor-worship, traces of snake-worship, witchcraft, tabu, vampires, whose astral bodies devour men's livers, all flourish, and animistic deities are worshipped no less than orthodox Hindu gods. Indeed, a special custodian of ancient godlings holds one of the most prominent religious posts.

The Maharaja is the divine head of the State, both religious and secular, and is the chief rain-maker. Like the Ahom princes he has a human "scapegoat" provided on certain occasions to take on him all his (the Maharaja's) guilt.

The language spoken is Tibeto-Burman and allied to the Kuki tongue. There is an archaic form of the language, now incomprehensible, and though the present script is derived from the Bengali, there is a tradition that the Chinese first taught them writing.

See T. C. Hodson, *The Meithei* (1908). (J. H. H.)

MEKNÈS: *see* MEQUINEZ.

MEKONG or ME NAM KONG (pronounced *Kawng*), sometimes known as the Cambodia River, the great river of Indo-China, having its origin in the Tibetan highlands. It is one of the longest rivers in Asia. It is about 2,800 m. in length, of which 1,200 flow through portions of the Chinese Empire and Tibet and 1,600 through French territory. Its sources are supposed to rise on the slopes of Dza-Nag-Lung-Mung in about 33° N., 93° E., at an altitude of 16,700 ft. above sea-level. Throughout the greater part of its course in Tibet, where it is called the Dza-Chu, it flows south-eastwards to Chiamdo, on the great east and west caravan route from China to Lhasa. At this point it is about 10,000 ft. above sea-level. From here it flows southwards through little-known mountain wastes. Below Dayul in lat. 29° it is known by the Chinese name of Lantsan Kiang. For the next 300 m. of its course the Lantsan Kiang, or, as it soon becomes known among the Thai peoples inhabiting its rugged valley, the Mekong, is very little known to us. The river flows beneath bare and rocky walls with the speed of a mountain torrent, although at its exit from Chinese territory its width reaches 300 to 400 yds. In 25° 18′ N. the Tali-Bhamo caravan route crosses the river by an iron suspension bridge at a height of 4,700 ft. above sea-level. From this point to Chieng or Keng Hung, the head of the old confederacy of the Sibsawng Punna or Twelve States, it is little known; the fact that it falls some 900 ft. for each degree of latitude indicates the character of the river, the course of which is constantly deviated by the varying directions of the mountainous massifs through which it passes. Under the provisions of the Anglo-French agreement of January 1896, from the Chinese frontier southwards to the mouth of the Nam Hok the Mekong forms the frontier between the British Shan States on the west and the territories acquired from Siam by France in 1893. By the treaty of 1893, from that point southwards to about 13° 30′ N. it is also the frontier between French Indo-China and Siam. Between the Siamese Shan town of Chieng Sen and Luang Prabang it is joined by some important tributaries: the Nam Beng, the Nam-Hou and the Nam-Khan. This portion is obstructed by rapids. From Luang Prabang the river cuts its way for two degrees through a lonely jungle country among receding hills of low elevation. From Chieng Khan the river forces its way through its most serious rapid-barrier, and receives some important tributaries from the highlands of Tung Chieng Kum and Chieng Kwang, the finest country in Indo-China. In 104° E. the river resumes its course through a country thinly peopled. At Kemarat (16° N.) the fourth serious rapid-barrier occurs, some 60 m. in length, and the last at Khong in 14° N. From here to its outfall in the China Sea the river winds for some 400 m. through the French territories of Cambodia, where it divides into three arms, and Cochin China, regions formed of the alluvium of the delta which is ceaselessly gaining on the sea. In origin a mountain stream, it becomes swollen at the melting of the snows. As a plateau river it is increased from June to October by the rains brought by the S.W. monsoon. From October to May it occupies only a portion of its bed. In the plain and delta part of its course, it floods, with its muddy waters, Cambodia and Cochin China, which owe to it their fertility. The French have done much to render the river navigable.

MELA, POMPONIUS (*fl. c.* A.D. 43), the earliest Roman geographer. His little work (*De situ orbis libri III.*) is a mere compendium, occupying less than one hundred pages of ordinary print, dry in style and deficient in method, but of pure Latinity, and occasionally relieved by pleasing word-pictures. Excepting the geographical parts of Pliny's *Historia naturalis* (where Mela is cited as an important authority) the *De situ orbis* is the only formal treatise on the subject in classical Latin. Nothing is known of the author except his name and birthplace—the small town of Tingentera or Cingentera in southern Spain, on Algeciras Bay (Mela ii. 6, § 96; but the text is here corrupt). The date of his writing may be approximately fixed by his allusion (iii. 6 § 49) to a proposed British expedition of the reigning emperor, almost certainly that of Claudius in A.D. 43.

Pomponius is unique among ancient geographers in that, after dividing the earth into five zones, of which two only were habitable, he asserts the existence of *antichthones*, inhabiting the southern temperate zone inaccessible to the folk of the northern temperate regions from the unbearable heat of the intervening torrid belt. In general he follows earlier classical geographers. But he defines the western coast-line of Spain and Gaul and its indentation by the Bay of Biscay more accurately than Eratosthenes or Strabo, and his ideas of the British Isles and their position are also clearer than his predecessors'. He is the first to name the Orcades or Orkneys, which he defines and locates pretty correctly. Of northern Europe his knowledge was imperfect, but he speaks vaguely of a great bay ("Codanus sinus") to the north of Germany, among whose many islands was one, "Codanovia," of pre-eminent size; this name reappears in Pliny as "Scandinavia."

The first edition of Mela was published at Milan in 1471; the first good edition was by Vadianus (Basel, 1522), superseded by those of Voss (1658), J. Gronovius (1685 and 1696), A. Gronovius (1722 and 1728), and Tzschucke (1806–07), in seven parts (Leipzig; the most elaborate of all); G. Parthey's (Berlin, 1867), gives the best text. The English trans. by Arthur Golding (1585), is famous; modern English translation by Philipp (1912). *See* also E. H. Bunbury, *Ancient Geography*, ii. 352–368, and D. Detlefsen, *Quellen und Forschungen zur alten Gesch. und Geog.* (1908).

MELAMPUS, a legendary seer and physician, son of Amythaon and Eidomene, brother of Bias, and eponym of the family of the Melampodidae. Two young serpents, whose life he had saved, licked his ears while he slept, and from that time he understood the language of birds and beasts. In the art of divination he received instruction from Apollo himself. To gain the consent of Neleus, king of Pylos, to the marriage of his daughter Pero with Bias, Melampus undertook to obtain possession of the oxen of the Thessalian prince Iphiclus. As Melampus had foretold, he was caught and imprisoned, but was released by Phylacus (the father of Iphiclus) on giving proof of his powers of divination, and was finally presented with the oxen as a reward for having restored the virility of the son. Melampus subsequently obtained a share in the kingdom of Argos in return for having cured the daughters of king Proetus. He was worshipped at Aegosthena in the Megarid. In his character of physician, he was the reputed discoverer of the herb melampodium, a kind of hellebore. (*See* Roscher's *Lexikon, s.v.*)

Melampus is also the name of the author of a treatise on Divination by means of Palpitation (Παλμῶν) and Birthmarks (Ἐλαιῶν), probably of the third century B.C. Edition by J. G. Franz in *Scriptores physiognomiae veteres* (1780).

MELANCHLAENI [from Gr. μέλας, and χλαῖνα, "Black-cloaks"], an ancient tribe which dwelt to the north of Scythia, probably about the modern Ryazan and Tambov (Herodotus iv. 20, 107). They have been identified with the Finnish tribes Merja

(extinct) and Cheremis, now driven north-east on to the middle Volga.

MELANCHTHON, PHILIPP (1497–1560), German theologian and reformer, was born at Bretten in Baden on Feb. 16, 1497. His father, George Schwartzerd, was an armourer under the Palatinate princes. His mother, Barbara Reuter, a niece of Johann Reuchlin, was shrewd, thrifty and affectionate. Reuchlin took an interest in the boy, and, following a contemporary custom, named him Melanchthon (the Greek form of Schwartzerd, black earth). In October 1509 he went to Heidelberg, where he took the B.A. degree, afterwards proceeding M.A. at Tübingen. The only other academic distinction he accepted was the B.D. of Wittenberg (1519). The elector of Saxony called him to Wittenberg as professor of Greek in 1518.

Wittenberg became the school of the nation; the scholastic methods of instruction were set aside, and in a *Discourse on Reforming the Studies of Youth* Melanchthon gave proof, not only that he had caught the Renaissance spirit, but that he was fitted to become one of its foremost leaders. He began to lecture on Homer and the Epistle to Titus. Luther received a fresh impulse towards the study of Greek, and his translation of the Scriptures, begun as early as 1517, now made rapid progress, Melanchthon helping to collate the Greek versions and revising Luther's translation. Melanchthon felt the spell of Luther's personality.

Melanchthon was first drawn into the arena of the Reformation controversy through the Leipzig Disputation (June 27–July 8, 1519), at which he was present. He had been reproved by Johann Eck for giving aid to Carlstadt, and was soon afterwards himself attacked by Eck. Melanchthon replied in a brief and moderately worded treatise, setting forth Luther's first principle of the supreme authority of Scripture in opposition to the patristic writings on which Eck relied. His marriage in 1520 to Catharine Krapp of Wittenberg gave a domestic centre to the Reformation. In 1521, during Luther's confinement in the Wartburg, Melanchthon was leader of the Reformation cause at the university.

With the arrival of the Anabaptist enthusiasts of Zwickau, he wavered. Their attacks on infant baptism seemed to him not altogether irrational, and in regard to their claim to personal inspiration he said "Luther alone can decide; on the one hand let us beware of quenching the Spirit of God, and on the other of being led astray by the spirit of Satan." In the same year, 1521, he published his *Loci communes rerum theologicarum,* the first systematized presentation of the reformed theology. From 1522 to 1524 he was busy with the translation of the Bible and in publishing commentaries. In 1524 he went for reasons of health into southern Germany and was urged by the papal legate Campeggio to renounce the new doctrines. He refused, and maintained his refusal by publishing his *Summa doctrinae Lutheri.*

After the first Diet of Spires (1526), where a precarious peace was patched up for the reformed faith, Melanchthon was deputed as one of twenty-eight commissioners to visit the reformed states and regulate the constitution of churches, he having just published a famous treatise called the *Libellus visitatorius,* a directory for the use of the commissioners. At the Marburg conference (1529) between the German and Swiss reformers, Luther was pitted against Oecolampadius and Melanchthon against Zwingli in the discussion regarding the real presence in the sacrament. How far the normally conciliatory spirit of Melanchthon was here biased by Luther's intolerance is evident from the exaggerated accounts of the conference written by the former to the elector of Saxony. He was at this time even more embittered than Luther against the Zwinglians. At the Diet of Augsburg (1530) Melanchthon was the leading representative of the Reformation, and it was he who prepared for that diet the seventeen articles of the Evangelical faith, which are known as the "Augsburg Confession." He held conferences with Roman divines appointed to adjust differences, and afterwards wrote an *Apology for the Augsburg Confession.*

After the Augsburg conference further attempts were made to settle the Reformation controversy by a compromise, and Melanchthon, from his conciliatory spirit and facility of access, appeared to the defenders of the old faith the fittest of the reformers to deal with. His historical instinct led him ever to revert to the original unity of the church, and to regard subsequent errors as excrescences rather than proofs of an anti-Christian system.

The year after Luther's death, when the battle of Mühlberg (1547) had given a seemingly crushing blow to the Protestant cause, an attempt was made to weld together the Evangelical and the papal doctrines, which resulted in the compilation by Pflug, Sidonius and Agricola of the Augsburg "Interim." This was proposed to the two parties in Germany as a provisional ground of agreement pending the decision of the Council of Trent. Melanchthon, on being referred to, declared that, though the Interim was inadmissible, yet so far as matters of indifference (*adiaphora*) were concerned it might be received.

The fact is that Melanchthon sought, not to minimize differences, but to veil them under an intentional obscurity of expression. Thus he allowed the necessity of good works to salvation, but not in the old sense; proposed to allow the seven sacraments, but only as rites which had no inherent efficacy to salvation, and so on. He afterwards retracted his compliance with the adiaphora, and never really swerved from the views set forth in the *Loci communes.* His later years were occupied with controversies within the Evangelical church, and fruitless conferences with his Romanist adversaries. He died in his sixty-third year, on April 19, 1560, and his body was laid beside that of Martin Luther in the Schlosskirche at Wittenberg.

His ready pen, clear thought and elegant style, made him the scribe of the Reformation, most public documents on that side being drawn up by him. He never attained entire independence of Luther, though he gradually modified some of his positions from those of the pure Lutherism with which he set out. His development is chiefly noteworthy in regard to these two leading points —the relation of the *evangelium* or doctrine of free grace (1) to free will and moral ability, and (2) to the law and *poenitentia* or the good works connected with repentance. At first Luther's cardinal doctrine of grace appeared to Melanchthon inconsistent with any view of free will; and, following Luther, he renounced Aristotle and philosophy in general, since "philosophers attribute everything to human power, while the sacred writings represent all moral power as lost by the fall." In the first edition of the *Loci* (1521) he held, to the length of fatalism, the Augustinian doctrine of irresistible grace, working according to God's immutable decrees, and denied freedom of will in matters civil and religious alike.

In the Augsburg Confession (1530), which was largely due to him, freedom is claimed for the will in non-religious matters, and in the *Loci* of 1533 he calls the denial of freedom Stoicism, and holds that in justification there is a certain causality, though not worthiness, in the recipient, subordinate to the Divine causality. In 1535, combating Laurentius Valla, he did not deny the spiritual incapacity of the will *per se,* but held that this is strengthened by the word of God, to which it can cleave. The will cooperates with the word and the Holy Spirit. Finally, in 1543, he says that the cause of the difference of final destiny among men lies in the different method of treating grace which is possible to believers as to others. Man may pray for help and reject grace. This he calls free will, as the power of laying hold of grace. Melanchthon's doctrine of the three concurrent causes in conversion, viz., the Holy Spirit, the word and the human will, suggested the semi-Pelagian position called Synergism, which was held by some of his immediate followers.

In regard to the relation of grace to repentance and good works, Luther was disposed to make faith itself the principle of sanctification. Melanchthon, however, for whom ethics possessed a special interest, laid more stress on the law. He began to do this in 1527 in the *Libellus visitatorius,* which urges pastors to instruct their people in the necessity of repentance, and to bring the threatenings of the law to bear upon men in order to instil faith. This brought upon him the opposition of the Antinomian Johannes Agricola. In the *Loci* of 1535 Melanchthon sought to put the fact of the co-existence of justification and good works in the believer on a secure basis by declaring the latter necessary to eternal life, though the believer's destiny thereto is already fully

guaranteed in his justification. In the *Loci* of 1543, he did not retain the doctrine of the necessity of good works in order to salvation, and to this he added, in the Leipzig Interim, "that this in no way countenances the error that eternal life is merited by the worthiness of our own works." Melanchthon was led to lay more and more stress upon the law and moral ideas; but the basis of the relation of faith and good works was never clearly brought out by him, and he at length fell back on his original position, that we have justification and inheritance of bliss in and by Christ alone, and that good works are necessary by reason of immutable Divine command.

Bibliography.—The principal works of Melanchthon, with the bulk of his correspondence, are contained in the *Corpus reformatorum* (vols. i.–xxviii.; Halle, 1834–50), edited by Bretschneider and Bindseil, to which must be added Clemens's *Supplementa Melanchthoniana* (1910 *seq.*), and his *Briefe* (vol. i., 1926) (Halle, 1874). Melanchthon's earliest and best biographer was his friend Joachim Camerarius (1566), a new annotated edition of which is much needed. The best modern life is that by Georg Ellinger (Berlin, 1902); next is that of Karl Schmidt (Elberfeld, 1861). The celebration in 1897 of the 400th anniversary of Melanchthon's birth produced many short biographies and *Festreden*, among them works by J. W. Richard (New York and London, 1898); George Wilson (London, 1897); Karl Sell (Halle, 1897); Ferdinand Cohrs (Halle, 1897); Beyschlag and Harnack (1897). Richard Rothe's *Festrede* (1860) also is good. The most learned of modern Melanchthon scholars was probably Karl Hartfelder, who wrote *Philipp Melanchthon als Praeceptor Germaniae* (Berlin, 1899); *Melanchthoniana paedagogica* (Leipzig, 1892), giving in the first named two full bibliographies, one of all works written on Melanchthon, the other of all works written by him (in chronological order).

MELANESIA, one of the three great divisions of the oceanic islands in the central and western Pacific. It embraces the New British Archipelago, north-east of New Guinea, the Louisiade, Solomon, Santa Cruz, New Hebrides and Loyalty islands, New Caledonia, Fiji and intervening small groups. The name (Gr. *μέας*, black, and *νῆσος*, island) is derived from the black colour of the prevailing native race, the Papuan and its allied tribes. (*See* Pacific Islands.)

ANTHROPOLOGY

A large element of Papuan origin (*see* Papuans) is found in the population of Melanesia. There have, however, been several movements through Melanesia of stocks from Indonesia and the main land. Some of these stocks were themselves of mixed origin before contact was established with the Papuan elements found by them on their arrival. The population is, therefore, not homogeneous and exhibits considerable variation. The heads are usually long, but here and there are round-headed groups. The stature varies from short to medium. The forehead is commonly rounded and the brow ridges are not usually prominent. The nose is generally broad and is sometimes straight, and smaller than in the Papuan. The hair is of the woolly type and is sometimes curly or wavy. The skin is sometimes very dark, shading to copper coloured.

Social Organisation.—Four kinds of social systems are found in Melanesia. Dual organisation with matrilineal descent is now found only in the Banks islands, Northern New Hebrides and perhaps one part of the Solomon islands. It may, however, have had a much wider extension. Then there are groups organised in totemic clans which are exogamic and matrilineal in one or two parts. Local exogamy is found in Murlav and perhaps elsewhere, while the clan system is found in the western Solomons and one or two other islands where marriage is regulated solely by kinship.

Secret Societies.—An important feature of Melanesian society is the secret societies which are found in the Torres and Banks islands, in the Northern New Hebrides. Some indications are found in New Caledonia; in Fiji they occur in the interior and again definitely in the Bismarck Archipelago. With the exception of Fiji the societies are associated with matrilineal descent and are most developed where dual organisation is found. The institution known as the *men's house* is here as elsewhere a prominent feature of secret societies. The use of masks is also important and it is suggested that the organisation of secret societies is in part due to the desire of immigrants to keep their magical processes hidden from the aborigines, because their supremacy rested on the superiority of their magic to that of the previous inhabitants. In one island, that of Mota, there are 77 societies with various sub-divisions. It is believed that the members represent ghosts, probably spirits of the dead. Societies own marks which are used to protect property. The importance of this institution from an economic aspect, therefore, is considerable.

Chiefs.—In certain cases the status of chief is conditioned by the reputation of the individual or by his rank in the men's club house, and in other cases definite hereditary patrilineal chiefship is found.

Adoption.—An interesting feature is the habit of adoption, which complicates social structure and may start quite early. In Mota, a new-born infant becomes the child of the man who pays the chief helper or midwife. The sisters of the father settle who shall be the midwife so that the father has a good chance of claiming his child as his own. The real father recovers his child under difficult conditions. The real mother would nurse the child. Cases of adult adoption are also permitted and associated with them is the practice of exchanging names. Whether there is evidence for communism in respect of children indicating a prior communism over their mothers is not clear; the vicissitudes of Melanesian history are totally hid from us.

Totemism.—An extended form is found in the Santa Cruz area. Elsewhere it has undergone modification. In several groups is found the belief in descent from the totem animals, from human beings closely identified with them.

Funeral Rites.—In one area Fox has recorded the presence of no less than twenty-one methods of disposing of the dead, wherein are traced the effects of contacts with various cultures of religious beliefs and of social distinctions.

Religion.—There are gods and nature spirits but the most prominent concept is undoubtedly that of Mana (*q.v.*). Magic is used to further private ends, for economic purposes as in garden culture and hunting. Knowledge of the right magical formulae is as essential to the canoe builder as knowledge of the correct engineering formulae is to the naval architect.

Head Hunting is most developed in the W. Solomon Is., hardly present in the matrilineal area and completely absent from S. Melanesia. It was of very great importance in the social life of the people, essential in the completion of a new house, the launching of a new canoe, garden cultivation and religious ritual. With its suppression enterprise has been diminished, the zest of life has gone and the deterioration of the people has been accelerated. The intricate investigations made by Malinowski into the Economics of the Trobriand Islanders reveal the existence of a complicated system of trade and the circulation of special kinds of articles.

Bibliography.—Codrington, *The Melanesians* (1891); W. H. R. Rivers, *History of Melanesian Society* (1914); C. G. Seligman, *The Melanesians of New Guinea;* B. Malinowski, *The Argonauts of the Western Pacific;* C. E. Fox, *The Threshold of the Pacific.*

MELANISM, the prevalence of black coloration in animals normally of lighter colour. Conspicuous among these is the black leopard, fairly common in the Malay peninsula, which in certain lights shows a pattern like black waved silk. Black cats, dogs and horses are examples of melanism, which is described, rather than explained, by attributing it to the presence of the black pigment, melanin. In the United States melanistic varieties of the gray squirrel are found occasionally in the east, more commonly about the Great Lakes. In England the peppered moth (*Anthydasis detularia*), normally marked by scattered black dots, has a melanistic variety, which is now becoming common in the smoky districts of the Black Country. Kindred phenomena are albinism (whiteness) and erythrism (redness), the latter appearing in the ruddy phases of some owls. All three tendencies are illustrated among domestic pigeons. (*See* Pigments of Skin and Hair.)

MELASTOMACEAE, a large family of dicotyledonous plants, comprising 200 genera and 2,590 species, nearly all tropical and sub-tropical. The family is represented in the eastern and southern United States by about 10 species of Rhexia (meadow-beauty). A few yield dyes and many are cultivated for their ornamental flowers. Some species live in harmony with ants, the

ants finding shelter within the plant, which is thus protected from the ravages of the leaf-cutter ants. (*See* MEADOW-BEAUTY; SOCIAL INSECTS.)

MELBA [NELLIE PORTER ARMSTRONG] (1861–), British operatic soprano, *née* Nellie Porter Mitchell, was born at Burnley, near Melbourne, Australia, her father being a contractor, of Scottish blood. She sang at a local concert when six years old, and was given a good musical education. In 1882 she married Captain Charles Armstrong, and in 1886 went to study singing in Paris under Mathilde Marchesi. In 1887 she made her début in opera at Brussels, taking the stage-name of Melba from her connection with Melbourne. In the next year she sang the part of Lucia, which remained one of her famous rôles, at Covent Garden, London; and, though critics complained of her coldness as an actress, her liquid voice and brilliant execution henceforth made her famous as the greatest successor to Patti, in pure vocalization, on the operatic stage. She maintained this position for over twenty years, her triumphs being celebrated in every country.

See the "authorized" biography by Agnes G. Murphy (1909); H. P. Armstrong, *Madame Melba, Melodies and Memories* (1925).

MELBOURNE, WILLIAM LAMB, 2ND VISCOUNT (1779–1848), English statesman, second son of Peniston Lamb, 1st viscount Melbourne, and Elizabeth Milbanke. William Lamb was born on March 15, 1779, and educated at Eton and Trinity college, Cambridge. He was called to the bar at Lincoln's Inn in 1804, and in 1805, he contracted his ill-starred marriage with Lady Caroline Ponsonby, only daughter of the 3rd earl of Bessborough.

In 1806 he entered parliament for Leominster as a Whig. He was defeated at the polls in 1812 because of his support of Catholic emancipation, and did not return to the House until 1816, when he was elected for Northampton, and later for other constituencies. In the meantime he attempted a separation from his wife in 1813, but this was not accomplished until 1825. In his relations with her he showed the greatest forbearance and kindness. He found refuge from his domestic troubles in extensive reading and in sport.

In parliament he spoke rarely, and, occasionally, voted against his party. Canning made him Irish secretary in 1827, and he retained the post under the duke of Wellington's administration; but he resigned with other Canningites in 1828. In 1829 he succeeded to his father's peerage, and went to the House of Lords. In Lord Grey's ministry of 1830 he was home secretary. He declined to use extraordinary means to deal with widespread disturbance, preferring to rely on the ordinary law, though pressure was put on him by the king to promote special legislation against political unions. He was, as home secretary, the responsible cabinet minister for the government of Ireland, and there he approved a policy of coercion which was not desired by the lord-lieutenant, Lord Wellesley. The difficulties arising over Irish policy led to the resignation of the Grey ministry (1834), and Melbourne was asked to form a ministry. He proceeded to reconstruct the late ministry. Internal dissensions in his cabinet on the Irish and other questions were serious, and the king dismissed his ministers in November. Melbourne was determined that a new Whig cabinet should not include Brougham, Durham, and O'Connell, and he objected to the negotiations conducted with O'Connell, whom he regarded as irreconcilable.

In April 1835 the Peel government resigned, and Melbourne formed his second government, hampered by the smallness of his majority in the Commons and by the king's hostility. The difficulties were aggravated by his appearance as co-respondent in the case of Norton v. Norton and Melbourne. (*See* NORTON, CAROLINE.) Melbourne and Mrs. Norton were acquitted (June 23, 1836); they were not even called on to make a defence. Difficulties with the king increased, and probably the ministry would have fallen but for his death on June 20, 1837. At the general election the ministry secured a majority. Melbourne at once assumed the duties of confidential adviser to the young queen Victoria. He spent much of his time at Windsor, accommodating his very worldly manners and his usually free conversation to the atmosphere of the new court. For his great, and beneficial influence on the young queen *see* VICTORIA, QUEEN. He never abused the intimacy thus formed, but, says Greville, used it to impress upon her mind sound maxims of constitutional government and truths of every description which it behoved her to learn. He showed her unceasing and understanding devotion, and secured her sincere attachment. The administration was still hampered by difficulties in Ireland, and in Canada, where Melbourne was not entirely in agreement with Lord Durham's policy. The ministry resigned on May 7, 1839. Peel refused to form a ministry because of the resistance of the queen on the Bedchamber question. Melbourne resumed office in deference to the queen and against his better judgment. The ministry was thoroughly discredited, and Palmerston, the foreign secretary, had involved the ministry in difficulties with France. Parliament was dissolved at the end of May 1841, and Melbourne resigned when the new parliament met at the end of August. He died on Nov. 24, 1848.

See W. McC. Torrens, *Memoirs of Lord Melbourne* (1878); Lloyd Sanders, *Lord Melbourne's Paper* (1889). There is an admirable sketch of Melbourne in Greville's *Memoirs*, and another in Lytton Strachey's *Queen Victoria*. *See also* Newman, *Lord Melbourne* (1930).

MELBOURNE, the capital of Victoria, Australia, and from 1901–1927 the seat of the Commonwealth Government, situated on Port Phillip in about the central south of the State, forms, with Sydney, one of the leading cities of the Commonwealth and of the southern hemisphere. Its growth from a small settlement, made near the mouth of the Yarra in 1835 by two groups of pioneers from Tasmania, to its present status is impressive and, in some respects, typical of the development of south-eastern Australia. The series of irregular and ancient block-plateaux which, aligned east and west, form the "Great Dividing Range" (*q.v.*) in Victoria is separated from another and more recent (Jurassic) line of heights (Cape Otway–Buln Buln hills) along the south coast by a long, and probably down-faulted, trough—the "Great Valley of Victoria." Near the centre severer subsidence has produced a series of coalescing basins (Port Phillip, Western Port, Middle Yarra, etc.), which together form a large area of lowland. In the centre Port Phillip (approximately 40 miles north-south; rather less east-west; area *c.* 800 square miles) penetrates to the very rim of the central plateau area and has a long extension reaching westwards (Corio Bay) on which stands Geelong. Thus from east-south-east to west-south-west Melbourne is girdled on its north side and at a distance of about 35 miles by a rim of plateau-like highlands (av. elevation on north-east *c.* 3,000 ft.; on north-west, *c.* 2,000 ft. with some volcanic bosses *e.g.*, Mount Macedon, 3,324 ft.), in which the Kilmore Gap (1,145 ft.) forms a significant break. On the southern sector the lowlands lead eastwards into Gippsland and westwards to the south-west (basalt) plains, while on the south Port Phillip has an opening little more than two miles wide having two channels (carrying 36 ft. and 40 ft. of water respectively), in which southerly winds and ebb-tide produce rough and choppy seas ("The Rip"). Upon the basin converge various streams (Saltwater, Werribee, etc.), the most important being the Yarra Yarra, which, with its tributary the Plenty, rises in the north-east highlands and flows into Hobson's Bay at the head of Port Phillip. Early Melbourne was laid out as a rectangular block on and along the northern banks of the Yarra *c.* 7 miles from its mouth and 2 miles (air-line) from the shore of the Bay. Here it occupied pleasantly hilly ground. But the city has long since expanded in all directions, northwards to form Brunswick, Fitzroy, Collingwood, etc.; eastwards to Kew, Richmond, Hawthorn, Camberwell, etc.; southwards to Prahran and especially along the shore of Port Phillip (St. Kilda, Brighton, etc.); on the west to Footscray, etc. On the north shore of Hobson's Bay Port Melbourne has arisen, while on the south-western promontory of the same bay, Williamstown is also important as a harbour. Greater Melbourne (founded in 1925), which includes all the districts within a radius of ten miles from the centre of the city (165,666 ac.), has a population (1927–28) of 975,200, or nearly 56% of the total population of the State. (*Cf.* 1901, 496,000 = 41·3%; 1911, 593,000 = 45·1%; 1921, 783,000 = 51·1%.) In the growth thus indicated geographical factors have played an important part. The railway net of Victoria sufficiently

reveals the reach and concentrating power of Melbourne as a financial and business centre and as a port. (The first railway in Australia was built from Melbourne to Port Melbourne in 1854.) Besides its immediate basin, rich in its agricultural and dairying industries, the fertile plains of southern and western Gippsland and the varied mineral, agricultural and pastoral lands of the western highlands and their southern slopes drain naturally to the city. Beyond these the broad wheat-lands of the north-west (Wimmera), and through the invaluable Kilmore Gap, the whole of the central Murray valley and central southern New South Wales (*e.g.*, Deniliquin) are also tapped by Melbourne with a wide fan-work of lines. Through the Kilmore Gap goes also the overland line to Albury and Sydney (*qq.v.*), tapping the north-western flanks of the Australian Alps and competing with Sydney for the trade of the Riverina (*q.v.*). Melbourne has no such barriers as hem in Sydney, and the occupation of its basin, followed by the opening up of the goldfields and the agricultural and pastoral development of the State in general, have contributed to its growth and long made it the most populous city in Australia.

While lacking hitherto ready sources of power (*cf.* imports of coal from New South Wales), Melbourne has nevertheless developed a considerable amount of the varied manufactures natural to a port (milling and food-preparation; leather, wool, wood and iron working industries, etc., carried on in *e.g.*, Port Melbourne and Footscray). The abundant supply of cheap electrical power now available (*see* VICTORIA) should do much to stimulate this side of Melbourne's activity and further industrial expansion may be anticipated. Her climate, prevailingly cool and invigorating with warm and sunny summers—(av. ann. temps. 67°–49·5° F, with occasional hot days—up to 110° F—and hot north winds ["brick-fielders"] in summer and occasional winter frosts; av. ann. rainfall: 25½ in.; 2,260 hours of sunshine per ann.)—together with her sturdy British stock has also helped to give Melbourne an air of solid and sober prosperity and of measured progress. The city proper—the "Square Mile City"—is solidly, even impressively, built and contains numerous fine streets (Collins, Bourke, Flinders, etc.) geometrically laid out and adorned with numerous massive buildings, though the narrowness of the "lanes" (about 45 ft. broad) interspaced between the larger streets (99 ft.) is a difficulty tending to increasing congestion of road traffic. A good water-supply (Yan Yean, Upper Yarra, etc. supply schemes), excellent electric tram and (suburban) train services, some 6,250 acres of parks and reserves (including fine Botanic Gardens), watering-places (St. Kilda, Brighton, etc.), the deepened and regulated Yarra with its gardens and drives, the Flemington race-course with its famous Melbourne Cup, and remoter holiday resorts in the hills, are amongst the amenities and conveniences of the city which possesses also many notable public and semi-public buildings (Government House; Houses of Parliament and Government Offices, two Cathedrals, University, Technological Museum, and numerous others). In addition to its highly concentrated facilities for banking, warehousing and trading, Melbourne possesses over 11 miles of wharfage (55,000 ft. berthing space) with accompanying modern port equipment. Williamstown is the main overseas cargo port, Port Melbourne that for the (mail and passenger) liners, while the Yarra, deepened and straightened by the Coode Canal, has the largest wharfage space (*c.* 30,500 ft. including the Victoria Dock) and is used by interstate vessels. Depths alongside range from 17–32 ft. and there are three dry docks, floating docks, patent slips and facilities for repairing. The southern entrance to Port Phillip is being dredged to 36 ft. and considerable sums are continually being spent on the enlargement, deepening and improvement of the docks and shipping accommodation in general. Melbourne's total trade for the two past years (1925–26 and 1926–27) has amounted to 5,000,000–5,250,000 tons (exports = 1,500,000 tons). About half of this total trade was "overseas," as distinct from interstate and New Zealand trade, and was valued at £78,000,000–£83,000,000 in the two years respectively. Exports are predominantly the primary produce of the State (wheat, flour, dairy produce, fruits, cattle products, and wool—Melbourne deals with 35% of the total wool export of Australia). Imports, besides manufactured and other goods from abroad, include coal (1926: 971,000 tons). The shipping—4,000 vessels annually with tonnage of 6–7,000,000 tons—includes vessels which call twice on their way to and from Sydney.

MELCHERS, (JULIUS) GARI (1860–   ), American artist, was born at Detroit (Mich.), on Aug. 11, 1860. The son of a sculptor, at seventeen he was sent to Düsseldorf to study art under von Gebhardt, and after three years went to Paris, where he worked at the Académie Julien and the École des Beaux Arts. Attracted by the pictorial side of Holland, he settled at Egmond. His first important Dutch picture, "The Sermon," brought him honourable mention at the Paris Salon of 1886. He became a member of the National Academy of Design, New York; the Royal Academy of Berlin; Société Nationale des Beaux Arts, Paris; International Society of Painters, Sculptors and Engravers, London, and the Secession Society, Munich. Besides portraits, his chief works are: "The Supper at Emmaus," in the Krupp collection at Essen, "The Family," National Gallery, Berlin, "Mother and Child," Luxembourg, the decoration at the Congressional Library, Washington, "Peace and War." His portrait of Charles Hutchinson is in the Art Institute, Chicago, and his portrait of President Roosevelt in the Freer collection of the Smithsonian Institution, Washington (D.C.).

MELCHETT, ALFRED MORITZ MOND, VISCOUNT (1868–   ), British politician, was born at Farnworth, near Widnes, Lancs. on Oct. 23, 1868, the son of the famous chemist Ludwig Mond (*q.v.*). He was educated at Cheltenham and St. John's college, Cambridge, and afterwards at Edinburgh University. In 1894 he was called to the bar, and afterwards joined the North Wales and Chester circuit. He entered the firm of Brunner, Mond and Co., becoming a director in 1895, and subsequently chairman of the Mond Nickel Co. and a director of the South Staffordshire Mond Gas Co. and various other companies. He was elected to Parliament in 1906 as Liberal member for Chester, losing his seat in 1910, but the same year was elected for Swansea and created a baronet. In 1913 he was sworn of the privy council. On the formation of Lloyd George's Ministry in 1916 Alfred Mond became first commissioner of works, and in 1921 minister of health. He lost his seat at the general election of 1923, but was returned for Carmarthen in October 1924. In January 1926, owing to his profound disagreement with the principles embodied in Lloyd George's land policy, Alfred Mond seceded from the Liberal party and transferred his allegiance to the Conservative party. Mond was created a peer, with the title of Viscount Melchett in 1928. In 1928, he organized the "Mond Conference," at which problems relating to industrial reorganization and industrial relations were discussed by a group of employers, headed by Lord Melchett, and the T.U.C. General Council. The first report of the Conference, which appeared in July, 1928, embodied a proposal for the establishment of a National Industrial Council, whose functions would be to further Britain's industrial progress, (a) by consultation, (b) by the establishment of suitable machinery for research and conciliation. He published many articles on the alkali trade in scientific and economic journals, besides a volume of essays, *Questions of To-day and To-morrow* (1912).

MELCHIADES or MILTIADES (other forms of the name being Meltiades, Melciades, Milciades and Miltides), pope from July 2, 310, to Jan. 11, 314. He appears to have been an African by birth. The toleration edicts of Galerius and of Constantine and Licinius were published during his pontificate, which was also marked by the holding of the Lateran synod in Rome (313) at which Caecilianus, bishop of Carthage, was acquitted of the charges brought against him and Donatus condemned. Melchiades was preceded and followed by Eusebius and Silvester I. respectively.

MELCHITES, the name given in the 5th century to those Christians who adhered to the creed supported by the authority of the Byzantine emperor. The Melchites therefore are those who accept the decrees of Ephesus and Chalcedon as distinguished from the Nestorians and Jacobite Church (*qq.v.*). Their name literally means "Royalists" from the Syriac *Melcha*, a king. They number about 80,000 and are found in Syria and Egypt.

MELCHIZEDEK, king of Salem and priest of "supreme El" who brought forth bread and wine to Abraham on his return from the expedition against Chedorlaomer, and blessed him in the name of the supreme God, receiving from Abraham tithes of his booty (Gen. xiv. 18–20). Biblical tradition tells us nothing more about Melchizedek (*cf.* Heb. vii. 3); but the majestic figure of this pre-Mosaic king-priest to whom even the father of all Israel paid tithes suggested a figurative or typical application: (1) in Psalm cx. to the vicegerent of Yahweh, the king of Israel who is also priest after the order of Melchizedek; and (2) after the Gospel had ensured the Messianic interpretation of the Psalm (Matt. xxii. 42 *seq.*), to the kingly priesthood of Jesus, as that idea is worked out at length in the Epistle to the Hebrews. The name may mean "king of righteousness."

MELCOMBE, GEORGE BUBB DODDINGTON, BARON (1691–1762), English politician (known as "Bubb Doddington"). His father's name was Bubb, but the son took the name of Doddington on inheriting a large property from an uncle of that name. He was educated at Oxford. In 1715 he was returned to parliament for Winchelsea, and was sent as envoy extraordinary to Spain. From 1722 to 1754 he sat in parliament for Bridgewater; from 1724 to 1740 was a lord of the treasury; and, in 1744 and in 1755 was treasurer of the navy. In 1761 he was raised to the peerage as Baron Melcombe of Melcombe Regis in Dorsetshire. He died at Hammersmith on July 28, 1762. He was a wit and a good scholar; Thomson's "Summer" was dedicated to him, Fielding addressed to him an epistle and Edward Young a satire. He was a leading spirit of the "Hell-fire" Club, whose members, called "Franciscans," from their founder Sir Francis Dashwood (d. 1781), held their revels in the ruined Cistercian abbey of Medmenham, Bucks.

His interesting diary appeared in 1784 (4th ed. 1828). *See* L. Sanders, *Patron and Place-Hunter: A Study of George Bubb Doddington* (1919).

MELDOLA, RAPHAEL (1849–1915), British chemist, was born at Islington on July 19, 1849. Educated at the Royal School of Mines, he became a lecturer at the Royal College of Science in 1873, and subsequently professor of chemistry at Finsbury Technical college in 1885, having spent eight of the intervening years at the Atlas Colour works, Hackney Wick, London. He was elected a fellow of the Royal Society in 1886, and died in London on Nov. 16, 1915.

Meldola's chief researches lay in the field of triphenyl methane dyes, but as a great deal of this was carried out whilst he was engaged in a chemical works, it was not published; his published work deals mainly with naphthalene and azo compounds. He made the first oxazine dyestuff ("Meldola's blue") in 1879, and also the dye called "Alkali blue xG" which has become important, under various names, for cotton dyeing. During the course of his life he urged the importance of the application of chemistry to industrial processes. He was also interested in biological questions, such as the colouring of butterflies and animals, and, in fact, his first published paper was on a natural history subject.

See *Raphael Meldola, Reminiscences of his Worth and Work* (edit. J. Marchant, 1916), with list of his publications; also obituary notice, *Proceedings of the Royal Society*, vol. xciii. (1916–17).

MELEAGER, in Greek Μελέαγρος, son of Oeneus, king of Calydon, and his queen Althaea. Oeneus, says Homer (*Il.*, ix. 529 ff.), forgot to sacrifice to Artemis when offering hecatombs to the other gods; she, in wrath, sent a great boar to ravage his land. Meleager gathered a band of huntsmen from many cities and killed the beast. Then arose a quarrel over the spoils between the Calydonians and the Curetes, which resulted in war. At first the Calydonians had the better of it; but presently Althaea's brother was killed (apparently by Meleager), and she cursed her son; he, in high dudgeon, refused to take any further part in the war, until the Curetes' missiles were striking the chamber in which he lay; then at last he yielded to the entreaties of his wife Cleopatra. At some time after defeating the enemy and before the Trojan war he died, Homer does not say how (*Il.*, ii. 642). Later tradition adds the following romantic details. One of the hunters was Atalanta (*q.v.*); Meleager was for giving her the spoils, because she was the first to wound the boar; his mother's brothers objected, and in the ensuing quarrel were killed by him. Now when he was born, his mother had overheard the Fates saying that he should live as long as a brand then on the fire was unconsumed; she had always kept this safely, and now threw it on the fire, and Meleager wasted away and died as it consumed. Althaea herself died, of grief or by her own hand, and Meleager's sisters so mourned for him that they were turned into *meleagrides* (guinea-fowl).

See H. J. Rose, *Handbook of Greek Mythology* (1928; bibl.).

MELENDEZ VALDÉS, JUAN (1754–1817), Spanish poet, became a professor at Salamanca, but the success of his poems (1785) induced him to resign his chair and try his fortune in politics. The friendship of Jovellanos obtained for him in 1789 a judgeship at Saragossa, whence he was transferred two years later to a post in the chancery court at Valladolid. On the fall of Jovellanos in 1798 Melendez Valdés was exiled from the capital; he returned in 1808 and accepted office under Joseph Bonaparte. He had previously denounced the French usurper in his verses. He now outraged the feelings of his countrymen by the grossest flattery of his foreign master, and in 1813 he fled to Alais. Four years later he died in poverty at Montpellier. In natural talent and in acquired accomplishment Melendez Valdés was not surpassed by any contemporary Spaniard; he failed from want of character, and his profound insincerity affects his poems. Yet he has fine moments in various veins, and his imitation of Jean Second's *Basia* is notable.

MELETIUS OF ANTIOCH (d. 381), Catholic bishop and saint, was born at Melitene in Lesser Armenia of wealthy and noble parents. He first appears (*c.* 357) as a supporter of Acacius, bishop of Caesarea, the leader of that party in the episcopate which supported the *Homoean* formula by which the emperor Constantius sought to effect a compromise between the Homoeusians and the Homousians. Meletius thus makes his début as an ecclesiastic of the court party, and as such became bishop of Sebaste in succession to Eustathius, deposed as an Homousian heretic by the synod of Melitene. The appointment was resented by the Homoeusian clergy, and Meletius retired to Beroea. According to Socrates he attended the synod of Seleucia in the autumn of 359, and then subscribed the Acacian formula. Early in 360 he became bishop of Antioch, in succession to Eudoxius, who had been raised to the see of Constantinople. Early in the following year he was in exile for uncertain reasons.

The successor of Meletius was Euzoeus, who had fallen with Arius under the ban of Athanasius. In Antioch itself Meletius continued to have adherents, who held separate services in the "Apostolic" church in the old town. The synod of Alexandria sent deputies to attempt an arrangement between the two anti-Arian churches; but before they arrived Paulinus had been consecrated bishop by Lucifer of Calaris, and when Meletius reached the city, he found himself one of three rival bishops. Twice, in 365 and 371 or 372, Meletius was exiled by decree of the Arian emperor Valens. Meletius had been more and more approximating to the views of the newer school of Nicene orthodoxy. Basil of Caesarea, throwing over the cause of Eustathius, championed that of Meletius who, when after the death of Valens he returned in triumph to Antioch, was hailed as the leader of Eastern orthodoxy. As such he presided, in Oct. 379, over the synod of Antioch, in which the dogmatic agreement of East and West was established; he helped Gregory of Nazianzus to the see of Constantinople and consecrated him; he presided over the second oecumenical council at Constantinople in 381. He died soon after the opening of the council. His body was carried to Antioch and buried with the honours of a saint.

Meletius was a holy man, whose ascetic life was all the more remarkable in view of his great private wealth. He was also a man of learning and culture, and widely esteemed for his honourable, kindly and straightforward character. He is venerated as a saint and confessor in both the Roman Catholic and Orthodox Eastern churches.

See the article G. F. Loofs in Herzog-Hauck, *Realencyklopädie* (ed 1897, Leipzig), xii. 552, and authorities there cited.

MELETIUS OF LYCOPOLIS (4th century), founder of the sect known after him as the "Meletians," or as the "Church of the Martyrs," in the district of Thebes in Egypt. With Peter, archbishop of Alexandria, he was thrown into prison during the persecution under Diocletian. He refused to receive, at least until the persecution had ceased, those Christians who during the persecutions had renounced their faith, and then repented. This refusal led to a breach with Peter, and other Egyptian bishops who were willing to grant absolution to those who were willing to do penance for their infidelity. Meletius, after regaining his freedom, held his ground and attracted many supporters, extending his influence even so far away as Palestine. He ordained 29 bishops and encroached upon Peter's jurisdiction. The Council of Nicaea in 325 upheld the bishops, but Meletius was allowed to remain bishop of Lycopolis though with merely nominal authority. His death followed soon after. His followers took part with the Arians in the controversy with Athanasius, and existed as a separate sect till the 5th century.

See Achelis in Herzog-Hauck, *Realencyk.* xii. (1903) 558, with the authorities there quoted, and works on Church History.

MELFI, a city and episcopal see, Basilicata, Italy, province of Potenza, 30 m. N. of Potenza, by rail, on the lower slopes of Monte Vulture, 1,591 ft. above sea-level. Pop. (1921), 12,671. The castle first erected by Robert Guiscard, is mainly the work of the Doria family, who have possessed it since the time of Charles V.; the cathedral founded in 1153 by Robert's son, Roger (though it retains its campaniles) was restored after the earthquake of 1851, when the town was ruined, over one thousand people perishing. In the town hall is a fine Roman sarcophagus found 6 m. W. of Venosa.

Melfi was made the capital of Apulia by the Normans (1041). The councils of Nicholas I. in 1059, of Urban II. in 1089, the rebellion against Roger in 1133 and the subsequent punishment, the plunder of the town by Barbarossa in 1167, the attack by Richard, count of Acerra, in 1190, and the parliament of 1223, in which Frederick II. established the constitution of the kingdom of Naples, are the chief dates in the annals of Melfi. In 1348 it was captured by the king of Hungary, who transferred it to Conrad the Wolf. In 1392 Goffredo Marzano was made count of Melfi; but Joanna II. granted the lordship to the Caracciolo family, and they retained it till the time of Charles V. An obstinate resistance was offered by the city to Lautrec de Foix in 1528; and his entrance was followed by the massacre of 18,000 people.

See G. de Lorenzo, *Venosa e la regione del Vulture* (Bergamo, 1906, well illustrated).

MELICERTES, the son of the Boeotian prince Athamas and Ino, daughter of Cadmus. Ino, pursued by her husband, who had been driven mad by Hera because Ino had brought up the infant Dionysus, threw herself and Melicertes into the sea from a high rock between Megara and Corinth. Both were changed into marine deities—Ino as Leucothea, Melicertes as Palaemon. The body of the latter was carried by a dolphin to the Isthmus of Corinth and deposited under a pine tree. Here it was found by his uncle Sisyphus, who had it removed to Corinth, and by command of the Nereids instituted the Isthmian games and sacrifices in his honour. It is uncertain whether Μελικέρτης is Greek ("Honey-cutter," *i.e.*, Bee-keeper, perhaps a minor deity presiding over apiculture) or Phoenician (Melgart). In either case, it is not easy to see why he should be called Παλαίμων (Wrestler) or why his legend is Boeotian and his cult Isthmian. At Rome, he was sometimes identified with Portunus (*see* NEPTUNE).

See Toutain in Daremberg and Saglio's *Dictionnaire des antiquités;* Stoll in Roscher's *Lexikon der Mythologie;* and L. R. Farnell *Greek Hero-Cults* (1921).

MELILLA, chief town of a Spanish military circumscription and the seat of an important garrison, on the north-east coast of Morocco, south of Cape Tres Forcas and 135 m. E.S.E. of Ceuta. The old town is built on a huge rock connected with the mainland by a rocky isthmus. The new town is built on the west and the south; it has an entirely European and modern aspect. The equipment of the port, completed in 1914, and the occupation of the country behind it by Spain have meant a rapid development of the town, which numbered hardly 3,000 inhabitants in 1895 and has to-day 40,000, of which 36,000 are Spaniards. The rich mines of Beni-bou-Ifrour, situated 16 km. from Melilla, with which they are linked by railway, give rise to an important trade (900,000 tons of haematite and 7,000 tons of lead and zinc).

The Phoenicians, then the Carthaginians and the Romans, had a settlement at Melilla, which was called *Rusaddir.* A Berber town succeeded it; it was conquered in 1470 by Spain, and has not ceased since then to belong to it. Melilla was, with Ceuta, the most important of the ports or *presidios* which Spain revived on the coast of Morocco, but until the beginning of the 20th century it remained closed and the history of the town is one long series of sieges, of which the last, that of 1893, necessitated an army of 25,000 men. In 1909, Gen. Marina, after a hard campaign, occupied the massif of Gorougou and the hinterland of Melilla, and the Spaniards made themselves masters of the whole region between Oued Kert and Moulouya. In 1921, the tribes of the Riff, in revolt under the leadership of Abd-el-Krim, inflicted upon them a costly defeat and pressed them back to the walls of Melilla. The east Riff was reoccupied in 1926 following the Franco-Spanish campaign which determined the submission of Abd-el-Krim.

See Gabriel de Morales, *Datos para la historia de Melilla* (Melilla, 1909); Budgett Meakin, *The Land of the Moors* (1901), ch. xix., and the authorities there cited.

MÉLINE, FELIX JULES (1838–1925), French statesman, was born at Remiremont on May 20, 1838. He entered the chamber of deputies in 1872, and in 1880 became one of the leaders in the demand for the protection of French industries; he had a considerable share in fashioning the protectionist legislation of the years 1890–1902. Méline was minister for agriculture (1883–85), president of the chamber (1888–89), and premier and minister for agriculture (1896–98). He was elected to the Senate in 1903, and from 1915 to December 1916 was again minister for agriculture. At one time he edited *La République française* (1893–1902). He wrote *Le Retour à la terre et la surproduction industrielle, tout en faveur de l'agriculture* (1905).

MELIORISM, in philosophy, a term given to that view of the world which believes that at present the sum of good exceeds the sum of evil and that, in the future, good will continually gain upon evil (Lat. *melior*, better). The term is said to have been invented by George Eliot to express a theory mediating between optimism and pessimism. The pragmatic movement in philosophy which puts stress upon the duty and value of effort is naturally favourable to the melioristic view: the best things that have been said recently in favour of it are found in books such as William James's *Pragmatism.*

See also J. Sully, *Pessimism,* 1877.

MELITO, bishop of Sardis, a Christian writer of the 2nd century, mentioned by Eusebius (*Hist. Eccl.* iv. 21) along with Hegesippus, Dionysius of Corinth, Apollinaris of Hierapolis, Irenaeus, and others, his contemporaries, as a champion of orthodoxy and upholder of apostolic tradition. The extant fragments of his works have been edited by Routh (*Reliquiae sacrae,* vol. i., 1814). These show that Melito took much part in the paschal, Marcionite and Montanist controversies.

It seems more than doubtful whether the *Apologia* of Melito "the Philosopher," discovered in a Syriac translation by Henry Tattam (1789–1868), and subsequently edited by W. Cureton and by Pitra-Renan, ought to be attributed to this writer and not to another of the same name. The Κλείς (clavis), edited by Pitra-Renan, is a much later Latin collection of mystical explanations of Scripture. *See* A. Harnack, *Texte und Untersuchungen,* i. 240–278 (Leipzig, 1882); Erwin Preuschen, *s.v.* "Melito" in Herzog-Hauck, *Realencyklopädie,* xii., 1903, giving full list of works and bibliography.

MELKSHAM, a town in Wiltshire, England, 95¼ m. W. of London by the G.W.R. Pop. of urban district (1931) 3,881. Melksham possesses rubber factories. On the discovery of a saline spring in 1816, baths and a pump-room were opened; but although two other springs were found later, the attempt to create a health resort failed. The surrounding deer-forest was often visited by Edward I. Lacock Abbey, 3 m. distant, was founded in 1232 for Austin canonesses, and dissolved in 1539. Portions of the monastic

buildings remain in and near the modern mansion called Lacock Abbey. The church preserves some remnants of Norman work and a Perpendicular south chapel.

MELLITIC ACID, first discovered in 1709 by M. H. Klaproth in the mineral honeystone (mellite), occurring in peat and brown coal; this is aluminium mellitate, $C_{12}O_{12}Al_2,18H_2O$, the acid being benzenehexacarboxylic acid, $C_6(CO_2H)_6$. The honeystone is warmed with ammonium carbonate, ammonia being added to precipitate alumina. The filtrate on concentration yields ammonium mellitate which is converted through the lead salt into mellitic acid, crystallising in colourless silky needles soluble in water, alcohol or ether. Mellitic acid decomposes indefinitely when heated in an open tube, but in a closed tube it melts at 286–8° C. It is best prepared by the oxidation of finely divided carbon by prolonged boiling with nitric acid (sp.gr. 1·5). When heated with benzoyl chloride, mellitic acid yields mellitic anhydride $C_6(C_2O_3)_3$ or $C_{12}O_9$, separating in colourless crystals insoluble in cold water. Ammonium mellitate when heated at 150–160° C furnishes a mixture of mellimide or "paramide," $C_6(C_2O_2{:}NH)_3$, and ammonium euchroate,

$$(C_2O_2{\cdot}NH)_2C_6(CO_2{\cdot}NH_4)_2.$$

Dry distillation of mellitic acid gives rise to pyromellitic acid, $C_6H_2(CO_2H)_4$, with evolution of carbon dioxide.

MELLITUS (d. 624), first bishop of London and third archbishop of Canterbury, was sent to England by Gregory the Great in 601. He was consecrated by St. Augustine before 604, and a church was built for him in London by Aethelberht, king of Kent. About ten years later the East Saxons reverted to heathenism and the bishop was driven from his see. He took refuge in Kent and then in Gaul, but soon returned to England, and in 619 became archbishop of Canterbury in succession to Laurentius. He died on April 24, 624.

See general bibliography in *Camb. Med. Hist.* (vol. 2, 1913).

MELLON, ANDREW WILLIAM (1855–), American banker and public official, was born in Pittsburgh, Pa., on March 24, 1855, and was educated at Western university (now University of Pittsburgh). He entered the banking house of Thomas Mellon and Sons, which later developed into the Mellon National Bank, the Union Trust Company and the Union Savings Bank, all of Pittsburgh; was president of the Mellon National Bank, Pittsburgh, and officer or director in various financial and industrial corporations, and also engaged in development of many industrial enterprises. He resigned as president of the Mellon National Bank on March 1, 1921, to assume office as secretary of the Treasury in the cabinet of President Harding (March 4, 1921), remaining in that office under President Coolidge. He was chairman ex-officio of the Federal Reserve board, Farm Loan board, War Finance corporation, United States section of the Inter-American high commission; director-general of railroads; and chairman of the Pennsylvania delegation to the Republican National Convention at Cleveland, O., on June 10, 1924.

As chairman ex-officio of the World War foreign debt commission, Mellon had a large share in formulating the policy of the United States in regard to funding the war debts of foreign Governments owed to the U.S. Government. He stressed the importance of debtor nations preserving the sanctity of their respective obligations, but laid down that no nation can be asked to pay another Government sums in excess of its normal capacity, and, further, that no settlement which is oppressive and retards the recovery and development of the foreign debtor or produces a bad effect on the standard of living is to the best interests of the United States or of Europe. In this spirit he conducted negotiations with the various European debtor States which resulted in funding agreements being arrived at with Belgium, Czechoslovakia, Estonia, Finland, France, Great Britain, Hungary, Italy, Latvia, Lithuania, Poland, Rumania and Yugoslavia. The principal obligations funded under these various agreements amounted to $9,811,094,094.03, in addition to funded interest of $1,711,259,905.97.

In the management of the large internal debt of the U.S. Government resulting from the World War, Mellon was equally successful. He laid down and rigidly adhered to a policy of providing for debt redemption annually out of current revenues. As the floating debts and the Liberty Loans fell due they were in part paid off, in part refunded at a lower rate of interest. As a result the U.S. national debt fell from $25,738,000,000 on June 30, 1921, to $17,604,000,000 on June 30, 1928. Mellon was a strong advocate also of tax reduction, especially in the case of the surtax rates on incomes, maintaining that these should not in peace times exceed a maximum of 10%. Congress gradually lowered the income tax rate until in 1926 the maximum surtax was reduced to 20%, yet without any corresponding reduction in tax receipts. Mellon, who has written for this *Encyclopædia,* is the author of *Taxation; The People's Business* (1924). He was continued in office under President Hoover.

See Philip H. Love, *Andrew Mellon: The Man and His Work* (1929).

MELLONI, MACEDONIO (1798–1854), Italian physicist, was born at Parma on April 11, 1798. From 1824 to 1831 he was professor at Parma, but he was then compelled to escape to France, having taken part in the revolution. In 1839 he went to Naples and was soon appointed director of the Vesuvius observatory, a post which he held until 1848. Melloni was a member of foreign learned societies and was awarded the Rumford medal of the Royal Society. He died at Portici near Naples of cholera on Aug. 11, 1854. Melloni's reputation as a physicist rests especially on his discoveries in radiant heat, made with the aid of the thermopile, invented by L. Nobili and perfected by him. His experiments were especially concerned with the power of transmitting infra red rays possessed by various substances and with the changes produced in the heat rays by passage through different materials. He showed that heat and light were very similar. Melloni coined the word "diathermancy" to denote transparency to heat. He measured the diathermancy of a large number of solids and liquids. His most important book, *La thermocrose ou la coloration calorifique* (vol. i., Naples, 1850), was unfinished at his death. He studied the reflection and polarization of radiant heat, the magnetism of rocks, electrostatic induction, etc.

MELODRAMA, the name of several species of dramatic composition. It was first applied to a form of dramatic musical composition in which music accompanied the spoken words and the action, but in which there was no singing. The first example of such a work has generally been taken to be the *Pygmalion* of J. J. Rousseau, produced in 1775. This is the source of romantic dramas depending on sensational incident with exaggerated appeals to conventional sentiment rather than on play of character. At first the music was of some importance, but this gradually disappeared, and if it remains it is used mainly to emphasize particularly strong situations, or to bring on or off the stage the various principal characters. Such plays first became popular in France at the beginning of the 19th century. One of the most prolific writers of melodramas was R. C. G. de Pixericourt (1773–1844). The *Silver King,* in which Henry Arthur Jones collaborated, is one of the best known of English melodramas. Another form of melodrama developed on lines which laid more emphasis on the music and belongs to the history of opera. Probably the first of this type is to be found in Georg Benda's *Ariadne auf Naxos* (1774). The most familiar of such melodramas is Gay's *Beggar's Opera.* In these the dialogue is entirely spoken. It may be noticed that the speaking of parts of the dialogue is not sufficient to class an opera as a "melodrama" in this sense, as is proved by the spoken grave-digging scene, accompanied by music, in *Fidelio,* and the incantation scene in *Der Freischütz.* To this the English term "declamation" is usually applied. (*See* OPERA.)

MELODY is the organization of successive musical sounds in respect of pitch (Gr. μελῳδία, a choral song, from μέλος, tune, and ᾠδή, song). In its most primitive state it already requires Rhythm (*q.v.*); but it can develop freely without the aid of Harmony, which removes it into a wider category. Thus a "melodic scale" is a scale that is not based on an harmonic system; and thus we call ancient Greek music "melodic." The popular conception of melody as "tunefulness" is modern and depends on symmetries of harmony and rhythm that seldom occur in recorded music before the 17th century, and are accidental, if frequent, potentialities in older folk-music. For us a melody is

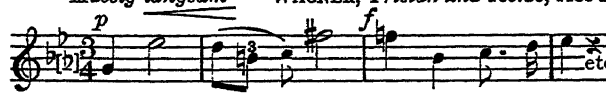
Ex. 1. Non-harmonic melody; a bag-pipe tune refractory to any harmonization beyond drones on A and E.

"MacRimmon's Lament."

*The F♯ is very flat and the G decidedly sharp.

Ex. 2. Unaccompanied melody with harmonic draughtsmanship capable of expressing an enharmonic modulation (F♯=G♭).

Mässig langsam WAGNER, *Tristan und Isolde*, Act I



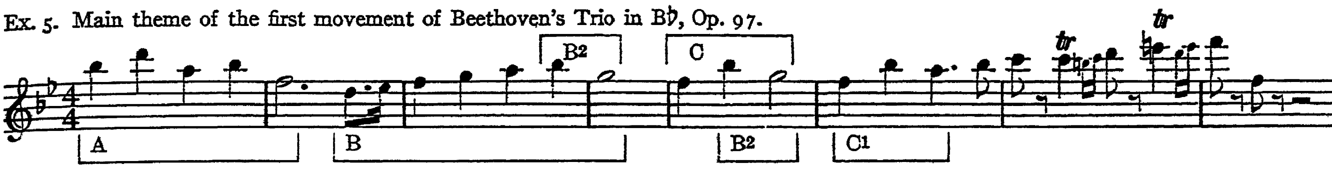
Westwärts schweift der Blick; ostwärts streicht das Schiff.

Ex. 3. *"Barbara Allen"* (showing the germ of binary form in the balance between A¹ on the dominant and A² on the tonic).

Ex. 4. Melody in keyboard polyphony, requiring two parts to complete the sense.

BACH. *Das Wohltemperirte Klavier II. Fugue 15.*

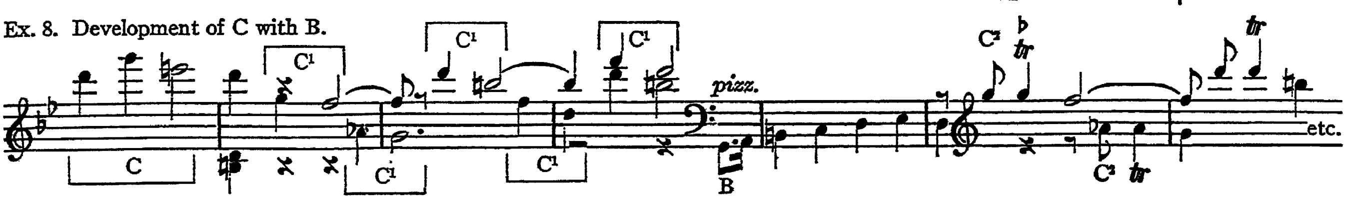
Ex. 5. Main theme of the first movement of Beethoven's Trio in B♭, Op. 97.



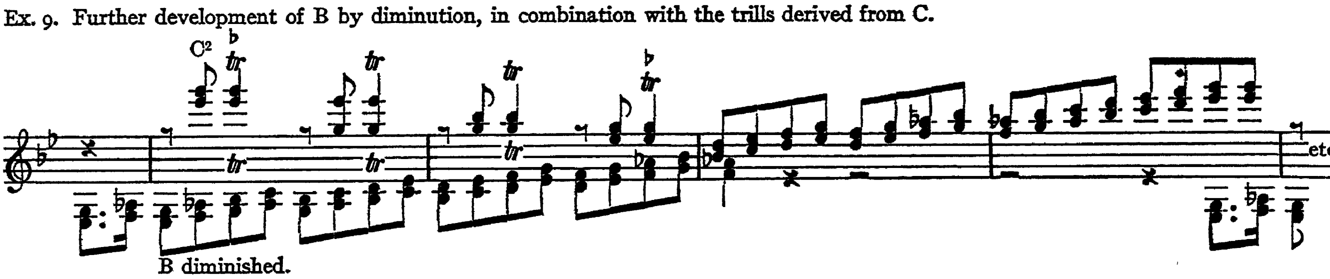
Ex. 6. Figure A of above developed in a new polyphonic 4-bar phrase.

Ex. 7. Further sequential developments of A.

Ex. 8. Development of C with B.



Ex. 9. Further development of B by diminution, in combination with the trills derived from C.



Ex. 10. Further development of B by diminution and contrary motion (inversion).

Ex. 11.

BRAHMS, *Quintet, Op. 34.*

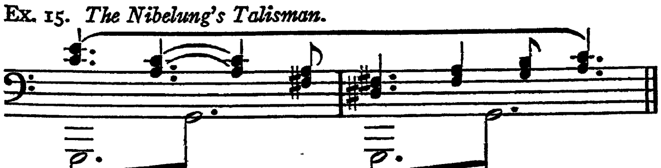
Ex. 12. A and B² diminished.

Ex. 13.

Ex. 14. *The Rheindaughter's Toy.*

WAGNER, *Das Rheingold.*

Ex. 15. *The Nibelung's Talisman.*



Ex. 16. *Walhalla.*

the surface of a series of harmonies, and an unaccompanied melody that fails to imply clear harmonies is felt to be strange and vague (*see* Ex. 1 and 2). Harmonic rationality and symmetrical rhythm thus combine to make a tuneful melody an epitome of musical form. The historical process is from the smaller to the greater. See SONATA FORMS for the gradations between such melodic forms as that of *Barbara Allen* (Ex. 3) and the larger dance forms of the suite, and for the gradation between these and the true dramatic forms of the sonata. Lastly, the most narrowly melodic element, the rise and fall of pitch, is a capacity of the human voice, and in later forms is enlarged not less by the characteristics of instruments than by rhythm, harmony and form. Thus modern melody is the musical surface of rhythm, harmony, form and instrumentation; and, if we take Wagnerian *Leitmotif* into account, we may as well add drama to the list. In short, melody, whether it be in an inner part or on the top, is the surface of music.

An immense number of musical resources are manifested on the melodic surface; and the following definitions and illustrations will be found to cover a very wide ground. In fact, one of the principal dangers that beset the teaching of composition has been the notion that the logic of music can be placed in melodic relations without regard to rhythm (especially in its larger aspects of phrasing) as well as harmony.

1. A *theme* is a melody, not necessarily complete in itself, except when designed for a set of *variations* (*q.v.*), but recognizable as a pregnant phrase or clause. Thus a fugue-subject is a theme, and the expositions and episodes of the sonata forms are more or less complex groups of themes.

2. A *figure* is the smallest fragment of a theme that can be recognized when transformed or detached from its surroundings. The grouping of figures into new melodies is the main resource of "development" or "working-out" in the sonata-forms (*see* Ex. 2–7) besides being the means by which fugues are carried on when the subjects and counter-subjects are not present as wholes. In 16th-century polyphony, melody consists largely of figures which are thus broken off from a *canto fermo*. (*See* CONTRAPUNTAL FORMS.)

3. A *sequence* is the repetition of a figure or group of chords at different levels of pitch. A *real sequence* repeats the initial group exactly, and therefore changes its key. Thus in the first movement of Beethoven's Waldstein sonata bars 5–8 are a step in real sequence below bars 1–4. A *tonal sequence* repeats the figure within the key, and modifies details accordingly, tolerating things that would be inadmissible in the initial group. In the first movement of the Waldstein sonata the theme, with a brilliant counterpoint above, is treated in tonal sequence 40 bars from the end. Repetition at the same pitch is not sequence. Thus, in illustration, there are no sequences in Ex. 1, but Ex. 4, 7, 9 and 10 contain tonal sequences.

4. *Polyphony* is harmony made of melodic threads. Some classical melodies are polyphonically composite, requiring an inner melody, appearing through transparent places in the outer melody, to complete the sense. This well suits the pianoforte with its evanescent tone, but is even more frequent in music for earlier keyboard instruments, as in the keyboard works of Bach (*see* Ex. 4). Beethoven often divides a melody between voices in dialogue, as in bars 35–42 of the first movement of the Waldstein sonata, op. 53.

5. (*a*) *Conjunct movement* is movement along adjacent degrees of the scale (Ex. 5, fig. B).

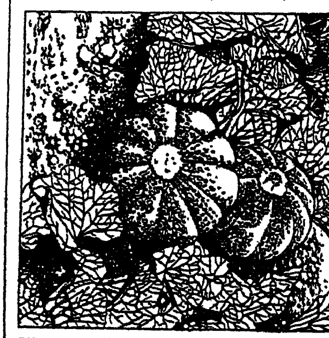
(*b*) *Disjunct movement* often tends to produce *arpeggio* types of melody, *i.e.*, melodies which trace out a chord, as in Ex. 11, 12.

The rigid devices of inversion, augmentation and diminution are illustrated in CONTRAPUNTAL FORMS and FUGUE.

The musical examples 5–10 show how Beethoven can develop a theme to results unrecognizable but for the intermediate steps. Ex. 11–16 show a later kind of metamorphosis requiring no intermediate steps, though the process in Wagner's *Ring motif* is gradual.

(D. F. T.)

MELON or MUSK MELON, *Cucumis melo*, a polymorphic species of the family Cucurbitaceae, including numerous varieties. The melon is an annual trailing herb with palmately-lobed leaves, and bears tendrils by means of which it is readily trained over trellises. It is monoecious, having male and female flowers on the same plant; the flowers have deeply five-lobed campanulate corollas and three stamens. Naudin observed that in some varieties (*e.g.*, of cantaloups) fertile stamens sometimes occur in the female flowers. It is a native of south Asia "from the foot of the Himalayas to Cape Comorin" (*see* Charles Naudin *Annales des sciences naturelles*, vol. 4. 1859), where it grows spontaneously, but is cultivated in the temperate and warm regions of the whole world. It is variable both in diversity of foliage and habit, but much more so in the fruit, which in some varieties is no larger than an olive, while in others it rivals the gourd (*Cucurbita maxima*). The fruit is globular, ovoid, spindle-shaped, or serpent-like, netted or smooth-skinned, ribbed or furrowed, variously coloured externally, with white, green, or orange flesh when ripe, scented or scentless, sweet or insipid, bitter or even nauseous. Like the gourd, the melon undergoes strange metamorphoses by crossing its varieties, though the latter preserves their characters when alone. The offspring of all crossings are fertile.



BY COURTESY OF THE CANADIAN PACIFIC RAILWAY

CANTALOUP MELON (CUCUMIS MELO), GROWING IN A GARDEN IN ALBERTA, CANADA

Naudin thinks it is probable that the culture of the melon in Asia is as ancient as that of all other alimentary vegetables. The Egyptians grew it, or at least inferior races of melon, which were either indigenous or introduced from Asia. The Romans and doubtless the Greeks were familiar with it, though some forms may have been described as cucumbers. The melon began to be extensively cultivated in France in 1629, according to Olivier de Serres. Gerard (*Herball*, 772) figured and described in 1597 several kinds of melons or pompions, but he has included gourds under the same name.

The region of origin of some of the chief modern races, such as "cantaloups," "Dudaim," "Cassaba" and probably the netted or nutmeg sorts, is believed to be Persia and the neighbouring west Asian regions. The first of these was brought to Rome from Armenia in the 16th century, and supplies the chief sorts grown for the French markets; but many others are doubtless artificial productions of west Europe.

The water-melon (*Citrullus vulgaris*), native to tropical and southern Africa, is a member of a different genus of the same family. It has been cultivated for its cool refreshing fruit since the earliest times in Egypt and the Orient, and was known before the Christian era in southern Europe and Asia.

In Great Britain the melon requires artificial heat to grow it to perfection, the rock and cantaloup varieties succeeding with a bottom heat of 70° and an atmospheric temperature of 75°, rising with sun heat to 80°, and the Persian varieties requiring a bottom heat of 75°, gradually increasing to 80°, and an atmospheric temperature ranging from 75° to 80° when the fruit is swelling, as much sun heat as the plants can bear being allowed at all times. The melon grows best in rich turfy loam, somewhat heavy, with which a little well-rotted dung, especially that of pigeons or fowls, should be used, in the proportion of one-fifth mixed in the compost of loam. Melons are grown on hot-beds of fermenting manure, when the soil should be about a foot in thickness, or in pits heated either by hot water or fermenting matter, or in houses heated by hot water, in which case the soil bed should be 15 or 18 in. thick.

The melon being one of those plants which produce distinct male and female flowers, it is necessary to its fertility that both should be produced, and that the pollen of the male flower should, either naturally by insect agency, or artificially by the cultivator's manipulation, be conveyed to the stigma of the female flower. After the fruit has set and has grown to the size of an egg, it

should be preserved from contact with the soil by placing it on a piece of tile or slate; or if grown on a trellis by a little swinging wooden shelf, just large enough to hold it. In either case the material used should be tilted a little to one side, so as to permit water to drain away. Before the process of ripening commences, the roots should have a sufficient supply of moisture, so that none may be required from that time until the fruit is cut for the table.

The varieties of melon are continually receiving additions, and as newer varieties spring into favour, so the older ones drop out of cultivation. A great deal depends on getting the varieties true to name, as they are very liable to get cross-fertilized by insect agency.

MELORIA, a rocky islet, surrounded by a shoal, almost opposite Leghorn, the scene of two mediaeval naval battles. The first, on May 3, 1241, was successfully fought by the fleet of the Emperor Frederick II., in alliance with Pisa, against a Genoese squadron bringing a number of English, French and Spanish prelates to attend the council summoned to meet at the Lateran by Gregory IX. The second, Aug. 6, 1284, was of higher historical importance for it accomplished the ruin of Pisa as a naval power. The long rivalry of that city and of Genoa had broken out for the last time in 1282, the immediate cause being the incompatible claims of the two cities to sovereignty over the islands of Sardinia and Corsica. The Genoese, who had the larger and more efficient fleet, sent their whole power, commanded by Uberto Doria, against their enemy. The Pisan fleet, commanded by the Podestà Morosini and his lieutenants Ugolino della Gherardescha and Andreotto Saraceno was nearly annihilated; the Podestà was taken, and Ugolino fled with a few vessels. As Pisa was also attacked by Florence and Lucca it could never recover the disaster. Two years later Genoa took Porto Pisano, the port of the city and filled up the harbour. The count Ugolino was afterwards starved to death with several of his sons and grandsons in the manner made familiar by the 32nd canto of Dante's *Inferno.*

See *Annali della republica di Genova,* by Agostino Giustiniani (ed. Canepa, Genoa, 1854).

MELOS (mod. *Milo*), an island of the Aegean Sea, at the S.W. corner of the Cyclades group, 75 m. due E. from the coast of Laconia; about 14 m. from E. to W., 8 m. from N. to S; area about 52 sq.m. The greater portion is rugged and hilly, culminating in Mount Elias in the west (2,538 ft.). It is of volcanic origin, with tuff, trachyte and obsidian. In one of the caves on the south coast the heat is still great, and there are hot sulphurous springs. The harbour, a crater with depths from 70 to 30 fathoms, entered from N.W., cuts the island into two, with an isthmus 1¼ m. broad. Sulphur is found on Mount Kalamo and elsewhere. In ancient times the alum of Melos was reckoned next to that of Egypt (Pliny xxxv. 15 [52]). The Melian earth (γῆ Μηλιάς) was employed as a pigment by ancient artists. Millstones, salt and gypsum are still exported. Orange, olive, cypress and arbutus grow throughout the island: vine, cotton and barley are the main objects of cultivation.

Above the harbour town, Adamanta, lie Plaka, the chief town, Kastro, on a hill above, and other villages. The ancient town occupied the slope between the village of Trypetè and the landing-place at Klima. Here are a Roman theatre, town walls, and other buildings, one with a fine mosaic excavated by the British School at Athens in 1896. Numerous fine works of art have been found on this site, notably the Aphrodite of Melos in the Louvre, the Asclepius in the British Museum, and the Poseidon and an archaic Apollo in Athens.

The site of Melos and its obsidian made it an important centre of early civilization. At this time the chief settlement was at Phylakopi, on the north-east coast, where the British School at Athens has cleared a town wall and houses of all the main periods of the Bronze Age and carried out other archaeological investigations in the district. There are traditions of Phoenician occupation, but in historical times Melos was occupied by Dorians from Laconia. In the 6th century it produced remarkable terra cotta reliefs, and large vases, with mythological subjects and orientalizing ornament.

Melos sent a contingent to the Greek fleet at Salamis, but held aloof from the Attic league, and remained neutral during the Peloponnesian War. But in 416 B.C. the Athenians attacked the island and compelled the Melians to surrender, slew all men of military age, enslaved the women and children, and introduced 500 Athenian colonists. Lysander restored the island to its Dorian possessors, but it never recovered its prosperity. Later there were many Jewish settlers in Melos and Christianity was introduced early. Under Frankish rule the island formed part of the duchy of Naxos, except for the few years (1341–1383) when it was a separate lordship under Marco Sanudo and his daughter.

Antimelos or *Antimilo* (*Eremomilo*), 5½ m. north-west of Milo, is an uninhabited mass of trachyte. *Kimolos,* or *Argentiera,* less than 1 m. to the north-east, was famous in antiquity for figs and fuller's earth and contained a considerable city, the remains of which cover the cliff of St. Andrew. *Polinos, Polybos* or *Polivo* (anc. *Polyaegos*) lies rather more than a mile south-east of Kimolos. It was the subject of dispute between the Melians and Kimolians, but has long been almost uninhabited.

MELOZZO DA FORLI (*c.* 1438–1494), Italian painter of the Umbrian school, was born at Forli about 1438. In all probability, Melozzo studied painting under Piero de' Franceschi, of Borgo St. Sepolcro; he may have worked under Ansinuo of Forlì, who assisted Mantegna in the decoration of the Eremitani Chapel at Padua. He seems also to have been well acquainted with Giovanni Santi, the father of Raphael. Only three works are extant which can safely be assigned to Melozzo. (1) He painted in 1472 the vault of the chief chapel in the church of the Apostoli in Rome, his subject being the "Ascension of Christ"; the figure of Christ is so boldly and effectively foreshortened that it seems to "burst through the vaulting"; this fresco was taken down in 1711, and the figure of Christ is now in the Quirinal Palace, while some of the other portions are in the sacristy of St. Peter's. (2) Between 1475 and 1480 he executed a fresco, now transferred to canvas, and placed in the Vatican picture-gallery, representing the appointment of Platina by Pope Sixtus IV. as librarian of the restored Vatican library. (3) In the communal gallery of Forlì is a fresco by Melozzo, termed the "Pestapepe," or Pepper-grinder, originally painted as a grocer's sign; it is an energetic specimen of rather coarse realism, now much damaged. He died at Forlì on Nov. 8, 1494.

See A. Schmarsow, *Melozzo da Forlì* (1886); Onni Okkonen, *Melozzo da Forlì* (1910); also Crowe and Cavalcaselle, *A History of Painting in Italy* (ed. 1914).

MELROSE, a police burgh and parish of Roxburghshire, Scotland. Pop. (1931), 2,052. It lies on the right bank of the Tweed, 37¼ m. S.E. of Edinburgh, by the L.N.E. railway. The name is derived from the Celtic *maol ros,* "bare moor," and the town figures in Sir Walter Scott's *Abbot* and *Monastery* as "Kennaquhair." Owing to the beauty of its situation between the Eildons and the Tweed, the literary and historical associations of the district, and the famous ruins of Melrose abbey, the town has become a holiday resort. There is a hydropathic establishment on Skirmish hill, a name which commemorates the faction fight on July 25, 1526, in which the Scotts defeated the Douglases and Kers. Trade is almost wholly agricultural. The market cross, dated 1642, but probably much older, stands in the triangular market place. Across the river are Gattonside, with orchards, and Allerly, the home of Sir David Brewster from 1827 till his death in 1868.

The original Columban monastery, colonized from Lindisfarne, was founded in the 7th century at Old Melrose, about 2½ m. to the east, in the loop of a bend of the Tweed. It was burned by Kenneth Macalpine in 839 during the wars between Scot and Saxon, and, though rebuilt, was deserted in the middle of the 11th century. The chapel, dedicated to St. Cuthbert, continued to attract pilgrims, but the building was finally destroyed by English invaders. Meanwhile in 1136 David I. founded an abbey dedicated to the Virgin, a little higher up the Tweed, the first Cistercian settlement in Scotland, with monks from Rievaulx in Yorkshire. Lying in the direct road from England, the abbey was

frequently assaulted and in 1322 was destroyed by Edward II. Rebuilt, largely by means of a gift of Robert Bruce, it was nearly burned down in 1385 by Richard II. Erected once more, it was reduced to ruin by the earl of Hertford (afterwards the Protector Somerset) in 1545. Later the Reformers dismantled much of what was left. The adaptation of part of the nave to the purposes of a parish church and the use of the building as a quarry did further damage.

The ruins, then the property of the duke of Buccleuch, were presented to the nation in 1918. Of the conventual buildings apart from the church nothing has survived but a fragment of the cloister with a richly-carved round-headed doorway and some fine arcading. The cruciform abbey is in the Decorated and Perpendicular styles, with pronounced French influence, due probably to the master mason John Morow, or Morreau, who, according to an inscription on the south transept wall, was born in Paris. The remains include part of the nave, the transepts, the chancel and choir, two piers of the tower and the roof of the east end. Sir Walter Scott has immortalized the east window, in *The Lay of the Last Minstrel*, but the south window with its flowing tracery is even finer. The heart of Robert Bruce was buried at the high altar, and in the chancel are many historic tombs.

The muniments of the abbacy, preserved in the archives of the earl of Morton, were edited by Cosmo Innes for the Bannatyne Club and published in 1837 under the title of *Liber sancte Marie de Melros*. Among the documents is one of the earliest specimens of the Scots dialect. The *Chronica de Mailros*, preserved among the Cotton mss., was printed at Oxford in 1684 by William Fulman and by the Bannatyne Club in 1835 under the editorship of John Stevenson.

MELROSE, a city of Middlesex county, Massachusetts, U.S.A., on the Boston and Maine railroad, immediately N. of Malden and 7 m. N. of Boston. The population was 23,170 in 1930, Federal census. The city covers 4·8 sq.m. of broken, hilly country, and includes part of the Middlesex Fells reservation. It is a residential suburb of Boston, and has a large rubber-shoe factory and other manufacturing plants, with a total factory output in 1925 valued at $4,758,125. Melrose (so named because of the similarity of its setting to that of the Scottish city) was settled, 1633; divided from Malden and incorporated as a town in 1850; and chartered as a city in 1899. It was the home of Samuel Adams Drake (1833–1905), the historian of Middlesex county, and of William Frederick Poole (1821–94), librarian, who devised the indexes to periodical literature.

MELROSE PARK, a village of Cook county, Illinois, U.S.A., 12 m. W. of the Chicago "Loop." It is served by the Chicago and North Western and the Indiana Harbor Belt railways. Pop. (1920) 7,147 (37% foreign-born white); and 10,741 in 1930 (Federal census). It is a residential and industrial suburb, with structural steel and coupler works, a battery-box plant, and large freight yards. The village was founded about 1870 and incorporated in 1882.

MELTON MOWBRAY, a market town in Leicestershire, England, situated at the confluence of the Wreake and the Eye. Pop. of urban district (1931) 10,437. It is 105 m. N.N.W. from London by the L.M.S. railway. The church of St. Mary is Early English and later, with a lofty, ornamented central tower and was enlarged in the reign of Elizabeth. Melton is the centre of a celebrated hunting district, and there are large stables in the town. It is known for its pork pies, and has a trade in Stilton cheese. There are foundries, rubber factories, textile factories, tanneries and an important cattle market. There are blast furnaces in the neighbouring parish of Asfordby for the smelting of the abundant supply of iron ore in the district.

MELUN, a town of northern France, capital of the department of Seine-et-Marne, situated north of the forest of Fontainebleau, 28 m. S.S.E. of Paris by rail. Pop. (1926) 13,565. In Caesar's Gallic wars Melun (*Melodunum*) was taken by his lieutenant Labienus, with a view to attacking Lutetia by the right bank of the Seine. It was pillaged by the Normans, and afterwards became the favourite residence of the first kings of the house of Capet. In 1359 Melun was given up by Jeanne of Navarre to her brother, Charles the Bad, but was retaken by the dauphin Charles and Bertrand Duguesclin. In 1420 it made an heroic defence against the English and Burgundians. Ten years later the people of Melun, with the help of Joan of Arc, drove out the English. It was occupied by the League in 1589, and retaken by Henry IV. in 1590. The town is divided into three parts by the Seine. The principal portion lies on the slope of a hill on the right bank; on the left bank is the most modern quarter, while the old Roman town occupies an island in the river. On the island stands the Romanesque church of Notre-Dame (11th cent.), formerly part of a nunnery. On the right bank of the river are the church of St. Aspais, an irregularly shaped structure of the 15th and 16th centuries; the *hôtel-de-ville* (1847), in the construction of which an old mansion and turret have been utilized; and the tower of St. Bartholomew of the 16th and 18th centuries. Jacques Amyot, the translator of Plutarch, was born at Melun in 1513. In the neighbourhood is the fine château of Vaux-le-Vicomte. Melun is a market for grain and farm produce, and has various small industries, the chief being the manufacture of wooden blinds and screens.

MELUSINE, tutelary fairy of the house of Lusignan, was a daughter of the fairy Pressine, to avenge whose wrongs she shut up her father in a mountain. For this she was metamorphosed every Saturday into a serpent from the hips down: and could be released only if she found a husband who would never see her on Saturdays. Such a husband she found in Raymond of Poitiers, who became by her means rich and powerful. She built the castle of Lusignan and many other of the family fortresses. When at length her husband, yielding to curiosity, saw her taking the purificatory bath on a Saturday, she flew away in serpent form. Thenceforward the death of a Lusignan was heralded by her cries. *Pousser des cris de Mélusine* is still a popular saying.

This story was written at length in 1387 by Jean d'Arras for John, duke of Berry, and his sister Marie, duchess of Bar. An ill-considered attempt was made by Baudot in *Les Princesses Yolande et les Ducs de Bar* (1900) to make it a *roman à clé*.

The work of Jean d'Arras was printed by Steinschaber (Geneva, 1478), and reprinted many times in the 15th and 16th centuries. Modern editions: Brunet (1854); Lecesne for the Arras academy (1888). English trans. from unique ms. in Brit. Mus. edit. by Donald, E.E.T.S. (1895). The versified form of the story by the 14th cent. poet Couldrette was published in 1854 by Fr. Michel.

MELVILLE, ANDREW (1545–1622), Scottish scholar, theologian and religious reformer, was born at Baldovy near Montrose, on Aug. 1, 1545. His father fell at the battle of Pinkie (1547). The boy was educated at the grammar school of Montrose, after leaving which he learned Greek from Pierre de Marsilliers, a Frenchman settled at Montrose; and when Melville went to the university of St. Andrews he excited astonishment by using the Greek text of Aristotle, which no one else there understood. Melville left St. Andrews in 1564 for the university of Paris. He there studied Oriental languages. He attended the last course of lectures delivered by Turnebus in the Greek chair, as well as those of Peter Ramus, whose philosophical method and plan of teaching he afterwards introduced into the universities of Scotland. From Paris he proceeded to Poitiers (1566) to study civil law, and was apparently at once made a regent in the college of St. Marceon. Political troubles compelled him to leave France, and he went to Geneva, where he was welcomed by Theodore Beza, and appointed to the chair of humanity in the academy of Geneva. From Cornelius Bertram, one of his brother professors, he acquired a knowledge of Syriac.

In 1574 Melville returned to Scotland, and almost immediately was appointed principal of Glasgow university, which had fallen into an almost ruinous state, the college having been shut and the students dispersed. Melville, enlarged the curriculum at the college, and established chairs in languages, science, philosophy and divinity, which were confirmed by charter in 1577. Students flocked from all parts of Scotland and even beyond, till the classrooms were overflowing. Melville assisted in the reconstruction of Aberdeen university in 1575, and was appointed principal of St. Mary's College, St. Andrews, in 1580. The reforms, however, which his new modes of teaching involved, and even some of his new doctrines, such as the non-infallibility of Aristotle, brought

him into collision with other teachers in the university. He was moderator of the General Assembly in 1582, and took part in the organization of the Church and the Presbyterian method. Troubles arose from the attempts of the court to force a system of Episcopacy upon the Church of Scotland (*see* SCOTLAND, CHURCH OF), and Melville prosecuted one of the "tulchan" bishops (Robert Montgomery, d. 1609).

Melville was summoned before the Privy Council in February 1584, and had to flee into England. He returned to Scotland in November 1585, and in March 1586 resumed his lectures in St. Andrews, where he continued for twenty years; he became rector of the university in 1590. During the whole time he protected the liberties of the Scottish Church against all encroachments of the government. In 1599 he was deprived of the rectorship, but was made dean of the faculty of theology. In 1606 Melville and seven other clergymen of the Church of Scotland were summoned to London in order "that his majesty might treat with them of such things as would tend to settle the peace of the Church." They told the king that the only way to settle affairs was to call a free Assembly. Melville delivered his opinion to that effect in two long speeches with his accustomed freedom, and, a sarcastic Latin epigram on some of the ritual practised in the chapel of Hampton Court having come to the king's ears, he was committed to the Tower, and detained there for four years. He was then invited to fill a professor's chair in the university of Sedan, and there he spent the last eleven years of his life. He died at Sedan in 1622 at the age of seventy-seven.

See McCries, *Andrew Melville* (ed. 2 vols. 1819); Andrew Lang, *History of Scotland* (1902).

MELVILLE, GEORGE WALLACE (1841–1912), American Arctic explorer and naval engineer, was born in New York city on July 31, 1841, and educated at the Brooklyn Polytechnic institute. In 1861 he entered the U.S. navy as third assistant engineer, and served throughout the Civil War. His first venture into Arctic regions was as engineer of the "Tigress" in search of the ill-fated "Polaris." In 1879 he accompanied George W. De Long (*q.v.*) on his famous polar voyage in the "Jeannette," which reached a higher latitude than any previous Arctic expedition. When the ship was crushed in the ice he was in charge of the only boat-load of men that survived, finding succour on the Lena river after a boat and sledge journey of many hundreds of miles. In the Arctic night he led an expedition 500 m. along the north Siberian shore in search of De Long and other surviviors, and recovered the bodies and records of De Long's boat-load. The incredible hardships of the expedition are modestly told in Melville's *In the Lena Delta* (1884). Melville was again chief engineer of the flagship "Thetis" in the historic Greely relief expedition of 1884. In 1887 he was made engineer-in-chief of the U.S. navy, from which position he retired in 1903, having been commissioned rear-admiral in 1899. His ability as head engineer during a period when a new and more modern navy was being constructed made his services of much importance. He designed the machinery of 120 naval ships of over 700,000 h.p., three of them, the "San Francisco," "Columbia" and "Minneapolis" being for a time the fastest ships afloat. He introduced the triple screw, made the departure from horizontal to the more efficient vertical boilers, and introduced boilers of the water-tube type. He carried out tests of oil fuel and predicted its future importance. Many minor improvements and a general reform of the entire naval engineering department are attributed to him. He died on March 17, 1912.

See W. L. Cathcart, "George Wallace Melville," *Amer. Soc. of Naval Engineers, Journal*, vol. xxiv., pp. 477–511 (1912).

MELVILLE, HENRY DUNDAS, 1ST VISCOUNT (1742–1811), British statesman, fourth son of Robert Dundas (1685–1753), lord president of the Scottish court of session, was born on April 28, 1742, at Edinburgh, where he was educated. He became solicitor-general to Scotland in 1766; but after his appointment as lord-advocate in 1775, he gradually relinquished his legal practice. In 1774 he was returned to parliament for Midlothian, and joined the party of Lord North; in 1791, he entered the cabinet as home secretary; from 1794 to 1801 he was secretary at war under Pitt. In 1802 he was elevated to the peerage as Viscount Melville and Baron Dunira. Under Pitt in 1804 he again entered office as first lord of the admiralty. Suspicion had arisen, however, as to the financial management of the admirality, of which Dundas had been treasurer between 1782 and 1800; in 1802 a commission of inquiry was appointed, the result being the impeachment of Lord Melville in 1806; and though it ended in an acquittal, and nothing more than formal negligence lay against him, he never again held office. An earldom was offered in 1809 but declined. He died on May 28, 1811.

MELVILLE, HERMAN (1819–1891), American author, was born in New York city on Aug. 1, 1819. He shipped as a cabin boy at the age of 18, thus being enabled to make his first visit to England, and at 22 sailed for a long whaling cruise in the Pacific. After a year and a half he deserted his ship at the Marquesas islands on account of the cruelty of the captain; was captured by cannibals on the island of Nukahiva, and detained, without hardship, four months; was rescued by the crew of an Australian vessel, which he joined, and two years later reached New York. Thereafter, with the exception of a passenger voyage round the world in 1860, Melville remained in the United States, devoting himself to literature—though for a considerable period (1866–85) he held a post in the New York custom house—and being perhaps Hawthorne's most intimate friend among the literary men of America. His writings are numerous, and of varying merit; his verse, patriotic and other, is forgotten, and his works of fiction and of travel are of irregular execution.

Nevertheless, few authors have been enabled so freely to introduce romantic personal experiences into their books; in his first work, *Typee: A Peep at Polynesian Life, or Four Months' Residence in a Valley of the Marquesas* (1846), he described his escape from the cannibals; while in *Omoo, a Narrative of Adventures in the South Seas* (1847), *White Jacket, or The World in a Man-of-War* (1850), and *Moby Dick, or The White Whale* (1851), he portrayed seafaring life and character with vigour and originality, and from a personal knowledge equal to that of Cooper, Marryat or Clark Russell. But these records of adventure were followed by other tales so turgid, eccentric, opinionative, and loosely written as to seem the work of another author. He died in New York on Sept. 28, 1891.

See R. M. Weaver, *Herman Melville* (1921); M. Minnigerode, *Some Personal Letters of Herman Melville, and a Bibliography* (1922); *Herman Melville's Works* (1924); John Freeman, *Herman Melville* (1926); Lewis Mumford, *Herman Melville* (1929).

MELVILLE, SIR JAMES (1535–1617), Scottish diplomatist and memoir writer, was the third son of Sir John Melville, laird of Raith, who was executed for treason in 1548. In 1549 he went to France as a page of Mary Queen of Scots, and at the battle of St. Quentin in 1557, was taken prisoner. He subsequently conducted various diplomatic missions for Henry II. of France. On Mary's return to Scotland in 1561 she gave Melville an appointment in her household, and employed him as special emissary to reconcile Queen Elizabeth to her marriage with Darnley. After Mary's imprisonment Melville again conducted several diplomatic missions, and won the confidence of James VI. when the king took over the government. In 1603 he retired to Halhill where he wrote *Memoirs of my own Life*, a valuable authority for the history of the period (first published in 1683, new ed. 1829). Melville died at Halhill on Nov. 13, 1617).

See A. F. Steuart, ed., *Memoirs of Sir James Melville* (1930).

MELVILLE, JAMES (1556–1614), Scottish reformer, nephew of Andrew Melville (*q.v.*), was born on July 26, 1556. He was educated at Montrose and St. Leonard's college, St. Andrews. He was one of the regents of Glasgow university, and then professor of oriental languages at St. Andrews. In 1584 he joined some of the leaders of the Scottish Presbyterian party in London for a short time. From 1586 to his death he took an active part in Church controversy. In 1589 he was moderator of the General Assembly and on several occasions represented his party in conferences with the court. Despite his antagonism to James's episcopal schemes, he appears to have won the king's respect. He answered, with his uncle, a royal summons to London in 1606 for the discussion of Church policy. Andrew Mel-

ville was sent to the Tower, and James was placed in easy detention within ten miles of Newcastle-on-Tyne. In 1613 negotiations were begun for his return to Scotland, but his health was broken, and he died at Berwick in Jan. 1614.

Melville has left ample materials for the history of his time from the Presbyterian standpoint, in (*a*) correspondence with his uncle Andrew Melville (ms. in the library of the university of Edinburgh), and (*b*) a diary (ms. in the Advocates' Library, Edinburgh). His sketch of John Knox at St. Andrews is one of his best passages.

The *Diary* was printed by the Bannatyne club in 1829, and by the Wodrow society in 1842. Large portions of it are incorporated in David Calderwood's (1575–1650) *History of the Kirk of Scotland* (first printed in 1678). For the life and times, *see* Thomas M'Crie's *Life of Andrew Melville.*

MEMBRANELLE, in some ciliate infusoria (*q.v.*) a flattened or compressed organ appearing near the mouth, and regarded as a short row of fused cilia, as shown in the plates of *Ctenophora* (*q.v.*).

MEMEL, a town of Lithuania, 91 m. by rail N.N.E. of Königsberg on the bank of the sound through which the Kurische Haff and the river Nemunas or Niemen (called Memel in its lower reaches) connect with the Baltic. Pop. 36,000, mainly German. The entrance to the harbour is protected by a lighthouse; the depth on the bar is about 20 ft., and icebreakers are needed to keep the port open between December and March. The town possesses iron foundries, shipbuilding yards, breweries, distilleries and manufactories of chemicals, soap and amber wares. The chief interest of the town, however, is its transit trade in timber, grain, other agricultural produce and fish. Its economic hinterland extends across Lithuania into Poland and Russia and much of the goods is brought down by the river.

History.—Memel was founded in 1252 by Poppo von Osterna, grand master of the Teutonic order, and was at first called New Dortmund and afterwards Memelburg. It soon acquired a considerable trade, and joined the Hanseatic League. During the 13th, 14th and 15th centuries it was repeatedly burned by its hostile neighbours, the Lithuanians and Poles. In the 17th century it remained for some time in the possession of Sweden. In 1757, and again in 1813, it was occupied by Russian troops. After the battle of Jena, King Frederick William III. retired to Memel; and here, in 1807, a treaty was concluded between England and Prussia. The poet Simon Dach was a native of Memel.

Before the World War the town of Memel, with a strip of territory east of the river, belonged to Germany, while the hinterland belonged to the Russian empire. Under the Versailles treaty (Article 99), Germany ceded all her territory east of the river to the Allied and Associated Powers and undertook to accept whatever disposal they made of it. Upon the ratification of the treaty the Allies occupied and administered the territory for three years. The conference of ambassadors did not take up the question of Memel till the autumn of 1922, and meanwhile it had been suggested that Memel might be given a status in regard to Lithuania like that which had been given to Danzig in regard to Poland. This was unacceptable to the Lithuanians, since the population of the country districts of Memel territory was Lithuanian in nationality, while the port was almost the only possible maritime outlet and inlet for Lithuania herself. Accordingly the Lithuanians seized Memel by a surprise attack on Jan. 15, 1923, and forced the French garrison to surrender and evacuate.

On Feb. 16 the conference of ambassadors proposed that Memel should be handed over to Lithuania, subject to local autonomy and to freedom of transit for Poland. Later, in Sept. 1923, the case was referred to the League of Nations. A commission of enquiry was appointed and in March 1924 presented a draft convention to the Council. This convention constituted the Memel territory as a unit within the sovereignty of Lithuania with a clearly defined measure of administrative and financial autonomy and with a governor to be appointed by the president of the Lithuanian republic. The port was defined as a port of international concern to which the provisions of the League's Barcelona transit conference apply, and was placed under a harbour board including a technical expert of neutral nationality appointed by the League. The convention was accepted and signed by all parties in May 1924.

Bibliography.—J. Sembritzki, *Geschichte der Königlich preussischen See- und Handelsstadt Memel* (Memel, 1900); British White Paper, Command 2,235 of 1924; Lithuanian Ministry for Foreign Affairs, *The Question of Memel* (London, 1924, Lithuanian Information Bureau); J. F. O. Didelot, *La Marine de l'Aigle blanc* (1924); A. J. Toynbee, *Survey of International Affairs,* 1920–23, pp. 256–261; R. Schürenberg, *Die Memelfrage als Randstaatenproblem* (Berlin, 1925); *Konvencija del Klaipidos krasto* (Statut du Territoire de Memel) (Memel, 1925).

MEMLINC, HANS (*c.* 1430–1494), Flemish painter, whose art gave lustre to Bruges in the period of its political and commercial decline. Memlinc was a skilled artist before he settled at Bruges. Hans Memlinc probably served his apprenticeship at Cologne, and later worked under Roger van der Weyden. The inventories of Margaret of Austria, made in 1524, describe a triptych of which the central panel was by Roger, the wings by "Master Hans." Another clear proof of the connection of the two masters is afforded by an altarpiece ordered for a patron of the house of Sforza. It is now in the Brussels gallery. The date of it is fixed at about 1460–62 by the apparent ages of Francesco Maria Sforza, Bianca Visconti, and their son Galeazzo, whose portraits appear upon it. The central portion of the tryptych was obviously done in the studio of Roger; the wings appear to be by Memlinc, and were probably done by him in Roger's workshop. Moreover in Memlinc's later work certain figures seem borrowed directly from pictures of Roger. Memlinc, therefore, may have stayed in Brussels working under Roger before going to Bruges. He resided at Bruges from about 1465 until his death on Aug. 11, 1494.

The earliest work, which can be dated, is the triptych in the collection of the duke of Devonshire at Chatsworth. It was painted for Sir John Donne of Kidwelly, whose portrait with that of his wife and daughter appears in the foreground as donors, kneeling before the Virgin Enthroned. On the wings are two saints. Sir John was one of the English courtiers who attended the wedding of Margaret of York with Charles the Bold which took place in Bruges in 1468. The picture was commissioned on that occasion. In the background of the left wing the artist painted himself peering behind a column. He is a man about 35 years of age and we may conclude that he was born about 1430–35. This picture is typical of Memlinc's art. His later works are painted in the same style.

The great "Last Judgment" altarpiece in St. Mary's church at Danzig is generally ascribed to Memlinc. It was ordered by Angelo Tani, the representative of the Medici in Bruges, and was finished in 1472. Destined for Florence, the ship that carried it was made prize of war by Danzig vessels in 1473. It is a picture measuring some 72 sq.ft. with upwards of 150 figures.

In 1477 he was under contract to furnish an altarpiece for the guild-chapel of the booksellers of Bruges; and this altarpiece is now preserved, under the name of the "Seven Griefs of Mary," in the gallery of Turin. The effect of the whole is chaotic. That did not prevent Peter Bultync from ordering a similar type of picture with the "Seven Joys of Mary," for presentation to the guild of the tanners in 1480. This panel is now in the Munich Pinakothek. All of Memlinc's pictures which have survived in Bruges, except one, are in the chapter house of the Hospital of St. John. He painted more than one masterpiece for his patrons of St. John. Of these the first in order of date is the great triptych of 1479. The subject of the central panel is "The Mystic Marriage of St. Catherine." On the wings are "The Martyrdom of St. John the Baptist," and "The Vision at Patmos." In the background is a view of Bruges.

In the same year he painted another triptych on a smaller scale and finely finished. An inscription on the frame informs us that it was painted for John Floreins. The central panel represents the "Adoration of the Magi," that on the right "The Nativity" and the other panel "The Presentation in the Temple." The triptych when closed shows the figures of St. John the Baptist and St. Veronica. In 1484 he painted the triptych in honour of St. Christopher in the municipal gallery at Bruges.

A beautiful diptych painted in 1487 for Martin van Nieuwenhove is now in the hospital of St. John. The left panel shows "The Virgin and the Child," the right has a portrait of the donor

with his hands clasped in prayer and an open breviary before him. This is one of Memlinc's finest portraits. The portraits of the donors on Memlinc's pictures were distinguished and lifelike. So are the groups of the family of James Floreins, father, mother and children, which fill the noble altarpiece of the Louvre. As single portraits the busts of Burgomaster Moreel and his wife in the museum of Brussels, and their daughter the "Sibyl Zambetha" (according to the added description) (1480) in the hospital at Bruges, are the finest.

Memlinc was favoured as a portraitist by Italians. The Antwerp museum has the portrait of the medallist, Niccolo Spinelli, who was engaged as a seal engraver by Charles the Bold from 1467–68. He is depicted holding a medal against a landscape background. In the Altman collection, Metropolitan Museum of Art, New York, a pair of portraits represent Thomas Portinari and his wife; in the J. P. Morgan collection is the Machiavellian "Man with a Pink," formerly in the possession of R. Kann. These four are early pictures. The portraits of a married pair of mature age, formerly at Milan, are now divided between the Berlin and the Louvre galleries. They are full of character and expression; and so is the portrait of an old man in the Altman collection, New York. Three panels of equal size, one dated 1487, are in the Uffizi and at Berlin. The last is a Madonna; the other two represent St. Benedict and a praying donor. It has been suggested that they may have been framed together. The pair in the Uffizi came from the hospital of Santa Maria Nuova in Florence. If they belong together the young donor was doubtless named Benedict, and he may be Benedetto Portinari, whose family were closely associated with Bruges and the said hospital. The portrait of a young man, probably again an Italian, in the Dun collection, has a distinct personality and a determined expression. Memlinc's Madonna pictures possess unusual charm. One of the earliest is the full length standing Virgin of 1472 in the Lischtenstein collection. The Madonna in the Radziwill collection, Berlin, is one of the finest.

The masterpiece of Memlinc's later years, a shrine containing relics of St. Ursula in the museum of the hospital of Bruges, is fairly supposed to have been ordered and finished in 1489. The delicacy of finish in its miniature figures, the variety of its landscapes and costume, the marvellous patience with which its details are given, are all matters of enjoyment to the spectator. There is a later work of the master, a large "Crucifixion," with scenes from the Passion, of 1491, in the cathedral of Lübeck. But as we near the close of Memlinc's career we observe that his practice has become larger than he can compass alone; and, as usual in such cases, the labour of disciples is substituted for his own. Moreover it is hard to distinguish between the work which may be attributed to his studio or to his followers. Memlinc's influence is felt in the work of his contemporaries and in that of the next generation.

The trustees of his will appeared before the court of wards at Bruges on Dec. 10, 1495, and we gather from records of that date and place that Memlinc left behind several children and a considerable property.

See A. Michiels, *Memlinc: sa vie et ses ouvrages* (Verviers, 1881); T. Gaedertz, *Hans Memling und dessen Altarschrein im Dom zu Lübeck* (Leipzig, 1883); Jules du Jardin, *L'Ecole de Bruges. Hans Memlinc, son temps, sa vie et son oeuvre* (Antwerp, 1897); Ludwig Kämmerer, *Memling* (Leipzig, 1899); W. H. J. Weale, *Hans Memlinc* (1901), *Hans Memlinc:* Biography (Bruges, 1901); Karl Voll, *Memling* (Stuttgart and Leipzig, 1909); M. Friedländer, *Van Eyck zu Bruegel* (1921); Sir Martin Conway, *The Van Eycks and their Followers* (1921).

MEMMINGEN, a town of Germany, in the republic of Bavaria, on the Ach, a tributary of the Iller, 35 m. S.W. of Augsburg on the railway to Ulm-Kempten. Pop. (1925) 14,049. Memmingen, first mentioned in a document of 1010, belonged originally to the Guelf family, and later to the Hohenstaufens. In 1286 it became a free city of the empire, a position which it maintained down to 1802, when it was allotted to Bavaria. It is partly surrounded with walls, and has some old gates and houses. It contains the Gothic church of St. Martin, which contains beautifully carved choir-stalls, and a town hall dating from about 1580. Its industries include linen spinning and weaving, and the manufacture of woollen goods, soap, ropes, emery cloth and machinery. Trade is carried on in cattle, timber, cloth and wine.

MEMNON, in Greek mythology, son of Tithonus (q.v.) and Eos (Dawn), king of the Aethiopians. Although mentioned in Hesiod and the *Odyssey,* he is rather a post-Homeric hero. After the death of Hector he went to assist his uncle Priam against the Greeks. He performed prodigies of valour, but was slain by Achilles, after he had himself killed Antilochus, the son of Nestor and the friend of Achilles. His mother, Eos, removed his body from the field of battle, and it was said that Zeus, moved by her tears, bestowed immortality upon him. His mother wept for him every morning, and the early dewdrops were said to be her tears. His companions were changed into birds, called *Memnonides,* which came every year to fight and lament over his grave, which was variously located (Ovid, *Metam.,* XIII. 576–622; Pausanias x. 31). The story of Memnon was the subject of the lost *Aethiopis* of Arctinus of Miletus; the chief source from which our knowledge of him is derived is the second book of the *Posthomerica* of Quintus Smyrnaeus (itself probably an adaptation of the works of Arctinus and Lesches). As an Aethiopian, Memnon was described as black, but was noted for his beauty. The fight between Achilles and Memnon was often represented by Greek artists. Later, the story was rationalized (Diod. Sic. II. 22). In Egypt, the name of Memnon was connected with the colossal statues of Amenhotep III. near Thebes, two of which still remain. The more northerly of these was partly destroyed by an earthquake (27 B.C.) and the upper part thrown down. A curious phenomenon then occurred. Every morning, when the rays of the rising sun touched the statue, it gave forth musical sounds, like the twang of a harp-string. This was supposed to be the voice of Memnon responding to the greeting of his mother Eos. After the restoration of the statue by Septimius Severus (A.D. 170) the sounds ceased. The sound, which has been heard by modern travellers, is generally attributed to the passage of the air through the pores of the stone, chiefly due to the change of temperature at sunrise. (Juvenal XV. 5, with Mayor's note; Tacitus, *Annals,* ii. 61).

See R. Holland in Roscher's *Lexikon der mythologie,* art. "Memnon."

MEMNON OF RHODES, brother of Mentor (*q.v.*), with whom he entered the services of the rebellious satrap Artabazus of Phrygia (363). In 344 Mentor, who had deserted to the Persians again, obtained Memnon's recall and pardon. Both Mentor and he rose high in the service of the king after the conquest of Egypt; Memnon assisted Mentor in quelling revolt in Asia Minor, and succeeded him as general of the Persian troops. He owned a large territory in eastern Troas (Arrian i. 17, 8; Strabo xiii. 587). He gained some successes against Philip II. of Macedon in 336 (Diod. xvii. 6; Polyaen. v. 44, 4, 5) and commanded the Persian army against Alexander's invasion. His plan was to avoid a decisive action, to lay waste the country and retire into the interior, meanwhile organizing resistance on sea (where the Persians were far superior to the Macedonians) and carrying the war into Greece. But his advice was overridden by the Persian satraps, who forced him to fight at the Granicus. After his defeat he tried to organize the maritime war and occupied the Greek islands, but in the beginning of 333 he died (Arrian ii. 1, 1).

MEMOIRS: *see* BIOGRAPHY.

MEMORANDUM OF ASSOCIATION: *see* COMPANY.

MEMORIAL DAY: *see* DECORATION DAY.

MEMORY. The term "Memory" denotes the mental processes whereby past experience is recalled to present consciousness. Used strictly it denotes an individual's recall of his own life story. His memory knowledge is what he can recall of events which happened to him in the past. The knowledge is *personal and is referred to the past.* It is recalled with some setting or background. "I remember the first time I rode in a motor car." "I remember posting the letter myself on Monday." All personal reminiscence is memory in this strict sense. In a looser use of the term memory denotes the recall of any knowledge which an individual has acquired through his past experience. Such knowledge is not recalled as part of the individual's life

story. It is ***not referred to his past*** and it is ***impersonal***. The knowledge has been acquired in the past and may even be about past events but it is remembered as an item of knowledge without a setting in personal experience. For example one remembers how to put up a given electric circuit but one need not recall when and how one acquired this knowledge nor recall the previous occasions on which one had set up this circuit. An individual's memory knowledge of Henry VIII.'s matrimonial adventures is knowledge about these past events, but not of the individual's own past and it is not necessarily more past for him than his knowledge of the fate of Charles I. The time order of these items of memory knowledge is determined by their place in his knowledge of English History and not by any personal reminiscences of when or how he learnt these facts.

Retentiveness.—From memory as the conscious recall of past experience must be distinguished retentiveness. Retentiveness is the basal fact of all life. All growth and development in an organism demands continuity. Each new stage of life arises out of, and continues the preceding stages. What will be is dependent upon what is, and what is rests upon what has been. By reason of its influence on the present the past is said to be retained in the present. Flaws in the leaf testify to (or retain) the bruises inflicted on the leaf bud. The stunted growth of a man testifies to the privations of childhood, the muscles of an athlete to years of training. Both the immediate and the remote past of an organism are retained in its habits, its present abilities and disabilities. What is true of bodily life is true of mental life. Ability to pick out the overtones in a chord testifies to past musical training, skill in typewriting to months of practice, dislike of cats to an episode in childhood of which there may be no remembrance. This last example will serve to bring out the difference between retentiveness and memory. The events of a life story would form no story, could have no continuity one with another, unless at every moment the past lived on into the present. But such continuity does not necessarily involve knowledge of the past. If there were memory in the strict sense of the cat episode, there would be a recognized continuity between the present dislike of cats and the episode in question. But there may be no recall of this far away episode of childhood. The individual may only know of it through the testimony of others. Although there may be no memory of this event, there is, none the less, continuity; the cat episode is retained and the present dislike of cats is evidence thereof. Memory is based on retentiveness, but is a more specialized characteristic of mental life. We may specify it thus: in retentiveness the past is continued on into the present and loses itself in making the present what it is; in memory the past is known *directly* for what it was in its own passing or *indirectly* by the contribution it has made to the sum of knowledge. All organisms show retentiveness but only the higher animals give evidence of memory. It is doubtful whether any animal other than man evinces memory in the more restricted sense, ability to recall incidents with a consciousness of their setting in the past life story. This reproduction of past experience may only be possible where there is the highly organized nervous system found in man.

Imagery.—Just as knowledge of the present physical environment and response to its demands involves the mental events named "sensations," so knowledge of the past or use of knowledge acquired in the past is bound up with events termed "images." For every variety of sensation, sight, sound, etc., there is a corresponding variety of imagery. When to-day we recall the sight of the fishing boats returning to harbour, we have visual imagery of what we saw last evening; similarly we may recall the cry of the gulls by auditory imagery. We may recall in verbal imagery the comments made when the scene was presented. The difference between sensation and imagery is not one which can be well expressed in words. Everyone knows it from his own experience. We call images "dead" as compared with actual sense data. They not only lack "liveliness" but seem fragmentary and fluctuating; now this is present, now that, and as we attempt to fixate them they are apt to die out. Imagery, again, does not stand in as close relation to movement as sense experience. A sensation produces a motor response. There is adjustment of sense organ and impulsive action. With imagery there may be some adjustment of sense organ as in the fixed look when trying to see a visual image clearly, but there is no attempt to stretch out a hand to take the imaged object nor to step aside to avoid it. Imagery is not normally accompanied by the wealth of organic sensations which form a background to sense experience of the special senses.

Conditions of Memory and Obliviscence.—Accepting retentiveness as the fundamental vital fact lying behind all memory, we may ask what are the special conditions which determine memory. They are: depth of impression and strength of association. The rationale of all memory training is based on these two conditions. To be recalled the original incident or acquirement must have made a sufficiently deep impression upon us. Physical circumstances may secure this; strength of stimulation or repeated stimulation. Important also is the physical fitness of the organism to receive impressions. Depth of impression also depends upon the individual's interest in the situation, its appeal to his emotions, its connection with some purpose he has in view. To be remembered or recalled the past experience must be suggested by the present. Suggestion depends upon continuity between the past and the present, a continuity of interest, direct or indirect. There is an association between the suggest*ing* present and the suggest*ed* past experience or acquirement. The conditions of suggestion are known as the "laws of association" (*see* ASSOCIATION OF IDEAS). If depth of impression and strength of association ensure memory, feebleness of impression and failure of association entail obliviscence or forgetting. If association links fail there can be no suggestion, and where there is no suggestion there can be no recall of past experience by the present. The breaking down of association links gives rise to a condition known as "dissociation." This may occur for a given group of ideas or for incidents connected with a given period in a man's life (*see* AMNESIA). Some psychologists attribute all failure of association to "repression." They assert that all experiences which are painful or in conflict with accepted standards of life are repressed into the unconscious and thereby cut off from the associations of conscious memory. They regard repression as the explanation of all forgetting. But this view is unwarrantably narrow. It not only overlooks natural decay which is the complement of growth in all living processes, but it confuses conditions which ought to be distinguished: the repression of an associated idea by reason of its pain value and the temporary inhibition of one line of association through interest in another. It is, surely, perverted pedantry to seek some painful association in a forgotten engagement when such obliviscence is due to the inhibition of all ideas unconnected with an absorbing occupation.

Characteristics of a Good Memory.—These may be summarized as *readiness* in forming deep impressions and strong associations, the *durability* of these and the *ease of recall*, their *faithfulness* to the originals of experience. The characteristic that renders memory serviceable in practical life is *relevancy*. In relevant recall only those associations are followed which have bearing on the purpose in hand. A rambling memory may be full and faithful but in the service of thought a controlled selective recall of important points is more fruitful.

BIBLIOGRAPHY.—M. Bergson, *Matter and Memory* (Eng. trans. 1912); J. Ward, *Heredity and Memory* (1913); Colvin, *The Learning Process* (1915); T. H. Pear, *Remembering and Forgetting* (1922); B. Edgell, *Theories of Memory* (1924).

Physiology of Memory.—The bodily structures involved in the memory process and the common order of events are as follows: (1) A stimulus affects a sense organ. (2) Nervous impulses pass from this structure to the centres in the brain. (3) Nervous connections are made by the association neurones in the brain. The function of the association neurones is similar to the connecting process in the central office of an automatic telephone system. (4) Nervous impulses pass outward from the brain and (5) cause a response in a muscle or gland. Learning or association consists in the formation of a functional connection in the central nervous system between a stimulus and a response

The important phase of memory called retention is the passive condition of the central nervous system in which this connection between a stimulus and a response persists for a period of time. The memory process is known as recall when the stimulus is given and the learned response occurs. Memory is never entirely conscious because we are never completely aware of the physiological activities in our own nervous systems. We learn and remember affective and motor activities, as well as intellectual material.

The mechanism of learning or association is a function of and is dependent upon the activity in the nervous system, muscles, glands, and also sense organs. The ways in which learning, retention and recall can be influenced by bodily fatigue, drugs, severe illness, lesion of the brain, and fracture of the skull have been studied experimentally. When learning and memory are seriously impaired, as in idiocy, the scientific studies have shown that (1) the brain has fewer nerve cells, (2) the neurones are more irregularly arranged, and (3) the functional efficiency is low. These facts are of great theoretical importance, because they have shown that memory is at the same time both a physiological and a psychological process.

MEMPHIS, the capital of Egypt through most of its early history, now represented by the rubbish mounds at Bedreshēn on the W. bank of the Nile 14 m. S. of Cairo. As the chief seat of the worship of Ptah, the artisan god (Hephaestus), Memphis must have existed from a very remote time. But its greatness probably began with Menes (*q.v.*), who united the kingdoms of Upper and Lower Egypt, and is said to have secured the site for his capital near the border of the two lands by diverting the course of the river eastward. The residence here of Pepi I. of the VIth Dynasty, as well as his pyramid in the necropolis, was named *Men-nefer,* and this gradually became the usual designation of the whole city, becoming Menfi, Membi in late Egyptian, *i.e.,* Memphis. It was also called Hakeptah, "Residence of the *ka* of Ptah," and this name furnishes a possible origin for that of Egypt (Αἴγυπτος). Memphis remained the centre of the government and the largest city in Egypt until the New Empire (Dyns. XVIII.–XX.), when Amen worship replaced that of Ptah and Thebes took the lead. After the conquest of Alexander the city quickly lost its supremacy to his new foundation, and although it remained the greatest native centre, its population was less than that of Alexandria. Its final fall was due to the rise of the Arabic city of Fostāt on the right bank of the Nile almost opposite the northern end of the old capital; and its ruins, so far as they still lay above ground, gradually disappeared, being used as a quarry for the new city, and afterwards for Cairo. Now the ruins of the city, the great temple of Ptah, the dwelling of Apis, and the palaces of the kings, are traceable only by a few stones among the palm trees and fields and heaps of rubbish. But the necropolis has been to a great extent protected by the accumulations of blown sand. Pyramids of the Old and Middle kingdoms form a chain 20 m. long upon the edge of the valley from Giza to Dahshur. At Saqqara, the step-pyramid of Zoser of the IIIrd Dynasty, several pyramids of the Vth and VIth Dynasties, and innumerable mastaba-tombs of the Old Kingdom, are crowded together in the cemetery. Later tombs are piled upon and cut through the old ones. One of the chief monuments is the Serapeum or sepulchre of the Apis bulls, discovered by Mariette in 1861. From 1905 J. E. Quibell was charged by the Service des Antiquités solely with the excavations in this vast necropolis. His principal discovery was the extensive remains of the Coptic monastery of St. Jeremias, with remarkable sculptures and frescoes. Flinders Petrie made a systematic exploration of the ruins of Bedreshēn; among his finds not the least interesting is a large series of terra-cotta heads representing the characteristic features of the foreigners who thronged the bazaars of Memphis. They date from the Persian rule down to the Ptolemaic period and are evidently modelled by Greek workmen. In the Old Testament Memphis is mentioned under the names of Moph (Hos. ix. 6) and Noph (Isa. xix. 13; Jer. ii. 16; Ezek. xxx. 13, 16).

MEMPHIS, the largest city of Tennessee, U.S.A., a port of entry and the county seat of Shelby county; on the Mississippi river, in the south-west corner of the State. It is on Federal highways 51, 61, 70, 72 and 78, and is served by the Frisco, the Illinois Central, the Louisville and Nashville, the Missouri Pacific, the Mobile and Ohio, the Nashville, Chattanooga and St. Louis, the Rock Island, the St. Louis Southwestern, the Southern, and the Union (an industrial belt line) railways, and by two barge lines and river packets. Pop. 162,351 in 1920 (38% negroes); and 253,143 in 1930.

The city is built on the Chickasaw bluffs, 50 ft. above the flood stage of the river, and has an area of 30·34 square miles. It is one of the country's chief centres of traffic, by rail, water and highway. Two cantilever railway bridges cross the Mississippi, one of which (the Harahan, completed 1917) carries also vehicular traffic, without toll charges, giving direct access to and from the fertile alluvial lands of Arkansas. Water and rail transportation facilities are co-ordinated by two municipal terminals, completed in 1913 at a cost of over $2,000,000. Natural gas was piped in from the Louisiana fields early in 1929, and hydro-electric power will be available from the Muscle Shoals district and from developments on the White river of Arkansas. The water-supply, from artesian wells, is ample for three or four times the present demand. The city operates under a commission form of government, established in 1910. Through a city-planning commission, created in 1921, a comprehensive plan for improvement and development has been prepared, and zoning ordinances have been adopted. The public parks cover 1,248 acres. The fine auditorium seats 12,500. Memphis is the see of a Protestant Episcopal bishopric. It is the seat of the colleges of medicine and dentistry and the schools of pharmacy and nursing of the University of Tennessee; the West Tennessee State Teachers college (1912) located at Normal, just outside the city limits; and Southwestern, a Presbyterian college, opened in Clarksville in 1875 and moved to Memphis in 1925. There are 84 schools and colleges in all.

Because of its geographical position and transport facilities, Memphis has long been a leading commercial city of the South, and since the World War and the revival of river traffic (beginning with the establishment of the Federal Barge Line in 1918) its trade area has greatly widened and the volume of its wholesale and distributing business has increased vastly. Manufacturing also has grown rapidly. In 1927 there were nearly 600 distributing houses, including the southern headquarters of many northern and eastern firms, and 286 widely diversified manufacturing establishments, with an output valued at $91,670,156. A branch of the Federal Reserve Bank is located here. Bank debits for the year totalled $1,906,725,500; postal receipts amounted to $2,371,720. Memphis is the largest inland cotton market (handling over 2,000,000 bales in a normal year) and the largest hardwood lumber market of the country. The Tri-State fair, in which Tennessee, Mississippi and Arkansas participate, is held here annually.

History.—From a high point in the park that bears his name, De Soto (according to tradition) first saw the Mississippi, in 1541, and there he met in consultation with Chisca, chief of the Chickasaw Indians. Late in the 17th century the French built a fort within the present limits of the city, and the site was held by the French and the Spanish alternately until the close of the French and Indian War, when it passed to Great Britain. In 1797 it came into the possession of the United States. By a treaty of Oct. 19, 1818, negotiated by General Andrew Jackson and General Isaac Shelby, the Chickasaws ceded all their claims east of the Mississippi, and early in 1819 Memphis was laid out in accordance with an agreement entered into by John Overton, Andrew Jackson and James Winchester, the proprietors of the land. Its name was suggested by the similarity of its location to that of the Egyptian city on the Nile. The town was incorporated in 1826, and in 1849 was chartered as a city. By 1830 the cultivation of cotton was general in the surrounding country. In 1834 Memphis established her first steamboat line (to New Orleans) and in 1836 began the construction of a railroad. About 1840 Congress established here an experimental inland navy yard, where one iron ship was launched. In 1857 through railway connection with the Atlantic (at Charleston) was completed. The

decade 1850–60 was one of rapid development, and by 1860 the city had a population of 22,623. On June 6, 1862, a Union fleet of 9 vessels and 68 guns defeated a Confederate fleet of 8 vessels and 28 guns just north of Memphis, and the city was then occupied by Federal troops until the end of the war, except for a few hours on Aug. 21, 1864, when General Nathan B. Forrest made a daring raid and took several hundred prisoners.

By 1870 the city was well on the way to recovery from the prostration left by the war: the railroads had been rebuilt, river commerce was re-established, building was active, and the population had increased to 40,226. Then, in 1873, 1878 and 1879, it was ravaged by epidemics of yellow fever, which resulted in over 8,000 deaths. Thousands fled the city and did not return. Business was suspended for three months both in 1878 and in 1879, and intercourse with the outside was practically cut off. The city was left almost bankrupt. As a means of relief the State legislature (on Jan. 29, 1879) repealed the city's charter, made it a "taxing district," and placed its affairs in the hands of a "legislative council." A complete sewer system was installed, at great cost, and artesian wells were dug to supply the city with water. In the next decade the population, which had fallen to 33,592 in 1880, almost doubled, reaching 64,495 in 1890. The first bridge across the Mississippi was completed in 1892.

MENA, JUAN DE (1411–1456), Spanish poet, was born at Cordova. His principal work is his allegorical poem, *El Laberinto de Fortuna* (1444?), dedicated to John II.; in the oldest mss. it consists of 297 stanzas, but three more stanzas were added to it later, whence the alternative, popular title of *Las Trezientas*. The *Laberinto* is modelled on Dante, and further contains reminiscences of the *Roman de la rose*, as well as episodes borrowed from Virgil and Lucan. It is marred by excessive emphasis and pedantic diction, and the *arte mayor* measure in which it is written is monotonous; but many octaves are of such excellence that the *arte mayor* metre (verses of 12 syllables) continued in fashion for nearly a century.

MENA, PEDRO DE (d. 1693), Spanish sculptor, was born in Adra. He was a pupil of his father and of Alonzo Cano. His first conspicuous success was achieved with the figures for the convent of El Angel at Granada. In 1658 he signed a contract for sculptural work on the choir stalls of the cathedral at Malaga. Other works are the statues of the Madonna and Child and of St. Joseph in Madrid, the polychromatic figures in the church of St. Isodoro, the Magdalena and the Gertrudis in the church of St. Martin (Madrid), the crucifixion in the Nuestra Señora de Gracia (Madrid), the statuette of St. Francis of Assisi in Toledo, and of St. Joseph in the St. Nicholas church in Murcia. Between 1673 and 1679 Mena worked at Cordova. About 1680 he was in Granada, where he executed a half-length Madonna and Child (seated) for St. Dominicos. He died in Malaga in 1693. Mena and Mora (*q.v.*) may be regarded as artistic descendants of Montañes and Alonzo Cano, but in technical skill and the expression of religious motive Mena's statues are unsurpassed in the sculpture of Spain. His feeling for the nude was remarkable, and he excelled in the portrayal of contemplative figures and scenes.

See B. Haendcke, *Studien zur Geschichte der spanischen Plastik* (Strasbourg, 1900).

MENADO, a government of the island of Celebes, Dutch East Indies, comprising the north-eastern peninsula and the coast of the Gulf of Tomini; area 63,761 sq.km.; pop. 967,520. (*See* CELEBES.)

MENAGE, GILLES (1613–1692), French scholar, son of Guillaume Ménage, king's advocate at Angers, was born in that city on Aug. 15, 1613. He became prior of Montdidier without taking holy orders, and lived for some years in the household of Cardinal de Retz (then coadjutor to the archbishop of Paris). Some time after 1648 he quarrelled with his patron and withdrew to a house in the cloister of Notre-Dame, where he gathered round him on Wednesday evenings those literary assemblies which he called "*Mercuriales*." Chapelain, Pellisson, Conrart, Sarrazin and Du Bos were among the *habitués*. Ménage was the original of the pedant Vadius in *Les Femmes savantes*. He died in Paris on July 23, 1692.

Of his works the following may be mentioned: *Poemata latina, gallica, graeca, et italica* (1656); *Origini della lingua italiana* (1669); *Dictionnaire étymologique* (1650 and 1670); *Observations sur la langue française* (1672–76,) and *Anti-Baillet* (1690).

MENAHEM, king of Israel, seized the throne *c.* 745 B.C., after the death of Zechariah, whose reign had lasted but six months. From his headquarters at Tirzah, the old royal city of Israel, he advanced against Shallum, a rival aspirant to the throne who maintained royal state in Samaria for a month, and slew him. He was not accepted by the district of which Tappuah (so read for Tiphsah in 2 Kings xv. 16) was the centre, and made his position good only by bitter fighting, after which he inflicted barbarous punishment on those who would have thwarted him. Towards the end of his reign, which lasted ten years, the peoples of Syria formed an anti-Assyrian coalition. Tiglath-Pileser III. advanced against the rebels, 738 B.C., and crushed them. The Assyrian king, in an inscription recording his successes, names among the kings who paid tribute Menahem of Samaria. The narrative 2 Kings xv. confirms this, and indeed suggests that Tiglath-Pileser advanced against Israel itself. The inscription is silent on this latter detail, and probably Menahem thought it wise to pay tribute before this pass was reached.

MENAI STRAIT, a channel of the Irish sea, separating Anglesey from Carnarvonshire, north Wales, extending 14 m. from Beaumaris to Abermenai, and varying in breadth from 200 yd. to 2 m. It is famous for the suspension and tubular bridges which cross it. The suspension bridge carries the Holyhead road from Bangor. It was designed by T. Telford, begun in 1819 and completed in 1826. The length of roadway between the piers is 550 ft., total length 1,000 ft. and height above the spring tide high-water level is 100 ft. The tubular bridge, which carries the L.M.S. railway, was finished in 1850. The bridge, 1,841 ft. 5 in. long, is supported by a central (Britannia) tower and two side towers. Here the channel is about 1,100 ft. wide, and divided in the middle by the Britannia rock, bare at low water. The tide generally rises 20 ft., with great velocity. There are 101 ft. between the sea at high tide and the bridge roadway bottom. The limestone used is from Penmon, 4 m. from Beaumaris. The engineer of the tubular bridge was Robert Stephenson, assisted by Sir William Fairbairn and Eaton Hodgkinson.

The origin of the Menai strait has been much discussed (*see* E. Greenly, "Geology of Anglesey," *Mem. Geol. Survey*, 1919). The channel consists of an eastern and a western reach, having a parallel direction from south-west to north-east, and being joined by a middle reach, 2 m. long, having a north to south direction. The two longer arms are typical valleys, belonging to a system of parallel valleys upon the Menaian platform. In pre-glacial times the strait did not exist, but its location was marked by three rivers, one flowing north-east, a small one flowing south and joining a larger one flowing south-west. In late glacial times the western and eastern reaches came into existence, but the water of the latter was dammed back by the Ogwen glacier from the mainland, thus forming a long glacial lake which overflowed into what is now the middle reach, following the line of the southward flowing river, the valley of which it quickly deepened and thus emptied the lake. Post-glacial subsidence and scouring by the tides have completed the work.

MENAM, the chief river highway of Siam, on whose yearly rise and fall depends the rice crop of Lower Siam. Rising in the state of Nan, upon the mountain mass of Doi Luang, it is known as the Nam Ngob, after a village of that name. As the Nam Nan, it flows southward between high forested ranges, and, notwithstanding the frequent rapids along its course, is used by the natives for the transport of hill produce. From Utaradit it flows through the plain of Lower Siam, is navigable for large flat-bottomed native craft and is known as the Menam Pichai. Below Pichai the river flows through forest and swamp, the latter providing vast overflow basins for the yearly floods. Thousands of tons of fish are caught and cured here during the fall of the river. Below Pitsunalok the waters of the Menam Yom, upon which two ancient capitals, Sawankalok and Sukotai, were situated, meander by tortuous clayey channels to the main river, and com-

bine to form the Nam Po. At Paknam Po the main western tributary comes in, the shallow Me Ping, the river of Raheng and Chieng Mai, bringing with it the waters of the Me Wang. As the chief duty-station for teak, and as a place of transshipment for boats, Paknam Po is an important and growing town. From this point the river winds by many channels through the richest and most densely populated portion of Siam. About Chainat the Tachin branches off, forming the main western branch of the Menam, and falling into the gulf about 24 m. west of the bar of the main river. At Ayuthia, the Nam Sak flows in from the north-east, affording communication with the tobacco district of Pechabun, and draining the western slopes of the Korat escarpment.

MENANDER (Μένανδρος) (*c.* 343/2–291/0 B.C.), the chief poet of the Greek New Comedy, was the son of a wealthy Athenian, Diopeithes, of the deme Cephisia, and his wife, Hegesistrate. Alexis, the distinguished poet of the Middle Comedy, was his uncle. Of his uneventful life almost nothing is known. He was a pupil of Theophrastus (Diog. L., v.36) as was also Demetrius of Phalerum (Diog. L., v. 39, v. 75), who in 317 B.C. had been appointed by Cassander to be governor of Athens, and with whom Menander was on friendly terms (Diog. L., v.79). Phaedrus, *Fab.* v. 1, tells how Demetrius was fawned upon not merely by prominent politicians but also by retired lovers of ease: "among whom Menander, famous for his comedies—whom Demetrius had not known personally though he had read him and admired his genius—came, perfumed and in flowing robe, with languid step and slow. Seeing him at the end of the line the tyrant asked "What effeminate is that who dares to enter my presence?" Those nearest replied "This is Menander, the writer!" He was no doubt acquainted also with his distinguished contemporary, Epicurus (Strabo, 638). He declined an invitation from the court of Macedon, as also one from Ptolemy Soter to Alexandria (Plin. N.H. vii. 111. Alciphr, *Ep.* iv.18) and remained in Athens till his death, which is said to have occurred through drowning in the Bay of Phalerum (schol. Ovid, *Ibis*). His tomb beside the cenotaph of Euripides between Athens and the Peiraeeus was seen by Pausanias. Of his personal appearance we are told that he had a squint (Suidas, *s.v.* Μένανδρος). His portrait is supposed to be represented by a head in the Vatican.

He appears to have produced his first play, the Ὀργή, in 324 and he won his first victory, according to the *Marmor Parium*, in 316/5. According to Apollodorus *ap.* Aul. Gell. xvii. 5 Menander "of Cephisia, son of Diopeithes, wrote 105 dramas and died at 52," but won the prize only eight times. In his own day Philemon was preferred to him. (Quintil. x.1.72.) "Yet other comic poets . . . and especially Philemon, who, if by the verdicts of his own time he was often wrongly preferred to Menander, is universally allowed to have deserved to be considered second to him" (*cf.* Aul. Gell. xvii. 4.1). Menander was often defeated by Philemon, by no means his equal as a writer, through canvassing and faction. Meeting him on one occasion "Excuse me, Philemon," he said, "when you defeat me, do you not blush?" (Martial v.10 *Rara coronato plausere theatra Menandro*). But after his death he came to be regarded not merely as the leading poet of the New Comedy, but as the chief representative of comedy in general.

At the beginning of the 19th century all that was extant of Menander was a number of fragments, some of uncertain source, quoted by grammarians or other writers, and a collection of single lines of a sententious character (Μενάνδρου γνῶμαι μονόστιχοι), 850 in all, and not all of them authentic. Considerable information as to the character of his plays was to be gathered at second-hand from the use made of them by Plautus, who based his *Bacchides* on the *Dis Exapaton*, his *Poenulus* probably on the *Karchedonios*, his *Stichus* on the *Adelphoi*, one of the two plays of that name written by Menander; and still more from Terence —who is saluted by Julius Caesar in the well known epigram (Sueton. *Vit. Ter.*) as "dimidiate Menander," "Menander in half" —of whose plays the *Andria* is a "contamination" of Menander's *Andria* and *Perinthia*, the *Eunuchus* a "contamination" of the *Eunouchos* and *Kolax*, the *Heautontimorumenos* a version of a play of the same name by Menander, while the *Adelphoi* is based on Menander's *Adelphoi* and the *Synapothneskontes* of Diphilus.

But since 1844 when C. Tischendorf found in the monastery of St. Catherine on Mt. Sinai three papyrus fragments containing 52 lines from the *Phasma*, 41 from the *Epitrepontes*, six from an uncertain play—all in a more or less mutilated condition—the Menander *corpus* has been greatly augmented by fresh papyrus discoveries. Incomparably the most important is the Cairo papyrus, discovered in 1905 by G. Lefebure at Aphroditopolis, containing 659 lines from the *Epitrepontes*, 83 from the *Heros*, 341 from the *Samia*, 324 from the *Perikeiromene*, and 61 from an uncertain play. In addition 87 lines of the *Georgos* were recovered in Egypt by I. Nicole in 1897. A series of Oxyrhynchus papyri published by Grenfell and Hunt restored to us, in 1899, 51 lines of the *Perikeiromene;* in 1903 and 1914, 115 (fragmentary) lines of the *Kolax;* in 1908, 23 lines of the *Perinthia;* in 1910 and 1920, some 80 (fragmentary) lines of the *Misoumenos*. A Berlin papyrus (pub. 1907) gives 93 (fragmentary) lines of the *Kitharistes,* while another (pub. 1918) contains 23 lines of the *Misoumenos*. Some mutilated lines of the *Georgos* are given in a Florence papyrus (pub. 1912) and 20 (mutilated) lines of the *Koneiazomenai* in a Dorpat papyrus.

In structure, in subject matter, and in general tone, the New Comedy, which is essentially a comedy of manners, presents a marked contrast to the Old Comedy as we know it in the plays of Aristophanes. The chorus as an organic element in the play has wholly vanished—although there seems to have been some sort of choric interlude between the acts, as indicated in our texts by the single word ΧΟΡΟΥ—and with it the Parabasis, and the agon, the central element in the Old Comedy, in the sense of a formal debate between two clearly defined antagonists, has also disappeared. The theme is no longer some high question of political or social or religious moment, but merely the presentation of some commonplace complication of ordinary Athenian life, in which common types of character—the wealthy father, the dissolute son, the cunning slave—play their part, the complication being most commonly due to love (Ovid, *Trist.* II. 369 *Fabula iucundi nulla est sine amore Menandri*) in its least lovely guise, and the disentanglement being usually effected, more or less plausibly, by recognition (Ἀναγνώρισις), *i.e.*, by the timely discovery that some supposed stranger is in reality a long lost son or daughter, who had disappeared, whether by exposure in infancy or by shipwreck in a foreign land or other similar misfortune. The humour, whether of situation or of character, is of a subdued type, and the general atmosphere is quiet and little charged with emotion. A glance at the titles of Menander's plays, such as Κόλαξ, *The Flatterer*, Δεισιδαίμων, *The Superstitious Man*, and the like, suggest the prominence of character study, while the long list of such titles as Ανδρία, *The Lady from Andros*, Κνιδία, *The Lady from Cnidus*, etc., emphasize the place of recognition as a mode of dénouement, the supposed foreigner being discovered to be a true-born Athenian.

"Truth to life," his scrupulous observation of "propriety" or what the Greeks called τὸ πρέπον, was the great merit which the ancients recognized in Menander. "Ὦ Μένανδρε καὶ βίε, πότερος ἄρ' ὑμῶν πότερον ἀπεμιμήσατο; O Menander and Life, which of you imitated the other?" so runs the highly flattering apostrophe to Menander attributed to Aristophanes of Byzantium. So Quintilian X. 1.69 writes of "Menander who, in my judgment, would alone, if carefully read, be sufficient to illustrate all my precepts: so well has he expressed the whole picture of life (*omnem vitae imaginem expressit*), such copiousness of invention has he, such a gift of speech, so appropriate is he in all his incidents, characters, emotions." *Cf.* Dio Chrysos. xviii. 7. Plutarch *comp. Menand. et Aristoph.* p. 853. A.P. vii. 370. ix. 187. The subtle presentation of character is perhaps a thing too delicate in its nature to exert its full appeal after the lapse of more than 2,000 years, but even the broken fragments of his work that remain enable us as assent to the judgment of antiquity.

Lastly it may be remarked that the sententious character, which he shared with Euripides (of whom he was a confessed admirer and imitator, Quintil. x. 1. 69) is not nearly so marked in the new fragments as one might have expected from the Μονόστιχοι, two of which—"Whom the gods love dies young" (ὃν οἱ θεοὶ

φιλοῦσιν ἀποθνήσκει νέος) and "Evil communications corrupt good manners" (*φθείρουσιν ἤθη χρήσθ' ὁμιλίαι κακαί*—*cf.* N. T. I Corinth. xv. 33)—are known to multitudes who never heard the name of Menander.

BIBLIOGRAPHY.—The old fragments are in *Comicorum Atticorum Fragmenta* ed. Kock (1880–88), iii. 3 *sqq.* Newly discovered fragments ed. Sudhaus (1909); *Menandrea*, A. Koerte, ed. major (Berlin, 1912); *Selections*, from Menander, ed. Waddell (Oxford, 1927).

(A. W. MA.)

MENANDER (MILINDA), a Graeco-Indian dynast. When the Graeco-Indian king Demetrius had been beaten by Eucratides of Bactria, about 160 B.C., and the kingdom of Eucratides (*q.v.*) dissolved after his assassination (*c.* 150 B.C.), a Greek dynasty maintained itself in the Kabul Valley and the Punjab. The only two kings of this dynasty mentioned by classical authors are Apollodotus and Menander, who conquered a great part of India. Trogus Pompeius described in his forty-first book (*see* the prologue) "the Indian history of these kings, Apollodotus and Menander," and Strabo, xi. 516, mentions from Apollodotus of Artemita, the historian of the Parthians, that Menander "conquered more tribes than Alexander, as he crossed the Hypanis to the east and advanced to the Osamus; he and other kings (especially Demetrius) occupied also Patalene (the district of Patala near Hyderabad on the head of the delta of the Indus) and the coast which is called the district of Saraostes (*i.e.*, Syrastene, in mod. Gujarat, Brahman *Saurashtra*) and the kingdom of Sigerdis (not otherwise known); and they extended their dominion to the Seres (*i.e.*, the Chinese) and Phryni (?)." The last statement is an exaggeration, probably based upon the fact that from the mouth of the Indus trade went as far as China. That the old coins of Apollodotus and Menander, with Greek legends, were still in currency in Barygaza (mod. Broach), the great port of Gujarat, about A.D. 70 we are told by the *Periplus maris Erythraei*, 48. Their reigns may be placed about 140–80 B.C. Menander appears in Indian traditions as Milinda; he is praised by the Buddhists, whose religion he is said to have adopted, and who in the *Milindapanha* or *Milinda Pañho* (*see* below), "the questions of Milinda" (Rhys Davids, *Sacred Books of the East*, xxxv., xxxvi.) relate his discourses with the wise Nāgasena. Plutarch (*Praec. reip. ger.* 28, 6) relates that "when Menander, one of the Bactrian kings, died on a campaign after a mild rule, all the subject towns disputed about the honour of his burial, till at last his ashes were divided between them in equal parts." (The Buddhist tradition relates a similar story of the relics of Buddha.) Besides Apollodotus and Menander, we know from the coins a great many other Greek kings of western India, among whom two with the name of Straton are most conspicuous. The last of them, with degenerate coins, seems to have been Hermaeus Soter. These Greek dynasts may have maintained themselves, with diminished realms, in some part of India till about 40 B.C. (*See* INDIA: *History*.)

The *Milinda Pañho* is preserved in Pali, in Ceylon, Burma and Siam, but was probably composed originally in the extreme northwest of India, and in a dialect spoken in that region. Neither date nor author is known; but the approximate date must have been about the 2nd century of our era. The work is entitled *Milinda Pañho*—that is, *The Questions of King Milinda.* The work is several times quoted as authority by Buddhaghosa, who wrote about A.D. 450, and it is the only work, not in the canon, which receives this honour.

AUTHORITIES.—V. Trenckner, *Milinda-pañho* (London, 1880); Rhys Davids, *Questions of King Milinda* (2 vols., Oxford, 1890–94); R. Garbe, *Beiträge zur indischen Kulturgeschichte* (Berlin, 1903, ch. 3, *Der Milinda-pañho*); *Milinda Prashnaya*, in Sinhalese (Colombo, 1877); R. Morris, in the *Academy* (Jan. 11, 1881); Sylvain Lévy, Proceedings of the 9th International Congress of Orientalists (London, 1892), i. 518–529, and *Journal of the Royal Asiatic Society* (1891), p. 476.

MENANGKABAUS, the most civilized of all the true Malays of Sumatra, inhabiting the mountains above Padang. Their district is regarded as the cradle of the Malay race, and thence began, about 1160, the migrations of the Malays throughout the peninsula and the Malay Archipelago. The Menangkabaus are said to be the original conquerors of the island. Though converts to Islam, the ancient village communes and the matriarchal system still exist. The people are divided into clans, the chiefs together forming the district council. Early in the 19th century a religious sect was founded among the Menangkabaus, known as "Padris" from its zealous proselytism, or *Orang puti* (white men) from the converts being dressed in white. The tendency was towards asceticism, the chief tenet being the prohibition of opium, the use of which was made a capital offence. The sect brought a large portion of the interior of Sumatra under its rule, but the neighbouring tribes asked the Dutch to protect them, and this led to the Netherlands acquiring the Menangkabau territory.

MÉNANT, JOACHIM (1820–1899), French magistrate and Orientalist, was born at Cherbourg on April 16, 1820. He studied law and in 1881 became a member of the *cour d'appel* of Rouen. He is known by his studies on cuneiform inscriptions. He died in Paris on Aug. 30, 1899.

His publications include: *Recueil d'alphabets des écritures cunéiformes* (1860); *Exposé des éléments de la grammaire assyrienne* (1868); *Le Syllabaire assyrien* (2 vols., 1869–73); *Les Langues perdues de la Perse et de l'Assyrie* (2 vols., 1885–86); *Les Pierres gravées de la Haute-Asie* (2 vols., 1883–86).

MENARD, LOUIS NICOLAS (1822–1901), French man of letters, was born in Paris on Oct. 19, 1822. His versatile genius occupied itself in turn with chemistry, poetry, painting and history. He discovered collodion in 1846, but its value was not recognized; and its application later to surgery and photography brought him no advantage. Louis Ménard was a socialist, always in advance of the reform movements of his time. After 1848 he was condemned to imprisonment for his *Prologue d'une révolution.* He escaped to London, returning to Paris only in 1852. Until 1860 he occupied himself with classical studies, the fruits of which are to be seen in his *Poèmes* (1855), *Polythéisme hellénique* (1863), and two academic theses, *De sacra poesi graecorum* and *La Morale avant les philosophes* (1860). The next ten years Ménard spent chiefly among the Barbizon artists, and he exhibited several pictures. He was in London at the time of the Commune, and defended it with his pen. In 1887 he became professor at the Ecole des Arts décoratifs, and in 1895 professor of universal history at the Hôtel de Ville in Paris. His *Rêveries d'un païen mystique* (1876), which contained sonnets, philosophical dialogues and some stories, was followed in 1896 by *Poëmes et rêveries d'un païen mystique,* in which he resuscitated many ancient myths. He had views on spelling reform, and adopts his own orthography in some of his work. Ménard died in Paris on Feb. 12, 1901.

His works include: *Histoire des anciens peuples de l'Orient* (1882); *Histoire des Israélites d'après l'exégèse biblique* (1883), and *Histoire des Grecs* (1884–86).

MENASHA, a city of Winnebago county, Wisconsin, U.S.A., 85 m. N. by W. of Milwaukee, on Lake Winnebago at its outlet into the (canalized) Fox river. It is on Federal highway 41, and is served by the Chicago and North Western, the Chicago, Milwaukee, St. Paul and Pacific, and the Soo Line railways, and by lake and river steamers. Pop. (1920) 7,214 (82% native white); 9,062, Federal census, 1930. Menasha and Neenah, across the river, are practically one community in economic and social interests. There is abundant water-power, and the manufactures of Menasha are numerous and diversified, with an annual output valued at $25,000,000. It is an important publication centre, printing some 20 periodicals of learned societies and college fraternities. The city owns both the water and the electricity plants. In 1634–35 Jean Nicollet visited the region, finding here villages of the Fox and Winnebago Indians, and later French and English trading posts were established on the site of Menasha. Permanent settlement began in 1848, and the city was chartered in 1874.

MENASSEH BEN ISRAEL (*c.* 1604–1657), Jewish leader, was born in Lisbon about 1604, and was brought up in Amsterdam. His family had suffered under the Inquisition, but found an asylum first in La Rochelle and later in Holland. Here Menasseh rose to eminence as rabbi, author and printer. He established the first Hebrew press in Holland. One of his earliest works *El Conciliador* won immediate reputation. It was an attempt at reconciliation between apparent discrepancies in various parts of the Old Testament. Among his correspondents were Vossius, Grotius and Huet. In 1638 he decided to settle in Brazil, as he still found it difficult

to provide in Amsterdam for his wife and family, but this step was rendered unnecessary by his appointment to direct a college founded by the Pereiras.

In 1644 Menasseh met Antonio de Montesinos, who persuaded him that the North American Indians were the descendants of the lost ten tribes of Israel. This supposed discovery gave a new impulse to Menasseh's Messianic hopes. But he was convinced that the Messianic age needed as its certain precursor the settlement of Jews in all parts of the known world. Filled with this idea, he turned his attention to England, whence the Jews had been expelled since 1290. He found much Christian support in England. Messianic and other mystic hopes were current in England. In 1650 appeared an English version of the *Hope of Israel,* a tract which deeply impressed public opinion. Cromwell had been moved to sympathy with the Jewish cause, chiefly because he foresaw the importance for English commerce of the presence of the Jewish merchant princes, some of whom had already found their way to London. At this juncture Jews received full rights in the colony of Surinam, which had been English since 1650. In 1655 Menasseh arrived in London. It was during his absence that the Amsterdam Rabbis excommunicated Spinoza, a catastrophe which might have been avoided had Menasseh—Spinoza's teacher—been on the spot.

One of Menasseh's first acts on reaching London was the issue of his *Humble Addresses* to the Lord Protector, but its effect was weakened by the issue of Prynne's *Short Demurrer.* Cromwell summoned the Whitehall Conference in December of the same year. The chief practical result was the declaration of Judges Glynne and Steele that "there was no law which forbade the Jews' return to England." Though, therefore, nothing was done to regularize the position of the Jews, the door was opened to their gradual return. Hence John Evelyn was able to enter in his *Diary* under the date Dec. 14, 1655, "Now were the Jews admitted." But the attack on the Jews by Prynne and others could not go unanswered. Menasseh replied in the finest of his works, *Vindiciae judaeorum* (1656). "The best tribute to its value is afforded by the fact that it has since been frequently reprinted in all parts of Europe when the calumnies it denounced have been revived" (L. Wolf). Among those who used in this way Menasseh's *Vindiciae* was Moses Mendelssohn (*q.v.*). Soon after Menasseh left London Cromwell granted him a pension, but he died, at Middleburg, before he could enjoy it. Menasseh was a friend of Rembrandt, who painted his portrait and engraved four etchings to illustrate his *Piedra gloriosa.* These are preserved in the British Museum.

See Graetz, *History of the Jews,* vol. v. ch. ii.; Lucien Wolf, *Menasseh ben Israel's Mission to Oliver Cromwell,* with a reprint of the English pamphlets (1901); H. Adler, "A Homage to Menasseh ben Israel," in *Transactions of the Jewish Historical Society of England,* i. 25–54; also M. Kayserling, *Menasseh ben Israel* (1861).

(I. A.)

MENCIUS, the latinized form of Măng-tsze, "Mr. Măng," or "Măng the philosopher" (*fl.* 3rd cent. B.C.), a Chinese moral teacher whose name stands second only to that of Confucius. His statue or spirit-tablet (as the case may be) has occupied, in the temples of the sage, since our 11th century, a place among "the four assessors," and since A.D. 1530 his title has been "the philosopher Măng, sage of the second degree."

The Măngs or Măng-suns had been in the time of Confucius one of the three great clans of Lû (all descended from the marquis Hwan, 711–694 B.C.), which he had endeavoured to curb. Their power had subsequently been broken, and the branch to which Mencius belonged had settled in Tsâu, a small adjacent principality, the name of which remains in Tsâu hsien, a district of Yenchâu Shan-tung. A magnificent temple to Mencius is the chief attraction of the district city, and thousands of Măngs are to be found in the neighbourhood.

Mencius, who died in the year 289 B.C., lived to a great age—some say to his eighty-fourth year, placing his birth in 372 B.C., and others to his ninety-seventh, placing it in 385. His father died before the child was three; his mother's virtues and dealings with her son were celebrated by a great writer in the 1st century before our era, and for two thousand years she has been the model mother of China. Mencius was forty when he made his first appearance in history.

He intimates that he had been in communication with men who had been disciples of Confucius, and in the doctrines which he had taught Mencius recognized the truth for want of an appreciation of which the bonds of order all round him were being relaxed, and the kingdom hastening to anarchy. When he emerged from Tsâu, he was accompanied by eminent disciples. His intercourse with his followers was not so intimate as that of Confucius had been with the members of his selected circle; and he did not secure from them the same homage and reverent admiration.

More than a century had elapsed since the death of Confucius, and during that period the feudal kingdom of Châu had been showing signs of dissolution and even of approaching anarchy. The sentiment of loyalty to the dynasty had disappeared. Marquesses and other feudal princes of earlier times had usurped the title of king. The smaller fiefs had been absorbed by the larger ones, or reduced to helpless dependence on them. Tsin, after greatly extending its territory had broken up into three powerful kingdoms, each about as large as England. Mencius found the nation nominally one, and with the traditions of two thousand years affirming its essential unity, but actually divided into seven monarchies, each seeking to subdue the others under itself. The consequences were constant warfare and chronic misery.

On lawlessness, wickedness, heresies and misery Mencius looked out from the quiet of his school, and his spirit was stirred to attempt the rescue of the people from misrule and error. "If Heaven," he said, "wishes that the kingdom should enjoy tranquillity and good order, who is there besides me to bring it about?" He formed his plan, and proceeded to put it in execution. He would go about among the different kings till he should find one among them who would follow his counsels and commit to him the entire administration of his government. That obtained, he did not doubt that in a few years there would be a kingdom so strong and so good that all rulers would acknowledge its superiority, and the people hasten from all quarters to crown its sovereign as monarch of the whole of China. This plan was much the same as that of Confucius had been; but, with the bolder character that belonged to him, Mencius took in one respect a position from which "the master" would have shrunk. The former was always loyal to Châu, and thought he could save the country by a reformation; the latter saw the day of Châu was past, and the time was come for a revolution. Mencius's view was the more correct, but he was not wiser than the sage in forecasting for the future. They could think only of a reformed dynasty or of a changed dynasty, ruling according to the model principles of a feudal constitution, which they described in glowing language. They desired a repetition of the golden age in the remote past; but soon after Mencius disappeared from the stage of life there came the sovereign of Ch'in, and solved the question with fire and sword, introducing the despotic empire which has since prevailed.

Attended by several of his disciples, Mencius went for more than twenty years from one court to another, always baffled, and always ready to try again. He was received with great respect by kings and princes. He would not enter into the service of any of them, but he occasionally accepted honorary offices of distinction; and he received gifts which enabled him to live and move about as a man of wealth. He was as fearless and outspoken as John Knox. He lectured great men, and ridiculed them. He unfolded the ways of the old sage kings, and pointed out the path to universal sway; but he could not stir any one to honourable action. He confronted heresy with strong arguments and exposed it with withering sarcasm; but he could work no deliverance in the earth. The last court at which we find him was that of Lû, probably in 310 B.C. The marquis of that state had given office to Yo-chăng, one of Mencius's disciples, and he hoped that this might be the means of a favourable hearing for himself. On the suggestion of Yo-chăng the marquis had ordered his carriage to be yoked, and was about to step into it and proceed to bring Mencius to his palace, when an unworthy favourite stepped in and diverted him from his purpose. The disciple told his master what had occurred, reproaching the favourite for his ill-timed interven-

tion; Mencius, however, said to him, "A man's advancement or the arresting of it may seem to be effected by others, but is really beyond their power. My not finding in the marquis of Lû a ruler who would confide in me and put my lessons in practice is from Heaven."

Mencius accepted this incident as a final intimation to him of the will of Heaven. He had striven long against adverse circumstances, but now he bowed in submission. He withdrew from courts and the public arena. According to tradition he passed the last twenty years of his life in the society of his disciples, discoursing to them, and giving the finishing touches to the record of his conversations and opinions, which were afterwards edited by them, and constitute his works. Mencius was not so oracular, nor so self-contained, as Confucius; but his teachings have a vivacity and sparkle all their own.

Mencius held with Confucius—and it was a doctrine which had descended to them both from the remotest antiquity—that royal government is an institution of God. An ancient sovereign had said that "Heaven, having produced the people, appointed for them rulers, and appointed for them teachers, who should be assisting to God." But how could it be known on what individual the appointment of Heaven had fallen or ought to fall? Mencius concluded that this could be ascertained only from his personal character and his conduct of affairs. The people must find out the will of Heaven as to who should be their ruler for themselves. There was another old saying which delighted Mencius—"Heaven sees as the people see; Heaven hears as the people hear." He taught that, while government is from God, the governors are from the people;—*vox populi vox Dei.* No claim then of a "divine right" should be allowed to a sovereign if he were not exercising a rule for the good of the people. "The people are the most important element in a nation; the altars to the spirits of the land and grain are the second; the sovereign is the lightest." Mencius followed this utterance to its consequences. The monarch whose rule is injurious to the people, and who is deaf to remonstrance and counsel, should be dethroned. In such a case "killing is no murder." But who is to remove the sovereign that thus ought to be removed? First, he would have the members of the royal house perform the task. Let them disown their unworthy head, and appoint some better individual of their number in his room. If they could not or would not do this, he thought, secondly, that any high minister, though not allied to the royal house, might take summary measures with the sovereign, assuming that he acted purely with a view to the public weal. His third and grand device was what he called "the minister of Heaven." When the sovereign had become a pest instead of a blessing, he believed that Heaven would raise up some one for the help of the people, some one who should so conduct himself in his original subordinate position as to draw all eyes and hearts to himself. Let him then raise the standard not of rebellion but of righteousness, and he could not help attaining to the highest dignity. Mencius was in fact counselling rebellion, but he held that the house of Châu had forfeited its title to the throne.

Mencius laid down as essentials of good government care for the general welfare of all the people; the abolition of game laws; a light system of taxation; the execution of public improvements such as drainage and irrigation; liberty of commerce; and a complete and all-embracing system of education.

But after all, unless the people could get food and clothing by their labour, he had not much faith in the power of education to make them virtuous. Give him, however, a government fulfilling the conditions that he laid down, and he was confident there would soon be a people, all contented, all virtuous. Mencius contended that the nature of man is good. "Water," he said, "will flow indifferently to the east or west; but will it flow indifferently up or down? The tendency of man's nature to goodness is like the tendency of water to flow downwards." Sometimes he may seem to express himself too strongly, but an attentive study of his writings shows that he is speaking of our nature in its ideal, and not as it actually is—as we may ascertain, by an analysis of it, like it was intended to be, and not as it has been made to become.

Mencius insists on the constituents of human nature, dwelling especially on the principles of benevolence, righteousness, propriety, and wisdom or knowledge, the last including the judgment of conscience. "These," said he, "are not infused into us from without. Men have these four principles just as they have their four limbs." But man has also instincts and appetites which seek their own gratification without reference to righteousness or any other control. He met this difficulty by contending that human nature is a constitution, in which the higher principles are designed to rule the lower. "Some constituents of it are noble and some ignoble, some great and some small. The great must not be injured for the small, nor the noble for the ignoble."

When he proceeded from his ideal of human nature to account for the actual phenomena of conduct, he was necessarily less successful. "There is nothing good," he said, "that a man cannot do; he only does not do it." But why does he not do it? Against the stubborn fact Mencius beats his wings and shatters his weapons—all in vain.

Above all the sages he extols Confucius, taking no notice of that sage's confession that he had not attained to conformity to his own rule of doing to others as he would have them do to him. No such acknowledgment about himself ever came from Mencius. Therein he was inferior to his predecessor: he had a subtler faculty of thought, and a much more vivid imagination; but he did not know himself nor his special subject of human nature so well. His thoughts were seldom condensed like those of "the master" into aphorisms, and should be read in their connection; but we have from him many words of wisdom that have been as goads to millions for more than two thousand years. For instance:—

"Though a man may be wicked, yet, if he adjust his thoughts, fast, and bathe, he may sacrifice to God."

"The great man is he who does not lose his child-heart."

"Benevolence is the distinguishing characteristic of man. As embodied in his conduct, it may be called the path of duty."

"There is an ordination for everything; and a man should receive submissively what may be correctly ascribed thereto. He who has the correct idea of what Heaven's ordination is will not stand beneath a tottering wall. Death sustained in the discharge of one's duties may be correctly ascribed to Heaven. Death under handcuffs and fetters cannot be correctly so ascribed."

"When one by force subdues men, they do not submit to him in heart. When he subdues them by virtue, in their hearts' core they are pleased, and sincerely submit."

Two translations of the works of Mencius are within the reach of European readers: that by Stanislaus Julien, in Latin (Paris, 1824–1829); and that forming the second volume of Legge, *Chinese Classics* (Hong-Kong, 1862). The latter has been published at London (1875) without the Chinese text. *See* also E. Faber, *The Mind of Mencius, or Political Economy founded on Moral Philosophy,* translated from the German by A. B. Hutchinson (London, 1882).

MENCKEN, HENRY LOUIS (1880–   ), American critic, was born at Baltimore (Md.), Sept. 12, 1880. He attended the Baltimore Polytechnic Institute and in 1899 became a reporter on the Baltimore *Morning Herald.* After other newspaper experience he joined the editorial staff of the Baltimore *Sun,* to which he continued to be attached while engaged in many additional literary activities. He became literary critic for the *Smart Set* in 1908, and in 1914–23 he was joint editor with George Jean Nathan. In 1921 he became contributing editor of the *Nation,* and in 1924 he was one of the two founders of the *American Mercury,* of which he became sole editor in 1925. He is a satirist rather than a critic and represents the viewpoint of the extreme anti-academic element in the literary world.

Among his publications are *Ventures in Verse* (1903); *George Bernard Shaw: His Plays* (1905); *The Philosophy of Friedrich Nietzsche* (1908); *A Book of Burlesques* (1916); *Damn!* (1917), re-issued as *A Book of Calumny* (1919); *A Book of Prefaces* (1918); *The American Language* (1919); *In Defense of Women* (1917); many series of *Prejudices* (1919 *seq.*); and *Americana* (1925). He has also written critical prefaces to works by Brieux, Swift, Stephen Crane, Cabell, and others.

See the compilation *H. L. Mencken* (1920) by Burton Rascoe and others, monographs by Ernest Boyd (1925) and Isaac Goldberg (1925), and Carroll Frey, *A Bibliography of the Writings of H. L. Mencken* (1924).

MENDE, a town of south-eastern France, capital of the department of Lozère, 59 m. N.E. of Millau by rail. Pop. (1926)

5,785. Mende (Mimate) grew up around the hermitage, partly excavated in the side of the Mimat cliff, to which St. Privat, bishop of Javols, retreated after the destruction of that town, and where he was subsequently slain in 408 by the Vandals. In the 14th century the new town became the civil, as it had previously been the ecclesiastical, capital of the Gévaudan district. Mende is situated on the left bank of the Lot, and at the foot of the Causse de Mende. The town is the seat of a bishopric under the archbishop of Albi. Its cathedral of St. Peter was founded in the 14th century by Pope Urban V., a native of the district, but the two towers were added in the early 16th century. Partly destroyed during the devastation of the town by the Protestants in 1579 and 1580, it was rebuilt in the 17th century. A Renaissance tower of the ancient citadel now serves as the belfry of the church of the Penitents, and a 14th century bridge crosses the Lot. The town is a convenient centre for visitors to the gorges of the Tarn. It is the seat of a prefect and a court of assizes, and has a tribunal of first instance and a chamber of commerce. The chief industry is the manufacture of serges and shalloons, known as Mende stuffs, exported to Spain, Italy and Germany.

MENDE is also the name of a sturdy, medium-statured people of Sierra Leone, from French Guinea, resembling the Sosso and speaking a related language.

See Arcin, *La Guinée Française* (1907); Migeod, *The Languages of West Africa* (1911).

MENDELÉYEV, DMITRI IVANOVICH (1834–1907), Russian chemist, the youngest of a family of seventeen, was born at Tobolsk, Siberia, on Feb. 7, 1834. After attending the gymnasium of his native place, he went to study science at St. Petersburg, where he graduated in chemistry in 1856, subsequently becoming *privatdozent.* He became professor of chemistry in the technological institute at St. Petersburg in 1863, and three years later succeeded to the chair in the university. In 1890 he resigned the professorship and in 1893 became director of the Bureau of Weights and Measures, a post which he occupied till his death at St. Petersburg on Feb. 2, 1907.

Mendeléyev's name is best known for his work on the Periodic Law (*q.v.*). Various chemists had traced numerical sequences among the atomic weights of some of the elements and noted connections between them and the properties of the different substances; but it was left to him to give a full expression to the generalization, and to treat it not merely as a system of classifying the elements according to certain observed facts, but as a "law of nature" which could be relied upon to predict new facts. Thus in 1871 he was led by certain gaps in his tables to assert the existence of three new elements so far unknown to the chemist, and to assign them definite properties. These three he called eka-boron, eka-aluminium, and eka-silicon; and his prophecy was completely vindicated within fifteen years by the discovery of gallium in 1871, scandium in 1879, and germanium in 1886. Again, in several cases he ventured to question the correctness of the "accepted atomic weights," on the ground that they did not correspond with the Periodic Law, and here also he was justified by subsequent investigation. Mendeléyev also devoted much study to the nature of solutions, which he looked upon as homogeneous liquid systems of unstable dissociating compounds of the solvent with the substance dissolved. In another department of physical chemistry he investigated the expansion of liquids with heat, and devised a formula for its expression, while so far back as 1861 he anticipated T. Andrews's conception of the critical temperature of gases (*see* LIQUEFACTION OF GASES), by defining the absolute boiling-point of a substance as the temperature at which cohesion and heat of vaporization become equal to zero and the liquid changes to vapour, irrespective of the pressure and volume. He also gave much time to the study of the nature and origin of petroleum.

Mendeléyev's best known book is *The Principles of Chemistry,* which was written in 1868–1870, and has gone through many subsequent editions in various languages (Eng. ed. 2 vols., 1905). He was awarded the Davy medal of the Royal Society in 1882, and in 1905 he received its Copley medal. He was one of the greatest teachers of his time. His lecture room was always thronged with students. "Many of them," writes one of these, "I am afraid, could not follow Mendeléev, but for the few of us who could it was a stimulant to the intellect and a lesson in scientific thinking which must have left deep traces in their development."

See W. A. Tilden, "Mendeléeff Memorial Lecture," *Jour. Chem. Soc.,* 95; P. Walden, "D. I. Mendelejeff" in *Berichte d. deutsch. Chem. Ges.* (1908); T. E. Thorpe, *Essays in Historical Chemistry* (1911); W. A. Tilden, *Famous Chemists* (1921).

MENDELISM is the scientific theory relating to the distributive mechanism of organic inheritance, promulgated in 1866 by the Abbot G. J. Mendel, to interpret certain phenomena revealed by the experimental breeding of plants. Born in a peasant family in 1822, Johann Gregor Mendel became a monk and eventually abbot in the Augustinian monastery at Brünn, in Moravia. He carried on his experiments in the garden of the monastery, where he died in 1884. Mendel took for his problem the question as to the manner in which true-breeding varieties within a species are related. He concentrated his attention upon the mode of inheritance of sharply contrasted pairs of characters. His experimental material was the culinary pea and the pairs of characters with which he dealt are shown below. His method was that of hybridization, keeping accurate pedigree records, and counting the number of individuals in each generation and the numbers of dissimilar kinds. In all cases the result was the same; the first cross (the first filial generation or F_1) exhibited only one of the two alternative characters which had distinguished its parents. The character that prevailed Mendel called the dominant member of the pair, that which was suppressed, the recessive. The F_1 plants were allowed to become self-fertilized and the seeds were harvested separately and sown separately, producing the second filial generation, F_2. This generation was mixed, consisting of individuals exhibiting the dominant character and others exhibiting the recessive, and in every four on the average there were three with the dominant to one with the recessive.

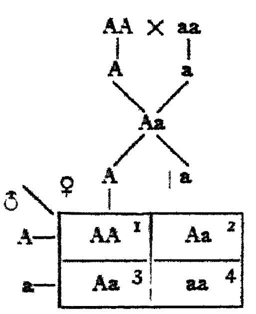
Structure	Property	Characters		Ratio
		Dominant	Recessive	
Seed	Form	5,474 round	1,850 wrinkled	2·96:1
Reserve material in cotyledons	Colour	6,022 yellow	2,001 green	3·01:1
Seed-coats	Form	882 inflated	299 wrinkled	2·95:1
Seed-coats	Colour	705 grey	224 white	3·15:1
Unripe pods	Colour	428 green	152 yellow	2·82:1
Flowers	Position	651 axial	207 terminal	3·14:1
Stem	Length	787 tall	277 dwarf	2·84:1
		14,949 (74·90%)	5,010 (25·10%)	2·98:1 or 3:1

The F_2 individuals were allowed to become self-fertilized and it was found that, whilst every individual exhibiting the recessive character bred true, of those which had exhibited the dominant, in every three on the average there was one which bred true and two which yielded a ratio of 3:1 as had the F_1 individuals.

Having thus collected by observation and controlled experimentation a sufficient number of data to enable him to recognize the orderliness and regularity of his results, Mendel then constructed a working hypothesis referring to the phenomena of segregation and the independent assortment and recombination of factors to account for the observed facts. He postulated that corresponding to every inherited character there are determiners or factors (now often designated *genes*) in the gametes. Each gamete carries a factor for each and every heritable character that the future individual may exhibit and thus an individual arising from the union of two gametes has a double set of factors, each gamete a single set. Characters can be classified as alternative (allelomorphic), *e.g.,* stem length can be either tall or dwarf, and allelomorphic characters are alternative characters of one and the same structure or function. A tall pea can have received the factor for this character by way of both male and female gametes, being duplex for this factor and homozygous for the character, or can have received this factor by way of one gamete and the alter-

native factor for dwarf stem by way of the other, being simplex for each of these factors and heterozygous for the character it exhibits, in this case tall because, for reasons as yet unknown, tall is dominant to dwarf. An individual exhibiting the recessive character of a pair must necessarily be nulliplex for the dominant factor, duplex for the recessive factor, and homozygous for the character it displays. The individual being constitutionally duplex, and the gamete simplex, it follows that into each gamete elaborated by an individual there must pass one or other of each pair of factors in the hereditary constitution. In respect of the factors for all characters for which the individual is homozygous, all gametes will be factorially similar, but in respect of those for characters for which the individual is heterozygous, there will be two sorts of gametes, one carrying the factor for one character of a pair, the other the factor for its alternative, and the two kinds will be elaborated in equal numbers. If, of the two characters, one is dominant, if at the time of fertilization there are equal numbers both of male and of female gametes carrying the dominant and recessive factors respectively (as will be the case for the gametes of the F_1), and if fertilization is at random, then chance will yield on the average in every four, three individuals exhibiting the dominant character of a pair and one exhibiting the recessive. Mendel's law of segregation refers to this clean separation of factors during the formation of the gametes. It can be illustrated by the following scheme.

Let A and a represent the factors corresponding to the dominant and recessive members of a pair of alternative characters.



First parental generation, P_1.
Gametes of P_1. Into each passes one member of each pair. The gametes of either parent are similar because the individuals were homozygous.
First filial generation, F_1. All individuals are heterozygous. Since A is dominant, they will exhibit the dominant character.
Gametes of F_1. *Segregation.* Into each gamete passes one member of each pair of factors. Equal numbers of two kinds of gametes are produced. Two series, male and female, are required.
Second filial generation, F_2.
Individuals exhibiting the dominant character:
Homozygotes, AA, . . 1
Heterozygotes, Aa, . . 2 . . . 3
Individuals exhibiting the recessive character:
Homozygote, aa 4

It is now known that dominance is not an essential feature of Mendelian inheritance; it is commonly not exhibited, the hybrid being intermediate in its characterization. What is essential is the orderly reappearance of the characters of P_1 and of F_1 in F_2 in definite numerical proportions.

Mendel's second law is that of the independent assortment of factors. This is illustrated when in one and the same experiment two different pairs of allelomorphic characters are present. The F_1 exhibit the two dominant members of the two pairs and in F_2 there are on the average in every sixteen individuals nine exhibiting both dominants, three exhibiting the dominant of one pair and the recessive of the other, three exhibiting the other dominant and the other recessive, and one the two recessives. All possible combinations of the four characters are yielded. For the production of these, there must be free assortment and recombination of the four factors concerned. The 9 : 3 : 3 : 1 ratio follows from the co-existence of two 3 : 1 ratios in the same mating. The F_2 of a trihybrid mating, one involving three pairs of allelomorphs, one member of each pair being dominant, is 27 : 9 : 9 : 9 : 3 : 3 : 3 : 1. (*See* HEREDITY, GENETICS, SEX.)

See W. Bateson, *Mendel's Principles of Heredity* (1913); R. C. Punnett, *Mendelism* (1919); F. A. E. Crew, *Heredity* (1928).
(F. A. E. C.)

MENDELSOHN, ERICH (1887–), German architect, was born at Allenstein in East Prussia in 1887, and is now one of the most prominent German architects. Mendelsohn has employed at different times many methods of construction and a wide selection of materials. Among his works may be mentioned the Mosse-haus, Berlin (in collaboration with R. Neutra and R. P. Henning), with its interesting interplay of horizontal and vertical lines, completed in 1923; the Potsdam observatory (Einstein tower), 1927, a poetic conception, moulded rather than erected, which illustrates the dynamic tendency of contemporary architecture, made possible by steel construction; a dye-works at Luckenwalde, 1921, which has a roof in remarkable imitation of crystal formations; a block of offices and shops at Gleiwitz, severely rectangular (1922); and the Mosse-Pavillon at the Pressa Exhibition, Cologne, 1928. It will be apparent that he is less interested in designing dwelling-houses than public buildings.

See *Bauten der Arbeit u. des Verkehrs* (Blauen Bücher), published by Langewiesche; G. A. Platz, *Die Baukunst der neuesten Zeit* (1927).

MENDELSSOHN, MOSES (1729–1786), Jewish philosopher, was born in Dessau in 1729. His father's name was Mendel, and he was later on surnamed Mendelssohn (=son of Mendel). Mendel Dessau was a poor scribe, and his son Moses in his boyhood developed curvature of the spine. His early education was cared for by his father and by the local rabbi, David Fränkel. The latter, besides teaching him the Bible and Talmud, introduced to him the philosophy of Maimonides (*q.v.*). Fränkel removed to Berlin in 1743, where Mendelssohn joined him a little later. With his scanty earnings he bought a Latin copy of Locke's *Essay concerning the Human Understanding,* and mastered it with the aid of a Latin dictionary. In 1750 he became tutor to the children of a wealthy silk-merchant, Isaac Bernhard, who made the young student successively his book-keeper and his partner. In 1754 he was introduced to Lessing. Just as the latter afterwards makes Nathan the Wise and Saladin meet over the chess-board, so did Lessing and Mendelssohn actually come together as lovers of the game. Lessing had already begun his work of toleration, for he had recently produced a drama (*Die Juden,* 1749), the motive of which was to prove that a Jew can be possessed of nobility of character. This notion was being generally ridiculed, but Lessing found in Mendelssohn the realization of his dream. Mendelssohn had written in lucid German an attack on the national neglect of native philosophers (principally Leibnitz), and lent the manuscript to Lessing. Without consulting the author, Lessing published anonymously Mendelssohn's *Philosophical Conversations* (*Philosophische Gespräche*) in 1755. In the same year there appeared in Danzig an anonymous satire, *Pope a Metaphysician* (*Pope ein Metaphysiker*), the joint work of Lessing and Mendelssohn. Mendelssohn now became (1756–59) the leading spirit of Nicolai's important literary undertakings, the *Bibliothek* and the *Literaturbriefe,* and ran some risk (which Frederick's good nature obviated) by somewhat freely criticizing the poems of the king of Prussia. In 1762 he married Fromet Gugenheim, who survived him by 26 years. In the year following his marriage Mendelssohn won the prize offered by the Berlin academy for an essay on the application of mathematical proofs to metaphysics, although among the competitors were Abbt and Kant. In Oct. 1763 the king granted Mendelssohn the privilege of Protected Jew (*Schutz-Jude*)—which assured his right to undisturbed residence in Berlin.

As a result of his correspondence with Abbt, Mendelssohn resolved to write on the immortality of the soul. His *Phädon* (1767) was modelled on Plato's dialogue of the same name. Mendelssohn's work possessed some of the charm of its Greek exemplar. The book was translated into nearly all the European languages, and its author was hailed as the "German Plato," or the "German Socrates."

Mendelssohn resolved to devote his life to the culture and the emancipation of the Jews. He began by his German translation of the Pentateuch and other parts of the Bible. This work (1783) constituted Mendelssohn the Luther of the German Jews. From it, the Jews learned the German language; from it they imbibed culture; with it there was born a new desire for German nationality; as a result of its popularity was inaugurated a new system of Jewish education. Mendelssohn was the first great champion of Jewish emancipation in the 18th century. He put forward his plea for tolerance in *Jerusalem oder über religiöse Macht und Judenthum* (1783; Eng. trans. 1838 and 1852). He asserted the

pragmatic principle of the possible plurality of truths: that just as various nations need different constitutions—to one a monarchy, to another a republic, may be the most congenial to the national genius—so individuals may need different religions. The test of religion is its effect on conduct. This is the moral of Lessing's *Nathan the Wise,* the hero of which is undoubtedly Mendelssohn. Having been taught that there is no absolutely true religion, Mendelssohn's own descendants—a brilliant circle, of which the musician Felix was the most noted—left the synagogue for the church. But despite this, Mendelssohn's theory was found to be a strengthening bond in Judaism.

Mendelssohn's *Morgenstunden, oder über das Dasein Gottes* appeared in 1785, and he died as the result of a cold contracted while carrying to his publishers in 1786 the manuscript of a vindication of his friend Lessing, who had predeceased him by five years.

Mendelssohn had six children. His sons were: Joseph (founder of the Mendelssohn banking house, and a friend and benefactor of Alexander Humboldt), whose son Alexander (d. 1871) was the last *Jewish* descendant of the philosopher; Abraham (who married Leah Bartholdy and was the father of Fanny Hensel and J. L. Felix Mendelssohn-Bartholdy); and Nathan (a mechanical engineer of considerable repute). His daughters were Dorothea, Recha and Henriette, all brilliantly gifted women.

See the biography by his grandson G. B. Mendelssohn prefixed to his *Sämtliche Werke* (7 vols., Leipzig, 1843–44) and by M. Brasch in the edition (2 vols., Leipzig, 1880) of his *Schriften zur Philosophie, Aesthetik und Apologetik;* also M. Kayserling, *M. Mendelssohn's Leben und Wirken* (2nd ed., Leipzig, 1888), and *Moses Mendelssohn Ungedrucktes und Unbekanntes von ihm und über ihn* (2nd ed., Leipzig, 1888); L. Goldstein, *Moses Mendelssohn und die deutsche Ästhetik* (Königsberg, 1904); H. Scholz, *Die Hauptschriften zum Pantheismusstreit zwischen Jacobi und Mendelssohn* (1916).

MENDELSSOHN-BARTHOLDY, JAKOB LUDWIG FELIX (1809–1847), German composer, grandson of Moses Mendelssohn (*q.v.*) was born in Hamburg on Feb. 3, 1809. His father, Abraham Mendelssohn, caused Felix, with his brother and two sisters, to be baptized as Lutheran Christians; and during the French occupation of Hamburg the family migrated to Berlin and lived with Abraham Mendelssohn's mother. Under the teaching of their mother and of other good musicians, Felix and his sister Fanny (some of whose compositions are included in Mendelssohn's songs and *Lieder ohne Worte*), soon showed extraordinary musical talent.

At the age of nine he played in public, and at 11 composed voluminously. He and Fanny played their own (or each other's) pianoforte compositions, and his sister Rebecka sang and his brother Paul played the violoncello. Five symphonies were written for this string-band in 1821, in which year Felix produced unaccompanied motets, two and a half operas and an immense amount of other music. The violin sonata of 1820 was published as op. 4.

In 1821 Mendelssohn, with Zelter as his bear-leader, visited Goethe. It is hard to say which of the two impressed the other most. Goethe had not been lucky in his musical acquaintances. Beethoven had repelled him. And now Goethe met this wonderful grandson of "Nathan der Weise," with gifts equal to Mozart's. The boy soon tried, with partial success, to convert Goethe to the gospel of Beethoven.

Before Mendelssohn was 17 he had composed his wonderful octet (op. 20) and a 13th symphony in C minor which he published as his first. A pianoforte quartet in B minor, the last of three, was dedicated to Goethe. Meanwhile he was making important discoveries apart from his own work. At the age of 12 he had read Bach's *Matthew Passion* in the autograph in the royal library, and was so excited by it that his mother had a copy made for him as a birthday present.

A visit to Paris in 1825 brought him into contact with many famous musicians, notably Rossini and Meyerbeer, and he found congenial friends in the great virtuosos of the pianoforte and violin, Hummel, Rode, Baillot and others. He also showed his compositions to the formidable Cherubini, whom he described as "an extinct volcano still throwing out occasional sparks and ashes." Cherubini astonished all musical Paris by praising Mendelssohn to his face, though in the third person. "Le garçon est riche: il fera bien. Mais il faut couper."

Perhaps Mendelssohn's parents overshot the mark in their anxiety to protect him from the dangers of conceit. He saw no great merit in his own smooth technique and was the less inclined to think that there was anything inherently noble in clumsiness. Yet his quick temper was so manifestly generous that artists like Schumann adored him as man and as musician.

After returning from Paris, Abraham Mendelssohn removed from his mother-in-law's house to a spacious old mansion with a music-room and grounds containing a "Gartenhaus" capable of seating several hundred persons. In Aug. 1826 Felix's overture to *A Midsummer Night's Dream* was performed here. He was only 17½ years old; but in later years he rarely equalled and never surpassed this work, which, written in the years of Beethoven's last quartets, belongs not only to fairyland but to an orchestration which Rimsky-Korsakov might have thought up-to-date.

A full-sized opera, *Die Hochzeit des Camacho,* on an episode in the story of Don Quixote, had been finished in 1825, and was produced under Spontini on April 29, 1827. After one much applauded performance Mendelssohn's opera was shelved, and violently abused by the critics.

This organized failure depressed Mendelssohn, but did not check his activity. Besides his usual flood of composition he collected a choir for the study of Bach's choral works (not one of which was then in print); and he succeeded, in 1829, in persuading the Berlin Sing-Akademie to perform the Matthew Passion, under his direction, with a chorus of some 350 voices. This was the first known performance of a choral work of Bach since his death in 1750.

In April 1829 Mendelssohn paid the first of ten visits to England, the last being shortly before his death, in 1847. From the outset he was received with unparalleled enthusiasm. The Philharmonic Society had forgotten the lesson in conducting given by Spohr in 1820; and Mendelssohn, on his first appearance, was obliged to conduct his C minor symphony from the pianoforte; a useless survival of the days of *continuo* orchestration (*see* INSTRUMENTATION, sec. 4). As Spohr said, "Of the two conductors not one is real; the leader of the orchestra has no score and cannot beat time while he is playing; while the gentleman at the pianoforte has no use for his instrument and cannot control the players." In later visits Mendelssohn changed all that. For this first concert he replaced the minuet of his symphony by a wonderful orchestration of the scherzo of his octet. This remained unpublished until 1911. He introduced Beethoven's concerto in E flat to English audiences and, during a visit five years later, the concerto in G. He was one of the first to play a concerto by heart in public; but though this was no effort to his Macaulayesque memory, he cared so little for display that once, when the score of one of his trios was mislaid, he put another volume upside down on the desk and asked somebody to turn the pages in order that he might not be seen to be playing by heart when his colleagues were playing from notes. After the first London performance of the *Midsummer Night's Dream* overture a friend left the score in a cab; but Mendelssohn rewrote it from memory.

During his visits to England his organ recitals revolutionized English organ-playing, and his productions of *St. Paul* and *Elijah* (the latter receiving its first performance at the Birmingham festival of 1846) established his influence on English music as co-equal with that of Handel.

One thing he emphatically did not establish. He did not found the "Mendelssohn tradition" in conducting. That accusation is one of Wagner's calumnies, and Wagner refutes it in the telling. He tells us that when he conducted in England he found that our overloaded programmes compelled him to concentrate his rehearsal on a few items and pull the rest through by bluff. Mendelssohn had had the same experience in the years from 1829 to 1847, and this was what the orchestral players chose to call "the Mendelssohn tradition." Wagner's vitriolic pen has saved him from having his own bluff immortalized by orchestral old stagers as "the Wagner tradition." The true Mendelssohn tradition was represented by Joachim (*q.v.*). It is a tradition of love and

disreputable class of mendicants, now rarely met with.

MENDIP HILLS, Somersetshire, England. The eastern boundary is formed by the upper valleys of the Frome and Brue, and the depression between them. The range extends from these north-westward with a major axis of about 23 m., while the outliers of Wavering Down and Bleadon Hill continue it towards the Bristol Channel. The range is generally about 6 m. in width. Its south-west face descends to the low "moors" drained by the Axe and other streams, and the towns of Axbridge, Cheddar and Wells Towards the north-east its limits are less clearly defined, being high ground, intersected by narrow vales. A depression, followed by the Radstock and Wells road, strikes across the range; the principal elevations lie west of this, and to the area thus defined the name Mendips is sometimes restricted. The summit of the hills is a gently swelling plateau, which reaches its extreme height in the north—1,068 feet. The Mendips consist principally of Carboniferous Limestone. Fine cliffs and scars occur on the flanks of the plateau, as in the gorge of Cheddar, and there is a wonderful series of caverns, the result of water action. The surface is often broken by deep holes ("swallets") into which streams flow. Some caves have yielded large quantities of animal remains (hyaenas, bears and others) together with traces of prehistoric human occupation. Lead was worked among the Mendips at a very early period. Roman workings have yielded pigs of lead, etc., inscribed with the names of emperors of the 1st and 2nd centuries A.D.

MENDOZA, ANTONIO DE (1490–1552), first Spanish viceroy of New Spain (Mexico), was born probably in 1490, at Alcala la Real, near Granada, the second son of Iñigo López de Mendoza, captain-general of the Christian forces investing Granada. At the age of 45, after military and administrative experience in the wars against the Moors, and as royal chamberlain and ambassador to Hungary, Antonio de Mendoza was appointed "viceroy, governor and president of the audiencia" of New Spain on April 17, 1535, and arrived in Mexico in October of the same year. His administration was marked by broad understanding of the problems at hand, by energy in attacking them and by moderation and integrity. Though obstructed by intrigue at court, opposition among his subordinates, uprisings of the partly subjected Indians and the negro slaves, Mendoza laid the foundation of colonial structure and viceregal procedure in Mexico which endured until the 19th century. He instituted a sound political and financial policy; established means of defence, public works and roads; suppressed a religious rebellion of the natives, north of Guadalajara, known as the Mixton War, 1541–42; inspired discovery and exploration in New Mexico (1540–42, *see* CORONADO), California (1540–43) and the Philippine Islands (1542–44); supported the church in converting, educating and protecting the Indians; stimulated agriculture, mining and industries; and introduced printing (1536). In 1551, having firmly impressed the royal authority upon New Spain and made it the best-organized of Spain's new-world colonies, Mendoza was promoted to the viceroyalty of Peru. He arrived there in Sept. 1551, but his health was failing and he died in Lima on July 21, 1552, the greatest of the Spanish viceroys in the New World.

The best account of Mendoza is by A. S. Aiton: *Antonio de Mendoza* (1927), which contains a full bibliography. (W. B. P.)

MENDOZA, ANTONIO HURTADO DE: *see* HURTADO DE MENDOZA, ANTONIO.

MENDOZA, DIEGO HURTADO DE (1503–1575), Spanish diplomatist, historian, scholar and poet, son of the count of Tendilla and great-grandson of the marquis of Santillana, born at Granada. He served under Charles V. in Italy, and preserved his confidence in spite of the failure of his mission in 1537, when he was sent to England to arrange a marriage between Henry VIII. and the duchess of Milan, as well as a marriage between Prince Louis of Portugal and Mary Tudor. Ambassador at Venice in 1539, he patronized the Aldi, procured copies of the Greek mss. of Cardinal Bessarion, and other rare codices from the monastery of Mount Athos. The first edition of Josephus was printed (1544) from the texts in Mendoza's collection. He was military governor of Siena, represented Spain at the Council of Trent and was special plenipotentiary at Rome from 1547–54. He was never a favourite with Philip II., and a quarrel with a courtier resulted in his banishment from court (June 1568). The remaining years of his life, which were spent at Granada, he devoted to the study of Arabic, to poetry, and to his history of the Moorish insurrection of 1568–70, the *Guerra de Granada* (Lisbon, 1627). In some passages of this work the author deliberately imitates Sallust and Tacitus.

See A. Señan y Alonso, *D. Diego Hurtado de Mendoza . . .* (Granada, 1886); *Calendar of Letters and Papers Foreign and Domestic, Henry VIII.*, vol. xii., xiii.; C. Graux, *Essai sur les origines du fonds grec de l'Escurial* (1880); R. Foulché-Delbosc, *Etude sur la "Guerra de Granada,"* in *Revue Hispanique*, i. (1894), pp. 101–165, 338.

MENDOZA, PEDRO GONZALEZ DE (1428–1495), Spanish cardinal and statesman, fourth son of Iñigo Lopez de Mendoza, marquess of Santillana, was born on May 3, 1428, at Guadalajara. The house of Mendoza claimed to descend from the lords of Lladio in Alava, and to have been settled in Old Castile in the 11th century. Pedro Gonzalez was an example of the worldly, political and martial prelates of the 15th century. Appointed bishop of Calahorra by John II. in 1452, in his secular capacity as civil and military ruler of the town and its dependent district, he led the levies of Calahorra in the civil wars of Henry IV. He fought for the king at the second battle of Olmedo (Aug. 20, 1467), and was wounded in the arm. During these years he became attached to Doña Mencia de Lemus, a Portuguese lady-in-waiting of the queen. She bore him two sons, Rodrigo, who was once selected to be the husband of Lucrezia Borgia, and Diego, the grandfather of the princess of Eboli. (*See* PEREZ, ANTONIO.) In 1468 he became bishop of Siguenza. In 1473 he was created cardinal, promoted to the archbishopric of Seville and named Chancellor of Castile.

During the last years of the reign of Henry IV. Mendoza was the partisan of the Princess Isabella, afterwards queen. He fought for her at the battle of Toro (March 1, 1476), and had a prominent part in placing her on the throne. In 1482 he became archbishop of Toledo. During the conquest of Granada he contributed largely to the maintenance of the army. On Jan. 2, 1492, he occupied the town in the name of the Catholic sovereigns. More soldier and statesman than priest, the "Great Cardinal," as he was commonly called, did not neglect his duty as a bishop. He devoted part of his revenue to charity and endowed the college of Santa Cruz at Valladolid. He died at Guadalajara, Jan. 11, 1495.

See Salazar de Mendoza, *Cronica del gran cardinal Don Pedro Gonzalez de Mendoza* (Toledo, 1625); W. H. Prescott, *History of the Reign of Ferdinand and Isabella* (3 vols., 1838).

MENDOZA, a province of western Argentina, bounded north by San Juan, east by San Luis and the territory of La Pampa, south by the territories of La Pampa and Neuquen, and west by the republic of Chile. Area, 56,502 sq.m.; pop. (1914), 277,535; (1927, estimate), 384,090. The Andes form the western boundary, and a considerable part of the territory is covered by the great Cordillera, its foot-hills and flanking ranges. The eastern part is an arid, sandy, level plain, with extensive saline basins, having no vegetation other than coarse grasses and thickets of low, spiny mimosas and "chañar" (*Gourliaea decorticans*). The fertile, populated districts of the province border on the Cordillera, particularly in the north where several streams from the snow-clad summits supply water for irrigation. The secondary ranges in this part of Mendoza are the Sierra de los Paramillos, which encloses the Uspallata valley, and the Sierra del Tunuyán, which encloses a number of populous valleys drained by the Tunuyán river and its tributaries. One of the largest of these is the Yuco valley. Farther south the country becomes more arid and sparsely populated, and unsubdued tribes of Indians for a long time prevented its exploration. In this region the Sierra de Payén and Sierra del Nevado (otherwise known as the Sierra Quero Matro Pellón) extend in a north-easterly direction. With the exception of the Río Grande in the south-west part of the province, which forms the principal source of the Colorado, all the rivers of the province flow easterly and southerly into the great saline depression of western Argentina, which includes a great part of Men-

doza. San Luis and La Pampa. There are the Mendoza, Tunuyán, Diamante and Atuel, with their numerous tributaries, all discharging into the sluggish river which flows from the Huanacache lagoons, on the San Juan frontier, southward to the marshes and lagoons of La Pampa. The upper part of this brackish, swampy stream is called the Desaguadero, and the lower the Salado. It forms the eastern boundary line of the province down to the 36th parallel. With the exception of the elevated districts of the Andes, the climate of Mendoza is hot and dry. Agriculture is the principal occupation where irrigation can be used, the province having a high reputation for its raisins and wines. Alfalfa is an important product, being grown for fattening the cattle driven through the province to the Chilean markets. The mineral resources of the province are said to be good, but receive little attention. Petroleum is found in the vicinity of San Rafael, on the Diamante river, and it is claimed that coal exists in the same region. Although Mendoza was settled by Spanish colonists from Chile as far back as 1559, its development has been hindered by its isolated position. This isolation was broken in 1884 by the completion of the Argentine Great Western railway to the provincial capital. Since then a railway has been built northward to San Juan, and the Trans-Andean line has been completed through the Andes to connect with the Chilean railway system. In addition to Mendoza, the capital of the province, the principal towns (hardly more than villages) are Guaymallén, Maipú, San Martín, Luján and San Rafael.

MENDOZA, a city of Argentina, capital of Mendoza province, 632 m. by rail W.N.W. of Buenos Aires. Pop. (1914), 58,790. It stands on a plain near the foot of a secondary Andean range called the Sierra de los Paramillos, at an elevation of 2,320 feet. The surrounding district is completely arid, but has been irrigated and is covered with gardens, orchards and cultivated fields. The city is about 15 m. N. of the Mendoza, or Luján river, whose waters are utilized for irrigation and for the requirements of the city by means of a channel which leaves the main river a little above the town of Luján and runs to the Tulumaya river and the lagoons of Huanacache. This channel is called El Zanjón, and is believed to have been opened by Guaymallén, the chief of the Guarpés who inhabited this district at the time of the Spanish conquest, but it is more probably natural. The city is laid out in a regular manner with broad, well-paved streets and numerous public squares. The Zanjón and another stream called the Guaymallén traverse the city, and the principal streets have water flowing through them and are shaded by poplars. The surrounding districts produce fruit, vegetables, alfalfa and cereals. The vineyard industry is first, with large exports of raisins and wine. A modern packing house has been established near the city and employs several hundred workmen. The position on the main route of the Trans-Andean railway across the Andes into Chile, by way of the tunnel under the Uspallata or Cumbre pass (highest point 10,542 ft.), has given the city commercial importance. It has railway connection with the principal cities of the republic, including the ports of Rosario, Buenos Aires and Bahía Blanca, and also with San Juan.

Mendoza was founded by Capt. Pedro del Castillo, who had been sent from Santiago across the Andes in 1559 by García Hurtado de Mendoza, the governor of Chile, to conquer and annex the territory extending north-east to Tucumán. The city was named after Mendoza. It was made the capital of the province of Cuyo, and belonged to Chile down to 1776, when the province was transferred to the newly created viceroyalty of La Plata. It was the headquarters of Gen. San Martín while he was organizing an army for the liberation of Chile, and greatly assisted him with men and money. Under republican administration Mendoza suffered much from revolutions. Moreover, on March 20, 1861, the city was destroyed by an earthquake and a fire which followed. Not a building was left standing, and the loss of life was estimated at 10,000 to 12,000. The French geologist Bravard, who had predicted the catastrophe, was one of its victims.

MENEDEMUS (350?–276? B.C.), Greek philosopher, and founder of the Eretrian school of thought, was born at Eretria. Though of noble birth, he worked as builder and tentmaker until he was sent with a military expedition to Megara, where he formed a life-long friendship with Asclepiades. He was subsequently a pupil of Stilpo and then of Phaedo of Elis, whose school he transferred to Eretria, by which name it was afterwards known. He took a leading part in the political affairs of his city from the time of the Diadochi, and obtained a remission of the tribute to Demetrius. His friendship with Antigonus Gonatas seems to have roused suspicion as to his loyalty, and he sought safety in the temple of Amphiaraus at Oropus, and later with Antigonus, at whose court he is said to have died of grief.

Athenaeus quotes Epicrates as stating that he was a Platonist, but other accounts credit him with having preferred Stilpo. Diogenes Laërtius (ii. 134 and 135) says that he declined to identify the Good with the Useful, and that he denied the value of the negative proposition on the ground that affirmation alone can express truth. Diogenes says that he left no writings, and the Eretrian school disappeared after a short existence.

See H. Mallett, *Histoire de l'école de Mégare et des écoles d'Elis et d'Erétrie* (1845); and the articles MEGARIAN SCHOOL; PHAEDO; STILPO.

MENELAUS (*mĕ-nĕ-lā'us*, Gr. *mĕ-nĕ-lah'ŏs*), king of Sparta, brother of Agamemnon (q.v.) and husband of Helen (q.v.). On the voyage from Troy his fleet was scattered by a storm, which drove him to Egypt. After eight years' wandering, he landed on the island of Pharos, where Proteus revealed to him the means of appeasing the gods and securing his return After a long and happy life in Lacedaemon, Menelaus, as the son-in-law of Zeus, did not die, but was translated to Elysium (Homer, *Odyssey*, iii. iv.). His grave and that of Helen were shown at Therapnae, where he was worshipped as a god (Pausanias iii. 19, 9).

MENELEK II. (SAHALA MARIEM) (1844–1913), emperor of Abyssinia, officially negus negusti (king of kings) of Ethiopia, son of Haeli Melicoth, king of Shoa, was born in 1844, and claimed to be a direct descendant of Solomon by the queen of Sheba. Menelek was the real creator of the modern Abyssinian state. On the death of his father in 1855 he was kept a prisoner at Gondar by Kassai, the governor, who had seized the throne under the title of Theodore III. After the death of Theodore in 1868 he continued to struggle against his successor, the emperor Johannes (better known to Europeans as King John of Abyssinia). Being again unsuccessful, he resolved to await a more propitious occasion; so, acknowledging the supremacy of Johannes, in 1886 he married his daughter Zeodita (b. 1876) to the emperor's son, the Ras Area; he was thereupon declared heir to the empire, and on his side acknowledged the Ras Area as his successor. Ras Area died in May 1888, and the emperor Johannes was killed in a war against the dervishes at the battle of Gallabat (Matemma) on March 10, 1889. The succession now lay between the late emperor's natural son, the Ras Mangasha, and Menelek, but the latter was elected by a large majority on the 4th of November, and consecrated shortly afterwards. Menelek had married in 1883 Taïtu (b. 1854), a princess of Tigré, a lady who had been married four times previously and who exercised considerable influence. Menelek's clemency to Mangasha was ill repaid by a long series of revolts.

In 1889, at the time when he was claiming the throne against Mangasha, Menelek signed at Uccialli a treaty with Italy acknowledging Italian claims to the Asmara district. Finding, however, that according to the Italian view of one of its articles the treaty placed his empire under Italian domination, Menelek denounced it; and after defeating the Italians at Amba-Alagi, he compelled them to capitulate at Adowa in February 1896, and a treaty was signed recognizing the absolute independence of Abyssinia. His French sympathies were shown in a reported official offer of treasure towards payment of the indemnity at the close of the Franco-Prussian War, and in February 1897 he concluded a commercial treaty with France on very favourable terms. He also gave assistance to French officers who sought to reach the upper Nile from Abyssinia, there to join forces with the Marchand Mission; and Abyssinian armies were sent Nilewards. A British mission under Sir Rennell Rodd in May 1897, however, was cordially received, and Menelek agreed to a settlement of the Somali boundaries, to

keep open to British commerce the caravan route between Zaila and Harrar, and to prevent the transit of munitions of war to the Mahdists, whom he proclaimed enemies of Abyssinia.

In 1898 the Sudan was reconquered by an Anglo-Egyptian army and thereafter cordial relations between Menelek and the British authorities were established. In 1889 and subsequent years, Menelek sent forces to co-operate with the British troops engaged against the Somali mullah, Mohammed Abdullah. Menelek had in 1898 crushed a rebellion by Ras Mangasha (who died in 1906) and he directed his efforts henceforth to the consolidation of his authority, and in a certain degree, to the opening up of his country to western civilization. He had granted in 1894 a concession for the building of a railway to his capital from the French port of Jibuti, but, alarmed by a claim made by France in 1902 to the control of the line in Abyssinian territory, he stopped for four years the extension of the railway beyond Dire Dawa. When in 1906 France, Great Britain and Italy came to an agreement on the subject, Menelek officially reiterated his full sovereign rights over the whole of his empire. In May 1909 the emperor's grandson Lij Yasu, or Jeassu, then a lad of thirteen, was married to Romanie (b. 1902), granddaughter of the negus Johannes. Two days later Yasu was publicly proclaimed at Adis Ababa as Menelek's successor. At that time the emperor was seriously ill. He died in 1913. *See* Hentze, *Am Hofe des Kaisers Menelek von Abessynien* (1905); Rossetti, *Storia diplomatica dell Etiopia durante il regno di M II.* (1910).

MENENDEZ DE AVILÉS, PEDRO (1519–1574), Spanish seaman, founder of St. Augustine, Florida, was born at Avilés in Asturias on Feb. 15, 1519. At the age of 14 years he ran away to sea, and was engaged in piracy till he was thirty. In 1549 he was commissioned by the emperor Charles V. to clear the north coast of Spain and the Canaries of French pirates. In 1554 he was appointed captain-general of the "flota" or convoy which carried the trade between Spain and America. The appointment was made by the emperor over the head and against the will of the Casa de Contratacion, or governing board of the American trade. His steady refusal to receive bribes, as the reward for permitting breaches of the regulations, made him unpopular with the merchants, while his high-handed ways offended the Casa de Contratacion. Re-appointed commander in 1557, and knowing the hostility of the Casa, he applied for service elsewhere. Until the close of 1559 ample occupation was found for Avilés in bringing money and recruits from Spain to Flanders. In 1560 he was again appointed to command the flota, and he made a most successful voyage to America and back in that and the following year. His relations with the Casa de Contratacion were, however, as strained as ever. On his return from another voyage in 1563 he was arrested by order of the Casa, and imprisoned for twenty months.

On his release he prepared to sail to the Bermudas to seek for his son Juan, who had been shipwrecked. At that time the French Huguenots were endeavouring to plant a colony in Florida. The Spaniards claimed the country as theirs, and its position on the track of the home-coming trade of Mexico rendered its possession by any other power highly dangerous. Philip II. made an *"asiento"* or contract (March 20, 1565) with Avilés, by which he advanced 15,000 ducats and constituted him proprietor of any colony which he could establish in Florida, on condition that the money was repaid. Avilés sailed on July 28 of the same year with one vessel of 600 tons, ten sloops, and 1,500 men. On Aug. 28 he entered and named the Bay of St. Augustine and began a fort there. He took the French post of Fort Caroline (Sept. 20, 1565) and in October exterminated a body of Frenchmen who, under the Huguenot Jean Ribault, had arrived on the coast of Florida. The Spanish commander, after slaying nearly all his prisoners, hung their bodies on trees, with the inscription, "Not as Frenchmen but as Lutherans." A French sea-captain named Dominique de Gourgues revenged the massacre by capturing in 1568 Fort San Mateo (as the Spanish had renamed Fort Caroline), and hanging the garrison, with the inscription, "Not as Spaniards but as murderers." Till 1567 Avilés remained in Florida, busy with his colony. In that year he returned to Spain. He made one more voyage to Florida, and died on Sept. 17, 1574.

See *The Spanish Settlements within the Present Limits of the United States, Florida, 1562–74,* by Woodbury Lowery (1905).

MENENDEZ PIDAL, RAMON (1869–), Spanish philologist, was born on March 13, 1869, at Corunna, and studied at the universities of Madrid and Toulouse. In 1899 he was appointed to the chair of romance philology at the University of Madrid. In 1907 he was member of a board created for the development of university education in Spain, and in 1913 was appointed counsellor of public instruction for the kingdom. His grammar, text and vocabulary of the *Cantar de Mio Cid* (1908) opened out new possibilities not only to Castilian philology but to historiography in general. Menendez Pidal became the leader of the *Centro de Estudios Históricos,* the main house of learning in philology and historical matters in Spain, and the editor of the *Revista de Filología Española.* His other works include *Primera crónica general* (1906); *L'épopée Castillane à travers la littérature espagnole* (1910); *Gramática Histórica Española* (1914); *Un aspecto en la elaboración del Quijote* (2nd ed. 1924).

MENÉNDEZ Y PELAYO, MARCELINO (1856–1912), Spanish scholar and critic, became famous through his *Ciencia española* (1878), a collection of polemical essays defending the national tradition against the attacks of political and religious reformers. The unbending orthodoxy of this work was, if possible, still more pronounced in the *Historia de los heterodoxos españoles* (1880–81), and the writer was hailed as the champion of the ultramontane party. His lectures (1881) on Calderón established his reputation as a literary critic; and his work as an historian of Spanish literature was continued in his *Historia de las ideas estéticas en España* (1883–91), his edition (1890–1902) of Lope de Vega, his *Antología de poetas líricos castellanos* (1890–1908), and his *Orígenes de la novela* (1905).

MENES, the name of the founder of the 1st Dynasty of historical kings of Egypt. He appears at the head of the lists not only in Herodotus and Manetho, but also in the native Turin Papyrus of Kings and the lists of Abydos, while the list of Sakkara begins with the sixth king of the 1st Dynasty, a fact which may throw some doubt on the supposed foundation of Memphis by Menes. He was probably ruler of Upper Egypt and conquered the separate kingdom of Lower Egypt. His grave was discovered by de Morgan at Negadr in Upper Egypt in 1897.

See EGYPT; K. Sethe, "Menes und die Grundung von Memphis," in his *Untersuchungen zur Geschichte und Alterthumskunde Aegyptens,* iii. 121.

MENGELBERG, WILLEM (1871–), Dutch composer of German race, born at Utrecht on March 28, 1871. He received his musical education at Cologne conservatoire, where he studied piano with Isidor Seiss and composition and conducting with Franz Wüllner. His first post was that of musical director at Lucerne. In 1895 he went to Amsterdam to conduct the Concertgebouw orchestra, which under his direction has become one of the most famous in Europe. From 1907 to 1920 he conducted the Museum concerts at Frankfurt, as well as the Amsterdam series, and directed the choral subscription concerts in both places. Before the World War he regularly visited London as a conductor, and from 1921 onward has been an annual visitor to the United States. On his suggestion the National Symphony and Philharmonic orchestras of New York were amalgamated in 1921. He has also toured extensively with his Amsterdam orchestra. Important festivals conducted by Mengelberg were the Netherlands-Hamburg in 1920, the French Music festival in 1922 and the Strauss celebration in 1924.

MENGENLEHRE: *see* AGGREGATES, THEORY OF.

MENGS, ANTONY RAPHAEL (1728–1779), German painter, was born in 1728 at Aussig in Bohemia, but his father, Ismael Mengs, a Danish painter, established himself finally at Dresden, whence in 1741 he took his son to Rome. The appointment of Mengs in 1749 as first painter to the elector of Saxony did not prevent him from spending much time in Rome, where he became in 1754 director of the Vatican school of painting, nor did this hinder him on two occasions from obeying the call of Charles

III. of Spain to Madrid. There Mengs produced some of his best work, and specially the ceiling of the banqueting-hall, the subject of which was the Triumph of Trajan and the Temple of Glory. After the completion of this work in 1777, Mengs returned to Rome, where he died two years later. Besides numerous paintings in the Madrid gallery, the "Ascension" at Dresden, "Perseus and Andromeda" at St. Petersburg, and the ceiling of the Villa Albani must be mentioned among his chief works. In England, the duke of Northumberland possesses a "Holy Family," and the colleges of All Souls and Magdalen, at Oxford, have altar-pieces by him.

See *Opere di Antonio Raffaello Mengs*, published by G. N. d'Azara (Parma, 1780); G. L. Bianconi, *Elogio storico di Mengs* (Milan, 1780); C. Woermann, *Ismael und Raphael Mengs* (Leipzig, 1893); V. Christoffel, *Der Schriftliche Nachlass des Anton R. Mengs* (1918).

MENGTZE, a city of south China in the south-east of the province of Yunnan (23° 24′ N., 103° 22′ E.), situated in a fertile and well cultivated basin on the high plateau, 4,300 feet above sea-level, and enjoying a climate which, tempered by the high altitude, is equable and healthy despite the latitude. The city was opened in 1888 as a Treaty Port and the seat of the French overland trade between Tongking and Yunnan. This overland trade has continued to increase with the result that Mengtze is a flourishing frontier port. It is 40 miles distant from its junk port, Manhao, which is situated at a lower level (900 feet) on the Red River. Before the Yunnan Railway, which connects Haiphong and Yunnan-fu via Mengtze, was opened to traffic in 1910, imports from Haiphong were conveyed along the Red River route by steamer and native craft as far as Manhao, and thence by coolies or pack animals to Mengtze for distribution throughout Yunnan. The bulk of the imports to Mengtze continue inland under transit pass as far as Kweichow. The value of the whole trade has developed yearly.

In 1924, for example, net foreign imports were 14,823,747 Hk. Taels, net Chinese imports were 584,678, and exports 9,976,363, making a total of 25,384,788. Of this total value, direct foreign trade represents 98%. The total Maritime Customs Revenue at Mengtze in the same year amounted to Hk. Taels 790,779. The greater part of both import and export trade of Mengtze is with Hongkong and most of the remainder with Tongking and Annam. Tin (in slabs) is by far the chief export. About 90% of the total Chinese output of tin comes from south Yunnan and of this almost the whole is exported either via Mengtze and the Red River or by rail, to Haiphong and so to Hongkong where it is refined and marketed. Prior to the construction of the railway (under French enterprise) almost the whole output of tin went from Mengtze down to Haiphong via the Red River passage. In 1925, the Mengtze export was 8,860 tons, and railway transport 8,554 tons. Textiles (chiefly cotton), sugar (refined and candy), metals, kerosene and matches are the chief imports.

MENHADEN (*Brevoortia tyrannus*), a Clupeoid fish of the western Atlantic, related to the shads (*q.v.*), but distinguished by the pectinated scales, and by the very long and exceedingly numerous gill-rakers. The menhaden reaches a length of 18 in.; it feeds on plankton, particularly microscopic plants, and approaches the coast to breed in very large shoals. It is the object of an important fishery, being valuable for oil and manure.

MÉNIÈRE'S DISEASE, a form of auditory vertigo, first described in 1861. It usually attacks persons of middle age whose hearing has been previously normal and depends upon haemorrhage into the labyrinth, followed by more or less complete deafness in either or both ears. The attack usually sets in with dizziness, noises in the ears, nausea, vomiting and staggering gait, and the patient may suddenly fall down unconscious. The seizures are usually paroxysmal, occurring at irregular intervals of days or weeks. Between the attacks the equilibrium may be disturbed, there being marked nystagmus and unsteadiness of gait. The attacks of vertigo tend to become less frequent and may entirely pass away, but the deafness may remain permanent. The treatment is very unsatisfactory.

MENIN (Flemish *Meenen*), town of Belgium, province of West Flanders on the Lys 7m. S. of Courtrai. Pop. (1925) 18,769. It manufactures linen and flannel, and in the neighbourhood are extensive tobacco plantations. It was first fortified in 1578, and in 1685 Vauban made it one of the strongest places on the French frontier, but the fortifications were razed in 1748 by the Treaty of Aix-la-Chapelle.

MENINGITIS, a term in medicine applied to inflammation affecting the membranes of the brain (cerebral meningitis) or spinal cord (spinal meningitis) or both.

Tuberculous meningitis (or *Acute Hydrocephalus*) is a disease due to inflammation of the meninges of the brain produced by *B. tuberculosis*. It is most common in children under ten years of age, but may affect adults and is a local manifestation, dependent upon local conditions of a generalized miliary tuberculosis the origin of which is often situated in the bronchial or mesenteric glands.

Certain features characterize the disease in each of its three stages. The premonitory symptoms are mostly nutritive. Wasting and loss of strength often precede the characteristic phenomena of the disease. The patient, if a child, becomes listless, easily fatigued, loses appetite, and is restless at night. There is headache and unusual irritability. These symptoms may persist during many weeks or the disease may come on suddenly. Onset generally begins with vomiting, convulsions or wryneck and with obstinate constipation. Headache is constant, intense and accompanied by a peculiar and characteristic cry especially at night. There is intolerance of light and sound, temperature is 100°–104°, yet the pulse is rather slow and irregular; breathing is irregular. Such symptoms, after one to two weeks, are followed by the stage of depression in which the patient becomes quieter from the existence of partial stupor. Vomiting ceases, there is less fever, pulse and breathing are slower and shallower and there is little suffering. The pupils are often dilated or unequal and scarcely respond to light; there may be squint or drooping of an eyelid. The patient can be roused, but is irritable and otherwise lies in apathy. In the final stage there is generally return of fever, convulsions, perhaps paralysis of limbs, and coma is profound though swallowing remains. Death is sudden in a fit, or gradual from exhaustion and takes place within three weeks from the onset of symptoms. Though much can be done to avert the onset of the original tuberculous infection (*see* TUBERCULOSIS) no measure is known whereby tuberculous meningitis, once it has started, can be cured or a fatal event averted.

Pathologically the brain shows a yellow fibrinous inflammatory exudation beneath the pia mater and particularly in the lozenge shaped space at the base and in the Sylvian fissure. On floating some of the membrane in water minute tubercles may often be seen along the course of the Sylvian vessels.

In what is known as *suppurative*, or *simple acute meningitis* (non-tuberculous), the disease arises from various causes, *e.g.*, middle ear disease, cerebral abscess, and the symptoms are similar to those described above.

In *posterior-basic meningitis*, inflammation of the membranes investing the posterior basis of the brain and the spinal cord, the chief symptoms are fever, with severe pain in the back or loins shooting downwards into the limbs (which are the seat of frequent painful involuntary startings), accompanied with a feeling of tightness round the body.

The local symptoms bear reference to the portion of the cord the membranes of which are involved. Thus when the inflammation is located in the cervical portion the muscles of the arms and chest are spasmodically contracted, and there may be difficulty in swallowing or breathing, or embarrassed heart action, while when the disease is seated in the lower portion, the lower limbs and the bladder and rectum are the parts affected in this way. At first there is excited sensibility (hyperaesthesia) in the parts of the surface of the body in relation with the portion of cord affected. As the disease advances these symptoms give place to those of partial loss of power in the affected muscles, and also partial anaesthesia. These various phenomena may entirely pass away, and the patient after some weeks or months recover; or, on the other hand, they may increase, and end in permanent paralysis.

Cases of posterior basic meningitis are now regarded as sporadic

and somewhat peculiar examples of spinal meningitis (*q.v.*) or cerebro-spinal meningitis. Still, William Hunter and George Nuttall isolated an organism similar to the diplococcus intracellularis (or meningococcus), while Henry Koplik in New York found cases of typical posterior basic meningitis due to the diplococcus intracellularis. The treatment is that for spinal meningitis.

MENINSKY, BERNARD (1891–), British painter, was born in Russia. He studied art at the Slade school, London, in Paris and in Italy. He was an official artist during the World War and one of his pictures of soldiers arriving at a London station from the front is in the Tate gallery. Other pictures are at the Imperial War museum, and at the galleries of Aberdeen, Manchester and Dublin. He is a member of the London group, with a clear and constructive sense of plastic form. His first important exhibition was given in London in 1919 at the Goupil gallery. A series of his drawings were published in *Mother and Child* (1920).

MENIPPUS, of Gadara in Coele-Syria, Greek cynic and satirist, lived during the 3rd century B.C. According to Diogenes Laërtius (vi. 8) he was originally a slave, amassed a fortune as a money-lender, lost it, and committed suicide through grief. His works (written in a mixture of prose and verse) are all lost. The Menippean satires of M. Terentius Varro, fragments of which give an idea of this kind of composition, were called after him (*see* Teuffel-Schwabe, *Hist. of Roman Literature*, § 165, 3).

BIBLIOGRAPHY.—F. Ley, *De vita scriptisque Menippi cynici* (Cologne, 1843); R. Helm, *Lucian und Menipp* (1906); C. Wachsmuth, *Sillographorum graecorum reliquiae* (1885), with an account of Menippus and similar writers. Menippus found an imitator in later times in Justus Lipsius, and in the authors of the famous *Satyre Menippée* (1593; latest editions by C. Marcilly, Paris, 1882; J. Frank, Oppeln, 1884), written against the Holy League during the reign of Henri IV.

MENKEN, ADAH ISAACS (1835–1868), American actress, was born in New Orleans, the daughter of a Spanish Jew. Her original name was Dolores Adios Fuertes. Left in poverty at the age of 13, she made her first appearance as a dancer in her native city. Successful there and in other southern cities, including Havana, she afterwards aspired to act in serious parts. In 1856 she married John Isaacs Menken, translated Adios to Adah, and thus took the name she thereafter bore through various matrimonial ventures. In 1864 she appeared at Astley's in London as Mazeppa, a performance of an athletic dramatic type suited to her fine physique. In England and France she became intimate with many literary men—Swinburne, Charles Reade, Dickens (to whom she dedicated in 1868 a volume of verse, *Infelicia*), Gautier and Dumas the elder. Paris saw her for a hundred nights in *Les Pirates de la Savane,* and she also played in Vienna and London. She died in Paris on Aug. 10, 1868.

MENNONITES, a body of religionists taking their name from Menno Simons (*see* below), who maintain a form of Christianity which, discarding the sacerdotal idea, owns no authority outside the Bible and the enlightened conscience, limits baptism to the believer, and lays stress on those precepts which vindicate the sanctity of human life and of a man's word. There was no hierarchy (as with the Familists), but "exhorters" chosen by the members, among them "elders" for administering baptism and the Lord's Supper. The place of origin of the views afterwards called Mennonite was Zürich, where in 1523 a small community left the state church and adopted the tenet of believers' baptism. Unlike other Reformers, they denied at once the Christian character of the existing church and of the civil authority, though, in common with the first Christians, it was their duty to obey all lawful requirements of an alien power. By Protestants as much as by Catholics this position was not unnaturally regarded as subversive of the established foundations of society. Hence the bitter persecutions which, when the safety of toleration was not imagined, made martyrs of these humble folk, who simply wished to cultivate the religious life apart from the world. There was something in this ideal which answered to that mediaeval conception of separation from the world which had leavened all middle-class society in Europe; and the revolt from Rome had prepared many minds to accept the further idea of separation from the church, for the pursuit of holiness in a society pledged to primitive discipline. Hence the new teaching spread rapidly from Switzerland to Germany, Holland and France. In Holland the Mennonites have always been numerous. An offshoot from them at Rhijnsburg in 1619, founded by the four brothers, farmers, Van der Kodde, and named Collegianten from their meetings, termed *collegia* (thus, as not churches, escaping the penal laws), has been compared to the Plymouth Brethren, but differed in so far as they required no conformity of religious opinion, and recognized no office of teacher. With them, as Martineau notes, Spinoza had "an intense fellow-feeling." Later, the exiled Socinians from Poland (1660) were in many cases received into membership. There had previously been overtures, more than once, for union with Mennonites on the part of Polish Socinians, who agreed with them in the rejection of oaths, the refusal to take human life, the consequent abstinence from military service and magisterial office, and in the Biblical basis of doctrine; differences of doctrinal interpretation precluded any fusion. (X.)

See W. J. Kühler, art. "Mennonites" in Hastings, *Encyclopaedia of Religion and Ethics,* with reference to the sources.

IN AMERICA

The first colony of Mennonites in America settled in Germantown, Pa., in 1683, to escape severe persecution in Europe. They became pioneers in this and other sections, living hardy and useful lives, and holding to freedom of conscience, opposition to war and slavery and such common practices as insurance and interest on money lent. For many years they did not think it necessary to build churches or parsonages or to provide salaries for their ministers or bishops, or special training to fit them for their calling. Strict adherence to the languages they brought with them from Europe—Dutch, German, Russian—strictness or laxity in doctrines or discipline, including the "ban" or excommunication, caused many divisions among them, so that there are a dozen or more separate bodies of Mennonites in the United States and Canada. Among these are the "Old" or Mennonite Church, the oldest and largest division (40,000 members in 1928), who still use the "Pennsylvania Dutch" tongue; the General Conference Mennonite Church (20,000 members), which seeks to heal divisions; the Old Order Amish (8,600 members), which still uses the hymns of the old *Ausbund* of 1571 and tunes which have never been printed; the Mennonite Brethren in Christ (8,600 members), also conservative. Some Mennonites have been opposed to nearly everything modern, including Sunday schools, missions and revivals, but rapid changes are taking place and not a few colleges, publishing houses and missionary enterprises are supported by them. Also there has been a remarkable increase in the number of church edifices, Sunday schools and salaried ministers. Evangelism has developed greatly in the last half century. A large number of ministers have entered upon a travelling plan, supported by $1,000,000 or more, which has been very successful. There were in 1927 about 115,000 members in America, 90,000 in the United States and about 25,000 in Canada.

BIBLIOGRAPHY.—C. Henry West, *Mennonites of America* (1910); *The Mennonites* (1920, Berne, Ind.); Daniel Kaufman, *Mennonite History* (1927); also a *Year Book* put out by the Mennonite publishing house. (H. K. C.)

MENNO SIMONS (1492–1559), religious leader, was born in 1492 at Witmarsum, Friesland. He was ordained priest, and was curate at Pingjum, near his native place when he began to read Luther's tracts, to study the New Testament and to question infant baptism. The execution, in 1531, at Leeuwarden, of the tailor Sicke Freerks, who had been rebaptized at Emden, introduced further questions. Menno was not satisfied with the inconsistent answers which he got from Luther, Bucer and Bullinger. In 1532 he exchanged his curacy for a living at Witmarsum. Anabaptism of the Münster type repelled him. A brother of Menno joined the insurgent followers of John Matthyszoon, and was killed at Bolsward (April 1535), and on Jan. 12, 1536, Menno left the Roman communion. There were now among the Anabaptists four parties, the favourers of the Münster faction, the Batenburgers, extremists, the Melchiorites and the Obbenites

For a time Menno remained aloof from both Melchior Hofman and Obbe Philipsz. Before the year was out, yielding to the prayer of a few who had left the Münster faction, he became their minister, and was set apart (Jan. 1537) to the eldership at Groningen, with imposition of hands by Obbe Philipsz, who is regarded as the actual founder of the Mennonite body. In fact, Obbe left the body and is stigmatized as its Demas. Menno repudiated the formation of a sect; those who had experienced the "new birth" were to him the true Christian church. His Christology was in the main orthodox, though he rejected terms (such as Trinity) which he could not find in Scripture, and held a Valentinian doctrine of the celestial origin of the flesh of Christ. His church discipline was drawn from the Swiss Baptists. Neither baptism (by pouring on the head) nor the Lord's Supper (with the accompaniment of feet-washing) conferred grace; they were divine ordinances which reflected the believer's inward state. Marriage with outsiders was prohibited. Oaths and the taking of life were absolutely forbidden; hence the magistracy and the army were for the Mennonite unlawful callings; but magistrates were to be obeyed in all things not prohibited by Scripture.

Menno was an active missioner; his changes of place, often compulsory, are difficult to trace. He was apparently much in East Friesland till 1541; in North Holland, with Amsterdam as centre, from 1541 to 1543; again till 1545 in East Friesland (where he held a disputation at Emden with John à Lasco in 1544); till 1547 in South Holland; next, about Lübeck; at Wismar in 1553–54 (holding disputations with Martin Micronius at Norden); lastly at Wüstenfelde, a village between Hamburg and Lübeck, where he died on Jan. 13, 1559.

The collection of Menno's *Opera Omnia Theologica* (Amsterdam, 1681), folio, in a Dutch version, comprises 23 tractates, with reference to nine unprinted. A selection (*Gedenkblätter*) from his writings, in a German version, was edited by J. Mannhardt (Danzig, 1861) with an appendix from the writings of Dirk Philipsz (1504–70), brother of Obbe, and Menno's henchman. His writings are published in English at Elkhart, Indiana. *See* R. Barclay, *Inner Life of Religious Societies of the Commonwealth* (1876) for a good account of Mennonite anticipations of Quaker views and practices; F. C. Fleischer, *Menno Simons, eene Levensschets* (1892); V. M. Reimann, *Mennonis Simonis qualis fuerit vita* (1894); S. Cramer, in Hauck's *Realencyklopädie* (1903); a separate article in the same, *Mennoniten*, by S. Cramer, gives a survey of the origin and ramifications of the movement in Europe and America.

MENOMINEE. This Algonkin tribe of Indians, of the Central group, has lived since its discovery early in the 17th century, about Menominee river, north-west of Lake Michigan. They lived largely on wild rice (*Zizania*), and were generally at war with their Algonkin neighbours. Some 1,700 survive in Wisconsin; the original population was little if any larger. *See* W. J. Hoffman, *Bur. Am. Ethn. Rep. XIV.*, 1896; A. E. Jenks, *ibid.*, xix., 1901; A. Skinner, *Am. Mus. Nat. Hist. Anth. Pap.*, vol. xiii. 1913–15, *Indian Notes and Monographs,* vol. iv. 1920, 1921.

MENOMINEE (mẹ-nŏm′ ĭn-ē), a city of the Upper Peninsula of Michigan, U.S.A., on Green bay (Lake Michigan) at the mouth of the Menominee river, opposite Marinette (Wisconsin). It is on federal highway 41, and is served by the Chicago and North Western, the Chicago, Milwaukee, St. Paul and Pacific, the Wisconsin and Michigan and (by car-ferry through the Sturgeon Bay canal and across the lake to Frankfort) the Ann Arbor railways, and lake steamers. The population was 8,907 in 1920 (21% foreign-born white) and was 10,320 in 1930 (by Federal census). The commerce of the harbour (including Marinette) amounted in 1926 to 822,468 tons (valued at $62,130,625) of which 481,911 tons was car-ferry traffic. Menominee has important manufactures, including the largest baby-carriage factory in the country. The county agricultural college was founded here in 1907. In 1634 Nicollet found the Menominee Indians (an Algonquian tribe) living at the mouth of the river. A trading post was established in 1799; permanent settlement began in 1833; the village became the county seat in 1864, and was chartered as a city in 1883. The name is a Chippewa word for wild rice.

MENOMONIE, a city of western Wisconsin, U.S.A., on the Red Cedar river, 65 m. E. of Saint Paul; the county seat of Dunn county. It is on Federal highway 12, and is served by the Chicago, Milwaukee, St. Paul and Pacific and the Chicago, St. Paul, Minneapolis and Omaha railways. Pop. (1920) was 5,104. It is the trade centre and shipping point for a rich farming region, and has brickyards and several other manufacturing industries. In earlier days it was one of the great lumbering centres of the North-west. Most of its public institutions were founded and endowed by James Huff Stout (1848–1910) who came here from Saint Louis in 1889 and made a considerable fortune as a lumberman. Chief among them is the Stout institute, established by him in 1893 as a training school for boys and girls in the manual arts and domestic economy; expanded in 1903 to train teachers for these subjects; taken over by the State in 1911, and since then administered (as one of the State teachers colleges. The enrolment is about 600. Menomonie was settled about 1846 and was chartered as a city in 1882.

MENOPAUSE (CLIMACTERIC), a medical term meaning primarily the cessation of menstruation, but has come to connote the permanent cessation of the monthly periods that forms the most obvious sign that the reproductive life of a woman has come to an end. Translated into popular language it is "the change of life."

The cessation of menstruation is but the outward indication of internal changes of which the primary one is the cessation of ovarian activity. Menstruation (*q.v.*) is determined by the periodic ripening and bursting of small sacs in the ovary containing the egg-cells. Associated with these cyclical changes in the ovary are internal chemical (metabolic) changes in the body, in which other glands of internal secretion, particularly the thyroid and pituitary, play a part with the ovarian secretions. The result of the withdrawal of the ovary and its secretions is that the time of adjustment is sometimes associated with disordered health.

The age at which the menopause occurs has wide variations, but is usually between 45 and 50. The way in which the menopause occurs is also very variable. Menstruation may end suddenly and completely and without warning or it may gradually cease by diminishing losses and lengthening intervals spread over a year or more; occasionally, but not to the extent credited by the women themselves, these irregular periods may be accompanied by profuse losses.

Normally the adjustment to these internal bodily changes is made without disturbance of health of mind or body, or at most with trifling discomforts. Such as do arise are liable to be exaggerated in certain individuals and may require medical treatment. The commonest psychical change is mental depression with lack of energy, sleeplessness, headaches and neuralgias and disordered sensations of various kinds. It is the time at which the childless woman may think herself pregnant and even have a phantom enlargement of the abdomen and mock labour pains. In those exposed to mental stress at this time or hereditarily predisposed, there are increased risks of insanity, which would appear to be greater in the more educated and cultured classes. Among the nervous phenomena the most common are "heats" and "flushes" with reddening of the face and neck, sometimes accompanied by sweating, which may be momentary or last for some minutes. More commonly a later effect, but sometimes beginning before the menopause is a tendency to adiposity.

A *premature menopause* may occur at any age from disease of the ovaries or other glands of internal secretion or grave nutritional disorder, but is occasionally met with before 40 as the result of a serious illness or profound emotional stress. An *artificial menopause* is produced by the complete removal of both ovaries or by the destruction of their function by radium or X-rays. The earlier in a woman's life it is brought about, the more severe are the symptoms produced, the psychical and nervous disorders being specially exaggerated.

From the medical standpoint the most important feature of the menopause is concerned with the fact that as reproductive activity wanes there is a tendency to overgrowth (obesity, goitre) and new-growth (tumours) of the uterus and ovary, for which a special watch must be maintained. Irregular bleeding is usually the first sign of cancer of the womb and increased menstrual losses of fibroid tumours and both are prone to be ascribed by women to

the "change of life" and their early stages to be disregarded. Also abdominal enlargement is liable to be considered as due to obesity when it may be tumour-formation. Hence it is important that a thorough investigation be made of all women in whom this time of life presents any marked deviation from the normal, particularly in the direction of excessive bleeding from the womb. (J. S. Fa.)

MENSA and **MAREA,** semi-nomad pastoral tribes of Africans occupying part of the Abyssinian highlands included in the Italian colony of Eritrea, and the adjacent coast plains of the Red Sea, the Marea chiefly in the valley of the Khor Anseba, the Mensa dwelling farther north. These tribes claim Arab origin, tracing their descent from an uncle of the Prophet. Under Abyssinian rule they were Christians, but became Mohammedans in the 19th century. They speak a dialect of Tigrin (Abyssinian). On the death of a Marea the head of every dependent *tigré* or slave family must give his heirs a cow. The tribes punish an illegitimate birth by putting parents and child to death.

MENSDORFF-POUILLY-DIETRICHSTEIN, ALBERT, Count von (1861–), Austro-Hungarian diplomatist, was born at Lemberg on Sept. 5, 1861, the second son of Alexander von Mensdorff-Pouilly, Prince Dietrichstein. In 1886 he was attached to the Austrian embassy in Paris, and transferred in 1889 to London, where he was ambassador from 1904 to August 1914. He supported every attempt to avert the danger of the World War, and was repeatedly entrusted during the War with missions directed towards peace, including the important but fruitless negotiations with General Smuts in Switzerland, Dec. 1917.

MENSHIKOV, ALEXANDER DANILOVICH, Prince (1663?–1729), Russian statesman, was born not earlier than 1660 nor later than 1663. At the age of twenty he was gaining his livelihood in the streets of Moscow as a vendor of meat-pies. François Lefort, Peter's first favourite, took him into his service and finally transferred him to the tsar. On the death of Lefort in 1699, Menshikov succeeded him as prime favourite. Ignorant, brutal, grasping and corrupt as he was, he deserved the confidence of his master. He could drill a regiment, build a frigate, administer a province, and decapitate a rebel with equal facility. During the tsar's first foreign tour, Menshikov worked by his side in the dockyards of Amsterdam, and acquired a thorough knowledge of colloquial Dutch and German. He took an active part in the Azov campaigns (1695–96), and superseded Ogilvie as commander-in-chief during the retreat before Charles XII. in 1708, subsequently participating in the battle of Holowczyn, the reduction of Mazepa, and the crowning victory of Poltava (June 26, 1709), where he won his marshal's bâton. From 1709 to 1714 he served during the Courland, Holstein and Pomeranian campaigns, but then, as governor-general of Ingria, with almost unlimited powers, was entrusted with a leading part in the civil administration. Menshikov was the right hand of the tsar in all his gigantic undertakings. But every time the tsar returned to Russia he received fresh accusations of peculation against "his Serene Highness." Peter's first serious outburst of indignation (March 1711) was due to the prince's looting in Poland. On his return to Russia in 1712, Peter discovered that Menshikov had winked at wholesale corruptions in his own governor-generalship. Peter warned him "for the last time" to change his ways. Yet, in 1713, he was implicated in the famous Solov'ey process over the export of corn, in the course of which it was demonstrated that he had defrauded the government of 100,000 roubles. He only owed his life on this occasion to a sudden illness. In the last year of Peter's reign fresh frauds and defalcations of Menshikov came to light, and he was obliged to appeal for protection to the empress Catherine. It was chiefly through the efforts of Menshikov and his colleague Tolstoi that, on the death of Peter, in 1725, Catherine was raised to the throne. During her short reign (February 1725–May 1727), Menshikov was practically absolute. He contrived to prolong his power after Catherine's death by means of a forged will and a *coup d'état.* While his colleague Tolstoi would have raised Elizabeth Petrovna to the throne, Menshikov set up the youthful Peter II., son of the tsarevich Alexius, with himself as dictator during the prince's minority. He now aimed at establishing himself definitely by marrying his daughter Mary to Peter II. But the old nobility overthrew him, and he was deprived of all his dignities and offices and expelled from the capital (Sept. 9, 1727). He died in exile at Berezov, Siberia, on Nov. 12 (O.S.), 1729.

See G. V. Esipov, *Biography of A. D. Menshikov* (Rus.) (St. Petersburg, 1875); N. I. Kostomarov, *The History of Russia in the biographies of her great Men* (Rus.), vol. ii. (St. Petersburg, 1888, etc.); R. Nisbet Bain, *The First Romanovs* (London, 1905); ibid. *The Pupils of Peter the Great,* ch. 2–4 (Westminster, 1897). (R. N. B.; X.)

MENSHIKOV, ALEXANDER SERGEIEVICH, Prince (1787–1869), great-grandson of the preceding, born on Sept. 11, 1787, accompanied the emperor Alexander throughout his campaigns against Napoleon, and retired from army service in 1823. At the time of the dispute as to the Holy Places he was sent on a special mission to Constantinople, and when the Crimean war broke out he was appointed commander-in-chief by land and sea. He commanded the Russian army at the Alma and in the field operations round Sevastopol. In March 1855 he was recalled. He died on May 2, 1869 at St. Petersburg.

MENSTRUATION. Normal menstruation consists in the escape of from 4 to 6 oz. of blood together with mucus from the uterus at intervals of 28 days (more or less). Menstrual blood does not coagulate under ordinary circumstances. The flow begins at the age of puberty, the average age of which in England is between 14 and 16 years. It ceases between 45 and 50 years of age, and this is called the menopause or climacteric period, commonly spoken of as "the change of life." Both the age of puberty and that of the menopause may supervene earlier or later according to local conditions. Very rarely the menstrual flow may be replaced by haemorrhage from distant organs (epistaxis, haematemesis, haemoptysis); this is called *vicarious menstruation.* Menstruation is closely associated with ovulation (*see* Embryo).

The usual disorders of menstruation are : (1) *amenorrhoea* (absence of flow), (2) *dysmenorrhoea* (painful flow), (3) *menorrhagia* (excessive flow), (4) *metrorrhagia* (excessive and irregular flow).

Amenorrhoea may arise from physiological causes, such as pregnancy, lactation, the menopause; constitutional causes, such as phthisis, anaemia and chlorosis, febrile disorders, some chronic intoxications, such as morphinomania, and some forms of cerebral disease; local causes, which include malformations or absence of one or more of the genital parts, such as absence of ovaries, uterus or vagina, atresia of vagina, imperforate cervix, disease of the ovaries, or sometimes imperforate hymen. The treatment of amenorrhoea must be directed towards the cause. In anaemia and phthisis menstruation often returns after improvement in the general condition, with good food and good sanitary conditions, an outdoor life and the administration of iron or other tonics. In local conditions of imperforate hymen, imperforate cervix or ovarian disease, surgical interference is necessary. Amenorrhoea is permanent when due to absence of the genital parts.

The causes of dysmenorrhoea (*see* Women, Diseases of) are classified as follows: (1) ovarian, due to disease of the ovaries or Fallopian tubes; (2) obstructive, due to some obstacle to the flow, as stenosis, flexions and malpositions of the uterus, or malformations; (3) congestive, due to subinvolution, chronic inflammation of the uterus or its lining membrane, fibroid growths and polypi of the uterus, cardiac or hepatic disease; (4) neuralgic; (5) membranous. The foremost place in the treatment of dysmenorrhoea must be given to aperients and purgatives administered a day or two before the period is expected. By this means congestion is reduced. Hot baths are useful, and various drugs. Medicinal treatment is, however, only palliative, and flexions and malpositions of the uterus must be corrected, stenosis treated by dilatation, fibroid growths if present removed, and endometritis when present treated by local applications or curetting according to its severity.

Menorrhagia (*see* Women, Diseases of) signifies excessive bleeding at the menstrual periods. Constitutional causes are purpura, haemophilia, excessive food and alcoholic drinks and warm climates; while local causes are congestion and displacements of

the uterus. endometritis, subinvolution, retention of the products of conception, new growths in the uterus such as mucous and fibroid polypi, malignant growths, tubo-ovarian inflammation and some ovarian tumours.

Metrorrhagia is a discharge of blood from the uterus, independent of menstruation. It always arises from disease of the uterus or its appendages. Local causes are polypi, retention of the products of conception, extra uterine gestation, haemorrhages in connection with pregnancy, and new growths in the uterus.

In the treatment of both menorrhagia and metrorrhagia the local condition must be carefully ascertained. When pregnancy has been excluded, and constitutional causes treated, efforts should be made to relieve congestion. Uterine haemostatics, as ergot, ergotin, tincture of hydrastis or hamamelis, are of use, together with rest in bed. In uncomplicated uterine haemorrhage local treatment with radium is very beneficial. Fibroid polypi and other new growths must be removed. Irregular bleeding in women over 40 years of age is frequently a sign of early malignant disease, and should on no account be neglected. (*See* also GYNAECOLOGY.)

MENSURATION, that branch of mathematics which deals with the quantitative measurement of length, areas and volumes; or, in a more limited sense, with so much of this subject as is not ordinarily treated under Geometry or Trigonometry. Mensuration of continuous graphs, *i.e.*, of figures which may be regarded as traced out by a moving ordinate, is usually known as *Quadrature* (*see* §6). The present article mainly gives formulae, without proofs.

MENSURATION OF GEOMETRICAL FIGURES

1. **Areas of Plane Rectilinear Figures.**—(i.) We begin with some simple plane figures. The square, rectangle, parallelogram and triangle may all be regarded as particular cases of the *trapezium* (U.S.A. usage, trapezoid, the word "trapezium" being generally dropped), which is a quadrilateral with two parallel sides. If the sides are a and b, and the distance between them is h, the area of the trapezium is $h\cdot\frac{1}{2}(a+b)$. In the case of the triangle, for instance, b is zero, so that the area is $\frac{1}{2}ha$, *i.e.*, half the product of a side by the perpendicular distance of the opposite angle from it.

(ii.) If the two parallel sides of a trapezium are at right angles to one of the remaining sides, the figure is called a *right trapezium.* The two parallel sides are the *sides*, the side at right angles to them is the *base*, and the fourth side is the *top*. The area is the product of the base by the mean of the two sides.

(iii.) A figure such as $ABCDEFSM$ (fig. 1), bounded by a base MS, two sides MA and SF at right angles to the base, and a rectilinear top $ABCDEF$, is called a *trapezoid.* (In U.S.A., generally referred to as a general quadrilateral, "trapezoid" being used for "trapezium.") It can be split up into a series of right trapezia by drawing perpendiculars BN, CP, DQ, ER. One or both of the extreme trapezia may be a triangle. This would be the case, *e.g.*, if in fig. 1 F and S coincide.

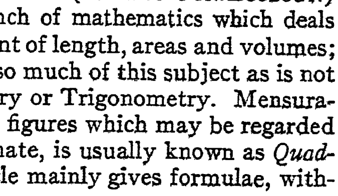


FIG. 1

(iv.) The area of any rectilinear figure may be found in various ways, as for example:

(*a*) The figure may be divided into triangles. The quadrilateral, for instance, can be treated as made up of two triangles, and its area is the product of half the length of one diagonal by the sum of the perpendiculars drawn to this diagonal from the other two angular points.

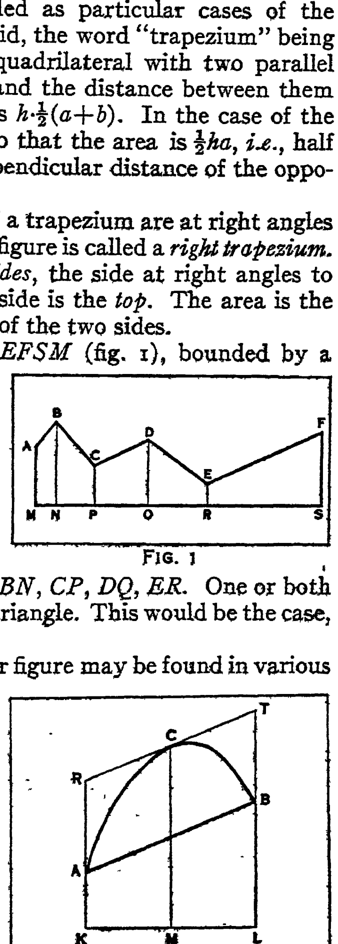


FIG. 2

(*b*) The figure may, by drawing a straight line through it, be divided into two trapezoids.

2. **Surfaces and Volumes of Solids.**—The solid figures with which we are concerned may be grouped as of various types, some coming under more than one type.

(i.) The *prism* is a figure bounded by two parallel planes, all sections by planes parallel to these planes being congruent figures with corresponding points lying on parallel lines. The length of any one of these lines is the length of the prism. The section at right angles to the lines is the *cross-section*. This definition includes the cube, the parallelepiped and the cylinder. The surface of a prism (excluding the two ends) is $=$(perimeter of cross-section)$\times$length; the volume is $=$(area of cross section) $\times$length.

(ii.) The *prismoid* (or *prismatoid*) may be defined as a solid figure with two parallel plane rectilinear ends, each of the other (*i.e.*, the lateral) faces being a triangle with an angular point in one end of the figure and its opposite side in the other. Two adjoining faces in the same plane may together make a trapezium. More briefly, the figure may be defined as a polyhedron with two parallel faces containing all the vertices. The definition covers prism, pyramid and frustum of a pyramid; the cylinder, cone and frustum of a cone may be regarded as limiting cases.

The volume of a prismoid is $\frac{1}{6}h(A+4C+B)$, where h is the perpendicular distance between the two ends, A and B are the areas of the ends, and C is the area of a section parallel to the ends and midway between them. This is the *prismoidal formula:* it applies to other figures than the prismoid, *e.g.*, to the sphere (*see* §13).

In the case of a cylinder, $A=B=C$; in the case of a pyramid or a cone A is 0, and C is one-fourth of B, so that the volume is $\frac{1}{3}hB$; in the case of a frustum of a pyramid or a cone $C^{\frac{1}{2}}$ is the mean of $A^{\frac{1}{2}}$ and $B^{\frac{1}{2}}$, and the volume is therefore $\frac{1}{3}h[A+(AB)^{\frac{1}{2}}+B]$.

(iii.) The surface (excluding the ends) of a prismoid is *developable, i.e.*, it can be unrolled flat on a plane. Hence the area of the curved surface of a right circular cone is $=\frac{1}{2}$(slant height) $\times$ (perimeter of base).

(iv.) The *sphere* is not a prismoid, but the prismoidal formula is applicable to its volume. If a is the radius of a sphere, then

Volume of sphere $=\frac{4}{3}\pi a^3=\frac{2}{3}$ vol. of circumscribing cylinder,
Surface of sphere $=4\pi a^2=$ curved surface of circumscribing cylinder
$=\frac{2}{3}$ total surface of circumscribing cylinder.

These formulae are due to Archimedes.

(v.) The *wedge*, in the most general sense, is formed by cutting a triangular prism by any two planes (not intersecting within the prism). Its volume is $=$(mean of the 3 parallel edges)$\times$(area of cross-section).

3. **Moments and Centroid.**—The ideas of moment and of centroid (centre of gravity) are extended to plane figures, surfaces and solids. Let F be a plane figure, L any straight line in its plane. Suppose F to be divided up into a large number n of equal elements. Let Σ be the sum of the products obtained by multiplying the area of each element by its distance from L. Then the limit of Σ when n is made indefinitely great is called the *moment*, or *first moment*, of F with regard to L. The *centroid* of F is a point G in F (or fixed with regard to F) such that, wherever L may be, this moment is equal to the product of the whole area of F by the distance of G from L. The centroid of a surface in general or of a solid is defined in the same way, moments being taken with regard to planes. The proof of the existence of a centroid is the same as the proof of the existence of the centroid of a material body. (*See* MECHANICS.) Moments of higher order than the first, *i.e.*, *second moments*, *third moments*, $\cdots$ are obtained by multiplying the elements by the squares, cubes, $\cdots$ of their distances from the line or plane.

4. **Moments About Central Line or Plane.**—When we have found moments of a plane figure with regard to a line in the plane, or of a surface or a solid with regard to a plane, we may require to find the moments about a line or plane through the centroid. Taking the case of a plane figure, let the area be M_0', and let the moments as found be M_1', M_2', M_3', $\cdots$, M_q'; and let x be the distance of the centroid from the original line. Then the first moment with regard to the central line is $M_1'-xM_0'$; this is 0, so that $x=M_1'/M_0'$. The qth moment with regard to the

central line is

$$M_q = M_q' - qxM'_{q-1} + \frac{q(q-1)}{2!}x^2M'_{q-2} - \cdots$$
$$\cdots + (-)^{q-1}qx^{q-1}M_1' + (-)^q x^q M_0';$$

and the last two terms are together $= +(-)^{q-1}(q-1)x^qM_0'$. The formula is the same for the moment of a surface or a volume with respect to a plane.

5. **Solids and Surfaces of Revolution.**—The solid or surface generated by the revolution of a plane closed figure or a plane continuous line about a straight line in its plane, not intersecting it, is a *solid of revolution* or *surface of revolution*, the straight line being its *axis*. The revolution need not be complete, but may be through any angle.

The two important theorems are:—

(i.) If any plane figure revolves about an external axis in its plane, the volume of the solid generated by the revolution is equal to the product of the area of the figure and the distance travelled by the centroid of the figure.

(ii.) If any line in a plane revolves about an external axis in the plane, the area of the curved surface generated by the revolution is equal to the product of the length of the line and the distance travelled by the centroid of the line.

These theorems were discovered by Pappus of Alexandria (*c.* A.D. 300, but possibly as early as the first century), and were made generally known by Guldinus (*c.* A.D. 1640). They are sometimes known as *Guldinus's Theorems*, but are more properly described as the *Theorems of Pappus*. The theorems are of use, not only for finding the volumes or areas of solids or surfaces of revolution, but also, conversely, for finding centroids or centres of gravity. They may be applied, for instance, to finding the centroid of a semi-circle or of the arc of a semi-circle.

QUADRATURE

6. Quadrature is, in its most general sense, the mensuration of areas. In the more limited sense in which it is used in this article, it is, viewed arithmetically, the process of expressing an integral in terms of certain values of the integrated quantity; viewed geometrically, it is the process of expressing the area of a particular kind of plane figure, called a trapezette, in terms of certain of its ordinates. These may be regarded as different aspects of the same process, if, on the one hand, the integrated quantity is represented by a graph, or if, on the other hand, the area of the figure is found by integration. The process is also called *mechanical quadrature* or *numerical integration*. The word may be taken as covering the determination not only of the area of a trapezette but also of its moments.

The extension of the methods of quadrature to solid figures is *cubature*: it will be convenient to treat these as two parts of one subject. We shall therefore proceed under the following heads:—I. Area of trapezette in terms of ordinates; II. Moments of trapezette in terms of ordinates or areas; III. Cubature.

I. AREA OF TRAPEZETTE IN TERMS OF ORDINATES

7. A *trapezette* is a figure of the kind with which we are familiar as the graph of a continuously varying positive function. It is bounded by a base, two sides, called the *bounding ordinates*, and an upper boundary which is a curved line; if this line meets the base at either extremity of the figure, the bounding ordinate is zero. Any line drawn from and at right angles to the base to meet the upper boundary is an *ordinate* of the figure. The figure may be regarded as traced out by an ordinate which moves from one extremity of the base to the other extremity.

8. **Notation.**—The moving ordinate of the trapezette will be denoted by u, and the *abscissa* of this ordinate, *i.e.*, the distance of its foot from a certain fixed point or origin O on the base (or the base produced), will be denoted by x, so that u is some function of x. The breadth of the trapezette, *i.e.*, the distance between its bounding ordinates, will be denoted by H. The *mid-ordinate* is the ordinate mid-way between the bounding ordinates.

The data of a trapezette are usually its breadth and either the bounding ordinates or the mid-ordinates of a series of minor trapezettes or strips into which it is divided by ordinates at equal distances. If there are m of these strips, and if the breadth of each is h, so that $H=mh$, it is convenient to write x in the form $x_0+\theta h$, and to denote it by x_θ, the corresponding value of u being u_θ. The data are then either the bounding ordinates $u_0, u_1, u_2, \cdots, u_m$ of the strips or their mid-ordinates $u_{\frac{1}{2}}, u_{\frac{3}{2}}, \cdots, u_{m-\frac{1}{2}}$.

The *central ordinate* is the ordinate through the centroid (*see* §3) of the trapezette. Its distance from any straight line parallel to the ordinate is equal to the mean distance of the trapezette from the line.

9. **Types of Formula.**—The formulae that we have to consider are of five types. In the first four the ordinates are supposed to be at equal distances.

(i.) The two trapezoidal rules.

(ii.) Rules such as Simpson's, in which more weight is given to some ordinates than to others.

(iii.) The rules (i.) with corrections depending on the extreme values.

(iv.) The rules (ii.) with corrections depending on the extreme values.

(v.) Formulae which involve ordinates taken at unequal intervals.

The formulae of types (i.) and (ii.) are called "rules." This name is given to a formula which is made up of repetitions of a simpler formula. Suppose, for instance, that m is even and $=2n$, so that the m strips of the trapezette can be grouped in pairs. Then, as will be seen presently, *Simpson's formula* gives $\frac{1}{3}h(u_0+4u_1+u_2)$ as the area of the first pair; taking this for each pair, we get *Simpson's rule* ($\fallingdotseq$ denoting approximate equality):

$$\text{Area} \fallingdotseq \tfrac{1}{3}h(u_0+4u_1+u_2)+\tfrac{1}{3}h(u_2+4u_3+u_4)+\cdots$$
$$\cdots+\tfrac{1}{3}h(u_{2n-2}+4u_{2n-1}+u_{2n})$$
$$\fallingdotseq \tfrac{1}{3}h(u_0+4u_1+2u_2+4u_3+2u_4+\cdots$$
$$\cdots+2u_{2n-2}+4u_{2n-1}+u_{2n}).$$

10. **Type (i.): Trapezoidal.**—Type (i.) covers two rules.

(*a*) The *trapezoidal rule*, ordinarily so-called, applies when we know the bounding ordinates $u_0, u_1, u_2, \cdots, u_m$. The area given by this rule is called the *chordal area*, and is denoted by C_1. The formula is

$$\text{Area} \fallingdotseq C_1 \equiv h(\tfrac{1}{2}u_0+u_1+u_2+\cdots+u_{m-1}+\tfrac{1}{2}u_m). \qquad (1)$$

(*b*) The *trapezoidal rule for mid-ordinates* applies when we know the mid-ordinates $u_{\frac{1}{2}}, u_{\frac{3}{2}}, u_{\frac{5}{2}}, \cdots, u_{m-\frac{1}{2}}$. The area given by the rule is called the *tangential area*, and is denoted by T_1. The formula is

$$\text{Area} \fallingdotseq T_1 \equiv h(u_{\frac{1}{2}}+u_{\frac{3}{2}}+\cdots+u_{m-\frac{1}{2}}). \qquad (2)$$

In each case, the formula is obtained by taking each strip separately and assuming that its top is a straight line, *i.e.*, that the strip is a trapezium. Taking the first strip, let KA and LB in fig. 2 be u_0 and u_1, and let MC be $u_{\frac{1}{2}}$. Then the "*chordal*" area of the strip is found by replacing the arc ACB by the chord AB, so that the area is $\frac{1}{2}KL(KA+LB)=\frac{1}{2}h(u_0+u_1)$; and the "tangential" area is found by replacing the arc by the tangent RT, so that the area is $KL.\,MC=hu_{\frac{1}{2}}$. Taking the sum of all the strips, we obtain C_1 in the one case and T_1 in the other.

11. **Type (ii.): Weighted.**—Under type (ii.) we shall only consider cases in which the data are the bounding ordinates $u_0, u_1, u_2, \cdots$. There are corresponding formulae for cases in which the data are the mid-ordinates $u_{\frac{1}{2}}, u_{\frac{3}{2}}, u_{\frac{5}{2}}, \cdots$, but they are not so important.

We have used C_1 to denote the chordal area $h(\frac{1}{2}u_0+u_1+u_2+\cdots+\frac{1}{2}u_m)$. Now suppose that m is even and $=2n$. Then we can get a different chordal area by considering only $u_0, u_2, u_4, \cdots, u_{2n}$. We call this C_2, so that

$$C_2 \equiv 2h(\tfrac{1}{2}u_0+u_2+u_4+\cdots+u_{2n-2}+\tfrac{1}{2}u_{2n}).$$

Generally, suppose that p is a factor of m. Then we write

$$C_p \equiv ph(\tfrac{1}{2}u_0+u_p+u_{2p}+\cdots+u_{m-p}+\tfrac{1}{2}u_m);$$

this being the chordal area when we only take $u_0, u_p, u_{2p}, \cdots$ into account. The "rules" we are considering are obtained by combining the C's in various ways.

The following are the most important rules of this type. In each case, as stated in §9, the rule is made up of repetitions of a formula. The "formula" and the "rule" are both given; "A" denoting the area given by the "rule."

(a) m a multiple of 2 (*Simpson's rule*).

$$\text{Area}(u_0 \text{ to } u_2) \simeq \tfrac{1}{3}h(u_0+4u_1+u_2) \tag{4}$$
$$A \simeq \tfrac{1}{3}(4C_1-C_2) \tag{4A}$$
$$\simeq \tfrac{1}{3}h(u_0+4u_1+2u_2+4u_3+2u_4+\cdots +4u_{m-1}+u_m). \tag{4B}$$

(b) m a multiple of 3 (*Simpson's second rule*).

$$\text{Area}(u_0 \text{ to } u_3) \simeq \tfrac{3}{8}h(u_0+3u_1+3u_2+u_3) \tag{5}$$
$$A \simeq \tfrac{1}{8}(9C_1-C_3) \tag{5A}$$
$$\simeq \tfrac{3}{8}h(u_0+3u_1+3u_2+2u_3+3u_4+\cdots +3u_{m-1}+u_m). \tag{5B}$$

(c) m a multiple of 4.

$$\text{Area}(u_0 \text{ to } u_4) \simeq \tfrac{2}{45}h(7u_0+32u_1+12u_2+32u_3+7u_4) \tag{6}$$
$$A \simeq \tfrac{1}{45}(64C_1-20C_2+C_4). \tag{6A}$$

(d) m a multiple of 6 (*Weddle's rule*).

$$\text{Area}(u_0 \text{ to } u_6) \simeq \tfrac{3}{10}h(u_0+5u_1+u_2+6u_3+u_4+5u_5+u_6) \tag{7}$$
$$A \simeq \tfrac{1}{10}(15C_1-6C_2+C_3). \tag{7A}$$

(e) m a multiple of 12.

$$A \simeq \tfrac{4}{5}(2C_1-C_2)+\tfrac{1}{35}(8C_3-C_4). \tag{8}$$

12. **A Method of Construction.**—The formulae given in the preceding section are not all obtained in the same way. They could all be found by a modification of the method mentioned later in §16. But the first three were originally obtained by making certain suppositions as to the upper boundary. For (a) two strips were taken together, and the top was supposed to be a parabola passing through the tops of three ordinates; for (b) three strips were taken, and the curve was supposed to be of the third degree; and for (c) four strips were taken, and the curve was supposed to be of the fourth degree.

For detailed consideration, (a) will be sufficient. We can use fig. 2; KA, MC, LB being the three ordinates u_0, u_1, u_2. The curve being a parabola, the tangent RCT is parallel to the chord AB. The area of the trapezium $AKLB$ is $h(u_0+u_2)$; and that of $RKLT$ is $2hu_1$. The true area $AKLBCA$ exceeds the former by the segment ACB, and falls short of the latter by the small pieces (spandrils) RAC and CBT. But we know that, for a parabola, the former difference is double the latter. We must therefore take a weighted mean of the two expressions, in the ratio of 1 : 2; *i.e.*, the area is

$$\tfrac{1}{3}h(u_0+u_2)+\tfrac{2}{3}\cdot 2hu_1=\tfrac{1}{3}h(u_0+4u_1+u_2).$$

We could, of course, have obtained this result analytically. If $u=p+qx+rx^2$, the area is $p(x_2-x_0)+\tfrac{1}{2}q(x_2{}^2-x_0{}^2)+\tfrac{1}{3}r(x_2{}^3-x_0{}^3)$; and this can be reduced to the above form by using the relations $u_0=p+qx_0+rx_0{}^2$, $u_1=$ etc., $u_2=$ etc., $h=\tfrac{1}{2}(x_2-x_0)$.

The general formula, when u is a polynomial in x of degree k, is:

$$\text{Area } (u_0 \text{ to } u_k)=h(g_0u_0+g_1u_1+g_2u_2+\cdots+g_ku_k), \tag{9}$$

where

$$g_r=\frac{(-1)^{k-r}}{r!(k-r)!}\int_0^k t(t-1)\cdots(t-r+1)(t-r-1)\cdots(t-k)dt. \tag{10}$$

This is, in effect, the *Newton-Cotes formula*.

13. **The Prismoidal Formula.**—An important application of quadrature-formulae is to finding the volume of a solid figure in terms of the areas of parallel cross-sections. In particular, suppose that a solid is bounded by two parallel planes, and that the area of the section by a plane parallel to these, at distance x from one of them, is of the form $p+qx+rx^2+sx^3$. Then, as is easily seen by drawing a graph of the areas of cross-sections, Simpson's formula applies to the volume of the solid; so that, if the areas of the ends are S_0 and S_2, and the area of the mid-section is S_1, the volume is $\tfrac{1}{6}H(S_0+4S_1+S_2)$, where H is the total breadth. This is called the *prismoidal formula*; it applies not only to prismoids but also to the cone, the sphere and the ellipsoid.

14. **The Euler-Maclaurin Theorem.**—For further progress, we have to use the *Euler-Maclaurin theorem*, discovered independently by Euler and by Maclaurin. The principle of this important theorem is that the difference between the trapezoidal area $\tfrac{1}{2}h(u_0+u_1)$ and the true area of the strip u_0 to u_1 can be expressed as the difference of the values, for $u=u_0$ and $u=u_1$, of a function which only involves derivatives of u; *i.e.*, that

$$\int_{x_0}^{x_1} udx=\tfrac{1}{2}h(u_0+u_1)+\Big[\phi\,(x)\Big]_{x=x_0}^{x=x_1}, \tag{11}$$

where $[\phi(x)]_{x=x_0}^{x=x_1}$ means $\phi(x_1)-\phi(x_0)$. The formula for $\phi(x)$ is

$$\phi(x)=-\tfrac{1}{12}h^2u'+\tfrac{1}{720}h^4u'''-\tfrac{1}{30240}h^6u^{\mathrm{v}}+\tfrac{1}{1209600}h^8u^{\mathrm{vii}}-\cdots \tag{12}$$

This theorem is exact if u is a polynomial in x; it is sufficiently exact in a good many other cases.

Applying this theorem to the successive strips, we get

$$\text{Area } (u_0 \text{ to } u_m)=C_1+\Big[\phi\,(x)\Big]_{x=x_0}^{x=x_m}, \tag{13}$$

which is the Euler-Maclaurin theorem.

An important feature of the theorem is that the terms in $\phi(x)$ involve h^2, h^4, $h^6 \cdots$, so that by increasing the number of the strips we make a much greater decrease in the magnitude of the corrective terms.

Another important point, which does not directly concern us here, is that we can transpose the terms so as to give a general formula for expressing a sum in terms of an integral (*cf.* CALCULUS OF DIFFERENCES).

To make the theorem applicable to quadrature, when u is not given explicitly in terms of x, we have to convert the derivatives hu', h^3u''', $\cdots$, into the equivalent expressions involving central differences. If we only know u_0, u_1, u_2, $\cdots$, u_m we do not know the central differences of u_0 and u_m; in this case two courses are open to us. We can express the derivatives in terms of the advancing differences of u_0 and the receding differences of u_m—*Gregory's formula*— or we can still use the central-difference formulae if we continue the series of differences forwards and backwards at the extremities.

15. **Type (iii.): Trapezoidal with Corrections.**—Expressing the derivatives in (12) in terms of central differences, we get

$$A=C_1+h\Big[-\tfrac{1}{12}\mu\delta u+\tfrac{11}{720}\mu\delta^3u-\tfrac{191}{60480}\mu\delta^5u+\cdots\Big]_{x=x_0}^{x=x_m} \tag{14}$$

as the corrected trapezoidal formula. The corrected trapezoidal formula for mid-ordinates is

$$A=T_1+h\Big[\tfrac{1}{24}\delta u-\tfrac{17}{5760}\delta^3u+\tfrac{367}{967680}\delta^5u-\cdots\Big]_{x=x_0}^{x=x_m}. \tag{15}$$

16. **Type (iv.): Weighted with Corrections.**—The Euler-Maclaurin formula gives us a method of constructing formulae such as those of Type (ii.), with additional terms to make the formula exact. Thus, to find a formula which would give a correct result if u were of the form $p+qx+rx^2+sx^3$, we must find one such that the term in u' in the [ ] disappears. Suppose that m is even and $=2n$. Then we have, the values for [ ] being throughout x_0 and x_m,

$$A=C_1+[-\tfrac{1}{12}h^2u'+\text{ terms in } u''' \text{ etc.}],$$
$$A=C_2+[-\tfrac{1}{3}h^2u'+\text{ terms in } u''' \text{ etc.}];$$

whence it follows that

$$3A=4C_1-C_2+[\text{terms in } u''', \text{ etc.}],$$

which, as we should expect, is Simpson's formula with corrections.

The following are the exact formulae corresponding to (*a*)-(*e*) of §11.

$$\text{(i.)}\quad A=\tfrac{1}{3}(4C_1-C_2)+\left[-\tfrac{1}{180}h^4u'''+\tfrac{1}{1512}h^6u^{\text{v}}-\cdots\right] \tag{16}$$
$$\text{(ii.)}\quad A=\tfrac{1}{8}(9C_1-C_3)+\left[-\tfrac{1}{80}h^4u'''+\tfrac{1}{336}h^6u^{\text{v}}\cdots\right] \tag{17}$$
$$\text{(iii.)}\quad A=\tfrac{1}{45}(64C_1-20C_2+C_4)+\left[-\tfrac{2}{945}h^6u^{\text{v}}+\cdots\right] \tag{18}$$
$$\text{(iv.)}\quad A=\tfrac{1}{10}(15C_1-6C_2+C_3)+\left[-\tfrac{1}{840}h^6u^{\text{v}}+\cdots\right] \tag{19}$$
$$\text{(v.)}\quad A=\tfrac{1}{35}(56C_1-28C_2+8C_3-C_4)+\left[-\tfrac{1}{2100}h^8u^{\text{vii}}+\cdots\right] \tag{20}$$

These formulae are not of great practical importance, but are useful as showing the relative accuracy of the various formulae.

17. **Degree of Accuracy.**—In applying any of the above formulae to a concrete case, it should be borne in mind that their accuracy depends on the nature of the case.

(1) If u is a polynomial in x, of whatever degree, the Euler-Maclaurin theorem, and therefore also the formulae of §§15 and 16, are exact, provided we take sufficient terms.

(2) If u is a definite function of x, other than a polynomial, the series of corrective terms in any of these formulae is not usually convergent; and the degree of accuracy has to be examined in each case.

(3) The cases in which u is only known to be some function of x are usually cases in which the u's are the result of observation and are liable to error; and in these cases an excessive accuracy in the formula itself is of no advantage.

18. **Numerical Example.**—For a numerical example, suppose that the relation between u and x is that $u=10/(x+20)$, and that we want the area of the graph of u from $x=0$ to $x=6$. We know from the Integral Calculus that this area is

$$\int_0^6 \frac{10}{x+20}dx=10(\log_e 26-\log_e 20)=2\cdot 62364\,26.$$

The values of u, and their differences (including some at the end which depend on values of u not shown here), are given in the following table:—

x	u	1st diff.	2nd diff.	3rd diff.
		−	+	−
		2632		41
0	.50000		251	
		2381		34
1	.47619		217	
		2164		30
2	.45455		187	
		1977		21
3	.43478		166	
		1811		22
4	.41667		144	
		1667		15
5	.40000		129	
		1538		16
6	.38462		113	
		1425		11

The sequence of differences shows that we can safely use the ordinary methods.

(i.) The trapezoidal rule gives

$$A\simeq h(\tfrac{1}{2}u_0+u_1+u_2+u_3+u_4+u_5+\tfrac{1}{2}u_6)$$
$$\simeq 2\cdot 62450,$$

since h is here $=1$.

(ii.) Since the number of strips is even, we can use Simpson's rule. This gives

$$A\simeq\tfrac{1}{3}h(u_0+4u_1+2u_2+4u_3+2u_4+4u_5+u_6)$$
$$\simeq 2\cdot 62365.$$

(iii.) The correction for the trapezoidal rule is

$$\left[-\tfrac{1}{12}\mu\delta u+\tfrac{11}{720}\mu\delta^3u\right]_{x=0}^{x=6}=-\cdot 00085.$$

The corrected value is therefore

$$A\simeq 2\cdot 62450-\cdot 00085\simeq 2\cdot 62365.$$

Thus (ii.) and (iii.) both give a fairly good result.

19. **Type (v.): Unequal Intervals.**—Under Type (v.) come two classes of cases.

(i.) When the given u's are not at equal intervals, the area is to be obtained by expressing the variable u in terms of x by Lagrange's formula (INTERPOLATION) and integrating.

(ii.) If we are free to choose the u's, we may want to choose them to satisfy some condition; *e.g.*, that we should restrict ourselves to a few ordinates, and place them so as to get the most accurate value possible for the area; or that the coefficients of the u's should all be equal. Under this head come certain formulae due to Gauss and Chebyshef (Tchebychev).

II. MOMENTS OF TRAPEZETTE

20. The moments of a trapezette with regard to a line L parallel to its ordinates are defined on the same principle as the moments of a lamina. Let L be at a distance X from the axis of u. We suppose the area to be divided into a very large number of very small equal elements dS. To find the rth moment M_r', we multiply each element dS by its $(x-X)^r$ and add the results. The limit of this sum when all the elements are made indefinitely small is M_r'.

We need only consider moments about the axis of u, so that $X=0$. The moments about the central ordinate ("moments about the mean") are denoted by $M_1, M_2, M_3, \cdots$; the formulae for obtaining these from $M_1', M_2', M_3', \ldots$ are given in §4.

21. **Ordinates Given.**—When the data are $u_0, u_1, u_2, \ldots, u_m$, the rth moment is the area of a trapezette whose ordinates are $x_0^r u_0,\ x_1^r u_1, \cdots, x_m^r u_m$. This area is to be found by a quadrature-formula.

22. **Areas Given.**—When, as is usually the case in the theory of statistics, the data are the areas of the strips (of breadth h) of the trapezette, there are two methods of calculating the moments of the trapezette. The areas of the m strips are denoted by $a_{\frac{1}{2}}, a_{\frac{3}{2}}, a_{\frac{5}{2}}, \cdots, a_{m-\frac{1}{2}}$, the total area being $A\equiv a_{\frac{1}{2}}+a_{\frac{3}{2}}+a_{\frac{5}{2}}\cdots+a_{m-\frac{1}{2}}$.

(i.) The first method involves an integration by parts. Let A_k be the sum of the areas from $a_{\frac{1}{2}}$ up to $a_{k-\frac{1}{2}}$ inclusive, so that

$$A_k\equiv a_{\frac{1}{2}}+a_{\frac{3}{2}}+a_{\frac{5}{2}}+\cdots+a_{k-\frac{1}{2}},\ A_m\equiv \text{total area}=A.$$

Then the rth moment is

$$M_r=x_m^r A_m-rT_{r-1},$$

where T_{r-1} is the area of a trapezette whose ordinates, at successive distances h, are

$$0,\ x_1^{r-1}A_1,\ x_2^{r-1}A_2,\cdots, x_m^{r-1}A_m.$$

This area is to be found by a quadrature-formula. The method applies to all cases in which this can be done.

(ii.) The principle of the second method is similar to that of the Euler-Maclaurin theorem. The rth moment of each strip, say the strip from u_0 to u_1, is split up into two portions, one of which is easily calculated from the data, while the other is of the form $\psi_r(x_1)-\psi_r(x_0)$, $\psi_r(x)$ being a certain function of u and of the derivatives of u and of x^r. The procedure is as follows:

(*a*) We regard the area of each strip as massed at its mid-ordinate, and thus obtain a *raw moment*

$$N_r'=x_{\frac{1}{2}}^r a_{\frac{1}{2}}+x_{\frac{3}{2}}^r a_{\frac{3}{2}}+\cdots+x_{m-\frac{1}{2}}^r a_{m-\frac{1}{2}}. \tag{22}$$

We have then to introduce certain corrections.

(*b*) The simplest case is that of a *double-tailed* figure, *i.e.*, a figure whose upper boundary has close contact with the base at its extremities. In this case we only require the *corrections for massing*. The corrected moments are then given by the formulae (N_0', of course, being A)

$$\begin{aligned}
M_1'&\simeq N_1'\\
M_2'&\simeq N_2'-\tfrac{1}{12}h^2N_0'\\
M_3'&\simeq N_3'-\tfrac{1}{4}h^2N_1'\\
M_4'&\simeq N_4'-\tfrac{1}{2}h^2N_2'+\tfrac{7}{240}h^4N_0'\\
M_5'&\simeq N_5'-\tfrac{5}{6}h^2N_3'+\tfrac{7}{48}h^4N_1'
\end{aligned} \tag{23}$$

(c) If the figure is not double-tailed, we require also the *corrections for abruptness*, which consist in adding $\psi_r(x_m)-\psi_r(x_0)$, as described above, to the expressions given in (23).

These corrections are due to W. F. Sheppard, and are known as Sheppard's corrections, though this name is sometimes given to the corrections for massing alone.

III. CUBATURE

23. The solid figure which corresponds to the trapezette is called a *briquette*. It is bounded by a pair of parallel planes, another pair of parallel planes at right angles to these, a base at right angles to these four planes (and therefore rectangular), and a top which is a surface of any form but such that every ordinate from the base cuts it in one point and one point only. The briquette may usually be regarded as divided into a number of minor briquettes by two sets of parallel planes, the distances between consecutive planes of each set being equal. If the breadth of the briquette is H one way and K the other, and it is divided into m slabs of breadth h by the one set of planes, and into n slabs of breadth k by the other set, then $H=mh$, $K=mk$. The position of an ordinate u is given by its co-ordinates with reference to two planes parallel to the two pairs of bounding planes; if these co-ordinates are $x=x_0+\theta h$ and $y=y_0+\phi k$, the length of the ordinate may be denoted by $u_{\theta\phi}$.

A process of cubature can usually be regarded as the combination of two processes of quadrature, so that cubature-formulae can easily be derived from quadrature-formulae. Suppose, for instance, that m is a multiple of 2 and n is a multiple of 3, and that u is a polynomial of degree not exceeding 3 in x and 3 in y. Then we can group the minor briquettes in sets of 2×3, as

Diagram 1.

u_{00}	u_{10}	u_{20}
u_{01}	u_{11}	u_{21}
u_{02}	u_{12}	u_{22}
u_{03}	u_{13}	u_{23}

Diagram 2.

$\frac{1}{3}\times\frac{3}{8}$	1	4	1
1	1	4	1
3	3	12	3
3	3	12	3
1	1	4	1

shown in diagram 1; taking one such group, we can regard the area of each section at right angles to the x-axis as found by Simpson's second formula; and, representing each area by an ordinate of a graph, we can use Simpson's formula to find the area of this graph, which represents the volume of the group of 6 briquettes. The result is an expression in which the coefficient of each u in diagram 1 is as shown in diagram 2. Or, as an alternative method of getting this result, we can use operators. What we want is the value of a double-integral. We can express the result of integrating with regard to x in the form $\frac{1}{3}h(1+4E+E^2)u_{00}$, where E denotes the result of changing from x to $x+h$ (*see* CALCULUS OF DIFFERENCES); and the integration with regard to y has the effect of operating with $\frac{3}{8}k(1+3E'+3E'^2+E'^3)$, where E' has a corresponding meaning. The combination of the two operations gives the result shown in diagram 2.

The formulae for the corrections of massing (§22) can be obtained in the same way. Suppose we are dealing with a briquette whose top has close contact with the base all along its boundary, and that we want the moment due to multiplying each element of the volume by x^py^q. Let the raw moment obtained by massing the volume of each minor briquette along its mid-ordinate be denoted by N'_{pq}. Then the corrected expressions for the moments are given by the formulae

$$\begin{aligned} M'_{11} &\simeq N'_{11} \\ M'_{21} &\simeq N'_{21}-\tfrac{1}{12}h^2N'_{01} \\ M'_{12} &\simeq N'_{12}-\tfrac{1}{12}k^2N'_{10} \qquad (24)\\ M'_{22} &\simeq N'_{22}-\tfrac{1}{12}k^2N'_{20}-\tfrac{1}{12}h^2N'_{02}+\tfrac{1}{144}h^2k^2N'_{00} \\ M'_{31} &\simeq N'_{31}-\tfrac{1}{4}h^2N'_{11}, \quad \text{etc.} \end{aligned}$$

where N'_{00} is the total volume of the briquette. (W. F. S.)

BIBLIOGRAPHY.—There is a large number of text-books on ordinary mensuration. R. M. Milne, *Mensuration and Elementary Solid Geometry* (1923), has a wide range. As to quadrature *see* INTERPOLATION: *Bibliography.*

MENTAL DEFICIENCY. Mental defectiveness, as defined by the British Mental Deficiency act 1927 is, "a condition of arrested or incomplete development of mind existing before the age of eighteen years, whether arising from inherent causes or induced by disease or injury." Mental deficiency, which is often inherited as a Mendelian recessive (*see* HEREDITY, MENDELISM), is to be distinguished from ordinary insanity (*q.v.*), in which there is a definite abnormality of the mind, whereas mental deficiency is due to arrested development of an otherwise normal mind, sometimes owing to deficiency of the secretion of the thyroid gland (*see* HORMONE, ENDOCRINOLOGY). Legislation both in England and elsewhere has recognized the essential difference between mental deficiency and lunacy and the class of so-called "mental defectives" is generally dealt with by laws differing from those affecting the insane. These laws are based mainly on a recognition of (*a*) the educational, (*b*) the social and racial problem created by the presence of uncontrolled mentally defective persons in the community.

Great Britain and Ireland.—In England the Mental Deficiency act of 1913 was the outcome of the Report (1912) of the Royal Commission on the Care and Control of the Feebleminded appointed in 1908, and embodied a considerable number of its recommendations. The Mental Deficiency act 1927 introduces certain amendments of the 1913 act.

The Elementary Education (Defective and Epileptic Children) act 1899, gave to local education authorities power to provide special schools (day or residential) for mentally defective children between the ages of 7 and 16 who, not being either dull or backward or idiots or imbeciles, were capable of benefiting by the education provided in such schools. Under the Elementary Education (Defective and Epileptic Children) act of 1914 these powers were made compulsory, and both acts were embodied in Part V., sections 51–9 of the Elementary Education act 1921. Attendance at such schools may be enforced by a magistrate, provided it is clearly for the child's benefit that he should attend a special school. Owing to the War and to the relatively high cost of these schools many authorities have failed to provide sufficient, in some cases, any special schools; there is practically no school provision for defective children in rural areas. The estimated number of defective children is calculated at eight to ten per thousand of the school population. The latter figure is probably the more accurate. This gives an estimated total of from 42,000 to 52,000 (approximately) defective children to be provided for, but provision has only been made for 16,292 children in 170 day and 20 residential schools. In addition, the local education authorities must notify the local control authority of children who are incapable of benefiting from education in special schools or who need to be placed under supervision or guardianship or given institutional care on leaving school. There are 109 occupation day centres, mainly in urban areas, for children excluded from schools, run for the most part by local voluntary mental welfare associations; after-care committees and the above associations look after the children who have left special schools, try to find them employment, supervise them at home and establish handicraft centres for them.

The Mental Deficiency Acts.—The Board of Control, a section of the Ministry of Health, administers the Lunacy and the Mental Deficiency acts. The local control authorities are statutory mental deficiency committees of county and county borough councils whose duty it is to provide for defectives, only when they can be certified as idiots, imbeciles, feebleminded or moral defectives, and who in addition are either (*a*) neglected, without visible means of support, cruelly used, etc.; (*b*) found guilty of any criminal offence and liable to be sent to or actually sent to an industrial school or prison; (*c*) notified by the local education authorities as ineducable or as needing institutional care on leaving a special school; (*d*) having given birth to or being pregnant of an illegitimate child whilst in receipt of poor relief. The duty of the authority is (*a*) to ascertain the defectives they must deal with, (*b*) provide supervision by visiting and watching over the defective at home. This supervision is carried out either by specially appointed officers or by voluntary associations to whom statutory duties are delegated by the local authority. If this supervision is

insufficient the authority may (*c*) send defectives to a certified institution under orders or (*d*) place them under guardianship under orders, *i.e.*, under the charge of an individual having the powers of a parent over them. This order is made by a magistrate on a petition supported by two medical certificates. Orders are renewable by visiting justices at the end of each of the first two years, then every five years. The authorities must also provide suitable training or occupation for defectives who are under supervision or guardianship, or have been sent to an institution.

Local authorities are required to provide certified institutions for defectives; they can also send defectives to institutions provided by other committees. The War prevented the development of institutions and a number of poor law institutions have been approved for the reception of defectives under orders. The Royal Commission estimated that there were 4·6 per thousand defectives in the population. Some 60,234 or 1·59 per thousand have been ascertained but only 20,091 defectives were in institutions or under guardianship under the act in Jan. 1927, many being found in institutions and homes as rescue cases, paupers, etc.

The difficulties are: incomplete ascertainment of defective children, which handicaps preventive measures; lack of special educational facilities for training defectives; lack of institution accommodation for adult defectives; lack of recognition of mental defect in cases coming before the courts. Greater efforts are being made to safeguard the community and the defective by segregation of defectives with anti-social tendencies in institutions.

Scotland.—The Mental Deficiency act for Scotland, 1913, does not differ very materially from the English act but the local authorities are local boards of control and the parish councils. There were 2,764 certified mental defectives on Jan. 1, 1927. A Scottish Association for Mental Welfare was established in 1922. There is also an active movement for the establishment of a large colony for the feebleminded.

Ireland.—The Mental Deficiency act does not apply to Northern Ireland. There is only one institution for defectives in the whole of Ireland but certain religious communities intend opening others.

British Empire.—Legislation in other parts of the British Commonwealth is generally modelled on the English Mental Deficiency act, 1913.

In South Australia a Mental Deficiency act was passed in 1913; in Tasmania in 1920. The Mental Deficiency board, then established, published in 1925 a report on a mental survey of the prisoners in Hobart gaol. In Melbourne and Sydney special schools and classes for mentally defectives and backward children are being established.

The Mental Disorders act of 1916 regulates the care of defectives in the Union of South Africa. A national council for the care of the feebleminded watches over the interests of individual defectives and guides public opinion.

In Canada a Federal act dealing with immigration prohibits the entry of mental defectives into the country. Each provincial government provides grants for the organisation of special classes for mentally deficient children in school attendance. Ontario, Alberta, Saskatchewan, Manitoba and Nova Scotia have made institutional accommodation for 1,500 cases. Several of the larger cities including Toronto, Winnipeg and Vancouver provide routine mental examinations for school children and for juvenile court cases, and since 1928 the Canadian national committee for mental hygiene has been conducting surveys throughout the Dominion to determine the prevalence and significance of the problem. Alberta has recently passed an act for the sterilisation of the feebleminded.

In New Zealand the Mental Defectives act of 1911 and the Education act of 1914 are the acts under which day schools, one or two residential schools and some institutions are established. A committee of enquiry (1925) under the Ministry of Health recommended the establishment of a eugenic board for the compilation of a register of mental defectives and made recommendations for the sterilisation of certain mentally defective persons.

European Countries.—The work among mentally defective persons in other countries follows much the same lines as are indicated in the description given below. The classification of defect differs somewhat in different countries, and a class of "moral defectives" is not universally recognised. Almost all countries have now made some provision for mentally defective persons, but the problem is still inadequately met.

In France, mental defectives are dealt with under the law for the *aliénés* passed as long ago as 1838 which has not been amended. Under this law persons can be placed in institutions at the request of their families, or by order of the prefect, if they are considered dangerous or in need of protection. Some difficulty is found in dealing with cases needing treatment but not institutional care but the work of treating the feebleminded at psychiatric clinics is likely to develop since the establishment of a clinic at Paris in 1921. A law passed in 1919 recommends special classes for children but does not make them compulsory.

In Italy the class *imbecili morali* is recognised. No exact figures are available as to the number of defectives. A general law on the protection of children was in preparation in 1926. There are only eight institutions set aside for the mentally defective; accommodation, 761 persons. Madame Montessori's educational methods (*q.v.*) were based on the experience gained among defective children in Rome.

Another educational pioneer Dr. Ovide Decroly of Brussels similarly first interested himself in the study of defectives and later adapted his methods in use in his special school in Brussels to the teaching of normal children. His methods have been adopted in many of the elementary schools in Brussels. Belgium has a remarkable institution, the colony at Gheel, whose origin goes back to the 6th century, when a shrine was built to St. Dymphna, a martyred Irish saint. The principle of the Colony of some 20,000 inhabitants caring for 2,000 *aliénés* is freedom and home-life in the families of the citizens. Other similar colonies have been founded in the country.

The institutional care of the feebleminded in Holland is almost entirely in private hands, but special schools exist in the towns.

The Scandinavian countries have a good system of special schools and several institutions, and considerable attention has been given to the training of defectives.

It is estimated that there are in Denmark between 6,000 and 7,000 mentally defective persons in a population of 3,500,000 but there are no exact statistics. There are four large institutions, accommodating about 3,450 persons, and private homes taking 350 patients. Special schools are not compulsory but they are established in most of the large towns such as Copenhagen, which has a school for 700. A Marriage act is on the statute book which prohibits marriage with a mentally deficient person.

Developments in Austria have been considerable since the War. There are special schools and classes for 2,794 children and 20 institutions for the care and instruction of 1,498 mentally defective and epileptic children.

Germany has a fine special school system, with schools in about 600 different places. There are in all about 3,500 classes in these schools, with accommodation for 67,000 children. Most of the special school children have had two years' trial in the elementary school, and those who are not able at the age of six to profit by the elementary school can attend a *Vorklasse* before being drafted into the special or normal schools. In Mannheim since the beginning of the century and later in Charlottenburg, Frankfurt-on-Main and other towns, a system of so-called *Forderklassen* has been established for the backward child whose mental difficulties may be due to exterior or physical causes and not to mental defect. In other towns there are classes for those who in later years of school life remain backward.

The Institut J. J. Rousseau in Geneva has been of inestimable value in the scientific study of the child. The founder Prof. Ed. Claparède has proceeded on the principle that the abnormal and normal child should be studied at the same time, and the institute has now become a laboratory for the study of the child in all his manifestations. In 1928 preparatory classes were established for children who cannot keep up with the lowest class. There are also "work-classes" which have more manual work even than the special schools. The employment schemes in institutions are

admirably organised. The Basle institution was opened in 1916 for the paid employment of defectives and a work and welfare home for girls, with similar aims was opened in 1924 at Komtz, near Berne.

BIBLIOGRAPHY.—*Final Report of the Royal Commission on the Care and Control of the Feebleminded* (1908); *Mental Deficiency Act* (1913) and *Mental Deficiency and Lunacy (Scotland) Act* (1913) 3 and 4 Geo. V. ch. 28 and 38; *Mental Deficiency Act* (1927) 17 and 18 Geo. V. Ch. 33; Cyril Burt, *The Young Delinquent* (1925); W. G. H. Cook, *Insanity and Mental Deficiency in Relation to Legal Responsibility* (1921); S. P. Davies, *Social Control of the Feebleminded* (1923); A. Descoeudres, *L'éducation des Enfants Anormaux* (1922). *Education Act* (1921), Part V., 11 & 12, Geo. V., Ch. 51; Henry H. Goddard, *Feeblemindedness; Its Causes and Consequences* (1914); W. Healy, *The Individual Delinquent* (1915); C. P. Lapage, *Feeblemindedness in Children of School Age* (1920); M. Montessori, *The Montessori Method* (1920); E. Seguin, *Traitement moral, hygiène et éducation des idiots et des autres enfants arriérés* (1906); G. E. Shuttleworth and W. A. Potts, *Mentally Deficient Children* (1922); A. F. Tredgold, *Mental Deficiency, Amentia* (1922). *See* also EUGENICS; BACKWARD CHILDREN; EDUCATION; INSANITY. (E. F.)

The United States.—The care of mental defectives in the United States is regulated and controlled entirely by the individual States. At the present time, there are 57 State institutions: every State except Utah, Nevada, New Mexico and Arizona has its own institution for mental defectives while some of the older and larger States have more than one. New York, for instance, has five, New Jersey, three, Massachusetts, three, Pennsylvania, three. These institutions frequently have a capacity of from 1,000 to 3,000 inmates.

Each institution has a school department for all those who are able to profit by school attendance. The curriculum comprises little or none of the academic studies, reading, writing, and counting, but is predominantly manual and industrial work. The older inmates work on the farm, in the shops, kitchens, dining rooms, etc., insofar as their mental condition permits. Practically all the work of the institution is done by them—under supervision. The ideal of the institution is to make the children happy. This is accomplished by giving them occupation that is pleasant and agreeable. The children are committed to these institutions by the County Court and their maintenance is provided for by the State or in some instances, by the counties.

Property valuation of the State institutions in 1923 was: real estate $35,407,762.01; personal property, $6,078,330.14. This is a total of $1,226.71 per patient. The real estate comprised 44,465 ac. or 1·31 ac. per patient. Of this approximately one third was under cultivation.

In addition to State institutions, there are 66 private institutions, usually licensed by the State, but managed for profit. Some of them give most excellent and expert training. Others are little more than custodial. Besides these, many public school systems provide special classes for defective children. These children live in their own homes, go to school as do other children, and devote their time to learning manual work and trades. (H. H. Go.)

MENTAL HYGIENE: *see* PSYCHOTHERAPY, etc.

MENTAL SCIENCE, (a) the science of the mind, psychology; (b) modern systems which seek to apply the power of the mind to the healing of mental and bodily ills. Taking as basis the doctrine that the Consciousness is the one reality, and that all ills are effects of disharmony in Consciousness, this school undertakes the cure of these ills by harmonization of Consciousness; the final development being the growth of a class of mental healers, giving both present and absent treatment.

MENTAL TESTS: *see* INTELLIGENCE TESTS.

MENTAWEI, a group of islands off the west coast of Sumatra, D.E. Indies. They include Siberut, Sipura and Pageh (Pagai), or Nassau. They are volcanic, and sunken coral reefs render them dangerous to approach. The islands generally are covered with thick forests. There are a few small rivers in Siberut. Pop. (1920), 8,310. The people are considered to be of Caucasian origin, probably related to the very early indigenous peoples of Sumatra, and pre-Batak. The Mentawei islanders have golden-brown skins, black hair, dark eyes, and broad and flat noses; the men are of middle height, the women short and thick-set. They tattoo and have a custom resembling one of Hawaii—wearing flowers in the hair and behind the ears. They have an inflexible moral code, knowing nothing of divorce and punishing adultery with death. The man is the head of his own family and marriage is either endogamic or exogamic. Polygamy is not practised. Their religion is nature-worship, oblations being made in the forest to nature-spirits: they have no idols, nor temples, but are known to set up a bamboo cylinder in the forest and decorate it with scraps of cloth, leaves, and flowers, a rite which may be phallic in origin. They are governed by village chiefs. Houses are of bamboo and *atap* on piles.

Although a peaceful folk amongst themselves, the Mentawei islanders carry arms, chiefly the bow, with poisoned arrows, and before Dutch influence became sufficiently assertive they were wont to raid neighbouring coasts, and even to attack small trading vessels. Agricultural development is at a low stage but they grow fruit, coco-nuts, sugar-cane and tobacco. They are keen hunters and fishers and collect forest products. They are good boat-builders. The islanders are fond of feasts, accompanied by much drum-beating and dancing; their language resembles that of the Karo Bataks. No roads exist, nor is there any regular communication with the mainland. (E. E. L.)

MENTEITH or **MONTEITH,** a district of south Perthshire, Scotland, roughly comprising the territory between the Teith and the Forth. Formerly it was a stewartry and gave the title to an earldom. The title was first held by Gilchrist, a Celtic chief ennobled by Malcolm IV., and passed successively to Walter Comyn, to a branch of the Stewarts, and finally to the Grahams, becoming extinct in 1694. The lake of Menteith, situated 2½ m. S. of Loch Vennachar measures 1½ m. long by 1 m. broad, and contains three islands. On Inchmahome (Gaelic, "the Isle of Rest") are the ruins of an Augustinian priory founded in 1238 by Walter Comyn. The island was the residence of Queen Mary, when a child of five, for a few months before her departure to France in 1548. On Inch Talla stands the ruined tower of the earls of Menteith, dating from 1428. The village of Port of Monteith (pop. of parish, 940), on the north shore of the lake, is 3¼ m. from the station of the same name on the L.N.E.R. Forth and Clyde line.

MENTHOL: *see* CAMPHORS.

MENTONE (Fr. *Menton*), a town in the department of the Alpes Maritimes in south-east France, on the shore of the Mediterranean, about 15 m. by rail E. of Nice. Pop. (1926) 19,599. Mentone was probably the Lumone of the Itineraries, but no Roman remains exist. After having belonged to the counts of Ventimiglia and a noble Genoese family, it was purchased about the middle of the 14th century by the Grimaldis, lords of Monaco. During the First Republic and the First Empire it belonged to France, but in 1815 it reverted to the prince of Monaco, who subjected it to such exactions that in 1848 its inhabitants proclaimed the town (with Roquebrune on the west) independent, under the protection of Sardinia. In 1860 both Mentone and Roquebrune were purchased by France from the prince of Monaco, and added to the department of the Alpes Maritimes then formed out of the county of Nice, ceded the same year to France by Sardinia. The town is built in the form of an amphitheatre on a rocky promontory, which divides its semicircular bay into two portions. Below, along the seashore, is the town of hotels and foreigners, while above, and inaccessible to wheeled vehicles, is that of the native Mentonese, with steep, narrow and dark streets, around the strong castle which was once its protection against pirates. In the old town is the church of St. Michel, partly rebuilt since an earthquake in 1887. Facing south-east, and sheltered on the north and west by mountains, the bay of Mentone has a good climate and is frequented by invalids. The mean for the year is 61° F, while that for the winter is about 46° F. Frost occurs on the average only once in ten years. Mentone has almost tropical vegetation, lemon-trees, olive-trees and pines rise in successive stages on surrounding slopes.

MENTOR, in Greek legend, the son of Alcimus and friend of Odysseus (*q.v.*), who makes him guardian of his household (*Od.*, ii., 226). In Fénelon's *Télémaque* he plays a prominent part, giving

the hero much good advice: hence the modern use of mentor for adviser, sage counsellor.

MENUS. The literal interpretation of the word menu is "minute detail," and it is used to denote the particulars of the different courses of a meal. A menu should be drawn up for every meal, however simple or elaborate, in order that the food may be well balanced and that variety may be introduced and the food made interesting.

The compilation of elaborate menus demands a knowledge of cookery in all its branches without which a meal would not be well planned, whilst the arrangement of simple home meals, although requiring less culinary skill, needs careful thought in order that the food may be well planned, varied and economical.

Monotony is the chief difficulty encountered when catering for the average household, where the amount of money which can be spent on food is limited.

Menu Making.—A full dinner menu comprises the following courses: Hors D'oeuvres; Potage or Soup; Poisson or Fish; Entree; Releve or Remove; Rôti or Roast; Entremet; Dessert; Coffee. But it is only for elaborate meals that all are introduced; the tendency to-day being for simpler and shorter repasts.

Careful consideration should be given to several points of which the following are the most important:—(1) The number of guests and the cost to be incurred. (2) The ability of the cook and the facilities of the kitchen. It would be unreasonable to expect a cook, working single handed, to prepare an elaborate hot meal of many courses. A capable and experienced person can cook and serve a dinner for six or eight guests provided some dishes included in the menu can be prepared in advance. (3) The taste of the guests. When possible one or two of the guests' favourite dishes should be introduced. (4) The season. In hot weather light and easily digested food should be selected, with plenty of fresh fruit and vegetables, whilst during the winter months more heat-giving and fat-forming food is preferable. Full use should be made of food that is in season. (5) The food value of the meal. When planning meals, whether elaborate or simple, thought should be given to the food value of each course, and a special effort made to provide a well-balanced meal. Therefore, some knowledge of the classification of the different foods and their food value is necessary. (*See* DIET AND DIETETICS.)

(D. D. C. T.)

MENZEL, ADOLPH FRIEDRICH ERDMANN VON (1815–1905), German artist, was born at Breslau on Dec. 8, 1815. Left an orphan in 1832, Menzel had to maintain his family. In 1833 Sachse of Berlin published his first work, an album of pen-and-ink drawings reproduced on stone, to illustrate Goethe's little poem, "Künstlers Erdenwallen." He executed lithographs in the same manner to illustrate *Denkwürdigkeiten aus der brandenburgisch-preussischen Geschichte*, pp. 834–836; "The Five Senses" and "The Prayer," as well as diplomas for various corporations and societies. From 1839 to 1842 he produced 400 drawings, reviving at the same time the technique of engraving on wood, to illustrate the *Geschichte Friedrichs des Grossen* by Franz Kugler. Later works are: *Friedrichs des Grossen Armee in ihrer Uniformirung, Soldaten Friedrichs des Grossen*, and finally, by order of the king Frederick William IV., he illustrated the works of Frederick the Great, *Illustrationen zu den Werken Friedrichs des Grossen* (1843–49).

Meanwhile Menzel devoted himself to the art of painting and he soon produced a great number and variety of pictures, always showing keen observation and honest workmanship. Among the most important of these works are "The Forge" (1875) and "The Market-place at Verona." Invited to paint "The Coronation of William I. at Koenigsberg," he produced an exact representation of the ceremony without regard to the traditions of official painting. Menzel died at Berlin on Feb. 9, 1905. He was the first painter to be given the order of the Black Eagle. The national gallery in Berlin contains 43 of his most important paintings.

MEPHISTOPHELES, in the Faust legend, the name of the evil spirit in return for whose assistance Faust signs away his soul. The origin of the conception and name has been much debated. In *Dr. Faust's Höllenzwang* "Mephistophiel" is one of the seven great princes of hell; "he stands under the planet Jupiter, his regent is named Zadkiel, an enthroned angel of the holy Jehovah." The origin of the idea of Mephistopheles in Faust's mind is thus clear. He was one of the evil demons of the seven planets, the *Maskim* of the ancient Akkadian religion, a conception transmitted through the Chaldeans, the Babylonians and the Jewish Kabbala to mediaeval and modern astrologers and magicians. This suggests a plausible theory of the origin of the name. In the ancient Mesopotamian religion the Intelligence of the planet Jupiter was Marduk, "the lord of light," whose antithesis was conceived as the lord of darkness. According to C. Kiesewetter (*Faust in der Geschichte und Tradition*, p. 163), then, Mephistopheles (or rather Mephostopheles) is "he who loves not light" (Gr. μὴ φῶς φιγεῖν). Schröer, however, prefers the derivation from Hebr. *Mephiz*, destroyer, and *tophel*, liar (*Faust*, ed. 1886, i. 25), which is supported by the fact that nearly all the names of devils in the 16th century magic books are derived from the Hebrew.

Kiesewetter, applying to the Faust legend the principles of modern psychical research, held that Mephistopheles had a real existence for Faust, the medium and somnambulist, as the objectification of his own "transcendental substance," appearing in various guises—as a bear, as a little bald man, as a monk, etc.—but always recognizable as the same "familiar." However this may have been, the Mephistopheles of the Faust-books, who combined the qualities of the devil of theology with those of the kobold of German myth, was certainly an objectification of the ideas of the age, which believed in kobolds and went in constant terror of the devil.

The Mephostophiles of the Faust-books and the puppet plays passed with little or no modification into literature as the Mephistophilis of Marlowe's *Faustus*. Mephistophilis has the kobold qualities; he not only waits upon Faustus and provides him with sumptuous fare, he indulges in horse-play and practical joking of a homely kind. He is, however, also the devil, as the age of the Reformation conceived him—a fallen angel who has not forgotten the splendour of his first estate, and who pictures to Faust the glories of Heaven in order to accentuate the horrors of the Hell to which he triumphantly drags him. Goethe's Mephistopheles is altogether another conception. Some of his traditional qualities are indeed preserved; the scene in Auerbach's *Keller* shows that he has not altogether shed his character as kobold, and, like the planet-spirits of the old magic, he appears alternately in animal and human shape. He is also identified with the devil; thus, in accordance with old German tradition, he is dressed as a nobleman (*ein edler Junker*), all in red, with a little cape of stiff silk, a cock's feather in his hat, and a long pointed sword; at the witches' Sabbath on the Brocken he is hailed as "the knight with the horse's hoof," and Sybel in Auerbach's *Keller* is not too drunk to notice that he limps. But his limp is the only indication that he is Lucifer fallen from Heaven. He could not, like Marlowe's Mephistophilis or Milton's Satan, regretfully paint the glories of the height from which he has been hurled; for he denies the distinction between high and low, since "everything that comes into being deserves to be destroyed." He is, in short, not the devil of Christian orthodoxy, a spirit conscious of the good against which he is in revolt, but akin to the evil principle of the older dualistic systems, with their conception of the eternal antagonism between good and evil, light and darkness, creation and destruction. (*See* FAUST.) (W. A. P.)

MEPPEL, a town in the province of Drente, Holland, 16½ m. by rail N. by E. of Zwolle. Pop. (1926) 12,108. It is situated at the confluence of a number of canals and rivers which communicate with the Zuider Zee by the Meppeler Diep, and rose rapidly into prominence in the 19th century. It trades in butter, eggs, cattle and pigs. Bleaching, dyeing and shipbuilding are also carried on.

MEQUINEZ, a city of Morocco, situated 514 metres above the sea, about 70 m. from the west coast and 36 m. W.S.W. of Fez, on a long spur in a plain bounded on the north by the massif of Jebel Zerhoun and on the south by the plateaux of mid-Atlas on the borders of the Wad Bou Fekrane, on the road to Rabat,

in 33° 56′ N., 5° 50′ W. The town wall, with its four-cornered towers, is pierced by nine gates. A lower wall of wider circuit protects the luxuriant gardens in the outskirts. Mequinez, at a distance, appears a city of palaces, but it possesses few buildings of any note except the palace and the mosque of Mulai Ismaïl, which serves as the royal burying-place. The palace, founded in 1634, was described in 1821 by John Windus in his *Journey to Mequinez* (London, 1825) as "about 4 m. in circumference, the whole building exceeding massy, and the walls in every part very thick; the outward one about a mile long and 25 ft. thick." The interior is composed of oblong courtyards surrounded by buildings and arcades. These buildings are more or less square, with pyramidal roofs ornamented outside with green glazed tiles, and inside with richly carved and painted woodwork in Mauresque style. The walls are tiled to a height of 4 or 5 ft., and above they are finished in plaster, whitewashed or carved into filigree work.

The ancient stables are particularly fine. One may note also some beautiful gateways, especially Bab-Mansour-el-Euldj (18th century), on the square El-Hedim, Bab-el-Khamis, on the west of the Mellah. Outside the walls to the north-west is the tomb of Sidi-Mohammed-ben-Aïssa, patron of Meknès and of the religious brotherhood of the Aïssaouas, so well known for its strange rites; they gather in great numbers at Meknès at the time of the festival of the saint. The new town stretches to the east of the original one, in a very open situation, near the railway station, which links it with Fez, Tangiers and Casablanca. Meknès is a makhzen or imperial town, one of the residences of the sultan. On the account of its geographical position in the middle of vast, fertile plains at the exit from the mid-Atlas and Jebel Zarhoun, it seems marked out for a great future. The population is 29,930, of which 18,682 are Muslim, 6,325 Jews and 4,923 Europeans.

Meknès is named from the great Zenata tribe of the Miknassa. It was at first an Almohade citadel called Tagraret. Its great importance dates from the 17th century; it was the favourite residence of Moulai-Ismaïl, who, during his long reign of 55 years, raised there the buildings which have given to Meknès the name of "Moroccan Versailles." Gen. Moinier entered it on June 8, 1911, and the surrounding region was afterwards pacified.

See O. Houdas, *Monographie de Meknès,* traduit de l'arabe (Paris, 1885); Ed. Arnaud, *Monographie de la region de Meknès* (Casablanca, 1917).

MERANO, a town of northern Italy, in the province of Bolzano, 20 m. N.W. of it by the Val Venosta railway, which runs to Malles Venosta, 37 m. N.W.: thence roads run to Landeck and the Lower Engadine by the Reschen Scheideck pass, or to the latter by the Münster valley and the Ofen pass. Pop. (1921) 19,185 (town); 21,312 (commune). The town is at a height of 1,001 ft., at the foot of the vine-clad Küchelberg, and on the right bank of the Passeria River, above its junction with the Adige. The name includes several adjacent villages, Maia Alta and Bassa being on the left bank of the Passeria, while Gratsch is on its right bank and north-west of the main town. The most noteworthy building is the parish church (14th to 15th centuries) but there are many handsome modern buildings and promenades for visitors. Merano is a resort for consumptives by reason of the pure air and the lack of wind and rain in the winter. It is also visited in spring for the whey cure and in autumn for the grape cure.

To the north-west, on the Küchelberg, is the half-ruined castle of Tirolo (2,096 ft.), the original seat of the family which gave its name to the county. Merano is first mentioned in 857. From the 12th century to about 1420 it was the capital of the Tirol, but then gave way to Innsbruck.

MERBECK (or MARBECK), **JOHN** (d. *c.* 1585), English theological writer and musician, was organist of St. George's, Windsor, about 1540. Four years later he was convicted of heresy and sentenced to the stake, but received a pardon through intervention of Gardiner, bishop of Winchester. In 1550 Merbeck published his *Booke of Common Praier noted* intended to provide for musical uniformity in the use of the First Prayer Book of Edward VI. Merbeck's object was to provide a "playne tune" for the daily offices of the church. His "playne tune" is defined by H. C. Colles in Grove's *Dictionary* as being "neither 'plain-song' in the technical sense (notes of undefined value) nor mensural music (notes of strict value), but a typically English compromise between the two, designed to guide the singer in his new problem of singing an accentual language in place of a quantitative language." Other principles triumphed, but in the 19th century Merbeck's excellent work was recognized. His *Booke* was reprinted in 1844 and the sung Eucharist in the English Church is largely based on his work. Merbeck compiled the first English concordance of the Bible, and several devotional and controversial works of a strongly Calvinistic character. A number of his musical compositions are preserved in manuscript in the British Museum, and at Oxford and Cambridge. He died, probably while still organist at Windsor, about 1585. His son, ROGER MERBECK (1536–1605), was the first registrar of the College of Physicians in London, and chief physician to Queen Elizabeth.

MERCANTILE (or COMMERCIAL) **AGENCIES.** The name given in America to organizations designed to collect, record and distribute to regular clients information relative to the standing of commercial firms. In Great Britain and some European countries trade protective societies, composed of merchants and tradesmen, are formed for the promotion of trade, and members exchange information regarding the standing of business houses. These societies had their origin in the associations formed in the middle of the 19th century for the purpose of disseminating information regarding bankruptcies, assignments and bills of sale. The mercantile agency in the United States is a much more comprehensive organization. It came into existence after the financial crisis of 1837. Trade in the United States had become scattered over a wide territory. Communication was slow and the town merchant was without adequate information as to the standing of many business men seeking credit. Undoubtedly the severity of the collapse of 1837 was due in part to the insufficiency of this information. New York merchants, who had suffered so severely determined to organize a headquarters where reports regarding the standing of customers could be exchanged. Lewis Tappan (1788–1873), founder of the *Journal of Commerce* (1828) and a prominent anti-slavery leader, undertook the work and established in New York (1841) the Mercantile Agency, the first organization of its kind. The system has been widely developed since.

MERCANTILE MARINE: *see* SHIPBUILDING, SHIPPING, HISTORY OF.

MERCANTILE SYSTEM. The name given to the economic policy which developed in Europe at the close of the middle ages. The doctrine of the mercantile system, stated in its most extreme form, made wealth and money identical, and regarded it therefore as the great object of a community so to conduct its dealings with other nations as to attract to itself the largest possible share of the precious metals. Each country's interest was to export the utmost possible quantity of its own manufactures and to import as little as possible of those of other countries, receiving the difference of the two values in gold and silver. This difference is called the balance of trade, and the balance is favourable when more money is received than is paid. Governments might resort to all available expedients—prohibition of, or high duties on, the importation of foreign wares, bounties on the export of home manufactures, restrictions on the export of the precious metals—for the purpose of securing such a balance.

But this statement of the doctrine, though current in textbooks, does not represent correctly the views of all who belonged to the mercantile school. Many members of that school were much too clear-sighted to entertain the belief that wealth consists exclusively of gold and silver. The mercantilists may be best described, as W. G. F. Roscher remarked, not by any definite economic theorem which they held in common, but by a set of theoretic tendencies, commonly found in combination, though severely prevailing in different degrees in different minds. The underlying principles may be enumerated as follows: (1) the importance of possessing a large amount of the precious metals; (2) an exaltation (*a*) of foreign trade over domestic, and (*b*) of the industry which works up materials over that which provides them; (3) the value of a dense population as an element of national strength; and (4) the employment of State action in furthering artificially

the attainment of the ends proposed.

The discoveries in the New World had led to a large development of the European currencies. The old feudal economy, founded principally on dealings in kind, had given way before the new "money economy," and the dimensions of the latter were everywhere expanding. Circulation was becoming more rapid, distant communications more frequent, city life and movable property more important. The mercantilists were impressed by the fact that money is wealth *sui generis,* that it is at all times in universal demand and that it puts into the hands of its possessor the power of acquiring all other commodities. The period, again, was marked by the formation of great States, with powerful governments at their head. These governments required men and money for the maintenance of permanent armies, which, especially for the religious and Italian wars, were kept up on a great scale. Court expenses, too, were more lavish than ever before and a larger number of civil officials was employed. The royal domains and dues were insufficient to meet these requirements, and taxation grew with the demands of the monarchies. Statesmen saw that for their own political ends industry must flourish. But manufactures make possible a denser population and a higher total value of exports than agriculture; they open a less limited and more promptly extensible field to enterprise. Hence they became the object of special governmental favour and patronage, whilst agriculture fell comparatively into the background. The growth of manufactures reacted on commerce, to which a new and mighty arena had been opened by the establishment of colonies. These were then viewed simply as estates to be worked for the advantage of the mother countries and the aim of statesmen was to make the colonial trade a new source of public revenue. Each nation, as a whole, working for its own power and the greater ones for predominance, they entered into a competitive struggle in the economic no less than in the political field, success in the former being indeed, by the rulers, regarded as instrumental to pre-eminence in the latter. A national economic interest came to exist, of which the government made itself the representative head. States became a sort of artificial hothouse for the rearing of urban industries. Production was subjected to systematic regulation, with the object of securing the goodness and cheapness of the exported articles, and so maintaining the place of the nation in foreign markets. The industrial control was exercised, in part directly by the State, but largely also through privileged corporations and trading companies. High duties on imports were resorted to, at first perhaps mainly for revenue, but afterwards in the interest of national production. Commercial treaties were a principal object of diplomacy, the end in view being to exclude the competition of other nations in foreign markets, whilst in the home market as little room as possible was given for the introduction of anything but raw materials from abroad. The colonies were prohibited from trading with other European nations than the parent country, to which they supplied either the precious metals or raw produce purchased with home manufactures. Under the Mercantile System a colony was thus regarded as a hewer of wood and drawer of water for the Mother Country. For Britain, the loss of the North American colonies was a major consequence of the doctrine.

That the efforts of governments for the furtherance of manufactures and commerce under the mercantile system were really effective towards that end is admitted by Adam Smith, and cannot reasonably be doubted, though doctrinaire free-traders have often denied it. Technical skill must have been promoted by their encouragements; whilst new forms of national production were fostered by attracting workmen from other countries, and by lightening the burden of taxation on struggling industries. Communication and transport by land and sea were more rapidly improved; and the social dignity of the industrialist was enhanced.

Such a mercantile policy had been already practised in the 14th and 15th centuries, thus preceding any formal exposition or defence of its speculative basis. At the commencement of the 16th century it began to exercise a widely extended influence. Charles V. adopted it, and his example contributed much to its predominance. Henry VIII. and Elizabeth conformed their measures to it. The leading States soon entered on a universal competition for manufacturing and commercial preponderance. Through almost the whole of the 17th century the prize, so far as commerce was concerned remained in the possession of Holland, Italy having lost her former ascendancy by the opening of the new maritime routes, and Spain and Germany being depressed by protracted wars and internal dissensions. The admiring envy of Holland felt by English politicians and economists appears in such writers as Raleigh, Mun, Child and Temple. Cromwell, by his Navigation Act, which destroyed the carrying trade of Holland and founded the English empire of the sea, and Colbert, by his whole economic policy, domestic and international, were the chief practical representatives of the mercantile system.

See G. Schmoller, *The Mercantile System* (Eng. trans., 1896); also the articles, BALANCE OF TRADE; FREE TRADE; PROTECTION; PHYSIOCRATIC SCHOOL, etc.

MERCAPTANS are organic chemical compounds of similar type to the alcohols (*q.v.*) but containing sulphur in the place of oxygen. They are thus thioalcohols or thiols. Their generic name is derived from "mercurio aptum" which refers to the formation of characteristic crystalline mercury salts by the interaction of the thiols with mercuric oxide.

Mercaptans may be either aliphatic or aromatic. *Ethyl mercaptan,* $C_2H_5{\cdot}SH$, a typical aliphatic thiol, is a volatile liquid boiling at 36·2 C and sparingly soluble in water; it has a disagreeable smell. It is made by warming calcium ethyl sulphate with aqueous potassium hydrosulphide, and also by passing sulphuretted hydrogen into a solution of aluminium bromide in ethyl bromide, when a crystalline product, $AlBr_3{\cdot}C_2H_5Br{,}H_2S$, separates which yields the mercaptan on treatment with water. Ethyl mercaptan is used commercially in the production of the drugs sulphonal (*q.v.*), trional and tetronal.

Phenyl mercaptan, $C_6H_5{\cdot}SH$, the simplest aromatic thiol, is a liquid boiling at 169·5° C, and is prepared by acting on benzenediazonium chloride (*see* DIAZO-COMPOUNDS) successively with potassium ethyl xanthate and caustic alkali.

MERCARA, the capital of the province of Coorg, in Southern India, situated on a plateau about 4,000 ft. above the sea. Pop. (1921), 5,675. It consists of two quarters: the fort, containing the public offices, the old palace, and the residence of the commissioner; and the native town of Mahadevapet.

MERCATOR, GERARDUS [latinized form of GERHARD KREMER] (1512–1594), Flemish mathematician and geographer, was born at Rupelmonde, in Flanders, on March 5, 1512. He studied at Bois-le-Duc and at Louvain where he met Gemma Frisius, a pupil of Apian of Ingolstadt, from whom he derived much of his inclination to cartography and scientific geography. In 1534 he founded his geographical establishment at Louvain; in 1537 he published his earliest known map, now lost (*Terrae sanctae descriptio*). In 1537–40 he executed his survey and map of Flanders (*Exactissima Flandriae descriptio*), of which a copy exists in the Musée Plantin, Antwerp. At the order of Charles V., Mercator made a complete set of instruments of observation for the emperor's campaigns. In 1538 appeared Mercator's map of the world in (north and south) hemispheres, rediscovered in 1878 in New York; this work shows Ptolemy's influence still dominant over Mercatorian cartography. In 1541 he issued the celebrated terrestrial globe, which he dedicated to Nicolas Perrenot, father of Cardinal Granvelle: this was accompanied by his *Libellus de usu globi,* which is said to have been presented to Charles V. In 1551 a celestial globe followed. In 1533 Mercator had retired for a time from Louvain to Antwerp, partly to avoid inquiry into his religious beliefs; in 1544 he was arrested and prosecuted for heresy, but escaped serious consequences. He now accepted in 1552 the chair of cosmography at the newly established University of Duisburg. The organization of the university was adjourned, and never completed in Mercator's lifetime; but he now became cosmographer to the duke and permanently settled on German soil. Soon after this, however, he paid a visit to Charles V. at Brussels, and presented the emperor with a *cosmos,* a celestial sphere enclosing a terrestrial, together with an explanatory *Declaratio:* this work marks an era in the observation of

longitude by magnetic declination, perfected by Halley. Charles rewarded the author with the title of *imperatorii domesticus* (*Hofrath* in the epitaph at Duisburg).

In 1554 Mercator published his great map of Europe in six sheets, three or four of which had already been pretty well worked out at Louvain; a copy of this was rediscovered at Breslau in 1889. Herein Mercator begins to emancipate himself from Ptolemy; thus Ptolemy's 62° for the length of the Mediterranean, reduced to 58° in the globe of 1541, he now cuts down to 53°. On Oct. 28, 1556, he observed an eclipse at Duisburg; in 1563 he surveyed Lorraine, at the request of Duke Charles, and completed a map of the same (*Lotharingiae descriptio*); but it is uncertain if this was ever published. In 1564 he engraved William Camden's map of the British Isles; in 1568 he brought out his *Chronologia, hoc est temporum demonstratio . . . ab initio mundi usque ad annum domini 1568, ex eclipsibus et observationibus astronomicis.* In the same year was published his memorable planisphere for use in navigation, the first map on "Mercator's projection," with the parallels and meridians at right angles (*Nova et aucta orbis terrae descriptio ad usum navigantium accommodata*). Improvements were introduced in this projection by Edward Wright in 1590; the more general use of it dates from about 1630, and largely came about through Dieppese support. In 1572 Mercator issued a second edition of his map of Europe; in 1578 appeared his *Tabulae geographicae ad mentem Ptolemaei restitutae et emendatae;* and in 1585 the first part (containing Germany, France and Belgium) of the *Atlas, sive cosmographicae meditationes de fabrica mundi,* in which he planned to crown his work by uniting in one volume his various detailed maps, so as to form a general description of the globe.

In 1585 he adapted his *Europe* to the *Atlas;* in 1587, with the help of his son Rumold, he added to the same a world-map (*Orbis terrarum compendiosa descriptio*), followed in 1590 by a second series of detailed maps (Italy, Slavonia, Greece and Candia). The rest of the regional and other plans in this undertaking, mostly begun by Gerard, were finished by Rumold. The designs are accompanied by cosmographical and other dissertations, some of the theological views in which were condemned as heretical. (*See* the Duisburg edition of 1594, folio.) In 1592 Mercator published, two years after his first apoplectic stroke, a *Harmonia evangeliorum.* He died on Dec. 5, 1594, and was buried in St. Saviour's church, Duisburg. With Ortelius he helped to free geography from the tyranny of Ptolemy; his map and instrument work is noteworthy for its delicate precision and admirable detail.

See the *Vita Mercatoris* by Gualterus Ghymnius in the Latin editions of the *Atlas; Gérard Mercator, sa vie et ses oeuvres,* by Dr. J. van Raemdonck (St. Nicolas, 1869); A. Breusing, *Gerhard Kremer* (Duisburg, 1878), and article "Mercator" in *Allgemeine deutsche Biographie;* General Wauwermans, *Histoire de l'école cartographique belge . . . au XVI.-siècle,* and article "Mercator" in *Biographie nationale* (de Belgique), vol. xiv. (Brussels, 1897). Also the lesser studies of Dr. J. van Raemdonck, *Sur les exemplaires des grandes cartes de Mercator; Carte de Flandre de Mercator; Relations entre . . . Mercator et . . . Plantin . . .* (St. Nicolas, 1884); *La Géographie ancienne de la Palestine: Lettre de Gérard Mercator . . . mai 22, 1567* (St. N., 1884); *Les Sphères terrestre et céleste de Mercator, 1541 . . . 1551* (St. N., 1885); F. van Ortroy, *L'Oeuvre géographique de Mercator; see* the *Vita Mercatoris* by Gualterus Ghymnius in the Latin editions of the *Atlas; J.* van Raemdonck, *Gerard Mercator sa vie et ses oeuvres* (St. Nicolas, 1869), *Sur les exemplaires des grandes cartes de Mercator; Carte de Flandre de Mercator, Relations entre Mercator et Plantin* (1884), *La Géographie ancienne de la Palestine: Lettre de Gerard Mercator* (1884), *Les Sphères terrestre et céleste de Mercator* (1885); A. Breusing, *Gerhard Kremer* (Duisburg, 1878); F. van Ortroy, *L'Oeuvre géographique de Mercator* and H. Averdunk and J. Mueller-Reinhard, *Gerhard Mercator* (1914).

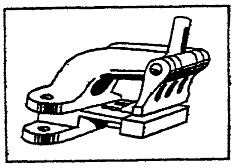
MERCENARY, one who serves or acts solely for motives of personal gain (Lat. *mercenarius,* from *merces,* reward, gain), particularly a soldier who offers himself for service in any army which may hire him. (*See* also CONDOTTIERE.)

MERCERIZING. The term applied to a process of treating cotton and other vegetable fibres with certain chemical reagents, especially caustic soda, whereby considerable improvement in some properties of the material is effected. Caustic soda solution of over 13·5% strength (30°Tw) causes cotton to shrink considerably and to become stiff and translucent. The two latter properties are lost on washing with water, but the threads become coarser and stronger so that a piece of treated calico appears closer and thicker than the original cloth. These observations were first recorded by John Mercer (1843) who suggested the use of 45°Tw caustic soda for obtaining cotton of improved strength and dyeing properties. The treated cotton has a greater affinity for direct, sulphur and vat colours than untreated cotton. The production of crimp effects—by printing caustic soda thickened with British gum on to calico—first suggested by Mercer was revived in 1890–91 and is frequently used, but it was about the only application of mercerizing without tension or as Mercer termed it *sodaizing* or *fulling* to attain a large measure of commercial success. In 1844 Depoully and Garnier produced crimps on union fabrics by submitting the material to the action of cold caustic soda. The cotton contracts and the wool and silk remain unaltered. The caustic soda is removed by washing and treating with dilute acid and again washing. The production of a *permanent* lustre as the result of treating cotton in a stretched condition (*under tension*) with caustic soda and washing until tension slackens was discovered and patented by H. Lowe in 1889 with a supplementary patent in 1890. The importance of Lowe's discovery was not recognized until 1895 when Thomas and Prevost repatented his invention. Their patent was subsequently annulled on the ground that it had been anticipated. The natural lustre of cotton can be seen when the fibre is viewed by reflected light under the microscope, but cotton mercerized under tension shows a spun silk-like lustre to the naked eye. Considerable change in the appearance of the cross section of the cotton fibre as seen in the microscope is effected by mercerizing. It is especially noticeable that the fibres appear more rounded. This has probably much to do with the appearance of lustre in the threads of yarn or cloth mercerized. No doubt many of the researches which have been carried out with the object of determining the cause of the lustre (a subject which has given rise to much controversy), have been undertaken with the object of ascertaining whether it would be possible to obtain lustre without applying tension to the cotton and thereby avoiding the use of somewhat elaborate machinery for large scale work. It has been proposed to add substances such as silicate of soda and glycerine to the alkali but these are only applied in conjunction with the device of applying tension.

Machines for mercerizing are designed to secure uniform impregnation and tension with the minimum volume and waste of caustic soda solution. Efficient washing is a matter of great importance. An efficient type of yarn mercerizing machine is constructed with a pair of strong steel rollers placed horizontally, arranged to rotate with reversing motion and fitted with hydraulic pistons for moving them apart when a comparatively shallow trough containing caustic soda 60°Tw is drawn into position under them. The yarn which is at first loosely passed over the rollers is stretched out, then allowed to shrink and again stretched. After a few minutes it is submitted to the action of a squeezing roller, which is caused to press against one of the stretching rollers, and is washed in the stretched condition with hot water from spurt pipes above. The caustic washings are collected by means of a separate trough from which they are conveyed to the recovery plant. In *warp* mercerizing the tension is supplied by double nip squeezing rollers placed at each end of the first of a set of four tanks or boxes each provided inside with guide rollers.

Mercerizing Piece Goods.—For *pieces* stentering machines are used. In these two endless chains carry clips which run in slotted grooves in the horizontal frame of the machine which is about 40ft. in length. The clips nip the cloth automatically on either side as it is fed into the machine from an impregnating bath and tension rollers (warp), at the same time the two rows of clips diverge and when the cloth has travelled about one-third of the length of the machine it is stretched slightly beyond its original width. At this point the cloth meets a spray of water from spurt pipes. The tension slacks and the mercerizing is effected. When the piece arrives at the end of the machine the clips open and release it. It is most economical and satisfactory to mercerize before bleaching, but the recovery and concentration

of the caustic soda (usually carried out in multiple effect evaporating plant) is not attained without difficulty for it is always contaminated with impurities, the constituents of the cotton which has been treated. The action of caustic soda on bleached cotton is complete in 30 seconds, but in the case of unbleached cotton an appreciable time is taken in wetting out the material. In order to save this time, or boiling out to some extent before mercerizing or the risk of uneven treatment, some people make use of certain agents for the purpose of effecting rapid wetting. The product *Prestabit* is stated by Rath (1928) to be very efficient in this respect. Cotton mercerized under tension has a greater affinity for colouring matters than ordinary cotton but not quite so much as that mercerized without tension. Mercerized cotton which is dried before dyeing takes up less colour than that dyed in a moist or air dried condition. Air dry untreated cotton contains 7·8% moisture, air dry mercerized cotton 12·6%.



BY COURTESY OF CLAY & ATKINSON, BRADFORD

CLIP FOR GRIPPING CLOTH, ONE OF AN ENDLESS CHAIN OF CLIPS ARRANGED ON BOTH SIDES OF A MERCERIZING MACHINE, IN ORDER TO GRASP THE SELVEDGE WITHOUT TEARING THE CLOTH

The action of caustic soda on cotton was regarded by Mercer as a chemical reaction in which one molecule of cellulose combined with one of caustic soda; by washing with water the radicle Na_2O is replaced by H_2O. In 1852 J. H. Gladstone found that the composition corresponded to $2C_6H_{10}O_5 \cdot NaOH$. This is in agreement with the moisture content of the washed and air dried mercerized cotton. Since 1900 many workers have attempted to determine the composition of alkali cellulose and some have cast doubt on the chemical nature of the action but it is evident that beyond a certain concentration (about 32°Tw) there are distinct signs of chemical action and the amount of caustic soda (of usual mercerizing strength) taken up by cotton agrees closely with Gladstone's formula. Knecht and Platt (1925) conducted a series of nine experiments using solutions of caustic soda from 20°–100°Tw. The amount of caustic soda taken up was 12·3% at 40°Tw and above that strength it was practically constant. Ermen and Jenkins (1927), using a similar method with certain modifications, found 15·7% caustic soda absorbed between 35° and 50°Tw caustic soda, but after that an increasing amount of caustic absorbed (25%) with 82°Tw. It is very difficult quantitatively to manipulate small experiments with caustic soda above 70°Tw. The space lattice of mercerized ramie cellulose as developed from X-ray data has been the subject of investigations by O. L. Sponsler and W. H. Dore (July 1928), who find definite evidence of action above a critical concentration of 13% caustic soda. With hot caustic soda a greater concentration is required and ice cold caustic may be of a lower concentration for mercerizing.

The colouring matter benzopurpurine may be utilized in testing for mercerization, by dyeing the cotton a full shade of red and then destroying the colour with titanous chloride in dilute hydrochloric acid solution. Just before the colour entirely disappears mercerized cotton shows a pink colour, untreated cotton remains blue until the colour vanishes. The ratio of the amount of benzopurpurine 4B taken up by untreated and mercerized cotton supplies a means of estimating the extent of mercerization. A test with a solution of iodine in potassium iodide together with a zinc chloride solution depends upon the indication of a blue colour in the case of mercerized cotton. Treatment with a mixture containing 320 cu.cm. sulphuric acid, 120°Tw and 260 cu.cm. formaldehyde 40% for 2min. and washing increases the affinity of mercerized cotton for chlorazol sky blue to such a great extent that it is still more easily distinguished from ordinary cotton treated with the reagent.

Many other reagents besides caustic soda modify the properties of cotton in a similar manner. Some of these were known to Mercer, sulphuric acid of 105°Tw and zinc chloride 145°Tw being included in the first patents. Nitric acid of 83°Tw acts very similarly to caustic soda and Knecht has shown that a compound with one molecule of nitric acid per molecule of cellulose is formed. It is decomposed by washing with water. Marshall finds that the lustre of China grass is improved by treating with nitric acid 83°Tw without tension. The lustre of linen is improved by mercerizing. Viktorov (1925) showed that in mercerizing linen there was a fall in strength which might amount to 10% but with 53°Tw caustic soda a 40% increase in dyeing affinity for direct colour was observed. (E. Hr.)

MERCHANDISE MARKS. The first attempt to make the falsification of trade marks a criminal offence was in the British Merchandise Marks act 1862. After the international convention for the protection of industrial property, made at Paris in 1883, to which Great Britain acceded in 1884, the Merchandise Marks act 1887 was passed generally to make better provision for the protection of merchandise. It was amended in 1891, 1894 and 1911. By these statutes, a person is guilty of an offence, punishable on indictment or summary conviction by fine or imprisonment, who does any of the five following acts, unless he proves as regards the first four of them that he acted without intent to defraud (there is a special defence to No. v. which is noted below): (i.) forges any trade mark, or makes, disposes of, or has in his possession for such purpose any die or instrument; (ii.) falsely applies any trade mark or a colourable imitation of any trade mark to goods; (iii.) applies any false trade description to goods; (iv.) causes any of the above offences to be committed; (v.) sells or exposes for sale, or has in his possession for sale, trade or manufacture, any goods or things to which any forged trade mark or false trade description is applied, or any trade mark or colourable imitation of a trade mark is falsely applied, unless *the defendant* proves that, having taken all reasonable precautions, he had no ground to suspect the genuineness of the mark, etc., and also that on demand he gave to the prosecutor all the information in his power as to the person from whom he obtained the goods, or proves that he acted "innocently."

"Trade description" is defined as any descriptive statement or other indication as to the number, quantity (not *quality,* it should be observed), or weight, place or mode of production, or the material of the goods, or as to their being subject to an existing patent, privilege or copyright. The test of what is a trade description depends upon the understanding of the trade and not on scientific correctness (*Fowler* v. *Cripps,* 1906, I K.B. 16).

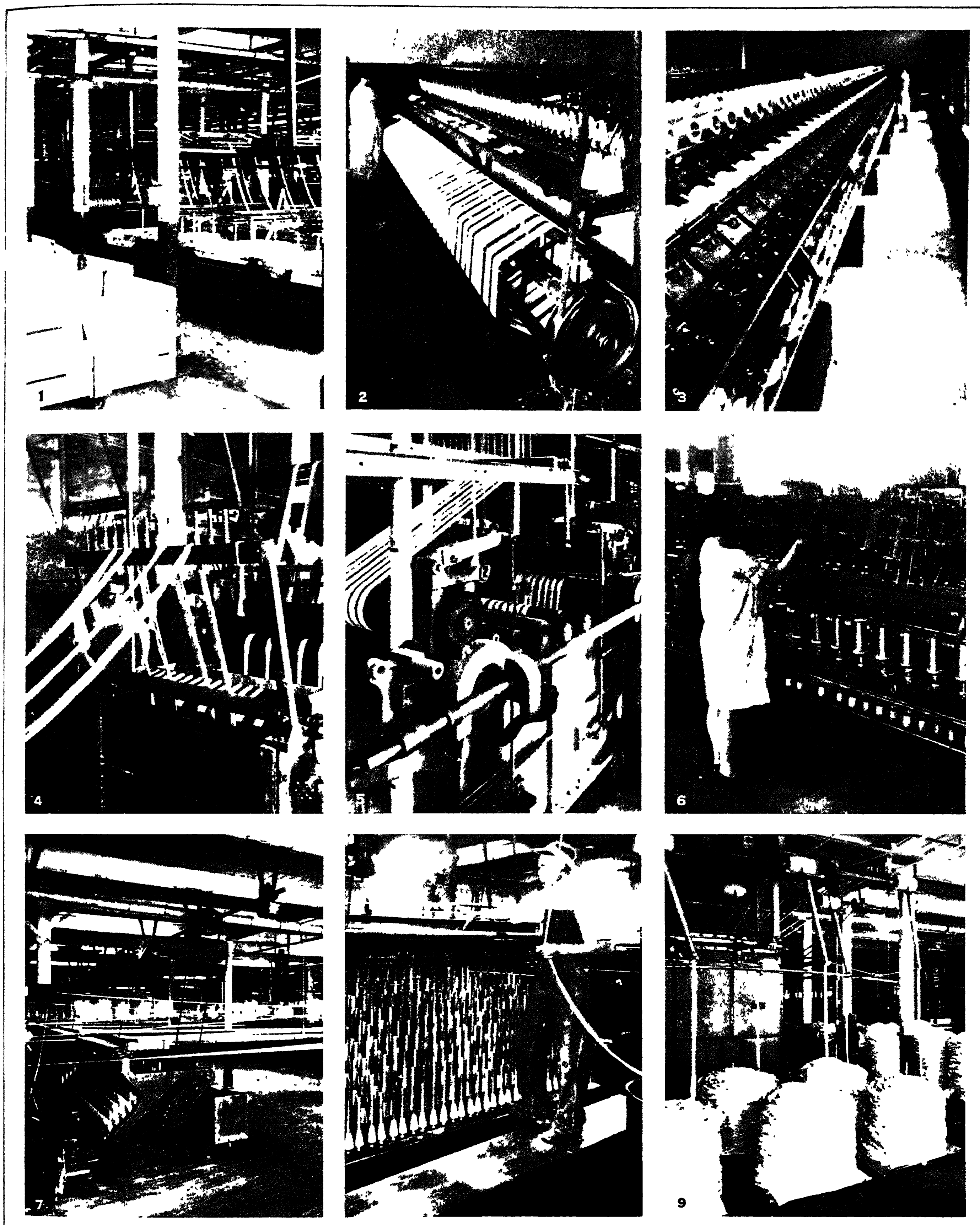
On a prosecution for any of these offences there is a power to forfeit the things found although no one is convicted. If the offender is indicted (it is in his option to be tried in this way) the punishment is fine and imprisonment, the latter not to exceed two years. On summary conviction the punishment is not to exceed, for a first offence, four months' imprisonment, with or without hard labour, and a fine of £20; and for any subsequent offence six months' imprisonment and a fine of £50. Any person procuring the commission of an offence outside the United Kingdom can be punished; a search warrant for offending goods can be issued by a justice; but prosecutions must be commenced within three years of the offence or one year of its discovery. (X.)

THE UNITED STATES

Under the Federal laws, providing for the registration and protection of merchandise marks or trade marks, infringement suits are brought in the Federal courts and the penalty for infringement is three times the amount of the verdict recovered. The statute law provides for injunctions and in a damage suit the plaintiff, if successful, shall be entitled to the defendant's profits in addition to the damages sustained. There are also provisions with penalties for fraudulent registrations and for imitating trade marks.

In addition to Federal laws safeguarding rights to merchandise marks, the various States have laws on the use and abuse of trade mark rights. The New York Penal law defines a trade mark as a mark used to indicate the maker, owner or seller of an article of merchandise and includes names, letters, words, devices, emblems.

Offence against a trade mark is a misdemeanour and punishable for the first offence by a fine of not less than 50 dollars nor more than 500 dollars, or by imprisonment for not more than a year, or both. For each subsequent offence the penalty is imprisonment for not less than 30 days, nor more than a year, or by both such



BY COURTESY OF THE STANDARD-COOSA-THATCHER COMPANY

VARIOUS PROCESSES USED IN MERCERIZING

1. Chemical immersion of cotton in caustic soda solution. 2. Reeling yarn to skeins. 3. Cone winders. 4. Warp dyeing. 5. Warp mercerizing machine. 6. Backwinding skeins of dyed mercerized yarn. 7. Quilling (preparing yarn for reeling onto cones). 8. Quiller in operation. 9. Finishing the mercerizing process

imprisonment and a fine of not less than 500 dollars or more than 1,000 dollars.

Some offences against trade marks include: (a) falsely making, counterfeiting or affixing the trade mark of another without the owner's consent; (b) knowingly selling, keeping or offering for sale an article to which is attached a false or imitation trade mark; (c) possessing a counterfeit trade mark or anything for the purpose of counterfeiting a trade mark; (d) knowingly selling or offering for sale goods represented to be the product of any person other than himself unless in original package and under the mark of the manufacturer; (e) selling or exposing for sale goods in bulk to which no trade mark is attached and representing the same as manufactured by one not the manufacturer; (f) knowingly selling or offering for sale any article of merchandise and by representation, name, mark or advertisement or otherwise making any false representations as to the person by whom the same was made or as to the propriety of any mark thereon. Other sections prohibit the refilling and reselling of trade marked bottles and vessels and keeping them with intent to refill and resell. (*See* TRADE MARKS.)

The General Business Law of New York provides that anyone engaged in the manufacture of certain enumerated products may register a trade mark by filing it in the proper county clerk's office and with the secretary of State. It also contains prohibitions in regard to the use of such trade marks by those other than the owner. Penalties are named for violations of this article. In other States, there are similar laws. (H. A.)

MERCHANT, a trader, one who buys and sells goods for profit. The term is now usually confined to a wholesale dealer or one who trades on an extended scale with foreign countries.

MERCHANT ADVENTURERS, a famous early English trading company. (*See* CHARTERED COMPANIES.)

MERCHANT BANKERS. Private banking firms which do not conduct an ordinary banking business but confine themselves chiefly to acceptance and loan issuing. In most cases they have been evolved out of merchant firms engaged in foreign commercial business; whose foreign connections and activities caused large amounts of foreign exchange to pass through their hands, and they were at one time the dominant figures in the London exchange market, though they had already left most of this business to smaller firms. Foreign exchange in the period before the World War was largely taken over by the London branches of the foreign banks, from whom it has since been again taken over by the English banks. Foreign trade connections also, by making their name and standing familiar to banks and merchants in all countries, made bills drawn on them universally acceptable and so developed the growth of their activity in acceptance, by which, on payment of a commission, they placed their names at the disposal of less eminent firms, and allowed bills to be drawn on themselves for transactions in which they were not directly concerned.

The foreign connections of such firms and their high prestige also led to their being applied to by foreign Governments, municipalities and other borrowers who desired to raise loans in the London market, and their wealth and high standing in the opinion of the investing public gave them exceptional qualifications for this task. By a gradual evolution they largely abandoned their activities as merchants and concentrated them on acceptance and loan-issuing. As bankers in the ordinary sense of the word were not until lately admitted on the board of the Bank of England, it was chiefly recruited from the ranks of the merchant bankers. Their acceptance business has lately been subject to keen rivalry on part of the joint stock banks both in England and America (where acceptance was first permitted to the national banks by the Federal Reserve Act), but their prestige and long experience as issuing houses are still unrivalled. (*See* MONEY MARKET.)

MERCHANT-SHIPPER: *see* EXPORTS: *Exports in Practice.*

MERCIA, one of the kingdoms of Anglo-Saxon England. The original kingdom seems to have lain in the upper basin of the Trent, comprising the greater part of Staffordshire, Derbyshire and Nottinghamshire and the northern parts of Warwickshire and Leicestershire. The name (*Merce*) seems to denote men of the March, and presumably was first applied when this district bordered upon the Welsh. In later times Mercia successively absorbed all the other territories between the Humber and the Thames except East Anglia, and some districts even beyond the Thames.

The origin of the kingdom is obscure. The royal family, according to Felix, *Life of St. Guthlac,* were called Iclingas. Icel, their ancestor, may have been the founder of the kingdom, but nothing is known of him. The family, however, claimed descent from the ancient kings of Angle (*cf.* Offa I. and Wermund). The first Mercian king of whom we have any record was Cearl, who apparently reigned about the beginning of the 7th century, and whose daughter Cwoenburg married Edwin, king of Deira. During Edwin's reign Mercia was subject to his supremacy, though it may have been governed throughout by princes of its own royal family. Its first prominent appearance in history may be dated in 633, when the Mercian prince Penda joined the Welsh king Cadwallon in overthrowing Edwin. According to the Saxon Chronicle, Penda began to reign in 626, and fought against the West Saxons at Cirencester in 628. In the Mercian regnal tables, however, he is assigned a reign of only twenty-one years, which, as his death took place in 654 or 655, would give 634 as the date of his accession, presumably on the overthrow of Edwin, or perhaps on that of Cadwallon. During the reign of Oswald Penda clearly reigned under the suzerainty of that king. In 642, however, Oswald was slain by Penda in a battle at a place called Maserfeld, which has not been identified with certainty. During the early part of Oswio's reign the Northumbrian kingdom was repeatedly ravaged by the Mercians, and on one occasion (before 651) Penda almost captured the Northumbrian royal castle at Bamborough. At the same time he extended his influence in other directions, and expelled from the throne of Wessex Coenwalh, who had divorced his sister. Indeed, at this time nearly all the English kingdoms must have acknowledged his supremacy. The Middle Angles, whose territory included the counties of Northampton, Rutland, Huntingdon, and parts of Bedfordshire, Cambridgeshire, Leicestershire and Lincolnshire, formed a dependent principality under his son Peada. At this time also the territory corresponding to the modern counties of Cheshire, Shropshire and Herefordshire seems to have been occupied. The last of these counties is said some time later to have been under the government of another son of Penda, named Merewald. In 654 or 655 Penda again invaded Northumbria, with a huge army divided into thirty *legiones,* each under a royal prince, among whom were Aethelhere, king of East Anglia, and several Welsh kings. He was slain, however, by Oswio, at a river called the Winwaed. Mercia then came again under Northumbrian rule. Peada, the eldest son of Penda, was allowed to govern the part south of the Trent, while north Mercia was put in charge of Northumbrian officials. Penda, although he did not prohibit the preaching of Christianity, had remained a heathen to the end of his life. His death was followed by the conversion of his kingdom. Peada had embraced Christianity on his marriage with a daughter of Oswio, and under him the first Mercian bishopric was founded. Shortly afterwards Peada was murdered, but in 658 the Mercians rose under his younger brother Wulfhere and threw off the Northumbrian supremacy.

Wulfhere seems to have been a vigorous ruler, for he extended the power of Mercia as far as it had reached in the days of his father, and even farther. According to the Chronicle he invaded Wessex as far as the Berkshire Downs in 661. At the same time he conquered the Isle of Wight, which he gave to Aethelwalh, king of Sussex. Between 661 and 665 he was defeated by the Northumbrian king Ecgfrith and had to give up Lindsey. In 675 he again fought with the West Saxons under Aescwine, and shortly afterwards died. His brother Aethelred, who succeeded him, invaded Kent in the following year, and in 679 fought a battle on the Trent against Ecgfrith, by which he recovered Lindsey. After this, however, we hear little of Mercian interference with the other kingdoms for some time; and since it is clear that during the last 15 years of the 7th century Wessex, Essex, Sussex and Kent were frequently involved in strife, it seems likely that the Mercian king had somewhat lost hold over the south of England. In 704 Aethelred resigned the crown and became a monk,

leaving his kingdom to Coenred, the son of Wulfhere. Coenred also abdicated five years later and went to Rome. Ceolred, the son of Aethelred, who succeeded, fought against the West Saxon king Ine in 715. On his death in the following year Aethelbald, a distant relative, came to the throne, and under him Mercian supremacy was fully restored over all the English peoples south of the Humber. After his murder in 757 the Mercian throne was held for a short time by Beornred. He was expelled the same year by Offa, who soon restored the power of Mercia, which seems to have suffered some diminution during the later years of Aethelbald. Offa's policy was apparently the extinction of the dependent kingdoms. In his reign the dynasties of Kent, Sussex and the Hwicce seem to have disappeared, or at all events to have given up the kingly title. In 787 he associated his son Ecgfrith with him in the kingdom, and after his death (796) Ecgfrith reigned alone for a few months. On the death of Ecgfrith the throne passed to Coenwulf, a descendant of Pybba, father of Penda. In 821 Coenwulf was succeeded by his brother Ceolwulf, who was deprived of the throne in 823, being succeeded by Beornwulf. In 825 Beornwulf was defeated by Ecgberht, king of Wessex, and in the same year he was overthrown and slain by the East Angles. The supremacy now passed to Wessex.

In 827 Ludeca, the successor of Beornwulf, was slain in battle with five of his earls. Wiglaf, who succeeded him, was expelled two years later by Ecgberht, but regained the throne in the following year. He died, probably in 839, and was succeeded by Berhtwulf, who reigned until 852. Under these later kings Mercia seems to have extended from the Humber to the Thames, including London, though East Anglia was independent, and that part of Essex which corresponds to the modern county of that name had been annexed to Wessex after 825. Berhtwulf was succeeded in 852 by Burgred, who married Aethelswith, daughter of Aethelwulf. His power seems to have been more or less dependent on the West Saxons. In 853, with the assistance of Aethelwulf he reduced North Wales to subjection. Again in 868 he called upon the West Saxon king Aethelred for assistance against the Danes under Loobrok's sons, who at this time invaded Mercia after their overthrow of the Northumbrians at York. No battle took place, and the Mercians subsequently made peace with the Danes. In 872 the Danes occupied London on their return from invading Wessex, after which a truce was again made. In 873 the Danes encamped at Torksey, Lincolnshire, and although another truce ensued, they advanced in the following year to Repton, and Burgred was driven from the kingdom. He went to Rome, where he remained until his death. In 874 Ceolwulf, a king's thegn, was made king by the Danes, and definitely acknowledged their overlordship. In 877, after the second invasion of Wessex, the Danes seem to have taken the eastern part of Mercia into their own hands. How long Ceolwulf reigned over the western portion is unknown. About 884 the most important person in English Mercia was an earl, Aethelred, who accepted the suzerainty of Alfred, and in or before 887 married his daughter Aethelflaed. Aethelred and Aethelflaed appear to have had practically regal power, though they did not use the royal title. In 886 London, which had been recovered by Alfred from the Danes, was restored to Aethelred. During the invasion of 893–97 English Mercia was again repeatedly ravaged by the Danes; but in the last of these years, by the united efforts of Alfred and Aethelred, they were at length expelled. In the following years the government was carried on by Aethelred and Aethelflaed, who after her husband's death co-operated with her brother Edward the Elder in the great campaigns which led to the conquest of Danish Mercia. After her death in 918 her daughter, Aelfwyn was soon deprived of the government by Edward, and English Mercia was definitely annexed to Wessex.

From this time onwards its existence as a separate kingdom was at an end, though during the last years of Eadwig's reign the Mercians and Northumbrians set up Eadgar as king. In the last century of the Saxon period the earls of Mercia frequently occupied a semi-royal position. The most important of these were Aelfhere under Eadgar, Edward and Aethelred, Eadric Streona, and Leofric, under Edward the Confessor.

Authorities.—Bede, *Historia Ecclesiastica* (ed. C. Plummer, Oxford, 1896); *Anglo-Saxon Chronicle* (ed. Earle and Plummer, Oxford, 1899); W. de G. Birch, *Cartularium Saxonicum* (1885–93).

(F. G. M. B.)

MERCIÉ, MARIUS JEAN ANTONIN (1845–1916), French sculptor and painter, was born in Toulouse on Oct. 30, 1845. He entered the École des beaux arts, Paris, and in 1868 won the Grand Prix de Rome. He made his name with the bronze statue "David" (1872) now in the Luxembourg museum in Paris, and the "Gloria Victis" for which he received the medal of honour of the Salon. Other popular successes were a relief, "The Genius of the Arts" (1877), now in the Tuileries, and a similar work for the tomb of Michelet in Père la Chaise. Mercié was appointed professor at the École des beaux arts, and was elected to the Académie Française in 1891.

His sculptures include "Le Souvenir" (1885), a monument of "Louis-Philippe and Queen Amélie" for their tomb at Dreux, and a stone group of "Justice" at the hôtel de ville, Paris. Among his paintings are a "Venus" (1883) and "Michael Angelo studying Anatomy" (1885). He died on Oct. 14, 1916.

MERCIER, DÉSIRÉ (1851–1926), Belgian cardinal, was born Nov. 21, 1851, at Braine-l'Alleud in the Walloon part of Brabant, of a bourgeois family. He studied at Malines. On April 5, 1874, he was ordained priest, a disciple of Aquinas. After two years at the university of Louvain, he was appointed professor of philosophy at the lesser seminary of Malines (1877). In 1880 Leo XIII., who wished to promote the study of Thomism, invited Cardinal Dechamps, Archbishop of Malines, to found a chair of Thomist philosophy at Louvain. The choice of the Cardinal fell on the young Abbé Mercier, who was appointed in 1882. Before assuming his new duties, the new professor studied in Paris under Charcot. While teaching psychology, logic, criteriology, metaphysics and ontology to his Louvain students, including a large number of laymen, he followed closely the research work of his colleagues, according to the tradition of the scholasticists, who combined theological and scientific studies.

In 1886 the Pope conferred a Roman prelateship upon him, and in 1888–9 issued two briefs urging the necessity of founding an Institut Supérieur de Philosophie at Louvain. This institute was finally opened in 1894 and included, besides the chair of philosophy held by Mgr. Mercier, chairs of cosmology, physics, sociology, etc., held first by his colleagues and later by the pupils he had formed. The institute published the *Revue Néoscolastique* and became the centre of Neo-Thomism which exerted considerable influence on Catholic thought all over the world. In 1906 Mgr. Mercier was appointed Archbishop of Malines, and in 1907 he was created a cardinal. He used his influence with his priests and his flock to break down the barriers existing between the members of the clergy and the laymen, to eliminate all class distinctions between the Catholic bourgeoisie and the labourers, and to bring about a better understanding between Catholics and non-Catholics.

On Aug. 20, 1914, while the Belgian Army was retreating upon Antwerp and the Germans were entering Brussels, the Cardinal was abruptly summoned to Rome to take part in the election of a successor to Pius X. Shortly after his return to Malines, he issued a pastoral letter, "Patriotism and Endurance," protesting against the burning of Louvain and the other excesses committed by the German army, and defining the position of the Belgian people towards the occupying Power. The Belgians, he said, owed, in soul and conscience, neither respect nor allegiance to this authority, which was not lawful, but must accept German regulations so long as they did not violate their duty to their country, the army alone having the right to resist openly the invaders' power. In spite of pressure exerted upon him by the German authorities, he maintained this attitude, protesting publicly in his sermons and pastorals against the arbitrary decrees of the governor-general, especially concerning the deportation of workmen and the administrative separation of the country, and urging the people, at the same time, to remain confident in the final victory of their just cause. In Jan. 1916 the Cardinal took a second journey to Rome and brought back a most cordial message from the Pope. He proclaimed, in his next pastoral letter,

that "The moral triumph of Belgium, in the eyes of civilization and history, is already an accomplished fact." In Oct. 1918, on the eve of the retreat of the German troops, the Cardinal received a message from the Governor greeting him as the "revered spiritual leader of the Belgian people" and announcing to him that prisoners and deportees would shortly recover their liberty.

After the War, Cardinal Mercier took part in the informal conversations which took place at Malines following the "appeal to all Christian people" issued by the Lambeth Conference of 1920. The first conference took place between Cardinal Mercier, Mgr. van Roey (his successor as archbishop of Malines), and Abbé Portal, on the one side, and the Dean of Wells, the Bishop of Truro (Rev. W. H. Frere) and Lord Halifax on the other. Bishop Gore, Dr. B. J. Kidd, Mgr. Batiffol and Abbé Hemmer took part in the third Conference, held in 1923. A full account of these conversations, which concentrated on doctrinal and historical rather than on administrative questions, was issued by the Archbishop of Canterbury at the end of the same year. In the spring of 1924 Cardinal Mercier celebrated the jubilee of his ordination. He died in Brussels on Jan. 23, 1926. (E. CA.)

His works include *Manual of Mod. Scholastic Philosophy*, by M. and professors of Louvain, trans. T. L. and S. A. Parker (1916–17); *Origins of Contemp. Psychology*, trans. W. H. Mitchell (1918). *See* also *Cardinal Mercier's own Story* (trans.) (1900); L. Noël, *Le Card. Mercier* (1920); G. Raemakkers, *Le grand cardinal belge* (1926); and *Conversations at Malines 1921–25* (1927).

MERCIER, HONORÉ (1840–1894), Canadian lawyer and statesman, was the son of Jean Baptiste Mercier, farmer, and of Marie Kimener, his wife. He was born at St. Athanase d'Iberville on Oct. 15, 1840. Mercier was educated at the Jesuit college of St. Mary, Montreal. Afterwards he was admitted to the bar of the province in April 1865. At the age of 22 he became the editor of the Conservative *Courrier de St. Hyacinthe*, in which he supported the policy of the Sicotte administration, which then represented the interests of Quebec, under the Act of Union (1840); but when Sicotte accepted a seat on the bench Mercier joined the Opposition, and contributed largely to the defeat of the Ministerial candidate. In 1864 he vigorously opposed the scheme of confederation, on the ground that it would prove fatal to the distinctive position held by the French Canadians. He resumed the editorship of the *Courrier* in 1866; but after a few months retired from journalism. In Aug. 1872 he was elected as member for the county of Rouville, and in May 1879 he became solicitor-general in the Joly Government, representing the county of St. Hyacinthe; and on the defeat of the ministry in October he passed, with his leader, into opposition. On the retirement of Joly from the leadership of the Liberal party in Quebec in 1883 Mercier was chosen as his successor. Mercier's attitude in the matter of the execution of Louis Riel, leader of the north-west rebellion brought adherents to the Liberal minority in the Legislative assembly, and at the general elections in Oct. 1886 the province was carried in the Liberal interest. In Jan. 1887 Mercier was sworn in as premier and attorney-general. He succeeded in passing without opposition the Jesuit Estates Act, a measure to compensate the order for the loss of property confiscated by the Crown. When Mercier appealed to the electorate in 1890, his policy was endorsed. Early in 1891 he negotiated a loan in Europe for the province, and whilst on a visit to Rome he was created a count of the Roman Empire by Leo XIII. For a few years he was the idol of the people of Quebec, but in 1891, it was alleged that subsidies voted for railways had been diverted to political use, and he was dismissed by the lieutenant-governor. At the elections held in March 1892, his party was hopelessly defeated. On the formation of a new Government he was brought to trial, and declared not guilty; his health, however, gave way.

See J.-O. Pelland, *Biographie, discours conférences, etc., de l'Hon. Honoré Mercier* (Montreal, 1893).

MERCIER, SEBASTIEN (1740–1814), French dramatist and miscellaneous writer, was born in Paris on June 6, 1740. He decried French tragedy as a caricature of antique and foreign customs in bombastic verse, and advocated the *comédie larmoyante* as understood by Diderot. To the *philosophes* he was entirely hostile. He denied that modern science had made any real advance; he even carried his conservatism so far as to maintain that the earth was a circular flat plain around which revolved the sun. Mercier wrote some 60 dramas, among which may be mentioned *Jean Hennuyer* (1772); *La Destruction de la ligue* (1782); *Jennéval* (1769); *Le Juge* (1774); *Natalie* (1775) and *La Brouette du vinaigrier* (1775). In politics he was a Moderate, and as a member of the Convention he voted against the death penalty for Louis XVI. During the Terror he was imprisoned, but was released after Robespierre's death. He died in Paris April 25, 1814.

See Léon Bechard, *Sebastien Mercier, sa vie, son oeuvre* (1903); R. Doumic in the *Revue des deux mondes* (July 15, 1903).

MERCK, JOHANN HEINRICH (1741–1791), German author and critic, was born at Darmstadt on April 11, 1741. He became paymaster at Darmstadt in 1768. Merck helped to found the *Frankfurter gelehrte Anzeigen* in 1772, and was one of the chief contributors to Nicolai's *Allgemeine Bibliothek*. In 1788 he was involved in serious financial difficulties, and although friends, notably Goethe, were ready to come to his assistance, his losses and the death of five of his children preyed upon his mind. He committed suicide on June 27, 1791. Merck influenced the *Sturm und Drang* movement by his acute criticisms, and was a mentor to the young poets of his day.

Merck's *Ausgewählte Schriften zur schönen Literatur und Kunst* were published by A. Stahr in 1840, with a biography. See *Briefe an J. H. Merck von Goethe, Herder, Wieland und andern bedeutenden Zeitgenossen* (1835), *Briefe an und von J. H. Merck* (1838) and *Briefe aus dem Freundeskreise von Goethe, Herder, Höpfner und Merck* (1847), all edited by K. Wagner. *Cf.* G. Zimmermann, *J. H. Merck, seine Umgebung und seine Zeit* (1871), and a selection of his writings and correspondence edited by K. Wolff in 1909 (2 vols.).

MERCOEUR, PHILIPPE EMMANUEL DE LORRAINE, DUC DE (1558–1602), French soldier, was born on Sept. 9, 1558, and married Marie de Luxemburg, duchesse de Penthièvre. In 1582 he was made governor of Brittany by Henry III., who had married his sister. Mercoeur put himself at the head of the League in Brittany, and had himself proclaimed protector of the Roman Catholic Church in the province in 1588. Invoking the hereditary rights of his wife, who was a descendant of the dukes of Brittany, he endeavoured to make himself independent in that province, and organized a Government at Nantes, calling his son "prince and duke of Brittany." With the aid of the Spaniards he defeated the duc de Montpensier, whom Henry IV. had sent against him, at Craon in 1592, but the royal troops, reinforced by English contingents, soon recovered the advantage. The king marched against Mercoeur in person, and received his submission at Angers on March 20, 1598. Mercoeur subsequently went to Hungary, where he entered the service of the emperor Rudolph II., and fought against the Turks, taking Stuhlweissenburg (Székes-Fehérvár) in 1599. Mercoeur died on Feb. 19, 1602.

See his *Correspondance* ed. by von de Carné (2 vols., 1899).

MERCUROCHROME is the trade name of the water-soluble disodium salt of dibrom-oxymercuri-fluorescein, $C_{20}H_9O_5Br_2$ (HgOH). Although the exact process of commercial manufacture is secret the general method of preparation is described in the *Journal of the American Chemical Society*, vol. xlii. (1920), page 2,355. It is claimed that Mercurochrome possesses many advantages over iodine. Like iodine, its stain (a deep cherry-red) gives a relatively permanent deposit of a bactericidal agent in the desired field and its visibility shows the extent of application. Mercurochrome does not burn, irritate or injure the body tissues, and it is not poisonous. It penetrates the tissues to a marked degree, preventing it from being washed away by body fluids or destroyed by other agents. Mercurochrome is frequently applied in the treatment of infectious diseases subject to local treatment, venereal diseases, infected and operative wounds, and is used successfully in the intravenous treatment of septicemias and local infections, such as pneumonia, erysipelas, scarlet fever and diphtheria. (F. J. G. DU.)

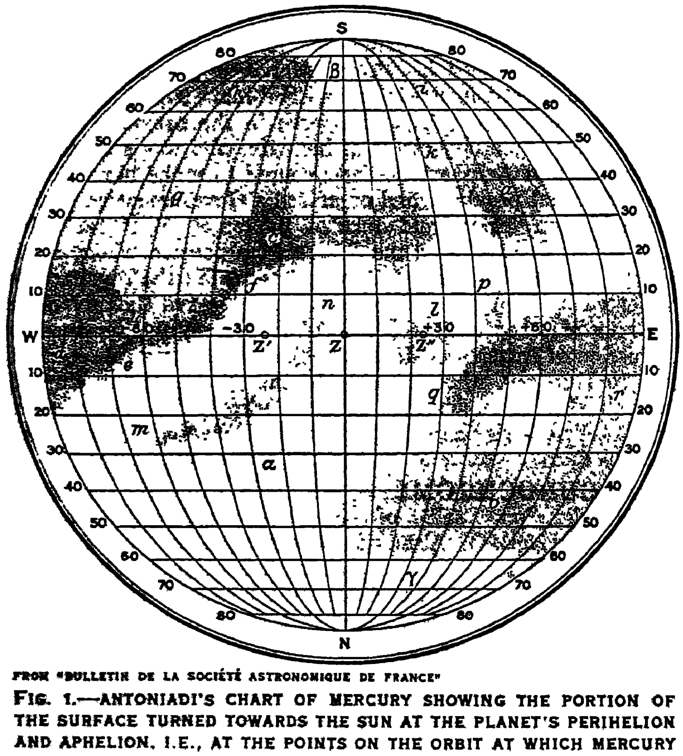
MERCURY (MERCURIUS, MIRQURIUS), the Italian god of merchandise (merx) and merchants. Rome frequently suffered from scarcity of grain during the unsettled times that followed the expulsion of the Tarquins. Various religious innovations were made to propitiate the gods, and, among other deities, in 495 the

Greek god Hermes was introduced into Rome under the Italian name of Mercurius (Livy ii. 21, 7; 27, 5). His temple on the Aventine became a sort of headquarters of the corn trade and of the merchants (*mercatores, mercuriales*) engaged in it, but he was soon worshipped by traders in general. His annual festival was on the 15th (the ides) of May, on which day his temple had been dedicated. May was chosen obviously because Maia (*q.v.*) was identified with her namesake the mother of Hermes; she was worshipped with Mercurius. His statues were in the business quarter (*e.g.* Festus, p. 157) and the water of his sacred spring near the Porta Capena was used by merchants for a lustral rite on May 15, see *Ovid*, Fast. v. 673ff.

In Roman art Mercury holds a caduceus and a purse (an element very rare in purely Hellenic representations).

See G. Wissowa, *Religion u Kultus*, 2nd ed. (1912), p. 304; Steuding in Roscher's *Lexikon, s.v.*

MERCURY (☿) is the smallest of the major planets, and has a diameter of only about 3,000 miles. It is also the nearest to the sun with a mean distance of 36,000,000 miles or 0·39 of the Earth's distance. But the eccentricity of its orbit, amounting to 0·206, is very much greater than that of any other major planet, and its perihelion and aphelion distances are respectively 28,500,000 and 43,350,000 miles or approximately in the ratio of 2 to 3. Its period of revolution in its orbit is 88 days, but its synodical period, *i.e.*, the interval between, say, successive superior conjunctions with the sun, is 116 days. At its most favourable elongations it recedes only about 28° from the sun. Its orbit has a greater inclination (7°) to the ecliptic than that of any other major planet. The albedo is low, but at a mean elongation its brightness is about equal to that of a star of zero magnitude; and



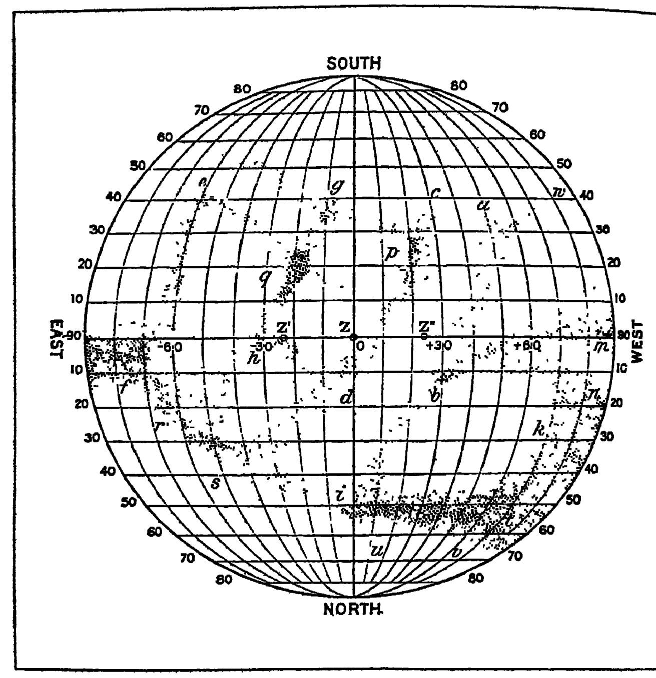
FROM "BULLETIN DE LA SOCIÉTÉ ASTRONOMIQUE DE FRANCE"

FIG. 1.—ANTONIADI'S CHART OF MERCURY SHOWING THE PORTION OF THE SURFACE TURNED TOWARDS THE SUN AT THE PLANET'S PERIHELION AND APHELION, I.E., AT THE POINTS ON THE ORBIT AT WHICH MERCURY IS NEAREST TO AND FARTHEST FROM THE SUN, Z' AND Z'' REPRESENTING EXTREME ZENITH POINTS OF THE SUN

although at a favourable elongation it can reach −1·2 magnitude, the planet is frequently dimmed or obscured by the haze and mists near the horizon. It can, however, be readily seen with a telescope in the daytime when high in the sky if the atmosphere is reasonably transparent.

As Mercury has no satellite it has been necessary to determine its mass from its attraction on Venus or some other body, and the result which has been deduced (about $\frac{1}{27}$ that of the earth) is somewhat uncertain. The density of the planet is apparently between that of Mars and the Moon.

Surface Features and Rotation.—As the angular diameter of Mercury varies from about 5″ to 13″ its phases are easily shown by quite a small telescope. But under the circumstances of observation it is far from easy to define the surface features with accuracy, and even the period of the planet's axial rotation was still regarded as uncertain until recently (1927). About the beginning of the 19th century Schroeter and Harding at Lilienthal



BY COURTESY OF DR. KOBOLD

FIG. 2.—SCHIAPARELLI'S CHART OF MERCURY SHOWING THE PORTION OF THE SURFACE TURNED TOWARDS THE SUN AT THE PLANET'S PERIHELION AND APHELION. Z, Z' AND Z'' INDICATE THE POINTS AT WHICH THE SUN IS IN THE ZENITH AT DIFFERENT TIMES IN MERCURY'S YEAR

recorded an occasional blunting of the S. cusp, and from the observations of this phenomenon and other features Bessel deduced a period of slightly more than 24 hours. Several other observers subsequently recorded light and dark patches and other features, but the conclusions drawn were somewhat discordant.

Between 1881 and 1889 Schiaparelli at Milan carried out a careful study of the planet, using at first a refractor of 8½ inches which was eventually replaced by one of 18 inches. His conclusion was that the periods of axial rotation and orbital revolution are identical, and that the axis of rotation is approximately normal to the orbit plane. Lowell at Flagstaff some years later came to a similar conclusion.

It would, of course, follow from such conditions that the planet always presents approximately the same face to the sun, as the Moon does to the Earth, though in consequence of the large eccentricity of the orbit, the effect of libration in longitude of the surface markings as seen from the sun would cause a displacement of nearly 24° on each side of a mean position. About 37% of the surface would be permanently sunlit; the same amount in perpetual night; and the remainder exposed alternately to sunlight and darkness with enormous changes of temperature during each revolution of the planet.

A fresh attack on the problem of Mercury's rotation was made by E. M. Antoniadi at Meudon with the help of the great 33-inch refractor of that observatory in 1927, and the result was to establish Schiaparelli's deductions. The markings were found to be somewhat variable in intensity, but—apart from the libration above mentioned—constant in position relatively to the terminator, thus indicating the identity of the periods of rotation and revolution. The charts of both Schiaparelli and Antoniadi are appended and it will be seen that many of the same features are presented in both, though Schiaparelli drew them as generally linear in character, whereas Antoniadi sees them rather as diffuse spots. Some of the objects shown by the latter can be also identified with features recorded at various times by Denning, Barnard,

Jarry-Desloges. Fournier, Danjon and other observers (see *L'Astronomie,* January 1928).

That Mercury has an atmosphere appears to be indicated by the varying intensity of the dark areas as observed at Meudon; but the visibility of the markings together with the planet's low albedo, and the absence of any appearance of an atmosphere as Mercury advances on or leaves the sun's disk on the occasions of its transit, would seem to show that it is scanty. This is what one would expect from a consideration of the smallness of the planet's mass and surface gravity. Radiometric observations at Mt. Wilson show that the temperature of the sunlit side is very far above the boiling point of water at the Earth's surface, but that of the opposite side may be not greatly removed from the absolute zero.

Transits.—Since the inclination of Mercury's orbit to the ecliptic is 7° it usually happens that at the time of inferior conjunction the planet passes N. or S. of the sun, but should conjunction occur when it is near one of its nodes it crosses the sun's disk and is seen during transit projected on it as a small black spot. As the earth passes the line of nodes about May 7 and November 9 transits can only take place near those dates. The November transits, however, which occur with Mercury in the neighbourhood of perihelion, and consequently more remote than usual from the earth, are very much more common than those in May when the conditions are reversed, the limits of distance from the node within which the planet must be for a transit to take place being 4° 45′ and 2° 40′ respectively.

The following table gives the dates and Greenwich Mean Astronomical Times of the middle of all the transits from 1677 (the date of the first one accurately observed) until the year 2003. The hours are in all cases reckoned from *noon.*

Transits of Mercury from 1677 to 2003

		h.			h.
1677	Nov. 7	0	1845	May 8	8
1690	Nov. 9	18	1848	Nov. 9	2
1697	Nov. 2	18	1861	Nov. 11	20
1707	May 5	11	1868	Nov. 4	19
1710	Nov. 6	11	1878	May 6	7
1723	Nov. 9	5	1881	Nov. 7	3
1736	Nov. 10	22	1891	May 9	14
1740	May 2	11	1894	Nov. 10	7
1743	Nov. 4	22	1907	Nov. 14	0
1753	May 5	18	1914	Nov. 7	0
1756	Nov. 6	16	1924	May 7	14
1769	Nov. 9	10	1927	Nov. 9	18
1776	Nov. 2	10	1940	Nov. 11	11
1782	Nov. 12	3	1953	Nov. 14	5
1786	May 3	18	1957	May 5	13
1789	Nov. 5	3	1960	Nov. 7	5
1799	May 7	1	1970	May 8	20
1802	Nov. 8	21	1973	Nov. 9	23
1815	Nov. 11	15	1986	Nov. 12	16
1822	Nov. 4	14	1993	Nov. 5	16
1832	May 5	0	1999*	Nov. 15	9
1835	Nov. 7	8	2003	May 6	19

*Mercury grazes the sun's limb.

Motion of Perihelion.—What was for a long time a perplexing problem was presented by the motion of Mercury's perihelion, the line of apsides—or the longer axis of the orbit—showing a greater advance in the direction of the planet's motion than could be accounted for by the gravitational action of all the other planets. Leverrier in 1845 concluded that the excess of motion was 35″ per century—but this was increased by later investigations to over 40″ per century. It was accordingly concluded either that Mercury is disturbed by some unknown masses of matter or that Newton's law of gravitation is not rigidly true. Leverrier attributed the excess of motion to the action of a group of planets revolving inside the orbit of Mercury, and at first this explanation seemed to be confirmed by the occasional reports of dark objects seen in transit across the sun's face. But for very many years past the sun has been photographed almost daily at some observatory or other, such as Greenwich or the Cape, without any such objects being detected, and photographs of the sky in the neighbourhood of the sun during total eclipses have likewise failed to disclose anything of the sort. If, then, such intra-Mercurial bodies exist, they must be extremely small. It was at one time suggested that the minute particles which produce the Zodiacal light might be invoked to explain the observed motion, but the idea was shown on theoretical grounds to be untenable. The solution of the difficulty has since been supplied by Einstein's Theory of Generalized Relativity and the matter is now regarded as satisfactorily cleared up. (T. E. R. P.)

MERCURY, in chemistry, a metallic element which is easily distinguished from all others by its being liquid at even the lowest temperatures occurring in moderate climates (symbol Hg, atomic number 80, atomic weight, 200·6, numerous isotopes 197 to 204). This metal does not appear to have been known to the ancient Jews, nor is it mentioned by the earlier Greek writers. Theophrastus (about 300 B.C.) mentions it as prepared from cinnabar by treatment with copper and vinegar; Dioscorides obtained it from the same mineral with the aid of iron, using at the same time a primitive distillation apparatus. With the alchemists it was an important substance. When, about the beginning of the 16th century, chemistry and scientific medicine came to merge into one, this same mysterious element of "mercury" played a great part in the theories of pathology; and the metal, in the free as in certain combined states, was looked upon as a powerful medicinal agent.

Occurrence.—Mercury occurs in nature chiefly in the form of a red sulphide, HgS, called cinnabar (*q.v.*), which, as a rule, is accompanied by more or less of the reguline metal—the latter being probably derived from the former by some secondary reaction. The most important mercury mines in Europe are those of Almaden in Spain and of Carniola, Italy, and in America those of California and Texas. Deposits also occur in Russia, the Bavarian palatinate, in Hungary, Tuscany, Transylvania, Bohemia, Mexico, Peru and in some other countries.

Mercury occurs in formations of all ages from the Archean to the Quaternary, and it has been found in both sedimentary and eruptive rocks of the most varied character, *e.g.,* conglomerates, sandstones, shales, limestones, quartzites, slates, serpentines, crystalline schists, and eruptive rocks from the most acid to the most basic.

In former times quicksilver deposits were supposed to be formed by sublimation, but from a careful study of the California occurrences S. B. Christy was convinced as early as 1875 that this was unlikely, and that deposition from hot alkaline sulphide solutions was more probable. By treating the black mercuric sulphide with such solutions, hot and under pressure, he succeeded in producing artificial cinnabar and metacinnabarite. He also showed that the mineral water at the New Almaden mines, when charged with sulphydric acid and heated under pressure, was capable of effecting the same change, and that this method of production agreed better with all the facts than the sublimation theory. (*See* "Genesis of Cinnabar Deposits," *Amer. Jour. Science,* xvii., 453.) The investigations of Dr. G. F. Becker on the "Quicksilver Deposits of the Pacific" (U.S. Geol. Survey, *Mon.* xiii., 1888) established the correctness of these views beyond doubt.

Properties.—Pure mercury is a coherent, mobile liquid, which does not wet glass or objects placed in it; it is silvery white with a metallic lustre; in very thin layers it transmits a bluish-violet light. It freezes at about −39° C with contraction, and the formation of a white, very ductile and malleable mass (sp. gravity 14·193 at m.p.) easily cut with a knife, and exhibiting crystals belonging to the cubic system. When heated the metal expands very uniformly, and vaporizes at about 360° (b.p. 357·01°/760 mm.); the volatility is generally increased by the presence of impurities; its high expansion and the wide range of temperature over which it is liquid render it especially valuable as a thermometric fluid. (*See* THERMOMETRY.) The vapour is colourless, and its density points to the conclusion that the molecules are monatomic. The specific gravity of liquid mercury at 0° is 13·5959 and 13·690 at its m.p. Mercury is about half as heavy again as copper volume for volume, a quarter as heavy again as lead, and nearly twice as heavy as zinc; this property is turned to account in the construction of barometers and air-pumps. Its specific heat is about 0·0333 (*see* CALORIMETRY); its electrical

conductivity is involved in the definition of the ohm (*see* CONDUCTIVITY); and its thermal conductivity is about two-thirds that of silver.

Pure mercury remains unchanged in dry air, oxygen, nitrous oxide, carbon dioxide, ammonia and some other gases at ordinary temperatures; hence its application for collecting and measuring gases. In damp air it slowly becomes coated with a film of mercurous oxide; and when heated for some time in air or oxygen it becomes transformed into the red mercuric oxide, which decomposes into mercury and oxygen when heated to a higher temperature; this reaction is of great historical importance, since it led to the discovery of oxygen at the hands of Priestley. The halogens and sulphur combine directly with the metal. Mercury is unattacked by dilute sulphuric acid; the strong acid, however, dissolves it on heating with the formation of sulphur dioxide and mercurous or mercuric sulphate according as mercury is in excess or not. Hydrochloric acid when concentrated has only very slight action. Dilute nitric acid readily attacks it, mercurous nitrate being formed in the cold with excess of mercury, mercuric nitrate with excess of acid, or with strong acid, in the warm. The metal dissolves in solutions containing chlorine or bromine, and consequently in aqua regia.

Mercury dissolves many metals to form compounds termed amalgams, of considerable importance to the arts.

COMPOUNDS OF MERCURY

Mercury forms two well-defined series of salts—the mercurous salts derived from the oxide Hg_2O, and the mercuric salts from the oxide HgO. Like mercurous oxide the mercurous salts are generally formulated as containing two mercury atoms in each molecule. According to H. B. Baker vaporized mercurous chloride or calomel (*q.v.*) has the formula Hg_2Cl_2.

Mercurous Oxide, Hg_2O, is an unstable dark-brown powder formed when caustic potash acts on calomel; it is decomposed by light or on trituration into mercury and mercuric oxide. *Mercuric oxide,* HgO, occurs in two forms: it is obtained as a bright-red crystalline powder (also known as "red precipitate," or as *mercurius praecipitatus per se*) by heating the metal in air, or by calcining the nitrate, and as an orange-yellow powder by precipitating a solution of a mercuric salt with potash; the difference is probably one of subdivision. The yellow form is the most reactive and is transformed into the red when heated to 400°. If the red oxide be heated it becomes black, regaining its colour on cooling, and on further heating to 630° it decomposes into mercury and oxygen. It is slightly soluble in water, to which it imparts an alkaline reaction and strongly metallic taste. A peroxide is obtained as a brown solid from mercury and slightly acid 30% hydrogen peroxide at low temperatures.

Mercurous and mercuric chlorides, known respectively as calomel (*q.v.*) and corrosive sublimate (*q.v.*), are two of the most important salts of mercury. *Mercurous bromide,* Hg_2Br_2, is a yellowish-white powder, insoluble in water. *Mercuric bromide,* $HgBr_2$, forms white crystals, sparingly soluble in cold water, readily in hot, and prepared by the direct union of its components *Mercurous iodide,* Hg_2I_2, is a yellowish-green powder obtained by heating its components to about 250°, or by triturating them with a little alcohol; it is also obtained by precipitating a solution of mercurous nitrate with potassium iodide. It is blackened by exposure to light. *Mercuric iodide,* HgI_2, exists in two crystalline forms. By mixing solutions of mercuric chloride and potassium iodide under a microscope, yellow rhombic plates are seen to be formed which are transformed very quickly into scarlet quadratic octahedra. On heating to about 126° the red form is transformed into the yellow modification; on cooling the reverse gradually occurs, and immediately if the yellow iodide be touched. When cooled to the temperature of liquid air red mercuric iodide assumes a pale yellow colour. Mercuric iodide is insoluble in water, but soluble in absolute alcohol; and also in potassium iodide solution, with the formation of K_2HgI_4, which may be obtained in lemon-yellow crystals. A strongly alkaline solution of this salt known as Nessler's reagent is specially used for determining traces of ammonia. (*See* below.) Mercuric iodide dissolves in other iodide solutions to form similar compounds; these solutions are characterized by their exceptionally high specific gravity, and hence are employed in density determinations. (*See* DENSITY.) It also forms many other double salts. Oxidation with strong nitric acid gives the *iodate,* $Hg(IO_3)_2$.

Mercurous Nitrite is obtained in yellow needles by the action of cold dilute nitric acid on mercury. Prolonged action of this acid transforms the salt into *mercurous nitrate*

$$Hg_2(NO_3)_2,2H_2O,$$

a white crystalline salt soluble in water. If the metal be in excess basic salts are obtained. By adding ammonia to a solution of mercurous nitrate a black precipitate of variable composition, known in pharmacy as *mercurius solubilis Hahnemanni,* is obtained.

Mercuric Nitrate.—By dissolving mercuric oxide in strong nitric acid there is obtained a heavy liquid which on the addition of more strong nitric acid gives a white precipitate of

$$2Hg(NO_3)_2,H_2O.$$

Water decomposes it to basic salts. By dissolving the oxide in dilute nitric acid, the crystalline basic salt

$$Hg(NO_3)_2 \cdot HgO \cdot H_2O$$

is obtained.

When mercurous or mercuric nitrate is treated with aqueous ethylene thiourea (etu) a stable neutral complex nitrate $[Hg,3etu](NO_3)_2$ is produced in rhombic plates which dissolve in water to a neutral solution and resemble the nitrates of the alkaline earths.

Mercuric Sulphide is the principal ore of mercury occurring in nature as the mineral cinnabar (*q.v.*), and is extensively used as a pigment, vermilion (*q.v.*). It is obtained as a black powder by triturating mercury with sulphur, the compound thus formed being known in pharmacy as *Aethiops mineralis,* and also by precipitating a mercuric salt with sulphuretted hydrogen. There are three crystalline forms of mercuric sulphide:—the light red form αHgS corresponding with cinnabar or vermilion; the black cubic variety α'HgS corresponding with metacinnabarite; a deep red hexagonal form βHgS not occurring in nature. Mercuric sulphide is only slightly acted upon by nitric acid; it dissolves in aqua regia; chlorine gives a yellow compound, $2HgS \cdot HgCl_2$; and it dissolves in potassium sulphide solutions to form double sulphides.

Mercurous Sulphate, Hg_2SO_4, is a white, sparingly soluble, crystalline substance obtained by adding sodium sulphate to a solution of mercurous nitrate. *Mercuric sulphate,* $HgSO_4$, is a white, soluble salt obtained by dissolving mercury in hot strong sulphuric acid; on digestion with water, it decomposes into an insoluble basic salt, $HgSO_4 \cdot 2HgO$, known as *turbith* or *turpeth mineral,* and into a soluble acid salt, $HgSO_4 \cdot 2SO_3$.

Mercury Phosphide, Hg_3P_2, is obtained as brilliant red, hexagonal crystals by heating mercury with phosphorus iodide to 300° and removing the mercuric iodide simultaneously formed by means of potassium iodide solution. *Mercurous phosphate,* Hg_3PO_4, and *mercuric phosphate,* $Hg_3(PO_4)_2$, are obtained as white precipitates by adding sodium phosphate to solutions of mercurous and mercuric nitrates respectively.

Mercurammonium Compounds.—With ammonia and ammonium salts, mercury compounds yield a number of substances, many of which have long been used in medicine. By the action of dry ammonia on calomel mercuroso-ammonium chloride, NH_3HgCl, is obtained; aqueous ammonia on calomel gives dimercuroso-ammonium chloride, NH_2Hg_2Cl. By adding ammonia to a solution of mercuric chloride, mercurammonium chloride, known in pharmacy as "infusible white precipitate," NH_2HgCl, is obtained; "fusible white precipitate" is mercuro-diammonium chloride, $Hg(NH_3Cl)_2$, and is obtained by adding a solution of mercuric chloride to hot solutions of ammonium chloride and ammonia so long as the precipitate first formed redissolves; the substance separates out on cooling. With ammonia and a strongly alkaline solution of mercuric iodide in potassium iodide (Nessler's solution) there is obtained a yellow precipitate of $HO \cdot Hg \cdot NH \cdot HgI$; this reaction is the most delicate test for ammonia, a yellow color-

ation being given by minute traces. By passing dry ammonia over precipitated mercuric oxide at 130°, a nitride, N_2Hg_3, is obtained. The oxide and ammonia solution gives the stable and basic mercurhydroxylamine, NHg_2OH.

Analysis.—Mercury compounds, when heated in a closed tube with sodium carbonate, yield a grey to black sublimate of metallic mercury, which readily unites to form visible globules. The metal is precipitated from solutions on to bright copper-foil; the mercury coating becomes silvery on rubbing and disappears when the quicksilvered copper is heated in a sublimation tube.

Solutions of mercurous salts with hydrochloric acid give a white precipitate of calomel, which becomes jet-black on treatment with ammonia. Stannous chloride, in its twofold capacity as a chloride and a reducing agent, precipitates both mercurous and mercuric solutions, at first as calomel, and on addition of an excess of reagent the precipitate becomes grey through conversion into finely-divided quicksilver. Sulphuretted hydrogen, when added very gradually to an acid mercuric solution, gives at first an almost white precipitate, which, on addition of more and more reagent, assumes successively a yellow, orange and at last jet-black colour. The black precipitate is HgS, identified by its great heaviness, and insolubility in boiling nitric or hydrochloric acid. Aqua regia (*q.v.*) dissolves it as chloride.

"Mercurous" mercury is quantitatively estimated by precipitating as calomel and weighing the precipitate on a tared filter at 100°. The metal may also be estimated by distillation in a closed tube with lime, the metal being collected and weighed, or by precipitation as sulphide with excess of sulphuretted hydrogen, the precipitate being collected on a tared filter or Gooch crucible, washed with carbon disulphide, dried and weighed.

PHARMACOLOGY AND THERAPEUTICS

The British Pharmacopeia contains some twenty-five mercurial preparations, including those of calomel (*q.v.*). Only the useful preparations will be mentioned here. Free mercury is contained in Hydrargyrum cum Creta, or "grey powder," which consists of one part of mercury to two of prepared chalk. The dose is 1–5 gr., and the preparation is usually employed for children. The Pilula Hydrargyri, or "blue pill," contains one part of mercury in three, and the dose is 4–8 gr. It is usually employed for adults. There are also five preparations of free mercury for external use. Of these the most useful is the Unguentum Hydrargyri, "or blue ointment," which contains one part of mercury in two. Weaker ointments are also prepared from the red and the yellow forms of mercuric oxide. The perchloride of mercury or corrosive sublimate is therapeutically the most important salt of mercury. The dose is $\frac{1}{32}-\frac{1}{16}$ gr. It is incompatible with alkalis, alkaline carbonates, potassium iodide, albumin and many other substances, and should therefore be prescribed alone. It is decomposed by impure water, and distilled water is therefore used in making the Liquor Hydrargyri Perchloridi, in which form it is usually prescribed. This contains half a grain of the perchloride to the fluid ounce and its dose is 30–60 minims. The perchloride is also compounded with lime-water to form the Lotio Hydrargyri Flava, or "yellow wash," which contains two grains of the salt to the fluid ounce. Mercuric iodide is an equally potent salt and has come into wide use. It has the same dose as the perchloride and is largely prescribed in the Liquor Arsenii et Hydrargyri Iodidi, or Donovan's solution, which contains 1% of arsenious iodide and 1% of mercuric iodide, the dose being 5–20 minims. An ointment widely used is prepared from the mercur-ammonium chloride (Unguentum Hydrargyri ammoniatum) of which it contains one part in ten. It is known as "white precipitate ointment."

In discussing the pharmacology of mercury and its compounds, it is of the first importance to observe that metallic mercury is inert as such, and that the same may practically be said of mercurous salts generally. Both mercury itself and mercurous salts tend to be converted in the body into mercuric salts, to which the action is due. When metallic mercury is triturated or exposed to air it is partly oxidized, the first stage of its transformation to an active condition being thus reached.

Metallic mercury can be absorbed by the skin, passing in minute globules through the ducts of the sweat-glands. The mercury contained in "blue ointment" is certainly thus absorbed, actually circulating in the blood in a very different form, as described below. There is no local action on the skin. The mercuric salts, and especially the chloride and iodide, are probably the most powerful of all known antiseptics. One part of the perchloride in 500,000 will prevent the growth of anthrax bacilli, and one part in 2,000—the strength commonly employed in surgery—kills all known bacteria. The action is apparently specific and not due to the fact that perchloride of mercury precipitates albumin, including the albuminous bodies of bacteria, for the iodide is still more powerful as a germicide, though it does not coagulate albumin. These salts cannot be employed for sterilizing metallic instruments, which they tarnish. As these drugs are essentially poisons they must be used with the greatest care in surgical practice, and as they are particularly deleterious to the secreting structure of the kidney they must not be employed as antiseptics in diseases where renal inflammation is already present or probable. They are therefore contra-indicated for application to the throat in scarlet-fever or to the uterus in eclampsia. The stronger mercurial ointments kill cutaneous parasites and also possess some degree of antipruritic action, especially when the cause of the itching is somewhat obscure. Mercuric salts, when in strong solution, are caustic. It is important to observe that the volatility of metallic mercury and many of its compounds causes their absorption by the lungs even when no such effect is intended to follow their external application. This fact explains the occurrence of chronic mercurial poisoning in certain trades.

Single doses of mercury or its compounds have no action upon the mouth, the characteristic salivation being produced only after many doses. Their typical action on the bowel is purgative, the effect varying with the state of the mercury. So relatively inert is metallic mercury that a pound of it has been given without ill effects in cases of intestinal obstruction, which it was hoped to relieve by the mere weight of the metal. Half a grain of the perchloride, on the other hand, is a highly toxic dose. The action of mercurials on the bowel is mostly exerted on the duodenum and jejunum, though the lower part of the bowel is slightly affected. Hence a dose of mercury usually needs a saline aperient to complete its action, as in the "blue pill and black draught" of former days. Mercurials do not cause, in therapeutic doses, much increase in the intestinal secretion, the action being mainly exerted on the muscular wall of the bowel. The bile is rapidly removed from the duodenum, before any re-absorption can occur, and the bacterial action which decomposes the bile-pigment is arrested by the antiseptic power of the drug, so that the excreta are of a very dark colour. The classical experiments of William Rutherford (1839–1899), of Edinburgh, showed that calomel does not increase the amount of bile formed by the liver. Corrosive sublimate does, however, stimulate the liver to a slight degree. In large doses mercurials somewhat diminish the secretion of bile. The greater part of the mercury administered by the mouth, in whatever form, is excreted as mercuric sulphide. Prior to this decomposition the mercury exists as a complex soluble compound with sodium, chlorine and albumen. When perchloride of mercury is injected subcutaneously the sodium chloride in the blood similarly prevents the precipitation of the albuminate of mercury, and it is therefore desirable to add a little sodium chloride to the solution for injection of mercuric chloride.

Mercury is largely used in affections of the alimentary canal, and has an obscure but unquestionable value in many cases of heart-disease and arterial degeneration. But its value in syphilis (*see* VENEREAL DISEASES) far outweighs all its other uses.

Toxicology.—Acute poisoning by mercurials usually occurs in the case of corrosive sublimate. There is intense gastro-intestinal inflammation, with vomiting, frequent "rice-water" stools and extreme collapse. The treatment, except when the case is seen at once, is very difficult, but white-of-egg or other form of albumin is the antidote, forming an insoluble compound with the perchloride.

Chronic poisoning (hydrargyrism or mercurialism) is of great importance, since any indication of its symptoms must be closely

watched for in patients who are under mercurial treatment. Usually the first symptom is slight tenderness of the teeth whilst eating, and some foetor of the breath. These symptoms become more marked and the gums become the seat of severe inflammation, being spongy, vascular and prone to bleed. The salivary glands are swollen and tender, and the saliva pours from the mouth, and may amount to pints in the course of a day. The teeth become quite loose and may fall out. The symptoms are aggravated until the tongue and mouth ulcerate, the jaw-bone necroses, haemorrhages occur in various parts of the body, and the patient dies of anaemia, septic inflammation or exhaustion. The treatment consists, besides stopping the intake of poison and relieving the symptoms, in the administration of potassium iodide in small, often repeated doses.

Mercuro Zinc Cyanide, $Zn_3Hg(CN)_8$ (Lister's antiseptic), was suggested in the early days of antiseptics (1886) by W. Martindale. In the form of "cyanide gauze" and "cyanide wool," this dressing has been largely used, both in general surgery and for the requirements of war.

Mercurochrome "220" (di-sodium hydro-oxy-mercury dibromo fluorescein) has been advocated through the work of various authorities in the United States for a variety of affections. This compound has an English equivalent *mercurome*, which is identical chemically. The drug is deemed of very great service as an antiseptic for vesical injections in cystitis, pyelitis, etc., and as a skin antiseptic it is highly recommended. Considerable strides have been made with the intravenous injection of this compound, *e.g.*, in puerperal fever, typhoid and grave bacterial infections in general, and it has been suggested for use intravenously in plague. As the limits of dosage are not as yet completely determined, mercurochrome is to be used with caution. At the same time, the remarkable fact remains that this compound, containing approximately 23% of mercury in a non-ionised form has been injected in the massive dose of 3 grains (0·2 gram) in contrast with an ordinary intravenous dose of mercuric chloride of about $\frac{1}{30}$ to $\frac{1}{16}$ grain (0·001 to 0·002 gram).

BIBLIOGRAPHY.—For the history of mercury *see* B. Neumann, *Die Metalle* (1904); A. Rossing, *Geschichte der Metalle* (1901). The general chemistry is treated in detail in O. Dammar, *Handbuch der anorganischen Chemie; H. Moissan, Traité de chimie minérale;* J. W. Mellor, *A Comprehensive Treatise on Inorganic Theoretical Chemistry*, Vol. iv., Longmans Green & Co., 1923; F. C. Whitman, *Organic Compounds of Mercury*, The Chemical Catalog Company, New York, 1921; W. H. Martindale and W. W. Westcott, *The Extra Pharmacopoeia*, Vol. i., 1924; Vol. ii., 1925. (G. T. M.)

MERCURY, FULMINATE OF. A highly explosive compound used in percussion caps and detonators. Substances which fulminate on heating or gentle percussion have been known for a long time, but the first of which we have any definite chemical knowledge was mercury fulminate, a substance first made by E. C. Howard in 1799. J. von Liebig, who is stated to have become acquainted with the substance when he was a boy, succeeded in isolating fulminic acid whilst working in Gay Lussac's laboratory in 1823. Previous attempts appear to have been made to utilize the explosive property of fulminate for igniting gunpowder and led to many inventions.

Mercury fulminate is retained for two military purposes: (1) as an igniter in so-called cap-compositions; and (2) as a detonator, in which case it may be used alone or mixed with a nitro-derivative, such as trinitrotoluene, where it can act as "starter" of a more powerful detonator.

Being too rapid in action, pure mercury fulminate will not ignite gunpowder, the grains being merely scattered. The application of fulminate as a cap-composition for setting fire to gunpowder, while being itself fired by percussion, has been reached by methods of "taming" or slowing down the detonating action by addition of diluents. These diluents, which could be ignited by the fulminate, burned at a sufficiently slow rate to set fire to the gunpowder or other propellant. The slowing down or taming mixture consists, generally, of sulphide of antimony, Sb_2S_3, and potassium chlorate, $KClO_3$, both in very fine powder, the fulminate being used in small crystals as made, for it cannot be ground or powdered. A silver fulminate was made by L. G. Brougnatelli in 1798, who dissolved silver in nitric acid and added this solution to spirits of wine. The white powder obtained is extremely sensitive to friction, percussion or heat and apparently unsuited to any practical application. Other fulminating substances obtained before this date by the action of ammonia on solutions of gold or silver are similarly unsuitable.

Manufacture.—Clean mercury, one part, and nitric acid of sp.gr. 1·36, about ten parts, are placed in a glass flask and, after the mercury has dissolved, allowed to cool to about 15° to 20° C. Ten to twelve parts of 90% alcohol are placed in a capacious flask and the mercury solution is added. A reaction commences in a few minutes with formation of copious white fumes followed after a short time by red gases. The action may require regulating by outward application of cold water, but generally after the temperature has risen to 80°–90° C it settles down quietly. The reaction mixture is poured into cold water; the sparingly soluble mercury salt is precipitated, and is washed with cold water until free from acid. Mercury fulminate is a grey, sandy, crystalline powder, is extremely poisonous, and has a sp.gr. of about 4·4, varying a little with the conditions of formation.

Many chemists, since Liebig, have suggested constitutional formulae for fulminic acid (*q.v.*); it may not be quite settled even now, but the formula $(CNO)_2Hg$ is almost certainly correct for mercury fulminate. Since the discovery of hydrazoic acid, N_3H, some of its salts, such as the azides of lead or silver, have for special purposes become rivals of fulminate (*see* LEAD AZIDE).

BIBLIOGRAPHY.—*The Rise and Progress of the British Explosives Industry* (International Congress of Applied Chemistry, 1909); O. Guttmann, *The Manufacture of Explosives, Twenty Years' Progress* (1909). (W. R. Ho.)

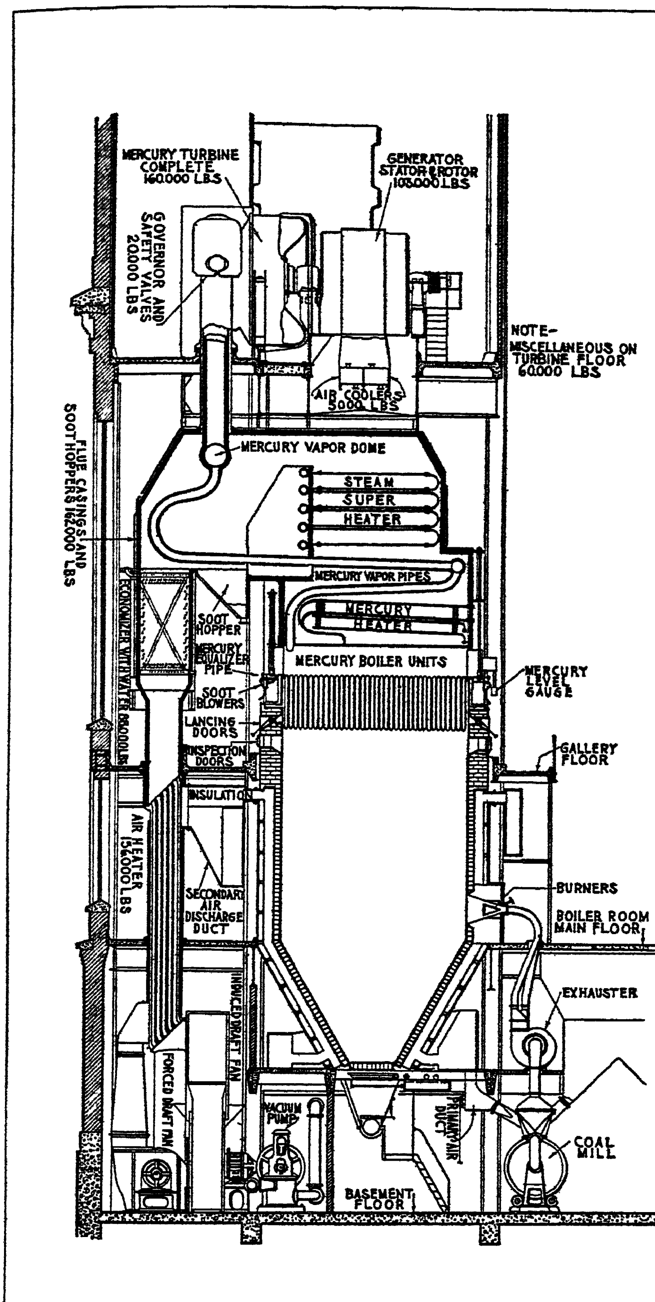
MERCURY-VAPOUR BOILER, a process of power generation which uses mercury instead of water in a boiler. The boiling point of mercury as compared with water is given below. It will be seen that with mercury saturated vapour can be obtained with low pressures and with much higher temperatures than is possible with water steam.

Pressures	Boiling Point	
	Mercury	Water
100 lb. gauge	928° F	338° F
80 „ „	899	324
60 „ „	866	307·6
40 „ „	824·6	287·1
20 „ „	769	259·3
10 „ „	730·4	240·1
	674·5	212
20 in. vacuum (atm.)	576	161·50
25 „ „ „	520	133·78
28 „ „ „	456·8	101·7
29 „ „ „	414	79·06

The highest pressure at which saturated water vapour can exist is 3,200 lb. pressure per square inch, and at that pressure the temperature is only 706° F. In the mercury cycle, mercury is boiled in a specially designed boiler at whatever pressure is desirable. In the Hartford, Conn., installation this pressure has been chosen at 70 lb. gauge. The vapour is then carried through a turbine where it does useful work. The exhaust pressure is kept at whatever vacuum is desirable to obtain the proper steam pressure. In Hartford the steam is generated at 350 lb. pressure, which means a mercury vacuum of about 28 inches.

In the mercury cycle all the latent heat of the mercury vapour is turned into steam at any steam pressure desirable, and this steam can be used either for power as in Hartford or for heating purposes. The mercury cycle can thus be considered as a steam producer, where a large amount of power can be obtained from the mercury vapour at practically theoretical rate, and the amount of steam produced is only slightly less than that produced by a steam boiler for the same amount of fuel.

A Typical Installation.—Figs. 1 and 2 give side and end elevation of the 10,000 kw. mercury turbine installation at Hartford, Conn., by the Hartford Electric Lighting Company, and a description of the same will give a clear view of the great gain in efficiency obtained by this installation. The equipment is de-



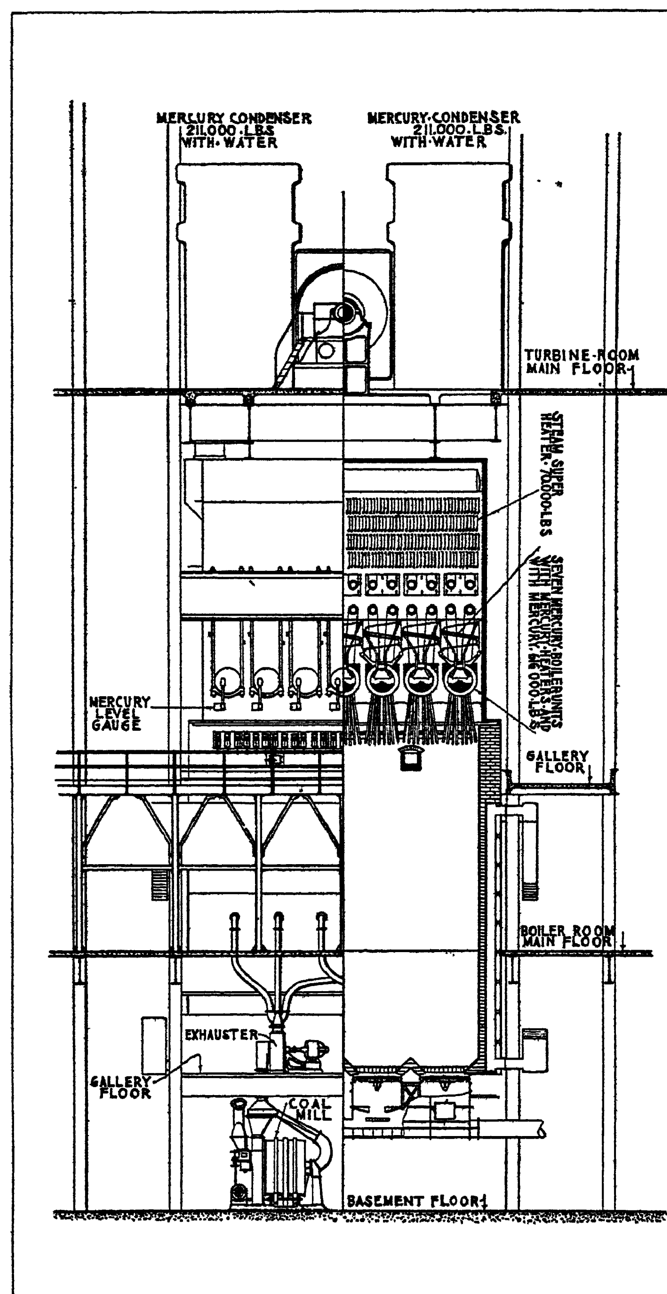
BY COURTESY OF THE GENERAL ELECTRIC COMPANY

FIG. 1.—ARRANGEMENT FOR MERCURY-VAPOUR BOILER AND TURBINE EQUIPMENT, SIDE ELEVATION

signed for the following results: Full-load output of mercury turbine, 10,000 kw.; coal burned per hour, 14,500 lb.; steam produced per hour, 350 lb. gauge, 700° F, 125,000 pounds. The fuel is burned in the furnace, as in a steam boiler, and the products of combustion pass successively through a mercury boiler, a mercury liquid heater, a steam superheater, a feed water heating economizer and an air preheater. The first two of these give heat to the mercury. The others give it to the steam or return it to the furnace.

The mercury vapour made in the boiler passes first through a turbine driving at 10,000 kw. generator at 720 r.p.m. and then exhausts into a pair of surface condensers. The tubes of these condensers contain water, so that the heat delivered to them by the condensation of the exhaust mercury vapour causes them to make steam which collects in drums above the tubes at which point it is available for use. In the equipment being described, this steam passes from these drums through the superheater mentioned. The condensed mercury is drained through a cleaning sump and then runs by gravity through the liquid heater and into the boiler. By mounting the condenser high enough above the boiler, the weight of the descending column of mercury overcomes the boiler pressure so that no feed pump is required.

Basis of Design.—The following list gives data as to designed conditions for the 10,000 kw. unit and its substantial accuracy is fully established by experience with apparatus now operating: Output of mercury turbine, 10,000 kw.; speed of mercury turbine, 720 r.p.m.; steam produced per hour, 125,000 lb.; steam pressure, 350 lb. gauge; steam temperature, 700° F; mercury vapourized per hour, 1,150,000 lb.; temperature mercury vapour, 884° F; pressure vapour at mercury turbine, 70 lb. gauge; vacuum in mercury condenser, 28 in.; temperature mercury exhaust, 458° F; gas temperature beyond mercury liquid heater, 950° F; gas temperature beyond steam superheater, 650° F; gas temperature beyond water economizer, 480° F; gas temperature to stack, 280° F; air temperature entering furnace, 390° F; coal burned per hour, 14,500 lb.; heat in coal per pound 14,500 B.T.U. It will thus be seen that when 14,500 lb. of coal (with a heat value of 14,500 B.T.U. per pound) is burned under the mercury boiler



BY COURTESY OF THE GENERAL ELECTRIC COMPANY

FIG. 2.—ARRANGEMENT FOR MERCURY-VAPOUR BOILER AND TURBINE EQUIPMENT, END ELEVATION

per hour, 10,000 kw. are generated by the mercury boiler and 125,000 lb. of steam are generated at 350 lb. gauge pressure and with a temperature of 700° F (264° F superheat).

What this amount of steam can accomplish in combination with the mercury turbine in existing power plants is shown by the table below:

Fuel Rates in B.T.U. per Kilowatt Hour

	Steam alone	Steam with mercury	Per cent gain
A . . .	14,000	9,400	33
B . . .	17,000	10,500	38
C . . .	22,000	11,600	47
D . . .	35,000	13,800	60·5

Case *A* represents the best development of modern plants with 350 lb. pressure, high superheat and the most effective auxiliary and feed heating arrangements. Case *B* represents a station that was considered very good a short time ago with about 200 lb. steam pressure, less perfect firing and auxiliary arrangements and less superheat. Case *C* represents a station in which conditions of size, load factor or efficiency are even less favourable. Case *D* represents what might be done in a good non-condensing station. The ratios here shown are not much affected by the usual causes of relative inefficiency such as load factor, turbine efficiency or condensing facilities.

The mercury cycle lends itself particularly to the increasing of station capacity of existing plants. By burning approximately 20% more fuel, the same amount of steam as before can be produced, the power from the mercury turbine will be almost equal that produced by the steam turbines, the fuel rate of the mercury turbine will be at approximately 4,000 B.T.U. per kilowatt hour, and the fuel rate of the steam turbine will remain as before. If this rate was 17,000 B.T.U. per kilowatt hour, the combined rate would be at about 10,500 B.T.U.—a gain of 38%.

Heating Plants.—From the figures that have been given, it will be seen that the gain in economy is incident to the production of steam by a method which gives a valuable by-product in the form of power. A very striking case of profitable use is found in a city heating plant. If, in such a plant, this unit were used in connection with a suitable steam turbine unit which would take steam at 350 lb. gauge pressure, superheated and exhausted into the street mains at 100 lb. per square inch and saturated, the results with the best coal burned efficiently would be about as follows: Fuel burned per hour, 14,500 lb.; steam delivered per hour, 125,000 lb.; power produced by mercury turbine, 10,000 kw.; power produced by steam, 3,400 kw.; total power produced, 13,400 kilowatts. From these figures it will be seen that the power is produced at a rate of about 16,000 B.T.U. in fuel per kilowatt hour, which is comparable with very good condensing steam stations, and that all this 100 lb. heating steam is produced in addition.

A careful investigation in regard to the probable mercury supply of the world indicates that it is sufficient to take care of this process for practically an indefinite time. The present mercury mines in operation could easily double their output which would take care of 1,000,000 kw. per year, in addition to the present uses of mercury.

BIBLIOGRAPHY.—W. L. R. Emmet, "Power from Mercury Vapor," in *Proceedings* Am. Inst. of Mech. Eng. vol. xxxii. (1913), "The Emmet Mercury Vapor Process" with appendix ("Properties of Mercury Vapor") by L. A. Sheldon, in *Proceedings* Am. Inst. of Mech. Eng. (1924), "Mercury Vapor Process" in *Journal* of the Franklin institute (Feb. 1925) and "Economies of the Emmet Mercury Process" in *General Electric Review* (July, 1927). (E. Bg.)

MERCY, FRANZ, FREIHERR VON, lord of Mandre and Collenburg (d. 1645), German general in the Thirty Years' War, who came of a noble family of Lorraine, was born at Longwy between 1590 and 1598. From 1606 to 1630 he was engaged in the imperial service. After distinguishing himself at the first battle of Breitenfeld (1631) he commanded a regiment of foot on the Rhine and defended Rheinfelden against the Swedes with the utmost bravery, surrendering only after enduring a five-months' siege He now became a general officer of cavalry, and in 1635, 1636 and 1637 took part in further campaigns on the Rhine and Doubs. In September 1638 he was made master-general of ordnance in the army of Bavaria, then the second largest army in Germany. In the next campaign he was practically commander-in-chief of the Bavarians, and at times also of an allied army of Imperialists and Bavarians. He was made general field marshal in 1643, when he won his great victory over the French marshal Rantzau at Tuttlingen (Nov. 24–25), capturing the marshal and seven thousand men. In the following year Mercy opposed the French armies, now under Enghien (afterwards the great Condé) and Turenne. He fought, and in the end lost, the desperate battle of Freiburg, but revenged himself next year by inflicting upon Turenne the defeat of Mergentheim (Marienthal). Later in 1645, fighting once more against Enghien and Turenne, Mercy was killed at the battle of Nördlingen (or Allerheim) as the crisis of the engagement, which, even without Mercy's guiding hand, was almost a drawn battle. He died on Aug. 3, 1645. On the spot where he fell, Enghien erected a memorial, with the inscription *Sta viator, heroem calcas.*

CLAUDIUS FLORIMOND, COUNT MERCY DE VILLETS (1666–1734), Imperial field marshal, was born in Lorraine, and entered the Austrian army as a volunteer in 1682. After seven years of service in Hungary and five years in Italy, he displayed great daring in the first campaigns of the Spanish Succession War in Italy, twice fell into the hands of the enemy in fights at close quarters and for his conduct at the surprise of Cremona (Jan. 31, 1702) received the emperor's thanks. With this he took part in the Rhine campaign of 1703, and the battle of Friedlingen, and his success as an intrepid leader of raids and forays became well known to friend and foe. He was on that account selected early in 1704 to harry the elector of Bavaria's dominions. His resolute leadership was conspicuous at the battle of Peterwardein (1716) and he was soon afterwards made commander of the Banat of Temesvár. At the battle of Belgrade (1717) he led the second line of left wing cavalry in a brilliant and decisive charge which drove the Turks to their trenches. After the peace he resumed the administration of the Banat, which after more than 150 years of Turkish rule needed a humane and capable governor. But he was called away to southern Italy, where he fought the battle of Francavilla (June 20, 1719), took Messina and besieged Palermo. For eleven years more he administered the Banat, reorganizing the country as a prosperous and civilized community. In 1734 he was made a field marshal, but on June 29, was killed at the battle of Parma while personally leading his troops. He left no children, and his name passed to the Mercy-Argenteau family.

MERCY, compassion, pardon, pity, or forgiveness. The Latin word *merces* was used in the early Christian ages for the reward that is given in heaven to those who have shown kindness without hope of return. In the mediaeval Church there were seven "corporeal" and seven "spiritual works of mercy" (*opera misericordiae*). The order of the Sisters of Mercy is a religious sisterhood of the Roman Church, founded in 1827.

MERCY-ARGENTEAU, FLORIMOND CLAUDE, COMTE DE (1727–1794), Austrian diplomatist, son of Antoine, comte de Mercy-Argenteau, entered the diplomatic service of Austria, going to Paris in the train of Prince Kaunitz. He became Austrian minister at Turin, at St. Petersburg, and in 1766 at Paris, where his first work was to strengthen the alliance between France and Austria, which was cemented in 1770 by the marriage of the dauphin, afterwards Louis XVI., with Marie Antoinette, daughter of the empress Maria Theresa. Mercy-Argenteau was in Paris during the years which heralded the Revolution, and supported first Loménie de Brienne, and then Necker. In 1792 he became Austrian governor-general of the Belgian provinces. In July 1794 he was appointed Austrian ambassador to Great Britain, but he died a few days after his arrival in London.

See T. Juste, *Le Comte de Mercy-Argenteau* (Brussels, 1863); A. von Arneth and A. Geoffroy, *Correspondances secrètes de Marie Thérèse avec le comte de Mercy* (1874); and A. von Arneth and J. Flammermont, *Correspondance secrète de Mercy avec Joseph II. et Kaunitz* (1889–91). Mercy-Argenteau's *Correspondances secrètes de Marie Thérèse* has been condensed and translated into English by Lilian Smythe as *A Guardian of Marie Antoinette* (2 vols., 1902).

MER DE GLACE. A glacier 16 sq.m. in area on the northern slope of Mt. Blanc, near Chamonix. During the summer months the rate of flow is estimated at two feet a day. It is a favourite tourist resort.

MERE. (1) An adjective primarily indicating something pure and unmixed (Lat. *merus*, pure).

(2) An arm of the sea, or estuary; a lake or any shallow stretch of inland water. In the Fen countries "mere" is applied to marshland, *cf.* Lat. *mare*, Fr. *mer*, Ger. *meer*.

(3) A landmark or boundary; an object indicating the extent of a property without actually enclosing it; a road which forms a dividing line between two places (O.E. *maere*, Lat. *murus*, a wall). A "meresman" is an official appointed by parochial authorities to ascertain the boundaries of a parish and to report upon the roads, bridges, waterways, etc. In the mining districts of Derbyshire a mere is a certain measurement of land in which lead-ore is found.

MEREDITH, GEORGE (1828–1909), British novelist and poet, was born at Portsmouth, Hants., on Feb. 12, 1828. About his early life little is recorded, but there is a good deal of quasi-autobiography, derived apparently from early associations and possibly antipathies, in some of his own novels, notably *Evan Harrington* and *Harry Richmond*. He had, as he said, both Welsh (from his father) and Irish blood (from his mother) in his veins. His father, Augustus Armstrong Meredith, was a naval outfitter at Portsmouth (mentioned as such in Marryat's *Peter Simple*); and his grandfather, Melchisedek Meredith, clearly suggested the "Old Mel" of *Evan Harrington*. Melchisedek was 35 when, in 1796, he was initiated as a freemason at Portsmouth; and he appears to have been known locally as "the count," because of a romantic story as to an adventure at Bath; he was church warden in 1801 and 1804; and some of the church plate bears his name.

Meredith's mother died when he was three years old, and he was made a ward in chancery. He was sent to school at Neuwied on the Rhine, and remained in Germany till he was 16. During these impressionable years he imbibed a good deal of the German spirit; and German influence, especially through the media of poetry and music, can often be traced in the cast of his thought and sentiment, as well as in some of the intricacies of his literary style. Returning to England he was at first articled to a solicitor in London, but he had little inclination for the law, and soon abandoned it for the more congenial sphere of letters, of which he had become an eager student. At the age of 21 he began to contribute poetry to the magazines, and he eked out a livelihood for some years by journalism, on the *Daily News* and other London papers, and for the *Ipswich Journal*, for which he wrote leaders; a certain number of his more characteristic fugitive writings are collected in the memorial edition of his works (1909–11). In London he became one of the leading spirits in the group of young philosophical and positivistic Radicals, among whom were John (afterwards Lord) Morley, Frederic Harrison, Cotter Morison and Admiral Maxse. But during the years when he was producing his finest novels he was practically unknown to the public. In 1849 he married Mrs. Nicholls, daughter of Thomas Love Peacock, the novelist, a widow, eight years his senior, whose husband had been accidentally drowned a few months after her first marriage (1844), and who had one child, a daughter; but their married life was broken by separation; she died in 1861, and in 1864 Meredith married Miss Vulliamy, by whom he had a son and daughter. His second wife died in 1885. Up to that time there is little to record in the incidents of his life; he had not been "discovered" except by an "honourable minority" of readers and critics. It must suffice to note that during the Austro-Italian War of 1866 he acted as special correspondent for the *Morning Post*; and though he saw no actual fighting, he enjoyed, particularly at Venice, opportunities for a study of the Italian people which he turned to account in several of his novels. Towards the close of 1867, when his friend John Morley paid a visit to America, Meredith undertook in his absence the editorship of the *Fortnightly Review* for Messrs. Chapman and Hall. They were not only the publishers of his books, but he acted for many years as their literary adviser, in which capacity he left a reputation for being not only eminently wise in his selection of the books to be published, but both critical and encouraging to authors of promise whose works he found himself obliged to reject. Thomas Hardy and George Gissing were among those who expressed their grateful sense of his assistance. He was indeed one of the last of the old school of "publishers' readers." In his early married life he lived near Weybridge, and later at Copsham between Esher and Leatherhead, while soon after his second marriage he settled at Flint cottage, Mickleham, near Dorking, where he remained for the rest of his life.

EARLY WORK

Meredith's first appearance in print was in the character of a poet, and his first published poem "Chillian Wallah," may be found in *Chambers's Journal* for July 7, 1849. Two years later he put forth a small volume of *Poems* (1851), which was at least fortunate in eliciting the praise of two judges whose opinion was of the first importance to a beginner. Tennyson was at once struck by the individual flavour of the verse, and declared of one poem, "Love in the Valley," that he could not get the lines out of his head. Charles Kingsley's eulogy was at once more public and more particular. In *Fraser's Magazine* he subjected the volume to careful consideration, praising it for richness and quaintness of tone that reminded him of Herrick, for completeness and coherence in each separate poem, and for the animating sweetness and health of the general atmosphere. At the same time he censured the laxity of rhythm, the occasional lack of polish, and the tendency to overload the description with objective details to the confusion of the principal effect. No doubt as a result of Kingsley's introduction, two poems by Meredith appeared in *Fraser's Magazine* shortly afterwards; but apart from these, and a sonnet in the *Leader*, he published nothing for five years.

In the meanwhile he was busy upon his first essay in prose fiction. It was on Dec. 19, 1855, that the *Shaving of Shagpat*, a work of singular imagination, humour and romance, made its appearance. Modelled upon the stories of the *Arabian Nights*, it catches with wonderful ardour the magical atmosphere of Orientalism, and in this genre it remains a unique triumph in modern letters. Though unappreciated by the multitude, its genius was at once recognized by such contemporaries as George Eliot and Dante Gabriel Rossetti, the latter of whom was one of Meredith's intimate friends. For his next story it occurred to Meredith to turn his familiarity with the life and legendary tradition of the Rhinelander into a sort of imitation of the grotesquerie of the German romanticists, and in 1857 he put forth *Farina, a Legend of Cologne*, which sought to transfer to English sympathies the spirit of German romance in the same way that *Shagpat* had handled oriental fairy-lore. The result was less successful. The plot of *Farina* lacks fibre, its motive is insufficient, and the diverse elements of humour, serious narrative, and romance scarcely stand in proportion to one another. But the *Ordeal of Richard Feverel*, which followed in 1859, transferred Meredith at once to a new sphere and to the altitude of his accomplishment. With this novel Meredith deserted the realm of fancy for that of the philosophical and psychological study of human nature, and *Richard Feverel* was the first, as it is perhaps the favourite, of those wonderful studies of motive and action which placed him among the literary demigods. It depicts the abortive attempt of an opinionated father to bring up his son to a perfect state of manhood through a "system" which controls his circumstances and represses the natural instincts of adolescence. The love scenes in *Richard Feverel* are gloriously natural and the book marked a revolution in the English treatment of manly passion. Certain chapters were omitted from later editions. In the following year Meredith contributed to *Once a Week*, and published in America (1860; 1st English edition 1861) as a book the second of his novels of modern life, *Evan Harrington*, originally with the subtitle "He Would be a Gentleman"—in allusion to the hero being the son of "Old Mel," the tailor—which contains a richly humorous—in its unrevised form, splendidly farcical—plot, with some magnificent studies of character. Afterwards revised, a certain amount of the farcical element was cut out, with the result

that, considered as comedy, it has weak spots; but the countess de Saldar remains a genuine creation. In 1862 he produced his finest volume of poems, entitled *Modern Love, and Poems of the English Roadside, with Poems and Ballads*. An attack upon the dramatic poem which gives the volume its title appeared in the *Spectator*, and is memorable for the fact that Meredith's friend, the poet Swinburne, with one of his characteristically generous impulses, replied (*Spectator*, June 7, 1862), in a spirit of fervent eulogy. Some of the "sonnets" (of 16 lines) into which *Modern Love* is divided rank with the most subtle and intense poetic work of the 19th century.

Returning to fiction, Meredith next published *Emilia in England* (1864), afterwards renamed *Sandra Belloni* (1886). His powerful story *Rhoda Fleming* (1865) followed soon afterwards. *Vittoria*, published in the *Fortnightly Review* in 1866, and in book form in 1867, is a sequel to *Emilia in England*. Four years later appeared *The Adventures of Harry Richmond* in the pages of *Cornhill* (1870–71). Its successor was *Beauchamp's Career* (*Fortnightly Review*, 1874–75), the novel which Meredith usually described as his own favourite. Its hero's character is supposed to have been founded upon that of Admiral Maxse. *Sandra Belloni*, *Rhoda Fleming*, *Vittoria* and *Beauchamp* are all masterpieces of his finest period, rich in incident, character and workmanship. "The House on the Beach" and "The Case of General Opie and Lady Camper" (*New Quarterly Magazine*, 1877) were slight but glittering exercises in comedy; the next important novel was *The Egoist* (1879), which shows an increase in Meredith's twistedness of literary style and is admittedly hard to read for those who merely want a "story," but which for concentrated analysis and the real drama of the human spirit is an astounding production. In an interesting series of lectures which Meredith delivered at the London Institution in 1877, his main thesis was that a man without a sense of comedy is dead to the finer issues of the spirit, and the conception of Sir Willoughby Patterne, the central figure of *The Egoist*, is an embodiment of this idea in the flesh. *The Tragic Comedians* (1880), the next of Meredith's novels, slighter in texture than his others, combines the spirits of comedy and tragedy in the story of the life of Ferdinand Lassalle, the German Socialist. The appearance of *Diana of the Crossways* (1885), a brilliant book, full of his ripest character-drawing, though here and there tormenting the casual reader by the novelist's mannerisms of expression, marks an epoch in Meredith's career, since it was the first of his stories to strike the general public. Its heroine was popularly identified with Sheridan's granddaughter, Mrs. Norton, and the use made in it of the contemporary story of that lady's communication to *The Times* of the cabinet secret of Peel's conversion to Free Trade had the effect of producing explicit evidence of its inaccuracy from Lord Dufferin and others. As a matter of historical fact it was Lord Aberdeen who himself gave Delane the information.

Meanwhile further instalments of poems—*Poems and Lyrics of the Joy of Earth* (1883)—had struck anew the full, rich note of natural realism which is Meredith's chief poetic characteristic. "The Woods of Westermain," in particular, has that sense of the mysterious communion of man with nature which is found in the poetry of Wordsworth and Shelley. *Ballads and Poems of Tragic Life* (1887) and *A Reading of Earth* (1888) gave further evidence of the wealth of thought and vigour of expression which Meredith brought to the making of verse. His readers, of the verse even more than of the prose, must be prepared to meet him on a common intellectual footing. When once that is granted, however, the music and magic of such poems as "Seed-time," "Hard Weather," "The Thrush in February," "The South-Wester," "The Lark Ascending," "Love in the Valley," "Melampus," "A Faith on Trial," are very real, amid all their occasional obscurities of diction.

Meredith had now completed his 60th year, and with his advancing years the angles of his individuality began to grow sharper, while the difficulties of his style became accentuated. The increase in mannerism was marked in *One of Our Conquerors* (1891), otherwise a magnificent rendering of a theme full of both tragedy and comedy, in the poem of "The Empty Purse" (1892) and in *Lord Ormont and His Aminta* (1894). In *The Amazing Marriage* (1895) he seemed to catch an afterglow of genius. In 1898 appeared his *Odes in Contribution to the Song of French History*, consisting of one ode ("France, Dec. 1870") reprinted from *Ballads and Poems* (1871), and three other previously unpublished; a fine example of his lofty thought, and magnificent—if often difficult—and individual diction. In 1901 another volume of verse, *A Reading of Life*, appeared. In later years, too, he contributed occasional poems to newspapers and reviews and similar publications, which were collected after his death (*Last Poems*, 1910). His comedy, *The Sentimentalists*, was performed on March 1, 1910; his early but unfinished novel, *Celt and Saxon*, was also posthumously published in that summer.

Now famous, Meredith was chosen to succeed Tennyson as president of the Authors' Society; on his 70th birthday (1898) he was presented with a congratulatory address by 30 prominent men of letters; he received the Order of Merit; and new editions of his books (both prose and verse), for which there had long been but scanty demand, were called for. One of the results was that Meredith, with very doubtful wisdom, recast some of his earlier novels; and in the sumptuous "authorized edition" of 1897 (published by the firm of Constable, of which his son, William Maxse Meredith, was a member) very large alterations are made in some of them. It meant the excision in old age of some of the most virile passages of books that were written in the full glow and vigour of his prime. In Constable's memorial edition (1910) of his complete works the excisions were published separately.

HIS STYLE AND PHILOSOPHY

Meredith's literary quality must always be considered in the light of the Celtic side of his temperament and the peculiarities of his mental equipment. His nature was intuitive rather than ratiocinative; his mental processes were abrupt and far-reaching; and the suppression of connecting associations frequently gives his language, as it gave Browning's, but even to a greater extent, the air of an impenetrably nebulous obscurity. This criticism applies mainly to his verse, but is also true of his prose in many places, though there is much exaggeration about the difficulties of his novels. When once, however, his manner has been properly understood, it is seen to be inseparable from his method of intellection, and to add to the narrative of description both vividness of delineation and intensity of realization. But when Meredith is at his best he is only involved with the involution of his subject; the aphorisms that decorate his style are simple when the idea they convey is simple, elaborate only in its elaboration. Pregnant, vividly graphic, capable of infinite shades and gradations, his style is a much finer and subtler instrument than at first appears, and must be judged finally by what it conveys to the mind, and not by its superficial sound upon the conventional ear. It owes something to Jean Paul Richter; something, too, to Carlyle, with whose methods of narrative and indebtedness to the apparatus of German metaphysics it has a good deal in common. To the novelist Richardson, too, a careful reader will find that Meredith, both in manner and matter (notably in *The Egoist* and in *Richard Feverel*), owes a good deal; in "Mrs. Grandison" in *Richard Feverel* he even recalls "Sir Charles Grandison" by name; and nobody can doubt that Sir Willoughby Patterne, both in idea and often in expression, was modelled on Richardson's creation. Careful students of the early 19th century English novel will find curious echoes again in Meredith of Bulwer-Lytton's (Baron Lytton's) literary manner and romantic outlook.

The philosophy which represents Meredith's "criticism of life," is broadly speaking a belief in the rightness and wholesomeness of Nature, when Nature—"Sacred Reality"—is lovingly and faithfully and trustfully sought and known by the pure use of reason. Man must be "obedient to Nature, not her slave." Mystical as this philosophy occasionally becomes, it is yet an inspiring one, clean, austere and practical; and it is always dominated by the categorical imperative of self-knowledge and the striving after honesty of purpose and thought. A strong vein of political Radicalism runs through Meredith's creed. It is, how-

ever, a Radicalism allied to that of the French *philosophes*, rather than to the contemporary developments of British party politics, though in later life he gave his open support to the Liberal Party. In spite of his German upbringing Meredith was always strongly French in his sympathies, and his appreciation of French character at its best and at its worst is finely shown in his Napoleon odes.

Meredith died at Flint cottage, Box hill, Surrey, on May 18, 1909. A strong feeling existed that he should be buried in Westminster Abbey, and a petition to that effect, which was approved by the prime minister, H. H. Asquith, was signed by a large number of men of letters. But this was not to be. A memorial service was held in the abbey, but Meredith's own remains, after cremation, were interred at Dorking by the grave of his second wife. He died just after his old friend Swinburne.

(H. C.)

Bibliography.—The first edition of Meredith's collected works was published by Messrs. Chapman and Hall (1885–95); other editions are the edition de luxe (39 vols., 1896–1912), the library edition (18 vols., 1897–1910), the memorial edition (27 vols., 1909–11), and the standard edition (1914, etc.), all published by Messrs. Constable. *The Poetical Works of George Meredith* were published with notes by G. M. Trevelyan (1912). *See* M. B. Forman, *Bibliography of the Writings in Prose and Verse of George Meredith* (1922) and *Meredithiana* (1924). *The Letters of George Meredith* have been collected and edited by his son, W. M. Meredith (2 vols., 1912); *see* also *Letters to Edward Clodd and Clement K. Shorter* (1913); *Letters to Richard Henry Horne* (Cape Town, 1919); *Letters to Swinburne and Watts-Dunton* (Cape Town, 1922); *Letters to Various Correspondents* (Pretoria, 1924); *Letters to Alice Meynell, . . . 1896–1907* (Nonesuch Press, 1923). For biography and criticism *see* R. Le Gallienne, *George Meredith: Some Characteristics* (1890), which includes a bibliography by John Lane; M. Sturge Henderson, *George Meredith, Novelist, Poet, Reformer* (1907); G. M. Trevelyan, *The Poetry and Philosophy of George Meredith* (1912); C. Photiades, *George Meredith sa vie* (1910, Eng. trans. 1913); Lady Alice M. Butcher, *Memories of George Meredith* (1919); R. Galland, *George Meredith and British Criticism* (1923); J. B. Priestly, *George Meredith* (1926); Robert E. Sencourt, *The Life of George Meredith* (1929).

MERES, FRANCIS (1565–1647), English divine and author, was born at Kirton in the Holland division of Lincolnshire in 1565. He was educated at Pembroke college, Cambridge. His kinsman, John Meres, was high sheriff of Lincolnshire in 1596, and apparently helped him in the early part of his career. In 1602 he became rector of Wing in Rutland, where he had a school. He died on Jan. 29, 1647. Meres rendered immense service to the history of Elizabethan literature by the publication of his *Palladis Tamia, Wits Treasury* (1598). The *Palladis Tamia* contained moral and critical reflections borrowed from various sources, and embraced sections on books, on philosophy, on music and painting, and a famous "Comparative Discourse of our English poets with the Greeke, Latin and Italian poets." This chapter enumerates the English poets from Chaucer to Meres's own day, and in each case a comparison with some classical author is instituted. The book was issued in 1634 as a school book, and has been partially reprinted in the *Ancient Critical Essays* (1811–15) of Joseph Haslewood, Prof. E. Arber's *English Garner*, and Gregory Smith's *Elizabethan Critical Essays* (1904).

MEREZHKOVSKY, DMITRI SERGEIEVICH (1865–), Russian novelist and critic, was born in St. Petersburg (Leningrad) on Aug. 2, 1865, the son of a court official, and graduated from St. Petersburg university. He married Zinaida Hippius, the poet (*q.v.*). His first volume of poetry, published in 1888, was followed by more poetry, *Vera, Sakya Muni, Avakum, Black Angel*, etc., by translations from Euripides and other Greek classics, by literary essays on Russian and foreign writers, *Eternal Companions* (1897), and by a trilogy of historical romances collectively entitled *Christ and Antichrist* and consisting of *Smert Bogov* (1895, Eng. trans. *The Death of the Gods*, 1901, popular ed. 1926), the central figure of which is Julian the Apostate; *Voskresenie Bogi* (1902, Eng. trans. *The Forerunner*, 1902; repr. 1924), which described the life and times of Leonardo da Vinci; and *Antikhrist: Pëtr i Aleksyey* (1905, Eng. trans. *Peter and Alexis*, 1905), based on the story of the relations between Peter the Great and his son. After the "trilogy" came the novels *Alexander I.* (1911, French trans. 5th ed. 1922), *December 14* (1920, Eng. trans. 1923), and in connection with the Tutankhamun excavations, *The Birth of the Gods* (Eng. trans. 1925), followed by *Akhnaton* (Eng. trans. 1927).

About 1900–02 Merezhkovsky evolved a mystic, neo-Christian or apocalyptic teaching, based on the equal sanctity of flesh and spirit as opposed to the cult of the flesh as represented by paganism, and the cult of the spirit as revealed by ecclesiastical Christianity. The influence of Sienkiewicz can be traced in many of Merezhkovsky's writings, which include critical studies such as *Tolstoï and Dostoïevsky* (2 vols., 1901–02). He also wrote on religious, political and social questions, and published several plays, including *Paul I.* (1908) and *Carewicz Aleksy* (Warsaw, 1921), a tragedy in five acts. After the revolution he left Russia and went to live in Paris, where he continued to write.

Merezhkovsky's collected works were published in 24 vols. in 1914. *See* also J. Chuzeville, *Dmitri Merezhkovsky* (1922).

MERGANSER, the name applied to a group of fish-eating ducks forming the subfamily *Merginae* of the *Anatidae*. Mergansers have long, narrow beaks, with a small hook at the tip and the edges beset with denticulations. There is a crest on the head, and the legs are set far back on the body. The birds have great diving power.

The largest species is the goosander (*Mergus merganser*), found throughout the northern parts of the world. In breeding plumage the male is a very beautiful bird. *M. serrator*, the red-breasted merganser, has the same range as the last but is smaller. In both the bill and feet are orange. *M. albellus*, the smew, is smaller still and confined to the old world. The feet are dull grey and the breeding plumage predominantly white. *M. cucullatus*, intermediate in size between the last two, is the hooded merganser of N. America. Other species inhabit S. America and the Antarctic.

Differing in possessing spiny tails and spurred wings are the S. American torrent-ducks (*Merganetta*).

MERGENTHEIM, a town of Germany, in the republic of Württemberg, situated in the valley of the Tauber, 7 m. S. from Lauda by rail. Pop. (1925) 5,430. Mergentheim (*Mariae domus*) is mentioned in chronicles as early as 1058, as the residence of the counts of Hohenlohe, who early in the 13th century assigned the greater part of their estates in and around Mergentheim to the Teutonic Order. On the secularization of the Order in Prussia in 1525, Mergentheim became the residence of the grand master, and remained so until the final dissolution of the Order in 1809. The town contains a castle with a natural history collection and the archives of the Teutonic Order. The industries include tanning, the manufacture of agricultural machinery and brewing.

MERGER, in law, the sinking or "drowning" of a lesser estate in a greater, when the two coalesce in one and the same person without any intervening estate, as, *e.g.*, when the tenant for life becomes owner of the absolute freehold. The term is also used for the extinguishment of any right, contract, etc., by absorption in another, *e.g.*, the acceptance of a higher security for a lower, or the embodying of a simple contract in a deed.

Merger in Industry.—The term merger is one that is used in the United States to denote the large industrial or commercial concern which results from a "merging" of previously independent and probably competing concerns in the same line of business. It corresponds almost exactly with the British term "combine" and, like "combine," enjoys the peculiarity of being a term in widespread use which is seldom, if ever, found in the registered title of the type of organization to which it is applied. Prominent among the objects for which firms are "merged" is the suppression of competition between them and its replacement by a unified control which, in cases where the merger gathers into one consolidated interest the bulk of the output of an industry, becomes a control over the price at which the product shall be sold. The merger is one of the several forms of monopolistic organization which has come into being as the result of the persistent movement from competition to combination. (*See* Amalgamation; Combination; Fusion; Monopoly; Trusts and Cartel.)

MERGUI, the southernmost district of Burma, in the Tenasserim division, bounded on the west by the Andaman sea of the

Bay of Bengal and on the east by Siam. Area 9,789 sq.m. Two principal ranges cross the district from north to south, running almost parallel to each other for a considerable distance, with the Tenasserim river winding between them till it turns south and flows through a narrow rocky gorge in the westernmost range to the sea. The whole district, from the water's edge to the loftiest mountain on the eastern boundary, may be regarded as almost unbroken forest. The timber trees found towards the interior, and on the higher elevations, are of great size and beauty, the most valuable being the teak (*Tectona grandis*) of the drier, sheltered valleys only, *thin-gan* (*Hopea odorata*), *ka-gnyeng* (*Dipterocarpus laevis*), etc. The coast-line of the district, off which lies an archipelago of two hundred and seven islands, is much broken, and for several miles inland is very little raised above sea-level, and is drained by numerous muddy tidal creeks. Southwards of Mergui town it consists chiefly of low mangrove swamps alternating with small fertile rice plains. After passing the mangrove limits, the ground to the east gradually rises till it becomes mountainous, even to the banks of the rivers, and finally culminates in the grand natural barrier dividing Burma from Siam. The four principal rivers are the Tenasserim, Le-nya, Pakchan and Palauk, the first three being navigable for a considerable distance. Coal is found on the banks of the Tenasserim and its tributaries, but is little worked. Gold, copper, iron and manganese are also found in various parts of the district, and there are tin mines at Maliwun and elsewhere, but the tin mines are less important than in the Tavoy district to the north.

From the notices of early travellers it appears that Mergui, when under Siamese rule, before it passed to the Burmese, was a rich and densely peopled country. On its occupation by the British in 1824–1825 it was found to be almost depopulated—the result of border warfare and of the cruelties exercised by the Burmese conquerors. At that time the entire inhabitants numbered only 10,000. Pop. (1921), 135,465, showing an increase of 24,091 in the decade and giving a density of 14 inhabitants to the square mile. Mergui carries on a flourishing trade with Rangoon and the Straits Settlements. The chief exports consist of rubber, tin ore, rice, rattans, dried fish, areca-nuts and edible birds' nests. The staple imports are piece goods, tobacco, cotton, earthenware, tea and sugar. The climate is remarkably healthy, the heat due to its tropical situation being moderated by land and sea breezes. The rainfall is very heavy and usually exceeds 150 inches, the dry season is short, so that these two factors combined have led to the development of rubber planting.

Mergui town has risen into prominence in recent years as the centre of the rubber and tin ore exporting trade, which has eclipsed its earlier importance as the centre of the pearling trade in the neighbouring archipelago. Pop. (1921), 17,297.

MERGUI ARCHIPELAGO, a cluster of islands in the Andaman sea, near the southern coast of Lower Burma. They are chiefly noted for their picturesque beauty, some of them rising to 3,000 feet. They are only sparsely inhabited by the island race of Selungs and by Burmans.

MERIAN, MATTHEW (1593–1650), Swiss engraver, was born in Basle on Sept. 25, 1593. In 1609 he was placed under Dietrich Meyer, a painter and engraver of Zürich, and in 1613 went to Nancy, where he worked at copper-engraving. After studying in Paris, Stuttgart (1616), and the Low Countries, he came to Frankfurt, where in 1618 he married the eldest daughter of J. T. de Bry, publisher, bookseller, and engraver. After working for some time with his father-in-law at Oppenheim, Merian returned to Basle, but came back to Frankfurt after Bry's death (1623), to take over his business. This remained in his family till 1726, when a great fire wiped it out of existence. In 1625 Merian became a burgher of Frankfurt, then the great centre of the book trade in Germany. He lived there till his death on June 22, 1650. He published a series of *Topographia*, with text by Martin Zeiller, an Austrian; and copper-plate illustrations furnished chiefly by Merian. The first volume, dealing with Switzerland, the Grisons, and the Valais contains the earliest known view of the glaciers of Grindelwald. He published a series of illustrations to the Bible (1625–30), and a *Dance of Death* (1649); and began (1635) the series *Theatrum Europaeum*.

See Life by H. Eckardt (Basle, 1887).

MÉRIDA, a city of Mexico and capital of the State of Yucatan, 23 m. by rail S. of Progreso, its port on the Gulf of Mexico. Pop. (1921) 79,225, the Maya element being predominant. Mérida is the centre of an isolated railway system, connected with the ports of Progreso and Campeche, and having short lines (chiefly narrow gauge, private lines) radiating in all directions to Peto, Valladolid and Izamal. It stands on a broad plain situated near the northern border of the peninsula, where the thin loose soil covering a limestone foundation permits the rapid percolation of the rainfall, and as a natural consequence supports a comparatively scanty vegetation. It is highly favourable to maguey cultivation, however, and Mérida is the centre of the henequén, or sisal fibre industry. There is an imposing 16th-century cathedral facing upon the principal plaza, a Franciscan convent, dating from 1547, and also an old university, with schools of law, medicine and pharmacy, an episcopal seminary and a number of other educational institutions. The exports are sisal, hides, sugar, rum, chicle and indigo. Mérida was founded in 1542 by the younger Francisco de Montejo on the site of a native city called Tihoo, or Thó, whose stone pyramids furnished building material in abundance for the invaders.

MÉRIDA (anc. *Augusta Emerita,* capital of Lusitania), a town of western Spain, in the province of Badajoz, on the right bank of the river Guadiana, 30 m. E. of Badajoz. Pop. (1920) 15,502. Mérida is an important railway junction, for here the Madrid-Badajoz railway meets the lines from Seville, Huelva and Cáceres. Augusta Emerita was founded in 25 B.C. As the capital of Lusitania it soon became one of the most splendid cities in Iberia, and was large enough to contain a garrison of 90,000 men. In 1129 its archbishopric was formally transferred to Santiago de Compostela, and in 1228, when Alphonso IX. of Leon expelled the Moors, Mérida was entrusted to the order of Santiago, in whose keeping it soon sank into decadence. Chief among the Roman remains is the bridge, constructed of granite under Trajan, or Augustus, and restored by the Visigoths in 686 and by Philip III. in 1610. It comprised 81 arches, 17 of which were destroyed during the siege of Badajoz (1812), and measured 2,575 ft. in length. There are a few remnants of Roman temples and of the colossal wall which encircled the city, besides a Roman triumphal arch, commonly called the Arco de Santiago, and a second Roman bridge, by which the road to Salamanca was carried across the small river Albarregas (*Alba Regia*). The Moorish *alcázar* or citadel was originally the chief Roman fort. From the Lago de Proserpina, or Charca de la Albuera, a large Roman reservoir, 3 m. N., water was conveyed to Mérida by an aqueduct, of which there are extensive remains. The massive Roman theatre is in good preservation; there are also a few vestiges of an amphitheatre and of a circus which measured 485 yd. by 120. Other Roman remains are exhibited in the archaeological museum.

MERIDEN, a city of New Haven county, Connecticut, U.S.A., midway between New Haven and Hartford, on Federal highway 5 and the New York, New Haven and Hartford Railroad. The population was 29,867 in 1920 (26% foreign-born white) and was 38,481 in 1930 by the Federal census. The city occupies 16·4 sq.m. and is traversed by the Quinnipiac river and Harbor Brook. West Peak State Park, with hills 700 ft. above sea-level, is on its north-west border. It is the seat of the Connecticut school for boys and of a State tuberculosis sanatorium. The assessed valuation in 1927 was $48,931,165. Meriden has a great variety of manufacturing industries, with an output in 1925 valued at $37,627,656, and is especially noted for its silverware, both sterling and plated. Samuel Yale began the manufacture of pewter and Britannia ware here in 1794. In 1847 the Rogers Brothers invented a process of depositing silver on other metals by electricity, and shortly afterward united with the Meriden Britannia Company to found the house which still operates under their name. The town of Meriden was separated from Wallingford and incorporated in 1806; the city was chartered in 1867; and in 1922 town and city were consolidated. The oldest building in the city is the Goffe House (1711).

MERIDIAN, a city of eastern Mississippi, U.S.A., county seat of Lauderdale county; 140 m. S.W. of Birmingham (Alabama). It is on Federal highways 11, 45 and 80, and is served by the Gulf, Mobile and Northern, the Illinois Central, the Mobile and Ohio and the Southern railways. In 1920 it was the largest city of the State; population then was 23,399 (36% negroes); in 1930 it was 31,954 by Federal census. The city lies in a valley of wooded hills, streams and lakes, in a lumbering and agricultural region of diversified products, including cotton, bright-leaf tobacco, corn, oats, strawberries, peaches, grapes, figs, hogs, dairy cattle and poultry. It has 15 wholesale houses, the only stock-yards in the State, and a retail trade territory with a 75 m. radius. There are large railway shops, cotton gins and compresses, cottonseed-oil mills, lumber mills, brick plants, canneries and knitting mills. The factory output in 1925 was valued at $8,630-636. Hydro-electric power is available. The city has an assessed valuation of $22,836,623 (1927). Meridian was laid out in 1854, and chartered as a city in 1860. On Feb. 14, 1864, General Sherman entered the city and within a week destroyed most of it. The "Meridian riot" of 1871 was a prominent episode of the Reconstruction period. On March 2, 1906, a cyclone caused great loss of life and property. A commission form of government was adopted in 1913.

MERIDIAN, in general a direction towards the south or towards the position of the sun at mid-day. Geographical meridians are the great circles drawn on the earth's surface which pass through the Poles, and thus pass through all places having the same longitude. The meridian of Greenwich (the great circle passing through Greenwich Observatory and the two Poles) is the zero from which terrestrial longitudes are reckoned. In astronomy the meridian is the great circle through the Pole and the zenith; it intersects the horizon in the north and south points.

MERIDIAN HIGHWAY, an American highway which, as its name implies, extends north and south from Canada to Mexico about midway between the Atlantic and Pacific oceans. It is gravelled, hard or paved its entire length of 1,769 miles. Winnipeg, Canada, is its northern terminus, whence it passes through Fargo, N.D., Watertown, S.D., Norfolk, Neb., Wichita, Kan., Chickasha, Okla. and Fort Worth and Austin to Laredo, Tex.

MERIKANTO, OSKAR (1868–1924), Finnish composer, was born at Helsingfors on Aug. 5, 1868. He received his musical education in Leipzig and Berlin. Returning to Finland he began to write operas, drawing his subjects from the legends of his country. In 1911 he was appointed conductor of the opera at Helsingfors. Outside Finland he is best known for his very beautiful Finnish songs. Besides the three operas, *Daughter of Pohja, The death of Elina, Queen of Emmeritz,* he wrote organ music and some choral works. He died at Helsingfors on Feb. 17, 1924.

MÉRIMÉE, PROSPER (1803–1870), French novelist, archaeologist, essayist, and in all these capacities one of the greatest masters of French style during the 19th century, was born at Paris on Sept. 28, 1803. His grandfather, of Norman extraction, had been a lawyer and steward to the maréchal de Broglie. His father, Jean François Léonor Mérimée (1757–1836), was a painter of repute. Mérimée had English blood in his veins on the mother's side, and had English proclivities in many ways. He was educated for the bar, but entered the public service instead. A young man at the time of the Romantic movement, he felt its influence strongly, though his peculiar temperament prevented him from joining any of the coteries of the period. Nothing was more prominent among the romantics than the fancy, as Mérimée himself puts it, for "local colour," the more unfamiliar the better. He exhibited this in an unusual way. In 1825 he published what purported to be the dramatic works of a Spanish lady, Clara Gazul, with a preface stating circumstantially how the supposed translator, one Joseph L'Estrange, had met the gifted poetess at Gibraltar. This was followed by a still more audacious and still more successful *supercherie.* In 1827 appeared a small book entitled *la Guzla* (the anagram of Gazul), and giving itself out as translated from the Illyrian of Hyacinthe Maglanovich.

This book, which has greater formal merit than *Clara Gazul,* is said to have taken in Sir John Bowring, a competent Slav scholar, and the Russian poet Pushkin, but, as Mérimée declares, a few words of Illyrian and a book or two of travels and topography were the author's only materials. In the next year appeared a short dramatic romance, *La Jacquerie,* in which is visible Mérimée's faculty of local and historical colour. This was followed by the *Chronique de Charles IX.* (1829).

He had already obtained a considerable position in the civil service, and after the revolution of July he was *chef de cabinet* to two different ministers. He was then appointed to the more congenial post of inspector-general of historical monuments. He did not, however, neglect novel writing during this period, and numerous short tales appeared, chiefly in the *Revue de Paris.* The best of all, *Colomba,* a Corsican story of extraordinary power, appeared in 1840. He travelled a good deal; and in one of his journeys to Spain, about the middle of Louis Philippe's reign, he made an acquaintance destined to influence his future life not a little—that of Mme. de Montijo, mother of the future empress Eugénie.

Mérimée, though in manner and language the most cynical of men, was a devoted friend, and shortly before the accession of Napoleon III. he had occasion to show this. His friend, Libri Carucci dalla Sommaja, was accused of having stolen valuable manuscripts and books from French libraries, and Mérimée took his part so warmly that he was actually sentenced too, and underwent fine and imprisonment. Between 1840 and 1850 he wrote more tales, the chief of which were *Arsène Guillot* and *Carmen* (1847), this last, on a Spanish subject, hardly ranking below *Colomba.*

The marriage of Napoleon III. with the daughter of Mme. de Montijo at once enlisted what was always strongest with Mérimée—the sympathy of personal friendship—on the emperor's side. He was made a senator, but his most important rôle was that of a constant and valued private friend of both the "master and mistress of the house," as he calls the emperor and empress in his letters. He was occasionally charged with a kind of irregular diplomacy, and once, in the matter of the emperor's *Caesar,* he had to give literary assistance to Napoleon.

At this time he wrote the letters which have been published as *Lettres à une inconnue,* and also the letters addressed to Sir Anthony Panizzi, librarian of the British Museum. After various conjectures it seems that the *inconnue* just mentioned was a certain Mlle. Jenny Daqin of Boulogne. The acquaintance extended over many years.

Both series, and others since published, abound in gossip, in amusing anecdotes, in sharp literary criticism, while both contain evidences of a cynical and Rabelaisian or Swiftian humour which was very strong in Mérimée. This characteristic is said to be so prominent in a correspondence with another friend, which now lies in the library at Avignon, that there is but little chance of its ever being printed. A fourth collection of letters, of much inferior extent and interest, has been printed by Blaze de Bury under the title of *Lettres à une autre inconnue* (1873), and others still by d'Haussonville (1888), and in the *Revue des Deux Mondes* (1896). In the latter years of his life Mérimée suffered very much from ill-health. He died at Cannes September 23, 1870.

Mérimée's character was a peculiar and in some respects an unfortunate one, but by no means unintelligible. Partly by temperament, partly it is said owing to some childish experience, when he discovered that he had been duped and determined never to be so again, not least owing to the example of Henri Beyle (Stendhal), who was a friend of his family, Mérimée appears at an early age to have imposed upon himself as a duty the maintenance of an attitude of sceptical indifference and sarcastic criticism.

All his literary work has the Renaissance character. It is tolerably extensive, amounting to some seventeen or eighteen volumes, but its bulk is not great for a life which was not short, and which was occupied, at least nominally, in little else. About a third of it consists of the letters already mentioned. Rather more than another third consists of the official work which has been already alluded to—reports, essays, short historical sketches, the chief of which latter is a history of Pedro the Cruel (1843),

and another of the curious pretender known in Russian story as the false Demetrius (1852). Some of the literary essays, such as those on Beyle, on Turgeniev, etc., where a personal element enters, are excellent. Against others and against the larger historical sketches—admirable as they are—Taine's criticism that they want life has some force. In purely archaeological matters his *Description des peintures de Saint-Savin* is noteworthy.

It is, however, in the remaining third of his work, consisting entirely of tales either in narrative or in dramatic form, and especially in the former, that his full power is perceived. He translated a certain number of things (chiefly from the Russian); but his fame does not rest on these, on his already-mentioned youthful *supercheries*, or on his later semi-dramatic works. There remain about a score of tales, extending in point of composition over exactly forty years and in length from that of *Colomba*, the longest, which fills about one hundred and fifty pages, to that of *l'Enlèvement de la redoute* (1829), which fills just half a dozen. They are unquestionably the best things of their kind written during the century, the only *nouvelles* that can challenge comparison with them being the very best of Gautier, and one or two of Balzac. The motives are sufficiently different. In *Colomba* and *Mateo Falcone* (1829), the Corsican point of honour is drawn on; in *Carmen* (written apparently after reading Borrow's Spanish books), the gipsy character; in *la Venus d'Ille* (1837) and *Lokis* (two of the finest of all), certain grisly superstitions.

Arsène Guillot is a singular satire, full of sarcastic pathos, on popular morality and religion; *la Chambre bleue*, an 18th-century *conte*, worthy of C. P. J. Crébillon for grace and wit, and superior to him in delicacy; *The Capture of the Redoubt* just mentioned is a perfect piece of description; *l'Abbé Aubain* is again satirical; *la Double méprise* (the authorship of which raised objections to Mérimée when he was elected to the Academy) is an exercise in analysis strongly impregnated with the spirit of Stendhal, but better written than anything of that writer's. These stories, with his letters, assure Mérimée's place in literature at the very head of the French prose writers of the century. He had undertaken an edition of Brantôme for the Bibliothèque Elzévirienne, but it was never completed. (G. SA.)

BIBLIOGRAPHY.—*Oeuvres Complètes* (ed. P. Trahard and E. Champion, 1927, etc.); *See* also a selected edition published by Nelson (1927); the collections of MM. Charpentier and Calmann Lévy; M. Tourneux, *Prosper Mérimée: sa bibliographie* (1876), and *Prosper Mérimée: ses portraits, sa bibliothèque* (1879); L. Pinvert, *Sur Mérimée. Notes bibliographiques et critiques* (1908). For reviews and criticisms, see *Chronique de Charles IX.* (trans. by G. Saintsbury, with an introduction, 1889), and the essay, containing a review of Mérimée's entire work, prefixed by the same writer to an American translation; A. Filon, *Mérimée et ses amis* (1894); Walter Pater, "Prosper Mérimée" in *Studies in European Literature. Taylorian Lectures 1889–1899* (1900); V. M. Jovanović, *"La Guzla" de Prosper Mérimée. Étude d'histoire romantique* (1911); E. Falcke, *Die romantischen Elemente in Prosper Mérimées Roman und Novellen*, Romantische Arbeiten, No. 6 (1915); P. Trahard, *Prosper Mérimée et l'art de la nouvelle* (1923), and *La Jeunesse de Prosper Mérimée* 2 vol. (1925).

MERINO. The Spanish name for a breed of sheep, and hence applied to a woollen fabric. The merino is a white, short-wool sheep, the male having spiral horns, the ewes being generally hornless. It is bred chiefly for its wool, because, though an excellent grazer and very adaptable, it matures slowly and its mutton is not of the best quality. The wool is close and wavy in staple, reaching four inches in length, and surpasses that of all other sheep in fineness; it is so abundant that little but the muzzle, which should be of an orange tint, and hoofs are left uncovered. The best wool is produced on light, sandy soils.

The merino is little known in Great Britain, the climatic moisture of which does not favour the growth of the finest wools, but it predominates in all regions where sheep are bred for their wool rather than their mutton, as in the western United States, Cape Colony, Australia, New Zealand and Argentina. In Australasia, especially in New Zealand, the merino has been crossed with Lincolns, Leicesters, Shropshires and other breeds, with the result of improving the quality of the mutton while sacrificing to some extent that of the wool.

The merino sheep appears to have originated in Africa, whence it was brought by the Moors to Spain and thence spread over Europe, especially to Austria-Hungary, Germany and France. The best-known breeds are the Rambouillet, a large merino named after the village near Paris to which it was imported towards the end of the 18th century, and the Negretti, which stands in closer relationship to the old Spanish stock and has shorter wool but a more wrinkled fleece. Importations to America began about the beginning of the 19th century. The so-called American merino, the Delaine, the Vermont and the Rambouillet, are well-known breeds in the United States.

The term "merino" is widely employed in the textile industries with very varied meanings. Originally it was restricted to denote the wool of the merino sheep reared in Spain, but owing to the superiority of the wools grown on merino sheep and shipped from Botany bay the name as applied to wool was replaced by the term "botany." In the dress-goods and knitting trades the term "merino" still implies an article made from the very best soft wool. The term "cashmere," however, is frequently confused with it, although cashmere goods should be made from true cashmere and not, as is often the case, from the finest botany wool. In the hosiery and re-manufactured materials trades the term "merino" is applied to fibre-mixtures of cotton and wool in contradistinction to "all wool" goods.

MERIONETH (Welsh *Meirionydd*), a county of North Wales bounded north by Carnarvon and Denbigh, east by Denbigh and Montgomery, south-east by Montgomery, south by the Dovey estuary, dividing it from Cardigan, and west by Cardigan bay. It is nearly triangular, its greatest length from north-east to south-west being about 45 m., and its greatest breadth about 30 miles. Area, 422,372 acres. Pop. (1931), 43,198 (administrative county).

Geology.—The outstanding geological feature is the Harlech dome—a mountain tract about 15 m. from north to south by 10 m. from east to west, from the coast inland. It is roughly oval, with Barmouth and Dolgelly, Harlech and Maentwrog around its edges. It is of Cambrian age and composed of grits, quartzites and slates, forming a large anticline. Its central portion is occupied mainly by Harlech grits and Menevian beds. Around the dome on the north, east and south, from Towyn around to Carnarvonshire, great volcanic masses, mostly greenstone, stand out in a sweeping curve. The igneous material is intruded into Lingula, Tremadoc and Arenig beds. This belt of high ground surrounding the dome includes Rhobell Fawr (2,313 ft.), composed of andesitic rock, while in the Arenig beds (interstratified with and overlaid by accumulations of volcanic ashes, felspathic traps or lava flows) are the rugged heights of Cader Idris (*q.v.*), Aran Fawddwy (2,970 ft.) and Arenig Fawr (2,600 ft.). The rough grits of the Harlech dome are separated from the grits and lavas further east by the valley of the Eden and Mawddach. The Ordovician volcanic rocks are, in turn, overlaid by the Llandeilo and Bala beds, the latter including the Bala limestone. South of Rhobell Fawr the great ring of volcanic mountains is broken across by the deep straight Bala cleft—one of the sharpest geological fault lines in Britain. The line of depression marking the fault runs from the sea near Towyn through the long and narrow Dysynni valley to Tal-y-llyn, and over the low hump of the Cross Foxes to the elongated Bala lake, the source of the Dee. The great fault line has many branches; the Mawddach estuary line, with its beautiful sands, represents a section which has sunk seawards.

Here and there along the eastern boundary of the county, Llandovery and Wenlock strata are included. The structure of the Silurian tract is synclinal; in the Berwyn mountains the Ordovician rocks again appear with associated andesitic and felsitic lavas and tuffs. West of Llangar, near Corwen, is a small patch of Carboniferous limestone. Glacial drift with boulder clay is a prominent feature in the valleys and on the mountain sides, while a good deal of blown sand fringes the coast north and south of Harlech.

The southern section of the county is bordered in some parts by the river Dyfi (Dovey), which rises in a small lake near Aran Fawddwy, passes Machynlleth and expands into an estuary on Cardigan bay, the origin of which is probably associated with

the Llyfnant fault zone of northern Cardiganshire and southern Montgomeryshire.

History and Early Settlement.—The Ardudwy coast between Barmouth and Harlech seems to have been important in Megalithic times, while finds of flat axes of bronze to the north-east of Bala lake indicate early attempts to reach the coast from England by way of the Bala cleft. The finds of gold and Late Bronze age hoards on the north-west coast near Harlech indicate contact with Ireland. The upper Dee valley, as well as other strategic sites in the county have hilltop camps of Romano-British age. A Roman trackway ran from the military site at Pennal, in the south of the county, northwards to Tomen y Mur and hence to Segontium and Kanovium in the north. Somewhere to the east of Dolgelly this trackway was met by another following the Bala cleft from Caergai. In the post-Roman centuries, the remoteness and isolation of the county became more pronounced. Shut off by hills on all sides, it experienced little Saxon; Scandinavian or early Norman influence. In this respect it bears a striking contrast to the neighbouring county of Montgomery, which had easier connections with England. In Saxon times the county was under the princes of Gwynedd, although some parts of what later became Merionethshire were under the princes of Powys. A Norman attempt to enter the county was repulsed in 1096. During the next 300 years there were many fights in the neighbourhood of Corwen, which commanded the entrance to the county via the Bala cleft. Here Owain Gwynedd was posted to repel Henry II., and hither Owain Glyn Dwr retired before Henry IV. The remoteness of the region made it a gathering ground of the Welsh resistance to the English, and in the county and over its borders, at Dolgelly and Machynlleth, there are traditions of Owain Glyn Dwr's parliaments. In this sheep-rearing county the Cistercian abbey of Cymmer (Y Fanner), near Dolgelly, was founded about 1200. It was dissolved by Henry VIII., though some interesting ruins remain. The county was still inaccessible in Elizabethan times, and its remoteness is mentioned by Churchyard (1587). About this time may be traced the beginnings of the slate industry, though it did not come into prominence until the 18th century. There were quarries in the 19th century at Festiniog, Corris, Aberllefeni, Pennal, Abergynolwyn and Arthog, though the depression in the slate industry since 1914 has seriously diminished the output. There are records of gold mines in the Mawddach valley from early times, and copper has been mined in the Ardudwy, and lead in the Dyfi valleys. The flannel and woollen industries were important in the county until recently. In the 18th century Dolgelly was famous for its production of a Welsh tweed cloth, and Bala made stockings and woollen caps. The coming of steam-driven machinery seriously diminished these trades and the county is now almost entirely a region of pastoral farming, exporting young men and women to the large cities.

Of recent years, however, with the advent of better roads and the motor car, the coastal towns, particularly Aberdovey, Barmouth and Harlech, have many summer visitors.

Communications, Travel and Government.—The climate varies much with the elevation. Grain crops cover a small area only; barley and oats are the most important crops. Potatoes, turnips and swedes are also grown, but there is very little cultivation of fruit. While the soil is generally thin, there are fertile tracts in the valleys, and there is some reclaimed land. The small hardy ponies (known as of Llanbedr, Conway valley) are now almost restricted to this county and Montgomeryshire. The Great Western railway skirts the coast from Portmadoc to Aberdyfi. At Barmouth junction a branch crosses to Dolgelly. Bala and Festiniog are also united by the G.W. railway, and Festiniog is further joined with Llandudno junction by the L.M.S. railway, and with Portmadoc by a narrow-gauge line. The coast is almost unnavigable, owing to sand-banks, and the only havens are Barmouth and Aberdyfi.

The county returns one member to parliament, and has neither parliamentary nor municipal borough. The urban districts are: Bala, Barmouth, Dolgelly, Festiniog, Mallwyd and Towyn. The shire is in the north-west circuit, and assizes are held at Dolgelly. It is partly in the diocese of St. Asaph, partly in Bangor.

MERISTEM, a botanical term for tissue which has the power of developing new forms of tissue, such as the cambium from which new wood is developed or the tissue at the apex which is responsible for the growth in length of the stem or root.

MERIVALE, CHARLES (1808–1893), English historian and dean of Ely, the second son of John Herman Merivale was born on March 8, 1808. He was at Harrow (1818–24) and St. John's college, Cambridge (1826), where he was elected fellow in 1833. He declined the professorship of modern history at Cambridge in 1869, but in the same year accepted from Gladstone the deanery of Ely, which he held until his death on Dec. 27, 1893. His principal work was *A History of the Romans under the Empire* (7 vols., 1850–62); but he wrote several smaller historical works, and published sermons, lectures and Latin verses.

See *Autobiography of Dean Merivale,* with selections from his correspondence, edited by his daughter, Judith A. Merivale (1899); and *Family Memorials,* by Anna W. Merivale (1884).

MERKARA: *see* MERCARA.

MERLE, a name sometimes applied to the European blackbird (*Turdus merula*), especially in association with the word mavis in Scottish poetry. *See* BLACKBIRD.

MERLIN, ANTOINE CHRISTOPHE (1762–1833), French revolutionary, called "of Thionville," was born at Thionville on Sept. 13, 1762. After studying theology, he devoted himself to law. In 1790 he was sent by the department of Moselle to the Legislative assembly. On Oct. 23, 1791 he moved and carried the institution of a committee of surveillance, and it was he who proposed the law sequestrating the property of the *émigrés.* He was elected deputy to the Convention, and pressed for the execution of Louis XVI. He took part in the reaction which followed the fall of Robespierre, sat in the council of the Five Hundred, and at the *coup d'état* of the 18th Fructidor (Sept. 4, 1797) demanded the deportation of certain republican members. In 1798 he was appointed director-general of posts, being sent subsequently to organize the army of Italy. He lived in retirement under the consulate and the empire. He died in Paris on Sept. 14, 1833.

See J. Reynaud, *Vie et correspondance de Merlin de Thionville* (Paris, 1860).

MERLIN, PHILIPPE ANTOINE, COUNT (1754–1838), French politician and lawyer, known as Merlin "of Douai," was born at Arleux (Nord) on Oct. 30, 1754, and was called to the Flemish bar in 1775. As deputy for Douai in the Constituent Assembly he carried important legislation abolishing the feudal and seignorial rights. On the dissolution of the Assembly he became judge of the criminal court at Douai. As a member of the council of legislation he presented to the Convention on Sept. 17, 1793 the law permitting the detention of *suspects.* He was closely allied with his namesake Merlin "of Thionville," and, after the counter-revolution which brought about the fall of Robespierre, he became president of the Convention and a member of the Committee of Public Safety. He persuaded the Committee of Safety to close the Jacobin club. He recommended the readmission of the survivors of the Girondin party to the Convention, and drew up a law limiting the right of insurrection. With Cambacérès he had been commissioned in April 1794 to report on the civil and criminal legislation of France, and produced his *Rapport et projet de code des délits et des peines* (10 Vendémiaire, an. IV.). Merlin's code abolished confiscation, branding and imprisonment for life. He was made minister of justice (Oct. 30, 1795) under the Directory. After the *coup d'état* of the 18th Fructidor he became (Sept. 5, 1797) one of the five directors, and, being accused of the various failures of the government, retired into private life on June 18, 1799. Under the consulate he became procureur-général in the court of cassation, and did more than any other lawyer to fix the interpretation of the Napoleonic Code. He became a member of the council of state, count of the empire, and grand officer of the Legion of Honour; but was banished on the second restoration. The years of his exile were devoted to his *Répertoire de jurisprudence* (5th ed., 18 vols., 1827–1828) and to his *Recueil alphabétique des questions de droit* (4th ed., 8 vols., 1827–28). At the revolution of 1830 he returned to France, and

re-entered the Institute of France. He died in Paris on Dec. 26, 1838.

See M. Mignet, *Portraits et notices historiques* (1852), vol i.

MERLIN, the famous bard of Welsh tradition, enchanter and counsellor of Arthurian romance. The personality of Merlin, on one side of demoniac, on the other of human, parentage, is now generally recognized as a combination of diverse traditions. Geoffrey of Monmouth, to whom we owe the conception of the romantic Merlin, probably knew more than one tradition, Nennius' story of the boy Ambrosius, "child without a father," who revealed to Vortigern the secret of the insecure foundations of his tower, being the starting point of his combination. Into this framework were introduced elements derived from the much older story of the demon Asmodeus (Aschmedai), who acted as familiar spirit to Solomon—the feats of divination with which the boy astonishes the messengers of the king, derive directly from this source. Later on a *Vita Merlini,* long attributed to Geoffrey—an attribution on which modern scholarship has thrown doubts—incorporated features from the Scotch tradition of a certain Lailoken, a "wild man of the woods," gifted with powers of divination. This led to the idea that there had been two Merlins, Merlin-Ambrosius and Merlin-Sylvestris, a view now very generally rejected. The second part of Robert de Borron's trilogy, which was the starting point of the Arthurian cyclic development, dealt with the birth of the seer and his relations with Uther Pendragon. This, originally in verse form, was later worked over in prose, and expanded, first with additions dealing with the wars incident to the opening of Arthur's reign, then with a medley of romantic incidents connected with Arthur's court. The two elements are combined in a unique ms., No. 337 (*Fonds Français*) of the Bibliothèque Nationale. Finally, a fantastic romance, entitled *Les Prophécies de Merlin,* belonging to a late period of Arthurian evolution, completed the cycle. Merlin is a strange and interesting personality, and his story may quite possibly have been inspired by popular tradition connected with an actual Welsh bard and sooth sayer.

BIBLIOGRAPHY.—For the life of Merlin *see* Geoffrey of Monmouth's *Historia* and the *Vita Merlini* (ed. J. J. Parry, University of Illinois, *Studies in Language and Literature,* vol. x. 1925). For the romantic Merlin see *Merlin,* ed. H. O. Sommer (1894) and vol. ii. of Sommer's *Vulgate Version of the Arthurian Romances* (1908–16); *Merlin,* ed. G. Paris and J. Ulrich (*Société des anc. textes fr.* 1886), an edition of the unique Huth ms., the version contained in which was utilized by Malory; *Les Prophécies de Merlin,* ed. L. A. Paton (1926–27). *See* also F. Lot, *Annales de Bretagne,* vol. xv. For the Oriental parallels *see* M. Gaster, *The Exempla of the Rabbis* (1925) and E. Seymour, *Tales of King Solomon* (1925). J. D. Bruce, *The Evolution of Arthurian Romance,* vol. ii. (1923), gives a bibliography of the scattered *Merlin* studies. (J. L. W.)

MERLIN, the name given to members of a group of small falcons (*Falco*) and especially to the European merlin (*F. aesalon*). This is a bold little bird, steel-blue above and red-brown below in the male, the female being brown. It nests on the ground, usually in heather. Scarcely to be distinguished is the N. American pigeon-hawk (*F. columbanus*), while other larger species occur in India and Africa. *See* FALCON.

MERLINO COCCAJA: *see* FOLENGO, TELEOFILO.

MERLON, the raised, solid portion of a battlement parapet, sometimes pierced by loop-holes (*see* BATTLEMENT).

MERMAIDS AND MERMEN, in the folk-lore of England and Scotland, semi-human beings who dwell in the sea, but can live on land and enter into social relations with humans.

The typical mermaid has the head and body of a lovely woman, but below the waist is fashioned like a fish, with scales and fins. For a time a mermaid may become to all appearance an ordinary human being; an Irish legend ("The Overflowing of Lough Neagh and Liban the Mermaid," in Joyce's *Old Celtic Romances*) represents the reverse case.

The mermaid legends of all countries may be grouped as follows: (*a*) "A mermaid or mermaids either voluntarily or under compulsion reveal things that are about to happen." Thus in the *Nibelungenlied.* (*See* also *Kong Fredericks den andens Krönike,* Copenhagen, 1680, p. 302.) (*b*) "A mermaid imparts supernatural powers to a human being." (*See* "The Old Man of Cury," in Hunt's *Popular Romances of the West of England,* 1871.) (*c*) "A mermaid has some one under her protection and for wrong done to her ward exacts a terrible penalty." (*See* the "Mermaid's Vengeance" in Hunt's book already quoted.) (*d*) "A mermaid falls in love with a human being, lives with him as his lawful wife for a time, and then, some compact being unwittingly or intentionally broken by him, departs to her true home in the sea." Here the typical legend is that of *Mélusine* (*q.v.*), made the subject of a romance by Jean d'Arras. (*e*) "A mermaid falls in love with a man, and entices him to go to live with her below the sea; or a merman wins the affection or captures the person of an earthborn maiden." This form of legend is very common, and has been a favourite with poets. Danish ballads are full of the theme; as "Agnete and the Merman," an antecedent of Matthew Arnold's "Forsaken Merman"; the "Deceitful Merman, or Marstig's Daughter"; and the story of Rosmer Hafmand (No. 49 in Grimm). The mermaid has generally to be bribed or compelled to utter her prophecy or bestow her gifts, and whether as wife or paramour brings disaster in her train. The fish-tail is really of secondary importance, for the true Teutonic mermaid—probably a remnant of the great cult of the Vanir—had no fish-tail. The Tritons, the Sirens of classical antiquity, the Phoenician Dagon, and the Chaldaean Oannes are well-known examples. (*See* also Jones, *Traditions of the North American Indians,* 1830; Dennis, *Folklore of China,* 1875.)

Quasi-historical instances of the appearance or capture of mermaids are common enough, and serve, with the frequent use of the figure on signboards and coat of arms, to show how thoroughly the myth had taken hold of the popular imagination.

The best account of the mermaid-myth is in Baring-Gould's *Myths of the Middle Ages. See* also Pontoppidan, who has collected much matter to prove the existence of mermaids; Maillet, *Telliamed* (Hague, 1755); Grimm, *Deutsche Mythologie,* i. 404, and *Altdän. Heldenlieder* (1811); Waldron's *Description of the Isle of Man.*

MEROBAUDES, FLAVIUS (5th century A.D.), Latin rhetorician and poet, probably a native of Baetica in Spain. He was the official laureate of Valentinian III. and Aëtius. Till the beginning of the 19th century he was known only from the notice of him in the *Chronicle* (year 443) of his contemporary Idacius, where he is praised as a poet and orator, and mention is made of statues set up in his honour. In 1813 the base of a statue was discovered at Rome, with a long inscription belonging to the year 435 (*C.I.L.* vi. 1724) upon Flavius Merobaudes, celebrating his merits as warrior and poet. Ten years later, Niebuhr discovered some Latin verses on a palimpsest in the monastery of St. Gall, the authorship of which was traced to Merobaudes, owing to the great similarity of the language in the prose preface to that of the inscription.

His "Panegyric" and minor poems have been edited by B. G. Niebuhr (1824); by I. Bekker in the Bonn *Corpus scriptorum hist. Byz.* (1836); his "De Christo" in T. Birt's *Claudian* (1892), where the authorship of Merobaudes is upheld; *see* also A. Ebert, *Geschichte der Literatur des Mittelalters im Abendlande* (1889).

MEROE, the southern capital of the Ethiopian kings of Napata, 700–300 B.C., becoming eventually the sole capital of the Meroitic kingdom which lasted till about A.D. 350; now an extensive field of ruins, found on the east bank of the Nile near Kabushia railway station in the Egyptian Sudan, lat. 15° 30′ N. The whole site was surveyed by Lepsius in 1844. A quarter of a mile from the river is an enclosure containing royal palaces and other important buildings, reaching back to Aspaluta, *c.* 590 B.C., in the lower levels. Here was found a bronze head of Augustus now in the British Museum, and many remnants of building and sculpture of Netekaman, *c.* A.D. 100, who built a temple of Ammon outside, backed against the east face of the enclosure. Baths were attached to the later palaces. Northwards from the enclosure was a little temple of Isis (*temp.* Akinirar, etc.); eastwards was another, rather earlier, of the lion god Apiremak with stelae down to Taqeriramane, A.D. 250, and a kilometre beyond a larger temple of the sun (?), containing a monument of Aspaluta but mostly built by Teriteqas, Candace and Akinirar, a trio of *c.* 30 B.C. All the above temples face the east; but southwards about 2m. was a shrine facing westwards, with great stelae at the

entrance of Candace and Akinirar containing a reference to Augustus. The nearest necropolis eastwards is Meroitic at the north end, post-Meroitic towards the south end, the latter part with burials on wooden beds and remarkable pottery. Our knowledge up to this point is due to Garstang's excavations, 1909–14; the more distant cemeteries and the pyramids were completely excavated by Reisner in 1921–23. On the hills about 2m. away are two groups of pyramids. In the southern group were buried three kings of the early part of the 3rd century B.C. surrounded by various tombs of the 8th to the 3rd century; the northern group was almost entirely royal with pyramids of 30 later kings and queens, the earliest being that of Ergamenes in the early part of the 3rd century B.C. Westwards of these and about 1m. from the city was a great cemetery of nobles and others of the Ethiopian and Meroitic periods. A fragment of the Greek inscription of a heathen invader from Axum was picked up by Sayce, and an Axumite graffito exists in one of the pyramid shrines.

See J. Garstang, *Meroë* (1911), and *reports* in "Annals of Archaeology and Anthropology," vols. iii.–vii. (Liverpool, 1910–14); G. A. Reisner, *articles* in "Boston Museum of Fine Arts Bulletin" xx., xxi., xxiii., and "The Journal of Egyptian Archaeology," vol. ix.
(F. Ll. G.)

MEROITIC LANGUAGE AND WRITING. The Ethiopian kings of Napata, and afterwards of Meroe, employed the Egyptian language in hieroglyphic writing for their formal inscriptions and presumably for other records; but dating from the first century B.C. to near the end of the third century A.D. there are found in Nubia monumental records, tombstones, funerary altars, and graffiti inscribed in a native language and in a special script which is called Meroitic, since Nubia was then ruled from Meroe. The same writing is found also on potsherds, and the use of it on prepared skins and writing tablets of wood can be certified from small fragments. For the decoration of temples, etc., there were employed the original hieroglyphic (pictorial) forms of the Meroitic writing symbols, but debased hieroglyphic Egyptian was also used for the same purpose.

The symbols of Meroitic writing were modelled on debased Egyptian, but were employed on an entirely different system. Like Egyptian, the Meroitic writing was from right to left; the signs, unlike Egyptian, face backwards. The elaborate Egyptian writing does not express vowels, whereas the simple Meroitic system aimed at recording syllables each consisting of a consonant followed by a vowel. The Meroitic alphabet consisted of seventeen consonantal signs and four rather vague vowel signs together with two syllabics *te* and *tē* or *tō*, making twenty-three characters in all. Besides the alphabet there were special symbols for numerals and perhaps in rare cases resort could be had to special picture signs to symbolize special words. The words were usually separated by double points so that the writing was admirably clear except in regard to the distinction of vowel sounds and the probability that a certain kind of vowel (*a*?) was not marked and had to be surmised from the context.

Meroitic writing was deciphered in 1910 after the discovery of a large number of new inscriptions in Lower Nubia and at Meroe; the language, however, is still almost entirely a sealed book, though names of persons, deities and places, also certain titles borrowed from Egyptian and Meroitic titles which occur in Egyptian demotic, are readily found. It can only be stated as yet that the Meroitic language shows agglutinative formation, absence of gender, and some degree of connection with Nubian.

See F. Ll. Griffith, *Karanòg, The Meroitic Inscriptions of Shablûl and Karanòg* (University of Pennsylvania, Eckley B. Coxe, Jr., Expedition to Nubia, vol. vi., 1911) and articles in *The Journal of Egyptian Archaeology*, vols. iii., iv. and xi. (F. Ll. G.)

MEROPE, name of: (1) The daughter of Cypselus, king of Arcadia, and wife of Cresphontes, ruler of Messenia. Cresphontes and two of his sons were murdered and the throne seized by Polyphontes, who forced Merope to marry him. A third son, Aepytus escaped; he returned later, killed Polyphontes and recovered the kingdom. (Apollodorus ii. 180; Pausanias iv. 3, 6.)

(2) The daughter of Atlas and wife of Sisyphus. She was one of the seven Pleiades, but remained invisible, hiding her light for shame at having become the wife of a mortal (Apollodorus i. 85; iii. 10, 1; Ovid., *Fasti*, iv. 175).

MEROVINGIANS, the name given to the first dynasty which reigned over the kingdom of the Franks. The name is taken from Merovech, an early king of the Salian Franks, who succeeded to Clodio in the middle of the 5th century, and soon became a legendary figure. At the great battle of Mauriac (the Catalaunian fields), in which Aetius checked the invasion of the Huns (451), there were present in the Roman army a number of Frankish *foederati*, and a later authority states that Merovech (Merovaeus) was their leader. Merovech was the father of Childeric I. (457–481), and grandfather of Clovis (481–511). *See* France: *History*.

Bibliography.—G. Richter, *Annalen des fränkischen Reichs im Zeitalter der Merowinger* (Halle, 1873); F. Dahn, *Die Könige der Germanen*, vii. (Leipzig, 1894); *Urgeschichte der germanischen und romanischen Völker*, iii. (1883); W. Schultze, *Deutsche Geschichte von der Urzeit bis zu den Karolingern*, ii. (Stuttgart, 1896). For the Merovingian legend *see* G. Kurth, *Hist. poét. des Mérovingiens* (1893).

MERRIAM, CLINTON HART (1855–), American biologist, born in New York on Dec. 5, 1855, was educated at Yale and Columbia universities. In 1872 he accompanied the Hayden surveys in Utah, Idaho, Montana and Wyoming as naturalist; in 1875 he was assistant to the U.S. fish commission at Woods Hole, Mass.; in 1876 he collected marine invertebrates in the Bay of Fundy; in 1881 he visited the Bermudas; in 1881 and 1882 he studied the life of the St. Lawrence river; and in 1883 he sailed to the Arctic seal fisheries as surgeon on the ship "Proteus." In 1885 he took charge of the newly-established division of ornithology and mammalogy in the U.S. Department of Agriculture, later called the U.S. biological survey in 1896. He had charge of the Death Valley expedition in 1890–91 and served as Bering sea commissioner to investigate seal fisheries off the Pribilof islands in 1891. In 1910 he became a research associate of the Smithsonian institution and conducted biological and ethnological investigations under the E. H. Harriman trust fund. He was also chairman of the U.S. geographic board, 1917–25. In later years he devoted himself to the distribution, linguistics and mythology of Pacific coast Indians. He first described many genera and species of North American mammals and plants and has published over 400 scientific papers.

Among his books are: *Birds of Connecticut* (1877); *Mammals of the Adirondacks* (1882–84); *Biological Survey of San Francisco Mountain Region and Desert of the Little Colorado, Arizona* (1890); *Biological Reconnaissance of Idaho* (1891); *Geographic Distribution of Life in North America* (1892); *Distribution of Trees and Shrubs in the Deserts and Desert Ranges* (1893); *Laws of Temperate Controls of the Geographic Distribution of Terrestrial Animals and Plants* (1894); *Monographic Revision of the Pocket Gophers* (1895); *Revision of the American Shrews* (1895); *Life Zones and Crop Zones of the United States* (1898); *Biological Survey of Mt. Shasta* (1899); *Indian Population of California* (1905); *Totemism in California* (1908); *The Dawn of the World* (1910); *Review of the Grizzly and Brown Bears of America* (1917); *Baird the Naturalist* (1924); *William Healey Dall* (1927).

MERRIAM, JOHN CAMPBELL (1869–), American palaeontologist, was born in Hopkinton, Ia., on Oct. 20, 1869. Educated at Lenox College, Ia., the university of California, and Munich, he taught palaeontology and historical geology at the University of California. He was chairman of the National Research Council, and has been president of the Carnegie Institution of Washington, Washington, D.C., since 1920. He is the author of the following: *The Thalattosauria, a Group of Marine Reptiles from the Triassic of California* (1905); *Cave Exploration* (1905); *Triassic Ichthyosauria* (with special reference to the American forms, 1908); *The Occurrence of Twisted Horned Antelopes in the Tertiary of Northwestern Nevada* (1909); *The Fauna of Rancho La Brea*, Part 1, *Occurrence* (1911); *Discovery of Human Remains in an Asphalt Deposit at Rancho La Brea* (1914); *Extinct Faunas of the Mojave Desert* (their significance in a study of the origin and evolution of life in America, 1915); *Relationships of Pliocene Mammalian Faunas from the Pacific Coast and Great Basin Provinces of North America* (1917); *The Function of Educational Institutions in Development of Research* (1920); *Earth Sciences as the Background of History* (1920); *Common Aims of Culture and Research in the University* (1922); also numerous other papers.

MERRICK, LEONARD (1864–), English novelist and dramatist, was born on Feb. 21, 1864, in London, the son of William Miller, and was educated at Brighton. He changed his name to Merrick by deed poll. A collected edition of his works was issued in 1918.

His numerous novels include:—*Conrad in Quest of his Youth* (1903); *When Love Flies out of the Window* (1906); *The Quaint Companions* (1903); *The House of Lynch* (1907); *While Paris Laughed* (1918). His plays are *The Free Pardon* (with F. C. Philips); *When the Lamps are Lighted; My Innocent Boy; The Elixir of Youth; A Woman in the Case* (with G. R. Sims).

MERRILL, a city of north-central Wisconsin, U.S.A., on the Wisconsin river, at an altitude of 1,270 ft., 185 m. N.W. of Milwaukee; the county seat of Lincoln county. It is on Federal highway 51 and is served by the Chicago, Milwaukee, St. Paul and Pacific railroad. Pop. (1920) 8,068, and in 1930, 8,458. In the picturesque environs, brook trout and game of various kinds (including deer) still abound. Lumber is the leading industry. Merrill was settled in 1875, incorporated as a village in 1880, and chartered as a city in 1883.

MERRIMAC, a river of the United States, rising in the White Mountains of New Hampshire, and flowing through Massachusetts into the Atlantic ocean. With its largest branch it has an extreme length of about 183m. and drains a region 4,553 sq.m. in extent. The Merrimac proper is formed at Franklin (N.H.), by the junction of the Pemigewasset and Winnepesaukee rivers. The river falls 269ft. in 110m. from Franklin, yielding water-power to Lowell and Lawrence in Massachusetts, and Manchester and Concord in New Hampshire. For 17½ miles (including Newburyport and Haverhill) the river is navigable.

MERRIMAN, HENRY SETON (d. 1903), the pen-name of Hugh Stowell Scott, English novelist. He was a member of the firm of Henry Scott and Sons, and was for some years an underwriter at Lloyd's. His literary career began in 1889 with *The Phantom Future,* and he made his first decided hit with his Russian story, *The Sowers* (1896), which was followed by many other well-constructed novels. He was an enthusiastic traveller, many of his journeys being undertaken with his friend Stanley Weyman. He was about 40 when he died near Ipswich, on Nov. 19, 1903.

Among his most successful books were *Roden's Corner* (1898); *The Isle of Unrest* (1899); *In Kedar's Tents* (1897); *The Velvet Glove* (1901); *The Vultures* (1902); *Barlasch of the Guard* (1903); and *The Last Hope* (1904).

MERRIMAN, JOHN XAVIER (1841–1926), South African statesman, was born on March 15, 1841 at Street, Somerset, England, the son of a clergyman who afterwards became bishop of Grahamstown, South Africa. His family moved to South Africa in 1849, and he was educated at the Diocesan College, Rondebosch, and later at Radley College, England, returning to the Cape in 1861. He entered politics in 1869. In 1875 he joined the Molteno Ministry as commissioner of public works, and was virtually Secretary for War during the Galeka war of 1877. In the Scanlen Ministry (1881–4) he was commissioner of public works. The Afrikander Bond caused the fall of the Scanlen administration because the Ministry opposed the attempt of the Transvaal Boers to seize Bechuanaland; and when Rhodes formed a Ministry in 1890 Merriman, alienated by the extreme policy of the Bond, joined it as treasurer-general. Meanwhile the Bond had adopted a constitutional programme, and 1890 saw a drawing together of the Dutch and British elements at the Cape. But the Uitlander troubles in the Transvaal became acute, and in 1893 Merriman resigned. He was chairman of the Cape parliamentary committee which inquired into the Jameson raid of 1895, and drew up its report. The general election in Cape Colony in 1898 gave the Bond a very narrow victory, and W. P. Schreiner became Prime Minister, with Merriman treasurer-general again, though he was not a member of the Bond. Merriman was among the ministers who in 1900 opposed the measure to disfranchise the Cape rebels, causing the cabinet to resign. At the general election of 1904 Merriman was defeated, but was returned shortly afterwards at a by-election. In Jan. 1908 he succeeded Dr. Jameson as Prime Minister and treasurer-general (*see* SOUTH AFRICA: *History*). Merriman was now head of the Afrikander Bond party, renamed the South African party. He was a member of the national convention which hammered out the new constitution. He supported the unitary as against the federal principle in South African policy. It was expected in some quarters that Merriman would be the first prime minister of the Union. The position fell to Botha. Merriman remained outside the ministry, though he gave the government steady support. He opposed the disruptive policy of Hertzog as strongly as he had formerly supported the independence of the Boer republics. He died Aug. 2, 1926.

MERRITT, WESLEY (1836–1910), American soldier, was born in New York city on June 16, 1836, graduating at West Point. He won distinction in the Virginian campaigns of 1864–65 and in Sheridan's Shenandoah valley campaign, and in 1895, he became major-general. He was superintendent at West Point (1882–87), and commanded the military department of Missouri (1887–95) and that of the Atlantic (1897–98). In May 1898 he commanded the U.S. forces sent to the Philippines after Admiral Dewey's victory; stormed Manila on Aug. 13, and was military governor of the islands until Aug. 30. At Paris, he was on the peace commission. He died at Natural Bridge (Va.) on Dec. 3, 1910.

MERRY DEL VAL, RAPHAEL (1865–1930), Spanish ecclesiastic and diplomat, was born on Oct. 10, 1865 in London, where his father was secretary to the Spanish legation. Educated at Baylis House, near Slough, and at Ushaw college, near Durham he took up diplomacy at the Vatican and in 1892 became Master of the Robes and acting private chamberlain to Pope Leo XIII., of whom he was a great favourite. In 1897 he was sent to Canada to report on the difficult Manitoba schools question, and in 1900 he became archbishop of Nicea. He was secretary of the Sacred College of Cardinals during the election of Pius X. (July 1903) under whom he became cardinal and secretary of state. On Jan. 12, 1913 he succeeded Cardinal Rampolla as archpriest of the Vatican Basilica; in the following October he was appointed secretary of the Holy Office, and in Dec. 1920 he became camarlengo of the Holy Roman Church. Cardinal Merry del Val died in Vatican City on Feb. 26, 1930.

MERSEBURG, in Saxony, on the river Saale. Pop. (1925) 25,703. From 968 until the Reformation, it was the seat of a bishop, also the residence of the margraves of Meissen, and a favourite residence of the German kings. Fifteen diets were held here, when its fairs enjoyed an importance anticipating Leipzig. From 1657 to 1738 it was the residence of the dukes of Saxe-Merseburg. It consists of an irregularly built old town, a new quarter and two suburbs, Altenburg and Neumarkt. The cathedral, restored in 1884–86, has a choir, a crypt and two towers of the 11th, a transept of the 13th and a late Gothic nave of the 16th century. It contains a great organ dating from the 17th century. The Gothic palace, formerly the residence of the bishops of Merseburg, is now used as public offices. The industries include machinery and paper, metal founding, tanning and brewing.

MERSEN (MEERSSEN), **TREATY OF,** concluded on Aug. 8, 870 at Mersen, in Holland, between Charles the Bald and his half-brother, Louis the German, by which the kingdom of their nephew, Lothair II. (d. 869) was divided between them. Charles received a portion of the kingdom of Lothair, afterwards called Lorraine, extending from the mouths of the Rhine to Toul, together with the town of Besançon, the Lyonnais, the Viennais, the Vivarais and the Uzège, while Louis had the cities of Cologne, Trier and Metz, together with Alsace, the Escuens and the Varais, *i.e.*, the greater part of the diocese of Besançon. The boundary between the two realms was marked approximately by the valleys of the Meuse and Moselle and by the Jura.

MERSENNE, MARIN (1588–1648), mathematician, was born of peasant parents near Oizé (Sarthe) on Sept. 8, 1588, and died in Paris on Sept. 1, 1648. He was educated at the Jesuit college of La Flèche, where he was a fellow-pupil of Descartes. In 1611 he joined the Minim Friars, and in 1620 he settled in Paris at the convent of L'Annonciade. In 1623 he published *Quaestiones celeberrimae in Genesim; L'Impiété des déistes* (1624); *La Vérité des sciences* (1624). Submitting Descartes' *Meditations* to John

Locke (*q.v.*), he defended him with enthusiasm against clerical critics. In later life he turned to scientific research, especially in mathematics, physics and astronomy. His *Harmonie universelle* (1636) deals with the theory of music and musical instruments.

See Hilarion de Coste, *La vie du rév. père Marin Mersenne* (1649); new ed. with unpublished letters, by B. T. de Larroque (1892); M. Frischeisen-Köhler in *Arch. für Gesch. der Philos.*, vol. xv. (1902).

MERSEY, JOHN CHARLES BIGHAM, 1ST VISCOUNT (1840–1929), was born on Aug. 3, 1840, and educated at the Liverpool institute, and in Berlin and Paris. He was called to the bar in 1870, and became Q.C. in 1883. In 1895 he was elected Unionist M.P. for a division of Liverpool, and kept his seat until 1897, serving on the South African committee of the House of Commons in 1896–97. In 1897 he was made judge of the king's bench division of the High Court of Justice and in 1909–10 was president of the probate divorce and admiralty division. He served on several Government commissions and from 1904 to 1910 was chief judge in bankruptcy. He was made a privy councillor in 1909, received a barony in 1910, and a viscountcy in 1916. He died in Sussex on Sept. 3, 1929.

MERSEY, a river in Cheshire, England, 70 miles long, formed by the Goyt which rises in Axe Edge, south-west of Buxton, and the Etherow between Penistone and Glossop, watering the narrow Longdendale in which are reservoirs for Manchester. The Mersey drains a large part of the Peak district of Derbyshire. At Stockport the river Tame joins from the north. The Bollin joins from the south-east near Heatley, and the main river expands into an estuary which narrows to less than ¾ m. at Liverpool and forms an important harbour. (*See* LIVERPOOL and BIRKENHEAD.) The Manchester Ship canal (*q.v.*) joins the estuary through Eastham locks, skirts its southern shore up to Runcorn, and crosses the river several times.

MERSINA, a seaport of Asia Minor, and in the vilayet of Adana. Pop. (1927) 46,831. Its existence began with the silting up of Tarsus and Pompeiopolis, east and west, in the early middle ages; but it grew with the Egyptian occupation of Cilicia (1832). It is the busiest port on the south coast, being the terminus of the railway from Adana and Tarsus, by which (but still more by road) the produce of the rich "Aleian" plain comes down. The anchorage is good, but the bay shoals for a long way out, and is exposed to swell from south-west and south. The low coastal section has a bad summer climate.

MERSWIN, RULMAN (1307–1382), German mystic, was born at Strasbourg in 1307, and became a banker. At the age of 40, he came into touch with Tauler and the group of 14th century mystics known as the Friends of God. In Merswin's *Story of the First Four Years of a New Life*, he writes: "Of all the wonderful works which God had wrought in me I was not allowed to tell a single word to anybody until the time when it should please God to reveal to a man in the Oberland to come to me. When he came to me God gave me the power to tell him everything." Merswin claimed that certain books were written by this "Friend of God," who has been identified with various people by different scholars, and that other books were written by himself. As all the writings bear the marks of a single authorship it has been assumed, especially by Denifle, that "the Friend of God" is a literary creation of Merswin just as William Langland in England about the same time drew the figure of Piers Plowman.

Karl Rieder (*Der Gottesfreund von Oberland,* Innsbruck, 1905) attributes the authorship to Merswin's secretary and associate Nicholas of Löwen, head of the House of St. John at Grünenwörth.

See besides the works cited Karl Schmidt, *Nicolaus von Basel* (Vienna, 1866); Denifle, *Der Gottesfreund im Oberland und Nikolaus von Basel* (1870); Rufus M. Jones, *Studies in Mystical Religion,* ch. xiii. (1909).

MERTENSIA, a genus of perennial herbs of the family Boraginaceae (*q.v.*) comprising about 40 species found in cool regions of the northern hemisphere and especially abundant in western North America. Many are very smooth plants, of pleasing habit, with brightly coloured usually blue or white flowers. Well known representatives are the sea lungwort and the Virginia cowslip (*q.v.*), which is not to be confused with the yellow cowslip of Europe.

MERTHYR TYDFIL or **MERTHYR TYDVIL,** municipal, county and parliamentary borough, of Glamorganshire, S. Wales, situated on the river Taff and the Glamorganshire Canal, and served by the G.W.R. and L.M.S.R., 2 m. N.W. of Cardiff. Pop. (1931) 71,099. It is said to have derived its name from the martyrdom of St. Tydfil, daughter of Brychan, put to death by Saxons in the 5th century. Three miles to the north on a limestone rock rising 470 ft. are the ruins of Morlais Castle, built about 1286 by Gilbert de Clare on the northern limits of his lordship of Glamorgan. The town is irregularly built and owed its early industrial prosperity to the abundant ironstone of the district. Four great iron works were established here between 1759 and 1782. With the earliest, that of Dowlais, the Guest family were associated. In 1765, Cyfarthfa was started by Anthony Bacon and sold in 1794 to Richard Crawshay. The Plymouth works were started soon after Cyfarthfa, by Wilkinson and Guest. They were closed down in 1882, but the collieries belonging to them continued to be worked. The fourth great ironworks were those of Pen-y-darran which were carried on from 1782 to 1859. It was at Dowlais (in 1856) that Bessemer steel was first rolled into rails, but the use of puddled iron was not wholly abandoned at the works till 1882. The use of the local coal for smelting gave a great impetus to the iron industry. The Dowlais Company work collieries and have since 1891 a branch steel and iron works on the coast near Cardiff. Industrial depression after the World War seriously affected the coal, iron and steel trades. Cyfarthfa was converted into steel works in 1883. The iron ore used latterly has been mainly imported from Spain. Merthyr Vale is mainly dependent on coal-mining. In 1850, the town had a local board of health; in 1894, an urban district council; in 1905, a corporation; in 1898, a county borough. In 1832, it was given one member and a second in 1867.

MERV, MERU or **MAUR,** an ancient and once famous oasis and town of Asiatic Russia in the Turkmen S.S.R. The oasis has an area of 134,400 sq.km., and a population (1926) of 253,049, mainly Turkmens of the Tekke tribe. The great chain of mountains which, under the names of Paropamisus and Hindu-Kush, extends from the Caspian to the Pamirs, is interrupted some 180 m. S. of Merv. Through or near this gap flow northwards in parallel courses the rivers Heri-rud (Tejend) and Murghab, until they lose themselves in the desert of Kara-kum, and the loess oasis of Merv depends on irrigation from the Murghab for its life. In 1895 the Russians completed further irrigation works bringing 436 sq.m. under cultivation, and in 1927 the Soviet Government began the construction of an electric power station. Cereals, cotton, fruits and vine are cultivated; cotton production is markedly increasing to supply the textile industry of European Russia. The railway from Krasnovodsk on the Caspian, linking with the Orenburg-Tashkent lines, passes through the town of Merv, from which there is a branch line southwards to Russia. The town of Merv, population (1926) 19,099, has cotton and wool cleaning factories, a flour-milling and brewing industry. The horses are famous throughout central Asia.

After the 1917 revolution, a period of disorder set in which markedly diminished cultivation and stock-raising, and resulted in the disorganization of the irrigation system. In 1926 new laws regulating the distribution of water were enforced, extensive repairs were carried out, and production has now almost reached the 1913 level, while as regards cotton production, it has markedly surpassed it. Native crafts include silver work, the making of armour, carpet weaving and the making of felt and woollen goods. Summer heat is oppressive, 97° F, and the least wind raises clouds of dust which darken the air and make respiration difficult. In winter the temperature is 19° F, but snow rarely falls and never lies; the rainfall is about 5 in. per annum, June to October being usually rainless months.

History.—In the Hindu (the *Puranas*), Parsi, and Arab tradition Merv is looked upon as the ancient Paradise, the cradle of the Aryan families of mankind, and so of the human race. Under the name of Mouru this place is mentioned with Bakhdi (Balkh) in the geography of the *Zend-Avesta* (*Vendidad,* ed.

Spiegel, 1852–63), which dates probably from at least 1200 B.C. Under the name of Margu it occurs in the cuneiform (Behistun) inscriptions of the Persian monarch Darius Hystaspis, where it is referred to as forming part of one of the satrapies of the ancient Persian empire. It afterwards became a province (Margiana) of the Graeco-Syrian, Parthian, and Persian kingdoms. On the Margus—the Epardus of Arrian and now the Murghab—stood the capital of the district, Antiochia Margiana, so called after Antiochus Soter, who rebuilt the city founded by Alexander the Great.

About the 5th century, during the rule of the Persian Sassanian dynasty, Merv was the seat of a Christian archbishopric of the Nestorian Church. The town was occupied (A.D. 646) by the lieutenants of the caliph Othman, and was constituted the capital of Khorasan. From this city as their base the Arabs, under Kotaiba (Qotaiba) ibn Moslim, early in the 8th century brought under subjection Balkh, Bokhara, Ferghana, and Kashgaria, and penetrated into China as far as the province of Kan-suh. In the latter part of the 8th century Merv became obnoxious to Islam as the centre of heretical propaganda preached by Mokanna (*q.v.*). In 874 Arab rule in Central Asia came to an end. During their dominion Merv, like Samarkand and Bokhara, was one of the great schools of learning, and the celebrated historian Yaqut studied in its libraries. In 1040 the Seljuk Turks crossed the Oxus from the north, and having defeated Masud, sultan of Ghazni, raised Toghrul Beg, grandson of Seljuk, to the throne of Persia, founding the Seljukian dynasty, with its capital at Nishapur. A younger brother of Toghrul, Daud, took possession of Merv and Herat (*q.v.*). Toghrul was succeeded by his nephew Alp Arslan (the Great Lion), who was buried at Merv. It was about that time that Merv reached the zenith of her glory. During the reign of Sultan Sanjar or Sinjar of the same house, in the middle of the 11th century, Merv was overrun by the Turkish tribes of the Ghuzz from beyond the Oxus. It eventually passed under the sway of the rulers of Khwarizm (Khiva).

Merv was conquered in 1221 by Tule (*see* MONGOLS), most of the inhabitants were massacred, and from that time the city began to decay. It was the seat of a Christian Archbishopric in the early 14th century and in 1380 was included in the possessions of Timur (*q.v.*). In 1505 the city was invested by the Usbegs, who were expelled (1510) by Ismail Khan of Persia. It remained in Persian hands until 1787 when the Emir of Bokhara captured it. In 1794 the Bokharians burned it to the ground and made the whole district a waste. When Sir Alexander Burnes traversed the country in 1832, the Khivans were the rulers of Merv. About this time the Tekke Turkomans, then living on the Heri-rud, were forced by the Persians to migrate northward. The Khivans contested the advance of the Tekkes, but ultimately, about 1856, the latter became the sovereign power in the country, and remained so until the Russians occupied the oasis in 1883.

NEW MERV, the present chief town of the oasis, founded in the first quarter of the 19th century, is on the Transcaspian railway, 380m. by rail south-west from Samarkand. It stands on both banks of the Murghab, 820ft. above the Caspian. In 1926 the population was about 12,000, including Russians, Armenians, Turkomans, Persians, and Jews. It has a meteorological observatory. Corn, raw cotton, hides, wool, nuts, and dried fruit are exported.

See C. Marvin, *Merv* (1880); E. O'Donovan, *The Merv Oasis* (1882); and H. Lansdell, *The Russians at Merv and Herat* (1883). (*See* TURKESTAN.)

MERX, ADALBERT (1838–1909), German theologian and orientalist, was born at Bleicherode, Prussian Saxony, on Nov. 2, 1838, and became (1875) professor of theology of Heidelberg. He elucidated the Sinaitic palimpsest discovered in 1892 by Mrs. Agnes Smith Lewis (*see* BIBLE), the results being embodied in *Die vier kanonischen Evangelien nach ihrem ältesten bekannten Texte* (1897–1905). He died at Heidelberg on Aug. 6, 1909.

MÉRYON, CHARLES (1821–1868), French etcher, was born in Paris on Nov. 24, 1821. His father was an English physician, his mother a French dancer. Méryon's childhood was spent with his mother, but she died when he was still young, and he entered the French navy, and in the corvette "Le Rhin" made the voyage round the world. He was already a draughtsman, for on the coast of New Zealand he made pencil drawings which he was able to employ, years afterwards, as studies for etchings of the landscape of those regions. Méryon left the navy as a lieutenant. Finding that he was colour-blind, he determined to devote himself to etching. He entered the work studio of one Bléry, from whom he learnt something of technical matters, and to whom he always remained grateful. Méryon was by this time poor. It is understood that he might have had assistance from his kindred, but he was too proud to ask it, and had to earn his living by irksome mechanical work. For the sake of practice he made some studies after the Dutch etchers, such as Zeeman and Adrian van de Velde. He then began the series of etchings called "Eaux-fortes sur Paris." These plates, executed from 1850 to 1854, are never to be met with as a set; neither were they published as such; but to Méryon they constituted a series.

Besides these twenty-two etchings "sur Paris," Méryon did seventy-two others, all of them being catalogued in Wedmore's *Méryon and Méryon's Paris*. This list includes, however, the works of his apprenticeship and of his decline, adroit copies and more or less dull portraits. Among the dozen outside his professed series which are worthy of special mention are three or four beautiful etchings of Paris and two or three of Bourges. Although a master of his craft, he was appreciated only by a few artists, critics and connoisseurs, and when he sold his etchings, it was for a few pence only. Disappointment told upon him, and, frugal as was his way of life, his poverty must have depressed him. He became subject to hallucinations, and a few years after the completion of his Paris series he was lodged in the madhouse of Charenton. A partial cure was effected, but in 1867 he returned to the asylum, where he died in 1868.

Of the twenty-two pieces in the *Eaux-fortes sur Paris*, ten were destined as headpiece, tailpiece, or running commentary on some more important plate. But each has its value, and certain of the smaller pieces throw great light on the aim of the entire set. Thus, one little plate—not a picture at all—consists of verses by Méryon describing the darker side of Paris life. His etchings are spoken of as views of Paris but they are likewise the visions of a poet and the compositions of an artist who had set himself to create an epic of the city. The Abside de Notre Dame, a general favourite, is commonly held to be Méryon's masterpiece. Light and shade play wonderfully over the great fabric of the church, as seen over the spaces of the river. Méryon was at home with every style of architecture, and in this respect it is interesting to contrast him with Turner, who, in drawing Gothic, often drew it with want of appreciation. It is evident that architecture must enter largely into any representation of a city, however much such representation may be a vision and not merely a chronicle. Generally speaking, Méryon's figures are those of a landscape painter; but sometimes, as in the case of *La Morgue*, it is they who tell the story of the picture, or, in the case of *La Rue des Mauvais Garçons*, with the two passing women conversing secretly, at least suggest it. In *L'Arche du Pont Notre Dame*, again, it is the figures which give vitality and animation to the scene.

Méryon was little called upon by the character of his subjects to deal with Nature. He drew trees and foliage badly, both in detail and in mass. But it was necessary that he should know how to portray a certain kind of water—river-water, mostly sluggish—and a certain kind of sky—the grey, obscured and lowering sky that broods over a world of roof and chimney. Of such water and such skies Méryon was past master.

Sir Seymour Haden has called Méryon a great original engraver rather than an etcher, and certainly he does not display those virtues of the etcher defined by Hamerton—"selection" and "abstraction." But he was an excellent draughtsman.

BIBLIOGRAPHY.—Philippe Burty, *Gazette des beaux arts* (1865); *Descriptive Catalogue of the Works of Méryon* (London, 1879); Aglaüs Bouvenne, *Notes et souvenirs sur Charles Méryon;* P. G. Hamerton, *Etching and Etchers* (1868); F. Seymour Haden, *Notes on Etching;* H. Béraldi, *Les Peintres graveurs du dix-neuvième siècle;* Baudelaire, *Lettres de Baudelaire* (1907); L. Delteil, *Charles Méryon* (1907); Frederick Wedmore, *Méryon and Méryon's Paris,* with a

descriptive catalogue of the artist's work (1879; 2nd ed., 1892); *Fine Prints* (1896; 2nd ed., 1905); W. A. Bradley, *Méryon and Baudelaire* (1912); Loÿs Delteil, *Catalogue Raisonée of the Etchings of Charles Méryon*, ed. by H. J. L. Wright (1924); Loÿs Delteil, *Méryon*, trans. by G. J. Remer (1928).

MESA, in geomorphology, a high table-land capped with harder rock, being the remnant of a plateau (Span. *mesa*, from Lat. *mensa*, a table), built up of horizontal or very gently inclined strata. During denudation the hard rock acts as a flat protective cap for those portions situated between places, such as stream valleys, where erosion is especially active. This results in land-forms resembling "table-mountains" or "fortress-hills." Many examples are found in the Colorado regions of North America. The term "butte" is generally employed for a "mesa" of small extent. (*See* also Marsh.)

MESATICEPHALIC or **MESOCEPHALIC,** a term applied by anthropologists to those skulls which exhibit a cephalic index intermediate between the dolichocephalic and brachycephalic crania (*see* Craniometry). Taking the longer diameter of a skull, *i.e.*, from front to back, as 100, mesocephalic skulls are those of which the transverse diameter varies between 75 to 80.

MESDAG, HENDRIK WILLEM (1831–1915), Dutch marine painter, was born at Groningen on Feb. 23, 1831. He entered the family banking firm of Mesdag, but about 1866, owing to the influence of Josef Israels, took up the study of art. His sea pieces became famous and earned him the gold medal of the Paris Salon, among them being "Effet du soir à Scheveningen" (1872); "Apres l'Orage" (1895); "Rentrée des bateaux de pêche" (1900) and "Une Soirée sur la plage de Scheveningen" (1911). He presented his fine collection of pictures and *objets d'art* to the nation, and they are housed in the Mesdag museum at The Hague. He died at The Hague on July 7, 1915.

MESEMBRIA, a town of Bulgaria, situated on a narrow promontory in the Black sea, connected by a causeway with the land, 20 m. N. of Burgas (*q.v.*). Coasting steamers from Varna and Burgas touch here, and there is a motor-bus service by land to Anhialo. Mesembria was founded as a colony of Megara in the 7th century B.C., and remained Greek ever after till 1925, when it was settled with Bulgarians under the exchange of populations. In the early middle ages it was very rich, and frequently visited by the Byzantine emperors, and the remains of over 40 Byzantine churches can be traced in its small area, showing examples of every style of Bulgarian ecclesiastical architecture. A few of these (St. John of the Sea, the new cathedral, St. John) are still in fair repair. The whole forms a collection of unique interest. Fine works of Greek art have been discovered here.

MESHCHERYAKS or Meshchers, a people inhabiting eastern Russia. Some of the Mordvinians (of Finnish origin) call themselves Meshchers. The town Meshchersk, now Meshchovsk, has maintained their name. After the conquest of the Kazan empire by Russia, part of them migrated north-eastwards. The western branch became Russified, and the eastern branch has fused with the Bashkirs.

MESHED (properly *Mash-had*, the place of martyrdom), capital of Khurasan in Persia, is situated at an elevation of 3,197 ft., in the valley of the Ab-i-Meshed or Kashaf Rud, a tributary of the Hari Rud. The town, in 37° 16′ N., 59° 36′ E. is 460 m. crowfly from Tehran (566 m. by road), 200 m. from Herat, and 472 m. by road from Duzdab near the frontier of India. The population is estimated at 60,000–80,000 of which about 10,000 are pilgrims. Meshed Jews number about 4,000 and inhabit a quarter near one of the gates. The climate is fairly healthy with an average maximum temperature of 90·9° Fahr. in July and minimum of 22·3° in January. The average rainfall over a period of 17 years was 9·37 inches. The town, irregular of shape, is about 6 m. in circumference and surrounded by a mud wall with towers. In the north-west stands the Ark, or citadel, which serves also as the residence of the Governor, and in front of this is the *maidan*, an open square about ¼ m. in extent. There are unusually large numbers of caravanserais. The city has five gates from one of which, the Bala Khiaban gate, the main street forms a fine avenue planted with plane and mulberry trees and having a stream running down the centre. Meshed has grown up around the tomb of the Imam Riza and has supplanted Tus, the ancient capital, now in ruins, about 15 m. to the north-west. It is visited annually by some 100,000 pilgrims. Riza (770–819) was the eighth of the twelve Imams in line of succession after Mohammed's cousin and son-in-law Ali, whose particular followers—as Shiahs—the Persians are. To the Shiahs, Imam Riza is a martyr, being believed to have been poisoned by the Caliph Mamun. The buildings of the shrine—"the Glory of the Shiah World"—together with a space extending to about one hundred yards beyond the gates of the shrine on each side, is *bast, i.e.*, sanctuary.

Meshed is very important politically as well as commercially and the British and Russian Governments maintain consulates-general there. The transit trade of Meshed to Central Asia is not so great as before the construction of the Trans-Caspian railway. It is the centre of the northern wool trade and of an important rug industry. It is a nucleus of trunk roads, being joined with Tehran (566 m.) by a partly metalled road passable for carts at all times and by light motors in summer. It is joined also with Ashgabad on the Trans-Caspian railway by a good carriage road; and southward there is at Duzdab (600 m.) the road to railhead of the Indian system, which was made passable by motor cars during the World War. The total value of the trade passing through Meshed in 1925–6 was 38,339,080 krans (£ St.=45 krans) exports about balancing imports. The chief items of export were carpets (5,669,-965 krans), hides and skins (5,550,213 krans), opium (4,351,600 krans), timber, and cotton tissues; the imports were sugar, skins and hides, cotton stuffs, carpets, minerals and metals.

Bibliography.—E. B. Eastwick, *Journal of a diplomat's three years' residence in Persia* (1864); G. N. Curzon, *Persia and the Persian Question* (1892); C. E. Yate, *Khurasan and Sistan* (1900); Earl of Ronaldshay and E. Penton, "A journey from Quetta to Meshed," *Geogr. J.*, 1902, XX.; P. M. Sykes, "Historical notes on Khurasan," *J.R.A.S.*, 1910, pp. 1129–48; P. M. Sykes and K. B. Ahmad Din, *The Glory of the Shia World* (1910); Ella C. Sykes, *Persia and its people* (1910); H. H. Schweinitz, *Orientalische Wanderungen in Turkestan und im nordöstlichen Persien* (1910); A. V. Williams Jackson, *From Constantinople to the home of Omar Khayyam* (1911); H. R. d'Allemagne, *Du Khorassan au pays des Backhtiaris. Trois mois de voyage en Perse* (1911); H. S. Massy, "An Englishman in the shrine of Imam Riza at Mashad," *Nineteenth Cent.*, 1913, No. 435.

(P. Z. C.)

MESHREBIYA (drinking places), the Arabic term given to projecting oriel windows enclosed with lattice-work, so-called from the small semicircular bows, in which porous water-bottles are placed to cool.

MESMER, FRIEDRICH (or Franz) **ANTON** (1733–1815), Austrian doctor, from whose name the word "Mesmerism" was coined (*see* Hypnotism), was born at Weil, near Constance, on May 23, 1733. He studied medicine at Vienna. Interested in astrology, he imagined that the stars exerted an influence on beings living on the earth. He identified the supposed force first with electricity, and then with magnetism; and it was but a short step to suppose that stroking diseased bodies with magnets might effect a cure. He published his first work (*De planetarum influxu*) in 1766. Ten years later, on meeting with J. J. Gassner in Switzerland, he observed that the priest effected cures by manipulation alone. This led Mesmer to discard the magnets, and to suppose that some kind of occult force resided in himself by which he could influence others. He held that this force permeated the universe, and more especially affected the nervous systems of men. He began to hold séances in Vienna, but the police interfered and ordered him to leave the city within 48 hours. He then went to Spa. He removed to Paris in 1778, and in a short time Mesmer's consultations became the fashion. The medical faculty of Paris stigmatized him as a charlatan; still the people crowded to him. The government appointed a commission of physicians and members of the academy of sciences to investigate the phenomena observed in the séances. Franklin and Baillie were members of this commission, and drew up an elaborate report admitting many of the facts, but contesting Mesmer's theory that there was an agent called animal magnetism, and attributing the effects to physiological causes. Mesmer himself was undoubtedly a mystic; and, although the excitement of the time led him to indulge in mummery, he was honest in his beliefs. However he was

denounced as an imposter. He left Paris and died at Meersburg in Switzerland on March 5, 1815. The most distinguished of his disciples was the marquis de Puységur.

MESNE, middle or intermediate, an adjective used in several legal phrases. A mesne lord is one who has tenants holding under him, while himself holding of a superior lord. Mesne process was such process as intervened between the beginning and end of a suit (*see* PROCESS). Mesne profits are profits derived from land whilst in wrongful possession, and may be claimed in damages for trespass in a separate action or joined with an action for the recovery of the land. The plaintiff must prove that he is entitled to re-enter into possession, his title during the period for which he claims, the fact that the defendant has been in possession during that period, and the amount of the mesne profits. The amount recovered as mesne profits need not be limited to the rental value of the land but may cover deterioration or reasonable costs of getting possession, etc.

MESOLITHIC: *see* ARCHAEOLOGY: *Iron Age.*

MESOMEDES of Crete, Greek lyric poet, who lived during the 2nd century A.D. He was a freedman of the emperor Hadrian, on whose favourite Antinous he is said to have written a panegyric. Two epigrams by him in the Greek anthology (*Anthol. pal.* xiv., xvi.) and a hymn to Nemesis are extant. The hymn is of special interest as preserving the ancient musical notation written over the text. Two other hymns—to the muse Calliope and to the sun—formerly assigned to Dionysius of Alexandria, have also been attributed to him.

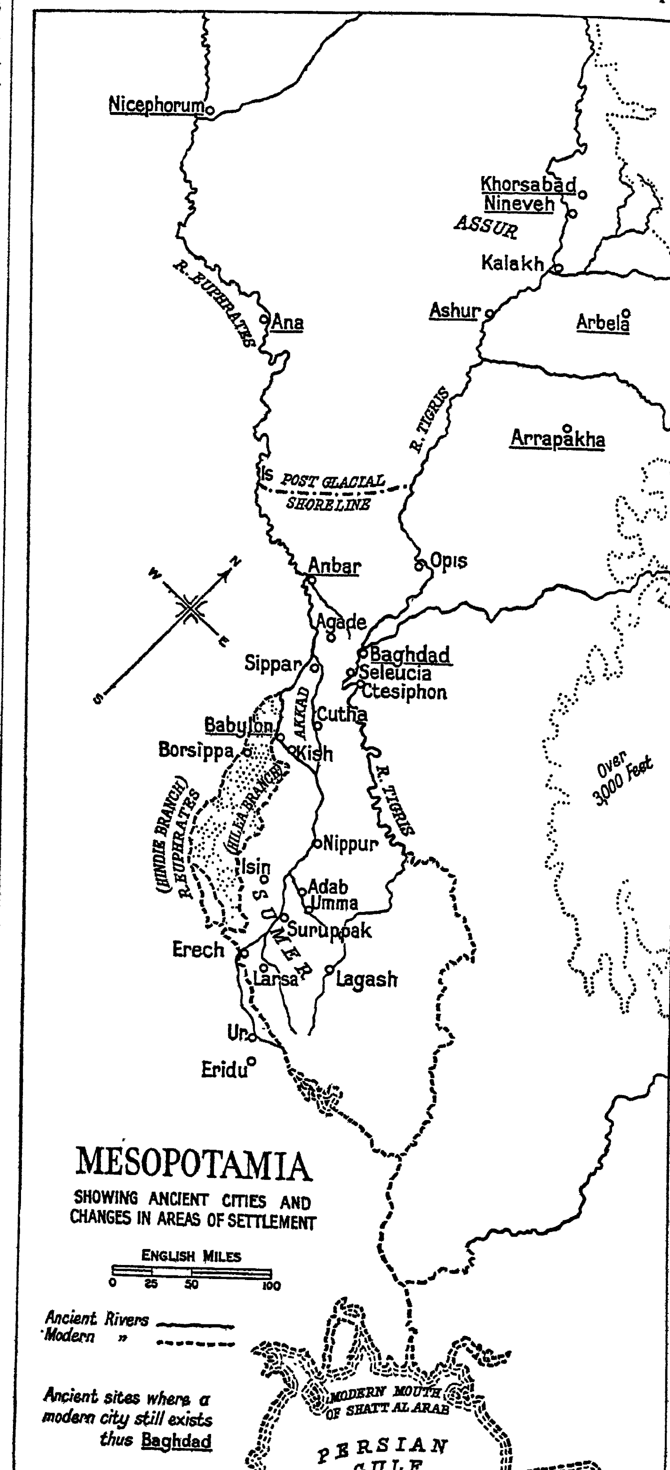
See J. F. Bellermann, *Die Hymnen des Dionysius und Mesomedes* (1840); C. de Jan, *Musici scriptores graeci* (1899); S. Reinach in *Revue des études grecques,* ix. (1896); Suidas, *s.v.*

MESONERO ROMANOS, RAMÓN DE (1803–1882), Spanish prose-writer, who was born in Madrid and died there, wrote the *Panorama matritense* (1835–36), a collection of interesting pen-pictures of old-time Madrid, and an autobiography, *Memorias de un setentón, natural y vecino de Madrid* (1880).

MESOPOTAMIA. Although the boundaries of the modern kingdom of 'Iraq, which occupies the land of ancient Mesopotamia, have recently been clearly defined the term Mesopotamia has been loosely used. In this article the area included is the great depression shut in between the escarpment of the Arabian desert and the mountains, which form the western boundary of the plateau of Iran on the west and east respectively, and bounded on the north by the mountains of Armenia and Asia Minor, and on the south by the Persian gulf. In the north there is a belt of stony country varying between 40 and 100 miles broad which extends as far as Hit, which stands on the site of the old coast line before the formation of the alluvial plain of the twin rivers, the Tigris and the Euphrates. This alluvial plain extends southwards, falling nearly 100 feet between Baghdad and Basra, and forms the fertile basin in which grew up the ancient civilizations of Sumer and Akkad. The plain is everywhere extremely flat and has a transverse slope away from the rivers and from the Persian hills to the Tigris. This flatness and the form of the slope combined to allow perennial irrigation on a large scale and so made the ancient civilizations possible. The alluvial plain itself is of comparatively small extent, about 35 thousand square miles, rather over a sixth of the whole area of Mesopotamia.

Geology.—South of the Eurasiatic massif there are three great plateaux, the remains of a tropical continent. Between these plateaux, India, Arabia and Africa south of the Atlas there are a series of basins, Mesopotamia itself forming the basin between the plateau of Arabia and the fold mountains of Persia. The latter parallel ranges, which bound it on the east are of many different ages. The south-western boundary is the Archaean rocks of the Arabian plateau. This contrast between the eastern and western boundaries is enhanced by the difference of climates. The rainfall of the Persian mountains has been accompanied by rapid rock decay and numerous canyons have carried down to the plain a rich and fertile alluvium, but the valley bottom lacking the rainfall of the Indo-Gangetic plain, to which it corresponds physiographically, has not been able to support the dense population of the latter area. On the west the plateau is arid, streams are few, and the denudation has been of the desert type, contributing but little to the plain.

The history of this condition seems to be as follows. The earliest direct information on the geological history of upper Mesopotamia is found at Ana on the Euphrates where upper



MESOPOTAMIA
SHOWING ANCIENT CITIES AND CHANGES IN AREAS OF SETTLEMENT

Cretaceous limestones were formed at a time when upper Mesopotamia was all submerged. A volcanic period in Oman seems to have occurred at the beginning of Cenozoic times, when most of Arabia and Persia were dry land, and coal seams were forming in Mesopotamia. The lower Eocene sea covered parts of the Persian gulf, and during the middle Eocene there was another advance of the sea. At this time there was a deposition of a nummulitic limestone, which is succeeded in upper Mesopotamia by beds which contain fish teeth and marine shells of the Upper

Eocene. This period is not widely developed, and in the succeeding Oligocene there was a land period of which at present only a few fossil remains have been discovered. During the Miocene the sea extended from northwest India to Asia Minor. A further advance appears to have followed which resulted in the deposition of red clays, which are interbedded with rocksalt, oil beds and gypsum. The deposition of these beds was interrupted by an uplift which eventually converted the whole area into a continuous land surface. This uplift was associated with foldings of the greatest significance. Previous foldings had already built the ranges of northern Persia and to a certain extent the Zagros range, but the main folding, which built up the mountain boundary to the northeast of Mesopotamia is probably Pliocene.

As a result of this folding a weak belt was formed along the outer edge of the folded zone. This belt formed the Mesopotamian depression. It has been estimated that the displacement on the Persian side was as much as 9,000 feet, due to the combination of faulting and monoclinal folding. On the west the displacement due to simple faulting alone was slight.

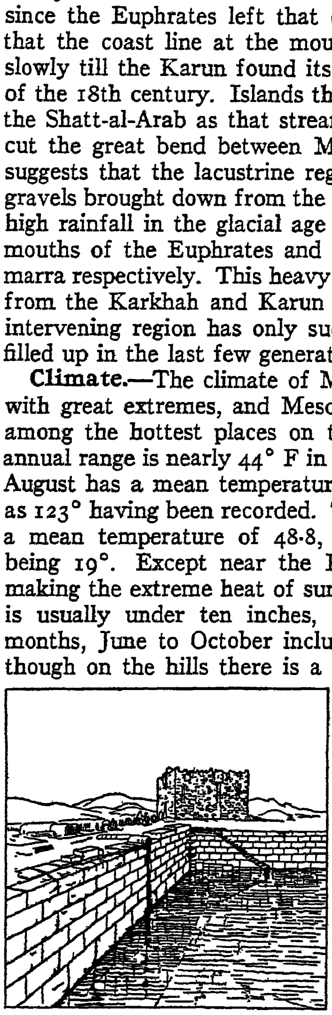
Upper Mesopotamia (Jezirah) contrasts strongly in formation with the lower alluvial valley. The mountain border of the Jezirah begins with the gently folded beds of sandstones, gypsum and conglomerates of Jebel Hamr. There are hills of a similar composition near Mosul on the southwest bank of the Tigris. At this point the river flows along the fault plane between lower Miocene on the southwest and Pliocene Conglomerate on the northwest. Farther to the northwest the range of hills is capped by basalt. Its continuation Jebel Sinjar also consists of basalt, overlying Miocene rocks, and the basalts have further a wide extension along the Tigris to the northeast of the Sinjar hills. Further to the west lies the Jebel Abd al-Aziz and still further north of a line drawn from Mardin to Urfah the land rises into the foothills of the Taurus which is composed chiefly of Cretaceous, Eocene and Miocene beds, although there are some basaltic lavas from the old volcano Qara Dagh. In the northwesterly corner of the Mesopotamian depression between Diarbekr and Mardin gault ammonites have been found but most of the country near Diarbekr consists of volcanic rocks through which the Tigris has cut a 300-ft. canyon. The Cretaceous beds to the northwest of Ana are Senonian but below this town they are partly Turonian. Above this belt of Cretaceous rocks along the great western bend of the Euphrates past Birijik and near Samsat there are Miocene beds. To the north they are succeeded by volcanic rocks, through which on both sides of the Taurus the Euphrates has cut a magnificent gorge.

Although lower Mesopotamia consists mainly of alluvium there are extensive outcrops of older formations. There are conglomerates at Beled on the Tigris, 84 miles from Baghdad by river, and a few miles above Beled at Qadisiyeh and also from Zobeir near Basra to the Euphrates at Suq esh Shuyukh. At Beled the conglomerates rest on a bed of clay.

Conglomerate is however exceptional on the great flood plain and in most of the region the tracts of marshy alluvium are only interrupted by areas of sandy and stony desert. These probably are found where Miocene beds outcrop as low plateaux of gypsiferous marls and are of great interest to students of human history as they probably formed ancient islands, which may have been inhabited in pre-Sumerian times. One of these plateaux forms a ridge about a mile wide between Museyib and Baghdad. Miocene outcrops also occur west of Basra.

The most interesting question however in the geology of the alluvial plain, in relation both to the ancient history of Mesopotamia and certain modern problems, is the growth of the deltaic region. While it seems probable that the old shore line was in glacial times near Hit the position of the sea coast in Sumerian times is open to considerable conjecture. Langdon in his map in the *Cambridge Ancient History* puts the site of ancient Eridu actually at the head of the gulf (Eridu lies a few miles southeast of Ur), a position fully justified by the explicit statements of ancient texts. Campbell Thompson however in his excavations on this site found fresh water mussels, and suggests that although there is no reason to doubt that Eridu was on the edge of the "sea" that sea was a fresh water lake and not the actual gulf itself but as he also found marine shells it is possible that the fresh water shells were used for food. Sir A. T. Wilson suggests that in ancient times there was a great lake or chain of lakes, all of which except that fed by the Jarrahi poured their waters as at present through the Shatt-al-Arab. He believes that at the beginning of the Christian era the coast coincided from Bubiyan island with the present shore, curving thence inwards to somewhere near Abadan, and joining the present coast near Qubban. He suggests further that 90% of the silt deposited in the lakes and therefore never reached the gulf. The size of Bubiyan island shows that in prehistoric times the Euphrates carried great deposits of silt, while the Tigris was less active. Under these circumstances the rapid extension of land at Fao, according to Rawlinson as much as 53 metres per annum between the years 1793 and 1833 is no indication of a stable coast line. There does not appear to be any reason to think that the coast east of Bahmishir has advanced since the Karun abandoned it, nor that the coast at Bubiyan has advanced at all in the past twenty centuries, that is since the Euphrates left that channel. Wilson's conclusions are that the coast line at the mouth of the Shatt-al-Arab advanced slowly till the Karun found its way into that channel at the end of the 18th century. Islands then began to form at the mouth of the Shatt-al-Arab as that stream began to enlarge its bed and to cut the great bend between Mohammerah and Abadan. Wilson suggests that the lacustrine region was formed by silt, sand and gravels brought down from the Arabian plateau during a period of high rainfall in the glacial age by the Batin, at a time when the mouths of the Euphrates and the Tigris were near Hit and Samarra respectively. This heavy material, together with lighter silt from the Karkhah and Karun have formed the barrier, and the intervening region has only succeeded in becoming more or less filled up in the last few generations.

Climate.—The climate of Mesopotamia is continental in type with great extremes, and Mesopotamia and the Persian gulf are among the hottest places on the face of the globe. The mean annual range is nearly 44° F in Baghdad, where the hottest month August has a mean temperature of 92·5°, a temperature as high as 123° having been recorded. The coldest month is January with a mean temperature of 48·8, the lowest recorded temperature being 19°. Except near the Persian gulf the humidity is low, making the extreme heat of summer less oppressive. The rainfall is usually under ten inches, falling mostly during the winter months, June to October inclusive being practically rainless, although on the hills there is a larger precipitation. On the plain irrigation is absolutely necessary for the crops, rain only falling on an average of 26 days in the year.



FROM MRS. S. ERSKINE, "THE VANISHED CITIES OF ARABIA"

A CARAVAN HALT IN THE DESERT ON THE PILGRIMS' ROUTE TO MECCA

In this hot dry land the winds are of importance, both for the relief they bring to the intense heat and for the dust storms they cause. The prevailing north-west wind, the *Shamal,* blows both summer and winter, sometimes blowing with great strength during the heat of the day.

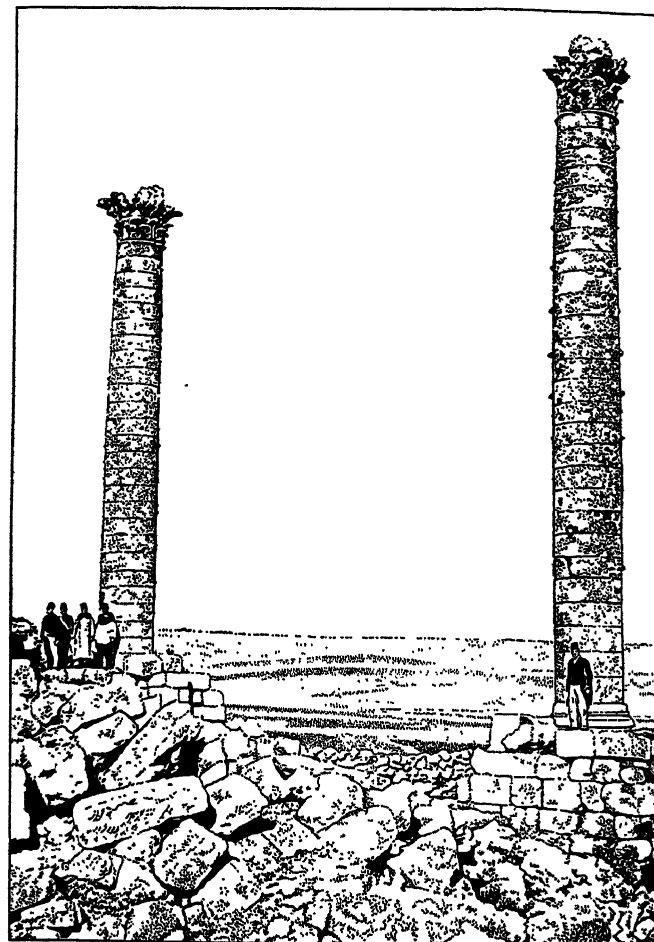
There is no exact information at present about the climate of Mesopotamia in ancient times. Such evidence as there is suggests that, within historic times at least, there has been no great change, such variations in the siting of cities and so on being rather due to an alteration in the direction of the rivers than to an actual change in climate. It is certain that in palaeolithic times the region was much wetter and no doubt at this time the dry wadis which lead down from the Arabian plateau carried water. The tributaries of the Tigris may have changed slightly (*see* TIGRIS) but insufficiently to warrant the suggestion that the desiccation is not of great antiquity, at least as far back as the Neolithic age.

Flora and Fauna.—While it may be said that Mesopotamia forms part of the region called by P. A. Buxton the "Palaearctic Desert" there are considerable differences in the flora and fauna

of the different parts. Northern Mesopotamia, the region through which the rivers flowed previous to the accumulation of the deltaic region, has a Mediterranean flora and fauna. It seems probable that wheat and barley are here close to their original wild home. On the whole the region is treeless, although there are trees on some of the hills. In southern Mesopotamia other conditions prevail. The rainfall is not really insufficient to support a considerable amount of vegetation but owing to the physical qualities of the soil, a very fine silt, combined with a high temperature and strong winds the evaporation is excessive. Under these circumstances the regions between the rivers often approach to more truly desert conditions than the north Syrian desert. As an example the unirrigated regions near Kish are in places absolutely devoid of vegetation and at one point in an area of about a square mile the only living plant found was a bush of Christ's thorn. Where however irrigation is practised and the water is allowed to drain off so that an excess of salts is not accumulated the soil produces good crops and after the crops abundant weeds of cultivation and a thorny flora of various species of a wide distribution in the palaearctic desert region. These weeds are extensively used for fire wood, a clear indication of the meagre floral resources of the country. The country is practically treeless, the only timber being supplied by the stems of the date palm, which grows along the rivers. There are also low beds of poplar. The vegetation along the rivers amounts to an extended oasis, although in places even the river banks are extraordinarily desolate. One of the characteristics of Mesopotamian vegetation as a whole is the comparatively few number of species which occur, a great contrast to the flora of the American desert. Secondly in common with all deserts the Mesopotamian vegetation shows a convergence of form between different species so that plants only distantly related are superficially similar. Thirdly, and this feature is also common to most deserts, the line which divides the green fertile land and the desert is very sharply marked, and the introduction of water by irrigation rapidly produces a marked change in the vegetation.

The fauna has as yet been imperfectly studied. Among large mammals the cheetah is not uncommon on the desert, the only other mammals of any size being various species of gazelles and antelopes. The lion so prominently figured on Assyrian bas-reliefs is said to exist, but recent records are uncertain. The wild ass is rare. Among the carnivora other than those mentioned the hyaena and species of wolves have been reported. The jackal is not uncommon and in certain regions wild pig abound. The desert hare is very common and where caves exist there are bats. Small mammals are extremely common, especially jerboas and their allies. Among the birds the ostrich reported as quite common by Xenophon is practically if not entirely extinct. The birds of prey are well represented, including the vulture, raven, owl and various species of hawks. In the steppe region the buzzard is very common, there are various species of sandgrouse and, where there is open water, ducks and geese; the black partridge is abundant near water. Among the reptiles one of the commonest and most interesting is the little lizard Agama. The details of the smaller animals are not yet worked out. P. A. Buxton has noted the fact that whereas in the stony desert the pebbles shelter a host of woodlice, millipedes, centipedes, spiders, scorpions, earwigs, cockroaches, crickets, beetles, bugs and ants and lice in southern Mesopotamia a similar fauna is found in the leaf-bases of the palm trees. Apart from technical lists the most interesting account of plant and animal life in Mesopotamia is found in P. A. Buxton, *Animal Life in Deserts*, London 1923.

Ancient Geography.—In most countries there is little change in the position of inhabited sites, which continue over long periods either on the same spot or on one nearby. In Mesopotamia on the other hand much of the desert is strewn with the ruins of ancient cities where now only an occasional shepherd is to be found. The reason for these changes is not always apparent but usually three causes appear to have operated. There may have been a change of climate, the rivers may have altered their position or their mouths, or in some cases political events may have triumphed over geographical situation. Whether there has been a change in climate or not in Mesopotamia since ancient times has been disputed. There is no doubt that in upper palaeolithic times the Syrian desert was sufficiently humid for permanent settlement, and Buxton found numerous traces of palaeolithic implements in districts now only inhabited by wandering Bedouins. There were even some traces of Neolithic peoples. In Mesopotamia itself we have no evidence before Sumerian times, since when most writers maintain that there is no evidence of any change of climate. Sir William Willcocks thinks the ancient canals were not in use at the same time and that the presence of all these waterways is not therefore evidence of a progressive desiccation. In the neighbourhood of Babylon and Kish where canals are particularly numerous a study of levels shows that there at least Willcocks' statement is abundantly justified. Thus the change in the siting of ancient cities was not due to a change in climate. Secondly there can be no reasonable doubt regarding the change in the position of the rivers, for both the Tigris and Euphrates have shifted their course since ancient times. All the cities of Sumer have therefore been left without water. Apart from Borsippa the only ancient city of Sumer on the river is Babylon, itself a relatively modern town which took the place of Kish, 15 miles away when a change in the river made that site no longer usable. It may seem difficult to understand how, if there has been no change in the climate, regions which are now desolate can once have been the site of prosperous cities. A study of the hydrography of ancient Mesopotamia will however explain this change. First the course of the old bed of the Euphrates, the river on which ancient Mesopotamia depended chiefly for its water supply, has changed its place very considerably. The modern stream runs ten and in places more miles east of its ancient course. Ancient Mesopotamia was therefore much smaller than modern 'Iraq. Apart from minor divergencies that have not yet been fully explored the Euphrates divided into two branches almost due west of where Baghdad now



FROM DR. S. GUYER, "MY JOURNEY DOWN THE TIGRIS" (MESSRS. E. BENN)
RUINS AT URFA. THE TWO ANCIENT COLUMNS BEAR SYRIAC INSCRIPTIONS CONTAINING THE NAMES OF THE PRINCES OF THE EDESSA DYNASTY

stands. One branch ran past Sippar and Cutha and the other followed the course of the present stream as far as Babylon, where it turned west and ran slightly north of but in the same general direction as the modern Shatt-al-Nil past Kish and Nippur. Lower it divided again, the western branch being in the general direction of the modern Shatt-al-Kar past the cities of Kisurra and Shuruppak and the more westerly branch running past the modern Bismya, the ancient Adab, in a south-easterly direction till it was joined by the Shatt-al-Hai, which communicates with the Tigris. From this point onwards its general direction was south, past the ancient city of Lagash. The true Mesopotamia therefore, the region between the rivers, as opposed to the lower marshes of both streams, was much narrower. Of all the ancient cities in Akkad—those in lower Sumer will be discussed later—only Borsippa lay away from this narrow strip and Borsippa was close at hand. In these circumstances it is clear that to a large extent the alteration in Mesopotamia has been the conversion of fertile land into desert and poor steppe in the central region, while on the western boundary the converse has taken place. But this movement of the rivers is not sufficient to explain the whole of the changes. In ancient times when the strip was narrower irrigation was comparatively easy. The normal method has always been to dig canals from one river to the other. When the Tigris was nearer at hand it was easier to ensure a more ready flow of water through the canals. It is also abundantly clear from an examination of the ancient canals that great difficulty was found in keeping them in proper condition. Further unless conditions are very favourable and the water used for irrigation is kept very dilute from certain salt solutions the irrigated land becomes very hard and impermeable. By itself the mere hardening of the land may not have been sufficient in ancient times to have converted cultivated land into desert, but it probably played its part. The increasing distance of the rivers and the consequent difficulty of irrigation has always been felt. Ancient Akkad consisted of a narrow strip of cultivated soil, bounded throughout much of its length by a river or canal on both sides, not as today a narrow strip along the Euphrates with desert to the west and a further strip of desert to the east, between the fertile lands and the Tigris.

In Sumer the changes have even been greater. Here also the country was much smaller. Pliny writing in the first century A.D. says that the Euphrates had in ancient times its own mouth, but that the men of Erech dammed it up, possibly as Sir A. T. Wilson suggests to irrigate the rich land near Suk-esh-Shuyukh. Before the time of Rim-sin the Euphrates ran west of Ur reaching open water near Eridu. This region is the only part of its course which in ancient times was more westerly than at present, but Ur is today only a little way from the stream. Rim-sin straightened out the course of the river so that it passed by Ur and left Eridu a waterless city. Here in ancient times Mesopotamia ended. It seems probable that both Eridu and Lagash were in ancient times on the edge of the sea and that they were closely connected owing to the ease of communications. The progressive silting up of this region and the action of Rim-sin and his successors have now left both cities in the desert and today the river runs east of Ur while Erech, which, in the opinion of ancient geographers was the cause of all the trouble, lies away in the waterless desert. South-east all the lands to Basra and the rich palm groves and marshes of modern Iraq were as yet to be. We do not know exactly where the true coast line was in ancient times but for all practical purposes Eridu marked the southernmost extension.

All these changes have been progressive, the Euphrates had ceased long before our era to flow past Cutha and Kish. Eridu was an inland city nearly four thousand years ago, and unless steps are taken the Euphrates threatens to run still farther to the west. The changing course of the rivers is partly due to natural causes and partly to methods of irrigation.

In spite however of these progressive changes most of the ancient sites do show evidence of continued occupation, at or near the spot where the ancient city stood. The Mongol invasion probably accomplished more in a few years than the hand of nature or the irrigation projects of ancient kings did in many centuries. In 1258 Hulagu Khan, a grandson of the great Genghiz sacked Baghdad and the invasion of the Mongols destroyed all the ancient irrigation systems and converted Mesopotamia into a desert. Many of the old towns had long ago ceased to exist but on many of the sites there are traces of continued occupation. The towns which grew up after the Mongol invasion have survived until today and mark the contrast between ancient and modern Mesopotamia.

The distribution of ancient cities in Mesopotamia is therefore extremely different from those in modern times. They fall into four groups, those of the northern foothills, the Assyrian group and the cities of Akkad and Sumer; all except the last two groups are widely separated from one another. In ancient times there were hardly any cities of importance on the middle Euphrates and as today few of any note on the lower Tigris. The foothill towns of the north including such cities as Samosata, Edessa and Nisibis were never of any great political importance except for their strategic value as border forts. Usually small in size they commanded various entrances between the plains and the mountains and passed from one hand to another, being used against the plain, or against the mountains according to the position of the dominant power. This line of towns was also of value as it still is owing to the fact that it commands the upper and easier route from east to west. Edessa and Nisibis therefore have played for a long time the dual rôle of forts in times of war and of *entrepôts* on a main caravan route in times of peace. The second group of cities lies within the fertile triangle of land which lies between the Tigris and the Greater Zab. It has always been a region of red earth and great fertility and is remarkable for the closeness of occupation in ancient times. To the north of the triangle, just below the mountains lay the city of Khorsabad, which has been generally accepted as being the site of Dur-Shurrukin, Sargon's city. Nineveh itself lay on the Tigris opposite the modern city of Mosul and about 40 miles above the confluence of the Greater Zab. Further south, but still in the triangle lay Kalakh, the modern Nimrud. The other cities of the group are more isolated. Ashur lies down the Tigris, about 60 miles from Nineveh, and separated from it by desert, an easy journey down stream, but more difficult up stream. The last city is Arbela, today Irbil. This is a foothill town of considerable importance lying almost due east of Kalakh and south of the river Zab. Of these cities it is interesting to note that three, Nineveh, Ashur and Arbela, are close to if not on the same site as a modern town. The foothill towns also have not moved. In lower Mesopotamia the towns are practically all on different sites.

Down the Tigris from Ashur there are no important ancient towns till the old glacial shore line is reached and the true alluvial valley begins. Here there are the first traces of ancient irrigation. The site of Opis, Upe, is probably on the Tigris close to its juncture with the Adhem. Apart from the site of Baghdad, which has always been an important centre and Ctesiphon, a little lower down the river the ancient cities from this point onwards lay on the old bed of the Euphrates. The most northerly of these cities is Sippar, probably on the actual edge of the glacial shore-line, and five miles from the present bed of the Euphrates. From this point onwards the traveller who abandons the modern river and passes along the old bed of the stream and the canals which have succeeded it will find a continuous string of imposing mounds in what is today a bare and monotonous plain, fringed along the western horizon by the palm trees which mark the course of the Euphrates. South of Sippar lay Agade, the city whose name is associated with that of Sargon. Cutha lay on the canal of Cutha, which may in ancient times have been one of the branches of the river. Below Cutha again, on what is today the Shatt-al-Nil, but which in ancient times was certainly the main stream, lay the great city of Kish. Fifteen miles westwards of Kish are the ruins of Babylon. These are today close to the Hilla branch of the Euphrates and since the foundation of the city it has always been on the river. It is from this point onwards that the main contrasts between ancient and modern Mesopotamia begin. When the river changed its course and flowed south past Babylon it deserted a whole line of ancient riparian cities and today there are only two ancient cities west of the modern course of the Euphrates, Borsippa, close to Babylon, and Ur far to the south. The

modern Shatt-al-Nil and the Shatt-al-Kar follow more or less the course of the ancient stream. Nippur lay south of Kish on the main river. Below Eridu there is only one ancient site, near Suk-esh-Shiyukh and all the modern marshland was non-existent. It is probable that southern Sumer consisted of a series of lakes and that much of what is now marshland was open water, although higher up the stream it is probable that marshes were still in existence. Otherwise the scenery of ancient Mesopotamia was probably not very different from what it is today, except for the alteration in position of the cities. Akkad, the northern alluvial plain, had the same steppe, the same fringing gallery of palms along the river, but this fringing gallery was at Kish and Nippur not at Hilla and Diwaniya. Where there are modern towns on the river there was desert or steppe, just as today the ancient cities are mere mounds waterless and bare. Southern Mesopotamia, Sumer, has altered considerably; most of the lakes have filled up, though they may recall their ancient form in flood time. The lakes have been succeeded by marshes and though some of these survive many have been transformed into steppe and desert. In each of the three areas there has always been a dominant town, shifting under the change of the rivers; in Assyria, Mosul is the direct descendant of ancient Nineveh and the site is almost the same. In Akkad the changes have been greater; the oldest paramount town is Kish. Agade was only temporarily important, and the hegemony shifted to Babylon and across the narrow neck of land to Seleucia and Ctesiphon on the Tigris, and later to Baghdad, itself on an ancient Sumerian site. In the south the changes have been greater. Larsa and Ur have ceased to hold a position of dominating geographical position, and the outlet of southern Mesopotamia passed under the Caliphs to Basra nearer to the Persian gulf. The true geographical history of Mesopotamia has a clear cut at the invasion of the Mongols and from this point begins the study of the modern cities.

Modern Geography.—Modern Mesopotamia, now the kingdom of Iraq, occupies most of the geographical region of Mesopotamia, although the eastern bank of the Shatt-al-Arab is under the Persian rule. It also extends westwards along a corridor into the Syrian desert. The delimitation of frontiers on the north and west has been a matter of considerable difficulty. It has been recognized that for pastoral nomads a sharply defined frontier, except where there are marked physical boundaries, is hardly possible. The nomads recognize definite frontiers, but these frontiers are rather to be expressed as grazing and water rights than as a definite line. These rights have been recognized and the frontiers allow the nomads to exercise their grazing rights irrespective of where the actual line has been drawn. Recent disturbances along the south-western border of Iraq have however shown that the existence of a paper frontier, even while it maintains traditional rights, will not always be a deterrent to raiding tribes. With these reservations however the frontiers of Iraq have now been delimited, and suitable allowance has been made for a zone in which grazing rights belong by ancient tradition to tribes on one side or other of the boundary. In the western corridor however the frontier is not at present clearly defined. It is extremely difficult to plot a frontier where the boundary is defined by natural features but where these features are not definitely located. Jebel Anaza is mentioned in the agreement and is stated to be 32° N. and 39° E., but Musil's map gives a location about two degrees south of this position. This western corridor is of considerable importance to modern Iraq. It is used at present as a motor route forming one of the readiest means of transporting passengers between Jerusalem and Baghdad. It is also used today by the Imperial airways who have a series of landing grounds plotted out between Amman and Rimadi.

Communications.—Apart from the airway and motor route Iraq possesses no direct communication by modern methods of transport except by sea to Basra. Internal communications are however better. During the World War a temporary line was laid along the lower Tigris. Since that time this line has been dismantled and a line from Baghdad to Basra along the Euphrates has been substituted, with a short branch to Kerbela. North of Baghdad there are two lines. One, standard gauge, runs to Kalat Shergat. This line is part of the proposed Baghdad railway. The original intentions of the builders were for this line to run northwards through Mosul and eventually by Nisibin and so connect with the Asia Minor and Syrian systems. The metre gauge runs along the Tigris to railhead at Kerkuk. It has recently been suggested that this line should be carried on to Mosul, as it travels through a comparatively highly populated area, whereas the old line would have to pass through practically uninhabited desert. As it is, the third most important town in Iraq is entirely without railway communications. Considering the size of Iraq it is at present extremely badly provided with railways, the most recent figures available being

Year	Route	Track	Sidings	Total
	Miles	Miles	Miles	Miles
1925 . .	757·30	757·30	243·86	1001·16
1926 . .	810·73	810·73	194·45	1005·18

About six hundred thousand passengers are carried a year.

In connection with the railways other communications have been developed. There is a weekly motor service connecting Baghdad and Syria, running across the desert to Damascus. From Kerkuk a new trade route has been developed to Tabriz via Ruwanduz, and Bulagh. The caravans go laden with teas and return with almonds and dried fruits which are sold in Baghdad. The second route via Khanakin does not seem at present to be very successful. There is a fairly regular service of cars to Teheran. In addition to the fortnightly air service with Cairo there are also air services between Baghdad and Mosul and Kerkuk and Sulaimaniya.

Apart from native boats the river services are practically limited to the Shatt-al-Arab and the Tigris. Sir William Willcocks was of opinion that the railways should be used for communications and the rivers for irrigation. Considerable divergence of opinion has existed on this point, but although developments seem quite possible (*see* TIGRIS; EUPHRATES) no great advances have been made at present. The most recent development of a river service has been between Basra and Siba, the Iraq frontier station opposite the Anglo-Persian refinery at Abadan.

Postal services have been considerably developed in Iraq since the war; in addition to the regular sea service by Basra the air routes take letters and parcels. Basra is an important wireless centre, in communication with Cairo, while the most recent development has been the establishment of a station at Rutba wells, in communication with Baghdad, Basra, Amman and Gaza. The telephone service has also been extended. With a touch of legitimate pride the post office reports the recent extension of the money order business to Esthonia.

Side by side with these developments the older routes and methods of travel exist and are used much as they have been for centuries. The two principal centres are Mosul, still without modern methods and Baghdad. Between these two cities are two roads, the shorter, the line taken by the railway follows the right bank of the Tigris via Samarra, Tekrit and Kalat Sherghat. The longer but better road follows the line of the Jebel Hamrin, and is considerably hampered by the necessity of crossing the tributaries of the Tigris which come down from the Persian highlands. It passes through Kirkuk and Erbil and then turns west to Mosul. This road avoids floods and passes through less desolate regions. It is nearer the centres of population and is usually preferred. From Mosul roads run west and east. The chief route to the Mediterranean goes to Nisibin and Mardin from which town there are roads to Erzerum and westwards to Alexandretta, and Aleppo, and from this point the railway can be reached. The eastern road to Persia from Mosul runs through Erbil. The Persian road from Baghdad runs along the same way to Khanaki which is now followed by the railway. This way is the regular route for the large number of pilgrims who visit the shrines of Mesopotamia. There are two main roads across the desert. Both cross the strip between the rivers and follow the right bank of the Euphrates as far as Deir and thence one goes south-west to Tadmor and Damascus or Homs, while the other follows the river to Meskineh whence it

crosses to Aleppo. It will be seen that apart from the western road where the prospect of a railway is still uncertain the railways closely follow the old roads with the exception of the Jebel Hamrin route which although it passes through centres of population presents considerable difficulties as rivers have to be crossed.

Distribution of the Population.—As in ancient times the population is distributed along the banks of the canals and rivers, only about 10% living elsewhere. Of the two rivers the Tigris is the least populated as was also the case in ancient times. On the Tigris the principal centres of population are round Amara, near the Shatt-al-Hai, to the north and north-west of Baghdad along the river and between the Tigris and the Diala, especially round Baquba. On the Euphrates there are three main centres of population, between Museyib and Diwaniya on the Hilla branch corresponding more or less to the ancient centre of population in Akkad near Kufa on the Hindieh branch and between Nasariye and Suk-esh-Shiyukh. By far the most densely populated part is however the Shatt-al-Arab.

In Upper Mesopotamia the population is sparse. The distribution is chiefly as follows. In the middle Euphrates valley, between the two rivers, especially on the northern and north-western side of the plain along the Jebel Sinjar and its foothills, east of the Tigris in the old land of Assur in the area north of the Lesser Zab as far as the line drawn from Erbil to Mosul, and in the Kurdish foothills. Elsewhere the population is limited chiefly to the nomads who wander from the plains to the mountains to find grazing for their cattle. The development of the system of irrigation is likely to extend the range of the population considerably.

The position of the towns corresponds closely to the possible lines of communication. Here as in ancient times there are three main centres. In the north Mosul, the centre of the wheat district and the starting point of the safest caravan route from east to west, corresponds to ancient Nineveh. While of lesser importance than formerly owing to the fact that the development of improved communications have helped its competitors, Baghdad is the capital city of Iraq not only for its mediaeval traditions and memories of the glories of the Caliphs but also because it commands the inner lines of communications. It takes the place of ancient Babylon, and still more ancient Kish because although in some ways less favourably situated than these it has in addition the command of the landroutes, for which in some ways the Euphrates valley is more favourable. It also forms a port on the navigable waterway of the Tigris, and forms a natural outlet for the trade route and the populous centres along the Diala. In event of the western railway or motor route developing Baghdad will naturally be the railhead of this route. Basra forms the gateway of the south, the only port of Iraq. Although owing to the rapid silting up of the river its position is threatened this may be mended by engineering projects to the Shatt-al-Arab. Not only is Basra the only port of Iraq and therefore the natural outlet of its produce but also it forms the capital city of the most populous region in the kingdom.

The other towns depend for the most part on their position on lines of communication between or from these three cities. But the exact siting has depended chiefly on three factors, first the possibility of markets, which has depended largely on positions along the rivers, and especially at the confluence of two rivers or canals, secondly a central position in a specially favourable district and thirdly, religious sanctity which has attached itself to a particular locality. Of these pilgrim centres the most important are Kerbela and Nejef, to which towns Shiah Muslims come from all over Mesopotamia and Persia and wherever else members of that faith are to be found. At Nejef there is the tomb of Ali, the finest of the Shiah monuments; it is also a starting point for one of the regular roads to Mecca, via the Wadi Jowf. Both these towns lie on the western boundary of Mesopotamia. Samarra on the Tigris, north of Baghdad, is a pilgrim centre of lesser importance.

The Euphrates towns group themselves first into those on the caravan route between Baghdad and Aleppo. This group which includes Birijik, Urfa, Diarbekr, Mardin, Nisibin and Jezireh-ibn-Omar have avoided the open plains and the southern end of the Karaja Dagh as being too insecure and waterless. Below Birijik on the middle Euphrates there are a series of towns of greatest importance. Rakka, the ancient Nicephorum, at the junction of the Belik and Euphrates lies somewhat off the road but Deir-ez-Zor near the junction of the Khabur and the main stream is of the greatest importance, because the regions both to the east and west are less arid than the corresponding regions lower down the river and are therefore more readily traversed by caravans. Further south along the river lie Werdi, Ana, Hit and Ramadi. All these towns, including Deir-ez-Zor lie on the western bank. At Ramadi there is a bridge of boats and the place is of some importance to-day as it forms the starting point of the overland motor route to Jerusalem. It is also an Air Force station, for apart from the Rutba wells out in the desert there is no other permanent water available till Amman is reached. A newer town is growing up on the other bank of the river. On the lower Euphrates apart from the pilgrim centres already mentioned there are a series of towns of growing importance owing to the presence of the railway. These are Hilla, close to the site of ancient Babylon, a great grain market, built on both sides of the river, the two parts of the town being connected with a bridge of boats. Hilla possesses large bazaars. It is of great interest as being a town which preserves, without any of the special prohibitions which attach to religious centres, the appearance of a truly oriental town little influenced by western culture. Lower on the river are Diwaniyeh, Nazariyeh and Suk-esh-Shiyukh, while Kurna lies at the junction of the twin rivers. There are few towns on the Tigris. Apart from Baghdad and Mosul the most important are Tekrit, with raft traffic downstream to Baghdad, an ancient industry in the time of Herodotus, and Kut-el-Amara and Kut. There are however a series of towns on the eastern frontier. Rowanduz in south Kurdistan is on the caravan route from Mosul to Tabriz, while Suleimaniye is the great market centre, being connected both with Mosul and Baghdad, and lies on the caravan route between this town and northern Persia. On the actual edge of the hills lie the towns of Erbil, Altun Kipri, Kirkuk, Tuz Khurmantli and Salahiye.

Economic Geography.—Mesopotamia is poor both in minerals and ores. There is little building stone and, with some exceptions the houses have from time immemorial been built either of mud, or in the marshy districts of reeds. There are deposits of iron ore in Upper Mesopotamia. In the Bohtan valley there are lodes of gold, lead and copper. From this point eastwards to the outlet of the Murad valley into the Euphrates these ores are found associated with platinum, silver and zinc. Of the earthy minerals both common salt and gypsum are abundant and are used locally. There are seams of brown coal in the Eocene beds north of Mardin at Harbol, near Jeziret-ibn-Omar and east of the Tigris. Brown coal is also worked at Nasaleh near Kufri. Poor as it is in ores, Mesopotamia has been famous from ancient times for its oil springs. The wells at Hit, Kirkuk and Jibbeh date from ancient times. The three localities which appear to be the most valuable are first in the Persian gulf; the wells here, however, though favourably situated geographically, are poor in quality. The second group on the Kuren, including the well at Qirab which is mentioned by Herodotus have been developed by the Anglo-Persian Oil Company. They lie outside the boundary of modern Iraq. The most promising field however lies within the boundaries of that state and extends in a southeasterly direction from Mosul to Kend-i-Shir and Mandala.

Apart then from oil Mesopotamia looks to agriculture chiefly to supply her economic needs. Such manufactures as she has, chiefly textiles, have given two words to most European languages, muslin from Mosul and tabby (watered silk) from a suburb of Baghdad, but these are to-day of little importance and Mesopotamia's development depends, as it has always depended, on irrigation to make the crops grow. Of these two are the most important, dates and cereals, although much is hoped from cotton in the future. V. H. Dowson has computed that out of the ninety million date palms in the world a third are grown in Iraq. Of these there are fifteen million on the Shatt-al-Arab, five million on the Hilla canal, one million round Baghdad, and the remainder on the Euphrates and in separate oases. Second in importance to the date is rice which is grown in the land bordering on the river

marshes over most of lower Mesopotamia, especially around Basra and to lesser extent in upper Mesopotamia. It is used both for home consumption and for export. Where the land is not suitable for rice, hard grain, especially barley and to a lesser extent wheat is grown. The Mosul district produces abundant cereals and with the development of railway communications will export a large amount. Fruit trees are cultivated throughout Mesopotamia varying from figs and pears to oranges, apricots and melons according to climate, while the apple is almost universal.

Live stock is a most important source of wealth, especially to the tribes who live on the borders of the desert. The camel belongs essentially to the nomad, but throughout the whole of Mesopotamia large numbers of sheep are kept, and the goats produce hair of high grade. In the south, water buffaloes are used but in the north the chief draught animal is the ox. Arab horses are bred, although the more or less settled tribes find great difficulty in finding fodder for their beasts in summer. The nomads solve this difficulty by migrating. Mules are seldom bred.

Although in an agricultural country the trade returns are not altogether a satisfactory estimate of the economic geography, an analysis of recent returns is very instructive. The figures are in lakhs of rupees (about £7,500, or $36,500).

Class	Imports			Exports		
	1923	1924	1925	1923	1924	1925
Textiles	765	764	629	394	448	352
Sugar	230	247	167	121	112	44
Dates	..	..	..	158	183	205
Carpets	165	154	183	167	158	186
Tea	96	116	101	65	75	50
Metals	22	79	44	10	11	41
Oil	76	74	77	..	..	..
Grain and flour	14	48	141	187	54	11·5
Intestines	16	28	27	31	53	56
Hides	..	..	..	21	35	47
Wood	34	18	34	..	..	..

Before the World War the Germans put very great faith in the cotton-growing possibilities of Iraq. The climatic advantages of the region lie in the fact that during the growing season there is a high and rising temperature, with none of the cold from which both Egyptian and American cotton suffer, there is no summer rain but from March to June when moisture is most needed it is available. There is no fall in temperature until after the period of growth at which time it helps to ripen the crop. The British Cotton Association is so hopeful of success in this direction that it has recently installed a modern ginnery which is capable of dealing with 10,000 bales a year.

BIBLIOGRAPHY.—Detailed bibliographies will be found at the end of each separate article on Mesopotamia, *e.g.*, BABYLON, EUPHRATES, etc. The following works all contain a fairly long bibliography. General: British Foreign Office Peace handbook, Mesopotamia, 1920; L. Delapotre, *Mesopotamia* (1925); L. H. D. Buxton and D. T. Rice, *Report on Excavations at Kish (Physical Anthropology)* (forthcoming). Geology, *British Admiralty Handbook*, 1918. Ancient Geography, *Cambridge Ancient History*, Vol. I. 1923; Sir A. T. Wilson, *Geographical Journal* 1925 LXV. Modern Geography; S. H. Longrigg, *Four Centuries of Modern Iraq* (1925). In addition to the above the annual colonial office reports are invaluable for modern statistics.

Racial History.—The basal type of the population of Mesopotamia belongs to a well marked type, extremely long-headed, slender boned and usually termed Eurafrican. This type is dominant in the earlier graves and has always formed the bulk of the population. In the earliest graves from Ur no brachycephals were found, but at the beginning of the third millennium this Armenoid type had already appeared at Kish, together with other skulls which closely resemble the ancient Egyptians and are of the type known as the "Mediterranean race." In spite of the invasions of many peoples, Semites, Sumerians, Kassites, Medes and Persians, the population of Mesopotamia to-day does not appear to differ essentially from that of the same region 5,000 years ago. The only intrusive racial type is the negro.

The grouping of the peoples of Mesopotamia depends largely on geographical surroundings, and in the towns also on religion. There is a marked distinction between the Arab of the desert, the true Bedouin, and the agricultural Arab of the irrigated land, though both belong to the same physical type. In the lower valley the so-called Marsh Arabs belong to a slightly different type. The urban communities contain a number of different trading peoples, though the Arab predominates.

Although the social organization of the desert intrudes to a certain extent on Mesopotamia this organization is most typical of Arabia. The agricultural communities however do not differ essentially. They form small groups under a patriarchal sheikh. Each family lives in a tent, or sometimes in a mud house. The typical form of marriage is that of first cousins, a man normally marrying his father's brother's daughter (*see* COUSIN MARRIAGE). Considerable attention is paid to keeping the blood pure and, apart from polygamy, the direct line is usually known for many generations. The village sheikh exercises a patriarchal rule, and claims certain dues from his subjects. Women are usually isolated, the women's part of the tent being separated from the men's part. The tribes in the settled area are better organized than most of the desert dwellers, and although the local sheikh has complete control within his own village, the district is governed more or less after the organization of the old Ottoman empire under a matasarrif.

Most of the inhabitants of Mesopotamia are Shia Moslems, whose sacred places (Kerbela being one of the most noted) are in the Baghdad region. They are mostly fanatical Muslims, but there is not that variety of religious sects so characteristic of the Mediterranean region of the Near East.

BIBLIOGRAPHY.—D. G. Hogarth, *The Nearer East,* (1902); F. von Luschan, *Journ. Royal Anthrop. Instit.* xli. (1911); Sir W. Willcocks, *The Irrigation of Mesopotamia* (1917); H. R. Hall, *Ancient History of the Near East* (4th ed. 1919); *Mesopotamia,* in Peace Handbook series (1921); G. Elliot Smith, *The Ancient Egyptians* (1923); L. H. D. Buxton, in *Excavations at Kish* (S. Langdon) (Paris, 1924); S. H. Longrigg, *Four centuries of modern Iraq* (1925, bibl.); Sir A. Keith, *Excavations at Al Ubaid* (1927). (L. H. D. B.)

HISTORY

EARLIEST TIMES

Functionally, Mesopotamia is the domain that lies between Babylonia and the related trans-Tigris districts on the one hand and the west Asian districts of Maritime Syria and Asia Minor on the other. Its position has given it a long, complicated and exciting history. The great rivers, in later times theoretically regarded as its boundaries, have never really been barriers (cf. *e.g.* Winckler, *Altorient. Forschungen,* iii. 348), whence the vagueness of the geographical terminology in all times. Its position, along with its character, has prevented it often or long, if ever, playing a really independent part.

The earliest inhabitants of Mesopotamia in times approaching the historical period are known as the Sumerians. The earliest Sumerian monarch who exercised dominion as far as the Mediterranean is Lugalraggizi, king of Erech, 2775–2750 B.C. His empire was before long eclipsed by the rising power of the Semites. Sumerian traditions and dynastic lists give a complete reconstruction of early history, beginning with ten mythical kings who lived before the Flood, for nearly a half million years, and after the Flood the first capital was Kish, followed by the dynasties of Erech, Ur, Awan, Kish II., Hamasi, Erech II., Ur II., Adab, Maer, Kish III., Akshak and Kish IV., when we reach the kingdom of Lugalraggizi of Erech.[1] According to the actual figures of the records, the first capital was founded, at Kish, 3768 B.C., which is clearly a mythical date. Early inscriptions of the city Lagash in the extreme south, and from Ur, Nippur, Adab, Erech and Kish, and especially from the earliest known sites, Shunuar (ki) near Kish, and Shuruppak in the south, indicate an advanced Sumerian civilization, before 4000 B.C. With the founding of the empire of Agade by the Semites under Sargon of Kish, begins the definite consecutive history of Babylonia and Assyria. That Sargon was or became supreme in Mesopotamia cannot be doubted, since there is contemporary evidence that he conquered Amurru. The three versions of the proceedings of Sargon in Subartu leave us in doubt what really happened. As he must have asserted himself in Mesopotamia *before* he advanced into the maritime district (and perhaps beyond: *see* SARGON), what is

[1] S. Langdon, Oxford Editions of Cuneiform Texts, vol. II.

referred to in the Omens and the Chronicle 26,472 may be an immigration of new elements into Subartu—in that case perhaps one of the early representatives of the "Hittite" group. According to the Omens text Sargon seems to have settled colonies in Subartu, and suggestions of an anticipation of the later Assyrian policy of transportation have been found by L. W. King (*History of Sumer and Akkad*) under the rulers of this time, and there are evidences of lively intercommunication. Mesopotamia certainly felt the Sumero-Babylonian civilization early. It was from the special type of cuneiform developed there, apparently, that the later Assyrian forms were derived. Mesopotamia would naturally share in the wide trade relations of the time, probably reaching as far as Egypt. The importance of Harrān was doubtless due not only to its fame as a seat of the Moon-god Sin, honoured also west of the Euphrates, and to its political position, but also to its trade relations. Contemporary records of sales of slaves from Amurrū are known.

When the Semitic settlers living in the age of Sargon, *i.e.*, the Akkadians, had become thoroughly amalgamated with the population, there appeared a new immigrant element, the Amurrū, whose advance as far as Babylonia is to be traced in the troubled history of the post-Gudean period, out of the confusion of which there ultimately emerged the Khammurabi dynasty. That the Amurrū passed through Mesopotamia, and that some remained, seems most probable. Their god Dagan had a temple at Tirqa (near 'Ishāra, a little below Circesium), the capital of Khana (several kings of which we now know by name), probably taking the place of an earlier deity. At Tirqa they had month names of a peculiar type. It is not improbable that the incorporation of this Mesopotamian kingdom with Babylon was the work of Khammurabi himself.

Not quite so successful eventually was the similar enterprise farther north at Asshur (or Assur [*q.v.*]) on the east margin of Mesopotamia, although we do not know the immediate outcome of the struggle between Asshur and the first Babylonian king, Sumu-abi. Possibly the rulers of Babylon had a freer hand in a city that they apparently raised to a dominant position than the Semitic rulers of Asshur, who seem to have succeeded to men of the stock which we have hitherto called Mitanni, if we may judge from the names of Ushpia who, according to Shalmaneser I. and Esarhaddon, built the temple, and Kikia who, according to Ashur-rem-nisheshu, built the city wall[1]. The considerable number of such names already found in records of the Sumerian kingdom Ur III. (2709–2301) and of First Dynasty records seems to show that the people of this race were to be found at home as far south as Babylonia.

HITTITE TIMES

When Khammurabi's fifth successor witnessed the downfall of the Amorite dynasty in consequence of an inroad of "Hittites," these may have been Mesopotamian Shubaru-Mitanni; but they may, as Ungnad suggests, represent rather ancestors of the Hittites of later times. It is difficult in any case not to connect with this catastrophe the carrying away to Khana of the Marduk statue afterwards recovered by Agum, one of the earlier kings of the Kassite dynasty. Whether Hittites were still resident at Khana we do not know. The earlier Kassite kings of Babylon still maintained the Amorite claim to "the four quarters"; but it is improbable that there was much force behind the claim, although we have a document from Khana dated under Kashtiliash. It is just as uncertain how long Asshur remained under the Babylonian suzerainty of which there is evidence in the time of Khammurabi, and what the relation of Asshur to western Mesopotamia was under the early kings whose names have lately been recovered. All these matters will no doubt be cleared up when more of the many *tells* of Mesopotamia are excavated. Only two have been touched; 'Arbān on the Khābūr, where remains of a palace of uncertain date, among other things an XVIII. dynasty scarab, were found by Layard in 1851, and Tell Khalaf, where the confluents join, and remains of the palace of a certain Kapar, son of Hanpan of "Hittite" affinities but uncertain date, were found by

[1]Ungnad, *Beitr. z. Assyr.* VI. v. 13.

von Oppenheim in 1899. A long inscription of a Shamshi-Adad I., contemporary with the first Kassite kings, 17th century, exists in which his claims extend over the land between the Tigris and the Euphrates, and he says that he erected memorials of himself on the shore of the Great Sea.

The first mention of Mitanni, as we saw, is under Tethmosis III., who clearly crossed the Euphrates. It is at least possible that common enmity to Mitanni led to a treaty with Assyria (under Ashur-nadin-akhe)[1]. Victorious expeditions into Naharin are claimed for Amenophis II., Tethmosis IV. and Amenophis III. The Egyptian references are too contemptuous to name the rulers; but Shaushatar may have begun his reign during the lifetime of Tethmosis III., and from cuneiform sources we know the names of six other Mitanni rulers. As they all bear Aryan names, and in some of their treaties appear Aryan deities (Indra, Varuna, Mithra, etc.), it is clear that Mesopotamia had now a further new element in its population, bearing apparently the name Kharri[2]. Many of the dynasts in North Syria and Palestine in the time of Tushratta bear names of the same type. The most natural explanation is that Aryans had made their way into the highlands east of Assyria, and thence bands had penetrated into Mesopotamia, peacefully or otherwise, and then, like the Turks in the days of the Caliphate, founded dynasties. The language of the Mitanni state, however, was neither Aryan nor Semitic, and may very well be that of the mysterious "Hittite" hieroglyphic inscriptions (*see* HITTITES). Mitanni was one of the great Powers, alongside of Egypt and Babylonia, able to send to Egypt the Ninevite 'Ishtar.

Assyria was now free, and Ashur-uballit knew how to make use of his opportunities, and, in the words of his great grandson, "broke up the forces of the widespread Shubari" (*AKA*, p. 7, I. 32 *seq.*). Knowing what we know of the colonizing power of the Assyrians, we may assume that among the "Mitanni" and other elements in the Mesopotamian population there would now be an increase of people of "Assyrian" origin. On the tangled politics of this period, especially Mesopotamia's relations with the north-west, the Boghaz-Keui documents throw a great deal of light. We know already a little more of the chequered history of the Amorites in the Naharin district, beset by great Powers on three sides. When Mitanni fell, Babylon no doubt adhered to its older claims on Mesopotamia; but the Kassite kings could do little to contest the advance of Assyria, although several rectifications of the boundary between their spheres are reported.

Aramaeans.—Mitanni's fall, however, opened the way for others also. Hence when Ashur-uballit's grandson, Arik-den-ili (written PU.DI.ili), carried on the work of enforcing Assyria's claim to the heirship of Mitanni, he is described as conquering the warriors[3] (?) of the Akhlame and the Suti. The references to these people, who practically make their first appearance in the Amarna correspondence[4], show that they were unsettled bands who took advantage of the loosening of authority to introduce themselves into various parts of the country, in this case Mesopotamia. Gradually settlements were made, the names of many of which are given by the various Assyrian kings who had at one time or another to assert or reassert supremacy over them—such as Chindanu, Laqe, Suhi along the South Euphrates boundary of Mesopotamia, and various districts bearing names compounded with *Bit*=settlement (*see* above), such as Bit-Adini (nearly equal to the later Osroene; *see* EDESSA), or Bit-Zamani in the north near Diārbekr. The specific name Aramaean first appears in the annals of Tiglath-pileser I., unless we identify the Arimi of Shalmaneser I. in Tūr 'Abdin with the Aramu[5], but the name may probably with fitness be applied to a very large number of the communities mentioned from time to time. Their position in Mesopotamia must have been very like that of the Shammar at the present time (see *ad fin.*). As they gradually adopted settled life in various parts of the country the use of Aramaic spread

[1]See *e.g.* P. Schnabel, *Stud. z. bab.-ass. Chron.* p. 25 (1908).
[2]Winckler has identified the Kharri with the Aryans, to whom he assigns a state in Armenia (*Or. Lit.-Zeit.*, July 1910).
[3]*See* M. Streck, *Zeit. Assyr.*, 18, 157.
[4]On a wrongly supposed much earlier occurrence of the name Achlamu, see *Klio*, vi. 193 n. 3.
[5]So for example A. Sanda, *Die Aramäer*, 5 (1902).

more and more (*see* below, "Persians").

ASSYRIAN INFLUENCE

Assyrian Empire.—Meanwhile Mesopotamia continued to be crossed and re-crossed by the endless marches of the Assyrian kings (such as Adad-nirari, Shalmaneser I. and his son), building and rebuilding the Assyrian empire (*see* BABYLONIA AND ASSYRIA), and eventually pushing their conquests towards Asia Minor at the expense of the Hittite domain. If, on the fall of the Kassites, Nebuchadrezzar I. established more direct relations between Mesopotamia and Babylon, his work was presently undone by the vigorous campaigns of Tiglath-pileser I., who seems even to have won Egypt's sanction of his succession to the Hittite claims. The tablet of Tukulti-Ninib, the grandfather of Shalmaneser II., is interesting from its account of an expedition down the course of the Tharthār to Hīt=Id (river and town now first mentioned in cuneiform sources) and up the Euphrates to the Khābūr district.

Now that Mesopotamia had passed out of the hands of Babylon, all that the later kings could do was to encourage local Mesopotamian rulers in their desire for independence (Nabuapluiddin). These were convinced that Assyria was master, but refused their tribute when they thought they dared. To overpower thoroughly the troublesome Bit-Adini (*see* above 3, viii.), which had naturally been aided by the states west of the Euphrates, Shalmaneser II. (860–825 B.C.) settled Assyrians in their midst. Harrān was one of the few places that remained on his side during the great insurrection that darkened his last days. Similarly the province of Guzanu (Heb. Gozan, Γαυζανῖτις) on the Kāhbūr, held with the capital Asshur in the insurrection that occurred in 763 (the year of the eclipse), when evidently some one (an Adad-nirari?) wore the crown, at least for a time. Harrān was clearly closely associated with Asshur in the rights and institutions that were the subject of so much party struggle in the new Assyrian empire that began with Tiglath-pileser IV. (*see* BABYLONIA AND ASSYRIA). When the policy of transporting people from one part of the empire to another was developed, new elements were introduced into Mesopotamia, amongst them Israelites, of whom perhaps traces have been found in the neighbourhood of Harrān at Kannu[1]. These new elements may have been more organically attached to the Assyrian state as such than the older inhabitants, to whom the affairs of state at Nineveh would be of little interest. On the conditions at Harrān some light is thrown by the census partly preserved in Ashurbanipal's library[2]. The governors of several Mesopotamian cities, such as Nasibin, Amid, took their turn as eponyms; but this would not have much significance for the people. Hence even the fall of Nineveh (612 B.C.) at the hands of Nabopolassar and the Medes would be a matter of comparative indifference; tribute paid to Babylon was just as hard to find as if it were going to Nineveh. Necho did not succeed, like his great XVIIIth dynasty predecessor, in crossing the Euphrates. He was defeated by Nebuchadrezzar at Carchemish (605 B.C.), and Mesopotamia was confirmed to Babylon. Its troubles began again shortly after Nebuchadrezzar's death; the Medes seized Mesopotamia and besieged Harrān. Before long, however, the overthrow of Astyages by Cyrus cleared Mesopotamia, and Nabonidus (Nabu-naid) was able, drawing on the resources of the whole of Syria for the purpose, to restore the famous temple of Sin at Harrān, where a few years later he erected in memory of his mother, who seems to have been a priestess there, the *stele* published in 1907 by Pognon.

Persians.—The fragmentary nature of the records does not enable us to follow the steps by which Cyrus became master of Mesopotamia, in which he probably met with little or no resistance. How much of Mesopotamia was involved in the revolt of what the Persian inscription calls Assyria (*Athur*) is not clear. Nor does it appear with certainty to which of the twenty satrapies into which, according to Herodotus, the Persian empire was divided, Mesopotamia belonged; probably it was included in *'Abar nahārā*. The fact is, we have no information from native sources[1]. The probability is that conditions remained very much what they had been; except, that the policy of transportation was not continued. The satraps and other high officials would naturally be of Persian extraction; but local affairs were probably managed in the old way, and there was no important shift of population. The large Aramaic infusion had by this time been merged in the general body of the people. These settlers doubtless influenced the "Assyrian" language[2]; but gradually, especially in the west, their own language more and more prevailed. Although Aramaic inscriptions of the Assyrian period, like those of Zanjīrli or that of King ZKR of Hamath, have not been found in Mesopotamia, already in the time of Shalmaneser II. mention is made of an Aramaean letter (Harper, *Ass. Bab. Letters*, No. 872, obv. l. 10.), and Aramaic notes on cuneiform documents begin to appear. Weights with Aramaic inscriptions (the oldest from the reign of Shalmaneser IV., 727–722) were found at Calah. By the Achaemenian period Aramaic had become the international language, and was adopted officially.

How Mesopotamia was affected by the passing of Persian armies on their way to suppress revolts in Syria or Egypt, or to conquer Greece, we do not know; on the whole it probably enjoyed unwonted peace. The expedition of Cyrus, the Younger, with which Xenophon has made us so familiar, only skirted the left bank of the Euphrates. The route followed by Alexander, though he also crossed at Thapsacus, took him unresisted across the northern parts; but the poor people of Mesopotamia suffered from the measures taken by their satrap Mazaeus to impede Alexander's progress. In spite of this, where Cyrus failed Alexander succeeded.

THE GRECIAN EMPIRE

Hellenism.—What would have happened had Alexander lived we can only guess. Under the Seleucids Babylon was moved across the plain to Seleucia; but before long the central authority was transferred to the other side of Mesopotamia, Antioch or elsewhere—a fateful move. It is improbable that cuneiform and the Babylonian language continued to be used in Mesopotamia during the Hellenistic period, as it did in Babylonia, where it was certainly written as late as the last century B.C.[3], and may have been a learned language till the second Christian century[4]. Unfortunately there are not native documents from the pre-Christian Hellenistic period. That the Hellenizing process went as far as it did in Syria is unlikely; and even there Aramaic remained the language of the people, even in the towns (*cf.* EDESSA). Still, Greek influence was considerable. This would be mainly in the towns, the growth of which was quite a feature of the Macedonian rule in Mesopotamia (Pliny, vi. 30, § 117)[5]. This is seen in the Greek names which now appear: such are Seleucia opposite Samosāta, Apameia (=Birejik) opposite Zeugma, Hierapolis (=Membij), Europus, Nicatoris, Amphipolis (=Thapsacus, or near it), Nicephorium (er-Rakka), Zenodotium (stormed by Crassus), all on or by the Euphrates; Edessa (*q.v.*) on the upper waters of the Belīkh, Ichnae (perhaps Khnēs, above the junction of the Qaramuch with the Belīkh). These are all in the Osroene district; but Nasībīn became an Antioch, and as its district was known as Mygdonia (from Macedon) there were doubtless many other Greek settlements. To a less extent the same influences would be at work in towns called even by Western writers by their real names, such as Batnae, Carrhae (Charran), Resaena.

Mesopotamia naturally had its share of suffering in the struggles that disturbed the time, when Eumenes or Seleucus traversed it or wintered there. It was invaded and temporarily annexed in

[1]S. Schiffer, *Keilinschriftliche Spuren der in der zweiten Hälfte des 8. Jahrhunderts von den Assyrern nach Mesopotamien deportierten Samarier* (10 Stämme) (1907); C. H. W. Johns in *Proc. Soc. Bib. Arch.* (March, May, 1908).

[2]C. H. W. Johns, *An Assyrian Doomsday Book* (1901).

[1]For the history from the time of Herodotus onwards, *see* Ritter, *Erdkunde*, x. 6–284.

[2]M. Streck, *Klio*, vi. 222 *seq.*

[3]Probably the latest cuneiform document of certain date is a contract of 68 B.C. (*cf. Klio*, vi. 223 n. 3).

[4]*See* G. J. F. Gutbrod, *Zeitsch. f. Assyr.* vi. 26–33; *cf.* M. Streck, *Klio*, vi. 223 n. 1.

[5]*See* E. R. Bevan, *House of Seleucus*, i. 219–222, and references given there.

245 by Ptolemy III. Euergetes in his rapid expedition to beyond the Tigris. When Molon revolted on the accession of the youthful Antiochus III. (224 B.C.) he entered Mesopotamia from the south. Antiochus skirted the northern highlands by way of Nasībīn. In Mesopotamia a large part of the army of Antiochus VII. Sidetes was destroyed in 130 B.C., and the Syrian kings did not again seriously attempt to assert their rule beyond the Euphrates. When Phraates II. turned the Scythians against himself, however, even Mesopotamia suffered from the plunderers (*Joh. Antioch*, in Müller iv. 561). The immigration of Arabs must have been going on for long. About this time they even founded a dynasty in Aramaean Osroene (*see* EDESSA).

Parthian Period.—Under Mithridates II. Mesopotamia was a definite part of the Parthian empire, of which the Euphrates became the western boundary; but in 92 B.C. on that river his ambassador met Sulla, though the long duel did not begin immediately.

It was perhaps a Parthian governor of Mesopotamia who was called in to help Straton of Beroea against Demetrius III.; but before long Mesopotamia (especially the district of Nisībis) was attached to the growing dominions of Armenia under its ambitious king Tigranes, perhaps with the consent of Sinatruces (Sanatruces). The lost territory, however, was recovered by Phraates III., and Mesopotamia was guaranteed to Parthia by the treaties of Lucullus and Pompey (66 B.C.). It was traversed, however, several times by Roman troops crossing from Armenia to Syria, and Parthia's declaration of war against Armenia involved it with Rome. Gabinius crossed the Euphrates (54); but the command was assumed by Crassus, who, though he seized Ichnae, etc., and Raqqa (Rakka), fell near Carrhae (53), and the Parthian dominion was confirmed. The tragedy of the Ides of March saved Mesopotamia and the East from a great campaign by Julius Caesar, and it was at the hands of Ventidius Bassus, and west of the Euphrates, at Gindarus (north-east of Antioch), that the Parthians received the check that put an end to any real rivalry with Rome. Mesopotamia narrowly escaped being the scene of the struggle when Antonius in 36 finally decided to make his disastrous attempt against Phraates IV. by way of Armenia. In A.D. 36, Tiridates found support in his attempt to secure the throne of Artabanus III. in Mesopotamia, and it was there that he saw his army melt away. The expedition against Rome of Vologaeses I. (*q.v.*) of A.D. 62 reached no further westwards than Nisībis, and in 66 a peaceable arrangement was come to. Of the half-century that preceded Trajan's great oriental undertaking not much is known. When in 115 Trajan entered Mesopotamia from the north no serious resistance was offered, and it became a province as far as Singara. The woods at Nisībis, the headquarters, provided material for the boats with which in 116 he crossed the Tigris. Hatra, an interesting fortress which seems to have been Aramaean, fell, and the army advanced to Hīt, where it found the fleet that was subsequently transferred to the Tigris. For the revolt that occurred while Trajan was on the Persian Gulf, in which the Jews had an important hand, Nisībis and Edessa suffered capture and destruction. Hatra successfully withstood siege, however, and Hadrian abandoned Mesopotamia, setting the boundary at the Euphrates. Again for half a century there is not much to relate. Then, when Vologaeses, yielding to his growing discontent, took advantage of the death of Antoninus to invade Armenia the Romans were victorious (164), and after the storming of places such as Nicephorium, Edessa, Nisībis, western Mesopotamia was once more Roman as far as the Khābūr, Carrhae becoming a free city and Osroene a dependency.

By this time Christianity had secured a foothold, perhaps first among the Jews (*see* EDESSA), and we enter upon the earliest period from which documents in the Edessan dialect of Aramaic, known as Syriac, have been preserved. Unfortunately they contain practically nothing that is not of Christian origin[1]. On the death of Aurelius, Hatra aided Niger against Septimius Severus in 194; Osroene rose against Rome, and Nisībis was besieged and other Roman places taken; but Septimius Severus appeared in person (195), and from Nisībis as headquarters subdued the whole country, of which he made Nisībis metropolis, raising it to the rank of a colony, the Sinjār district, where Arabs from Yemen had settled, being incorporated. On his retiring everything was undone, only Nisībis holding out; but on his reappearance in 198 the Parthians withdrew. Again the Euphrates bore a Roman fleet. Hatra, however, was besieged twice in vain. Peace then prevailed till Caracalla's unprovoked attack on Parthia in 216, after he had reduced Osroene to a province. On his assassination near Carrhae (217), Macrinus was defeated at Nisībis and had to purchase peace, though he retained Roman Mesopotamia, reinstating the princely house in Osroene.

[1]The earliest inscription in Syriac yet known dates from A.D. 77, and was found at Serrīn (opposite Kal'at en-Najm) by von Oppenheim.

SASSANIAN PERIOD

Ardashir's power was rising when the Parthian Artabanus died in 224 (227); and Ardashir proposed to prove himself the successor of the Achaemenidae. Hatra resisted the first Persian attack as it had resisted Rome; but Mesopotamia was overrun, Nisībis and Carrhae being taken (233). It was immediately, indeed, recovered by Alexander Severus, and retained, whatever was the precise success of the war; but Nisībis and Carrhae were retaken by the Persians in the reign of Maximin. Under Gordian III. in 242 Mesopotamia was entered by a great Roman army which recovered Carrhae and Nisībis, and defeated the Persians at Resaena; but when Gordian after a difficult march down the Khābūr, was murdered at Zaitha below Circesium, Philip the Arabian (244) made the best terms he could with Shapur I. Whatever they were, the Roman garrisons seem not to have been really withdrawn. A rest for Mesopotamia seems to have followed; but in 258 Shapur, tempted by the troubles in the Roman empire, overran the country taking Nisībis and Carrhae, and investing Edessa, and when Valerian invaded Mesopotamia he was eventually made prisoner near Edessa (260). After Shapur's cruel victories in Syria, however, he was defeated by Odaenathus, who relieved Edessa, and Mesopotamia became for ten years practically part of an Arabian empire (*see* PALMYRA), as it was to be four centuries later. In consequence of the revolt of Zenobia Mesopotamia was lost to Rome, and the Euphrates became the frontier. Aurelian overthrew the Palmyran rule; but he was assassinated before he could carry out his intended expedition against Persia, Probus was assassinated before he was able to do anything (or much), and although Carus easily overran Mesopotamia, which became Roman again, and even took Ctesiphon, the Romans retreated on his death (283–284). The next incident is the defeat of Galerius, between Carrhae and Callinicus, where he had entered Mesopotamia (about 296), in the war provoked by Narses in consequence of his relations with Armenia. When it was retrieved by a signal victory, Diocletian advanced to Nisībis and thence dictated terms of peace by which Mesopotamia to the Tigris was definitely ceded to Rome (298).

After a forty years' peace the struggle was resumed by Shapur II. Nisībis thrice endured unsuccessful siege (338, 346, 350), although meanwhile Constantine had suffered defeat at Singara (348). Then Mesopotamia enjoyed two short rests (separated by a sharp struggle) while the rivals were engaged elsewhere, when in 363 Julian (*q.v.*) made his disastrous attempt, and Jovian bought peace at the price, among other things, of Singara and Nisībis, *i.e.*, practically all eastern Mesopotamia.

The surrender of Nisībis, which had been in the possession of Rome for so many generations, caused consternation among the Christians, and Ephraem (*q.v.*) moved to Edessa, where his "school of the Persians" soon became famous (*see* EDESSA). In the war of 421, in which the north-east of Mesopotamia was chiefly concerned, the Romans failed to take Nisībis, and it became a natural rallying point for the Nestorians after the decision of Ephesus (431). Matters were still more complicated when the Western Christians of Edessa found themselves unable to accept the ruling of Chalcedon against Monophysitism in 451 (*see* MONOPHYSITES), and there came to be three parties: Nestorians (*q.v.*), Jacobites (*see* JACOBITE CHURCH) and Melchites (*q.v.*).

In the beginning of the 6th century there was another severe struggle in Mesopotamia, which found an anonymous Syriac historian (*see* EDESSA), and in infringement of agreement the Ro-

mans strongly fortified Dārā against Nisībis. The Persian invasion of Syria under Kavadh I. (*q.v.*) was driven back by Belisarius; but the latter was defeated in his pursuit at Rakka (531). The peace begun by Chosroes I. (532) was not long kept, and Roman Mesopotamia, except the pagan Ḥarrān, suffered severely (540), Edessa undergoing a trying siege (544). The fifty years' peace also (562) was short lived; the Romans again failed in an attempt to recover Nisībis (573), whilst Chosroes' siege of Dārā was successful. Mesopotamia naturally suffered during the time of confusion that preceded and followed the accession of Chosroes II., and the Romans recovered their old frontier (591).

With the accession of Phocas (602) began the great war which shook the two kingdoms. The loss of Edessa, where Narses revolted, was temporary; but the Roman fortress of Dārā fell after nine months' siege (*c.* 605); Ḥarrān, Rās al-'Ain and Edessa followed in 607, many of the Christian inhabitants being transported to the Far East, and Chosroes carried the victorious arms of Persia far into the Roman empire. Finally Heraclius turned the tide, and Kavadh II. restored the conquests of his predecessor. The Syrian Christians, however, found that they had only exchanged the domination of a Zoroastrian monarch for an unsympathetic ecclesiastical despotism. In the confusion that followed, when men of letters had to live and work in exile, Nisībis set up for a time (631–632) a grandson of Chosroes II. Finally all agreed on Yazdegerd III.; but, while Chosroes II. and Heraclius had been at death grips with each other a great invasion had been preparing in Arabia. (S. L.; H. W. H.)

MEDIAEVAL AND MODERN TIMES

The Arab Conquest.—The Muslim Arab conquest both of 'Iraq (southern Mesopotamia) and of Jazirah (northern Mesopotamia to Urfa) was rapid and complete. By 640 Heraclius had lost the northern cities. Conversion to Islam became general. The invaders were tolerant by comparison with the Byzantines and the rapid spread of Islam among the conquered was due as much to its simplicity and fashionableness as to the disabilities which it imposed on non-Muslims. An effect of the Arab conquest was the gradual ousting of Syriac by the kindred Arab speech, the language of religion and of government, already well-established in parts of Mesopotamia by the Christian Arab tribes.

The Caliphate.—The religious and political history of Mesopotamia during the next six centuries is given elsewhere. (*See* CALIPHATE, ISLAM, PERSIA.) Here it need only be said that the people of Mesopotamia could not escape the consequences of their geographical position and of the wealth of their country and were involved in the sectarian and political disputes of their Arab lords. The Omayyad Caliph Merwan abandoned Damascus for a Mesopotamian capital at Harran and the Abbassids, whose power was based as much on Persian as on Arab support, ruled Islam from 'Iraq.

Qarbala (Kerbela) in 'Iraq was the scene of the tragedy (680) which made the great schism in Islam permanent. Qarbala and Nejef are still the great Shiah holy cities and Southern 'Iraq is predominantly Shiah to this day, while the north and the Jazirah are Sunni. Aramaean Christian influences, emanating from Harran, are thought to have contributed to the development of the Mu'tazilite heresy, and the revolutionary Kharijite sect found militant supporters in the Jazirah. But there is no evidence that these occasional civil and religious wars of the first two Muslim centuries seriously damaged the prosperity of the region. The irrigation system of 'Iraq was preserved by the Arabs; the centre of Islam attracted wealth from the outlying provinces and at the beginning of the 9th century no region in the world was wealthier.

Decay set in rapidly. The introduction of black slaves from East Africa for the cultivation of the marshlands of 'Iraq resulted in the long servile "War of the Zanj" (869–883). More fatal was the introduction of the Turkish soldiery, as hardy as Arabs and more amenable to discipline, first as slaves who received a veneer of Mohammedanism in barracks, and later, when Islam had established itself in southern Turan as professional soldiers coming singly or in war-bands to play the part which the Teutonic *foederati* had played during the Roman decline. Mutasim (833–847) son of Harun Al-Rashid first formed a Turkish bodyguard and, when his people murmured, transferred his capital to Samarra.

Ambitious or rebellious governors could hire Turks as well as the Caliphs and political disintegration had begun before the 9th century ended. The Saffarids revolted in Persia; Ahmad-ibn-Tulun of Egypt seized part of the Jazirah and Arab Hamdanids and Oqailids followed him. A Byzantine revival under the Macedonian dynasty threatened the northern borders in the last half of the 10th century and the Caliphs, terrorized by their Buwaihid Amirs (practically "Mayors of the Palace"), their sovereignty restricted to little more than the Euphrates valley, were reduced to the defensive. The Seljuk invasion of Western Asia in the middle of the 11th century rallied Islam but the Seljuk power waned quickly. Their Anatolian Satrapy separated itself from Persia, and the intervening Jazirah became a hunting ground for Turkish princelets (Atabegs) and Crusaders till Zangi expelled the latter from Edessa (1144). But for a generation after him the north remained a mosaic of warring Turkish states. The great Kurd Saladin, having checkmated the Franks in Syria, established Egyptian supremacy in northern Mesopotamia, but with his death polyarchy revived. In spite of earlier Karmathian devastations the south was fairly prosperous while the Caliph Nasir (1180–1242) intrigued against the decaying Seljuks with the more vigorous and barbarous rulers of Khwarezm and, when these rude warriors threatened him, called in the Mongols of Jenghiz Khan to destroy the Muslim buffer between him and the disciplined heathen of the north.

The Kingdom of Khwarezm went down in 1219. In 1258 Mesopotamia paid for the policy of Nasir. Hulagu Khan, grandson of Jenghiz and ruler of Persia, inspired by his queen and by his general Kitbugha (both Nestorian Christians), picked a quarrel with the last Caliph Mutasim, killed him, sacked Baghdad, and made 'Iraq into a wilderness. Next year it was the turn of the north. Two murderous campaigns wiped out the principalities and most of their populations and the Mongol flood rolled on into Syria.

The Decadence (1258–1534).—The conquest was unprecedentedly ruinous. By ordering the destruction of the embankments and headworks of the rivers and canals Hulagu converted vast areas of 'Iraq into steppe or swamp. The cultivators, thinned first by massacre and then by malaria and famine, were too weak to rebuild the canal system and prevent the nomads of Arabia terrorizing the countryside and encroaching on the remnants of cultivation. Henceforth the internal history of 'Iraq is that of an unending struggle between a few towns and the pastoral tribes—Arabs in most of the region, Kurds and Turkomans in the north—who regarded farmer and townsman as inferiors to be blackmailed and robbed.

For 80 years after the conquest 'Iraq was a poor province of the empire of the Ilkhans, the house of Hulagu. When their empire broke up Hasan Jalair, a Muslim Mongol noble, seized its western provinces and made Baghdad his winter capital. His successors ruled the Eastern Jazirah. The Ortoqids, the only Atabeg dynasty to survive the Mongols, were more or less independent on its western flank. In 1393 Timur the Tatar took Baghdad, but the Jalair expelled his governor. He returned in 1401 and sacked the city only less barbarously than Hulagu. On his death the Jalair returned but were soon overthrown by their rivals, the Turkomans of the Black Sheep (Qara-Qoyunly), whose capital was at Van. But their unstable power was challenged by the Turkomans of the White Sheep (Aq-Qoyunly), whose power was based on Diyarbekir. Their chief, Uzun Hasan, conquered 'Iraq and the Jazirah, but the new empire was distracted by rebellion and threatened by the growing ambition of the Osmanli Turks and of the new Persian dynasty of the Safawids. In 1508 Shah Ismail's general, Lala Hussein, took Baghdad and soon added Mosul, the capital of the Jazirah, to his master's empire.

Turco-Persian Rivalry (1512–1638).—In 1512 Selim the Grim girt on the sword of Osman and promptly made war on the Safawis. Shah Ismail's defeat at Chaldiran gave the Turk Ardalan, Mosul, Amadia and Raqqa, but Kirkuk and Baghdad remained Persian until 1534, when Suleiman the Magnificent took Baghdad

Basra was taken 12 years later by the Turks.

Unfortunately frequent wars with Persia and the turbulence of the tribes prevented the Turks organizing an anarchical country as they had organized their more central conquests. Their hold on Basra was precarious and the province was practically independent during most of the 17th century under a local dynasty. Shahrizor (the Kirkuk region) was constantly disputed by the Persians, sometimes aided, sometimes opposed, by local Kurdish chiefs. Local treachery brought the Persians into Baghdad in 1623. After 15 years Murad IV. retook the city and massacred many Persian prisoners. For three generations there was peace between Persian and Turk. From 1724, when war broke out again, to 1747 fighting was almost continuous and the exploits of Nadir Quli, who became Nadir Shah, and of his opponent Topal Osman Pasha gave an epic grandeur to an indecisive struggle. The wars of 1774–79 and of 1820–23 were less destructive and equally indecisive.

The Tribal Problem.—Wars with the Arab tribes were constant from 1638 to the middle of the 19th century. The names of the tribes or confederacies changed but there was no change in their politics. The close proximity of Arabia and of the vast Syrian steppe gave rebels a sure refuge. In 1641 the Shammar from Nejd reached the Euphrates and long controlled the towns of Anah and Zor.

The central government was at its weakest between 1760 and 1820 owing to foreign war and the ambitions of provincial pashas. In Mesopotamia it tolerated a succession of "Slave Pashas," mostly Georgian freedmen, who ruled as independent satraps of 'Iraq, though they never renounced their allegiance to the sultan.

The Last Phase.—The period of direct Ottoman rule began in 1831 when Ali Riza Pasha deposed Daud, the last slave pasha of 'Iraq. The Jalili were followed into exile or retirement by the ruling families of the Kurdish hill states. Mohammed "the Blind" of Ruwanduz had a brief period of rebellious success but was captured and made away with, and the last and best of the Kurdish princes disappeared when the Babans of Suleimaniyah ceased to rule (1850). In the south Qarbala was sternly disciplined (1842 and 1852). But until Midhat Pasha no Mesopotamian governor made any attempt to solve the tribal problem by other means than striking, often feebly, at the elusive nomads in the hope that they would be compelled to obedience. Midhat (*see* Midhat Pasha) won his reputation as a reformer in Baghdad (1869–72) by imposing conscription and founding municipalities and administrative councils and by inaugurating a policy of land settlement. His aim was to wean the tribes from nomadism by selling state lands to their sheikhs upon easy terms giving security of tenure; where the sheikhs became landlords, as among the Muntafiq, their power over their followers waned and by the beginning of the 20th century the nomad Arabs, though by no means tamed, were less powerful and dangerous.

Meanwhile the development of international communications had brought Mesopotamia and especially 'Iraq into the sphere of European politics. Great Britain sought a rapid route to India through a country where her Indian traders prospered and her consuls at Baghdad had been almost ambassadors since 1807. Captain Chesney brought the first steamer down the Euphrates from Birijik in 1836. A Turkish steamship company for river navigation was formed in 1855 and in 1861 the Lynch Company obtained a concession for the maintenance of two steamships on the Tigris, though the idea of the Euphrates line as a mail-route to India had been abandoned. The telegraph was introduced between 1861 and 1864; railway schemes, first mooted in 1842 and temporarily abandoned owing to the opening of the Suez canal were revived by the Germans, who in 1899 obtained the original concession for a railway to the Persian gulf. The subsequent effect of this great scheme upon international politics and particularly upon the relations of Great Britain, Germany and Turkey is described elsewhere (*see* Baghdad Railway; Turkey). The section from Baghdad to Samarra was completed on the eve of the World War. Schemes for the revival of prosperity by the repair of the old irrigation works began to interest the Turks, and the Hindiyah Barrage was completed by Sir W. Willcocks in 1913.

But though the latest Turkish rulers were more efficient in some respects than those of the 19th century they were equally unpopular. Their ideas on education went no further than the conversion of Arabs and Kurds into indifferent copies of the Turkish *effendi;* their justice was still venal; their customs officials were still corrupt and the accessible taxpayer still paid for those whom the tax-collector dared not assess or was bribed not to see. Hopes disappointed by the Turkish revolutionaries of 1908 began to turn to Arab nationalism and the outbreak of the World War found the Arabs of Mesopotamia with few exceptions either hostile to the Turk or, more often, indifferent to what might befall him. (For subsequent history *see* 'Iraq.) (P. Gr.)

Bibliography.—For the conditions since the Arab conquest, Guy le Strange, *Lands of the Eastern Caliphate* (1905), is especially useful. For the Mongol invasions, Leon Cahun, *Turcs et Mongols* (1907), is good. Of recent works the following are valuable: M. v. Oppenheim, *Vom Mittelmeer zum Persischen Golf* (vol. ii. 1889); D. G. Hogarth, *The Nearer East* (1902) *passim;* Sir M. Sykes, *Dar ul Islam* (1904) and *The Caliphs' Last Heritage* (1915) and, above all, S. W. Longrigg, *Four Centuries of Modern Iraq* (1925). The annual consular reports most nearly bearing on Mesopotamia were those for Aleppo, Mosul, Baghdad and Basra.

Maps.—The following deserve special mention: v. Oppenheim *op. cit.,* a most valuable large scale map in pockets of volumes; Sir M. Sykes, *Geog. Journal* xxx. op. p. 356 and xxxiv. op. p. 120; Hogarth, *op. cit.,* Longrigg, *op. cit.,* tribal map.

MESOPOTAMIA, OPERATIONS IN. The Anglo-Indian operations of 1914–18 in Mesopotamia were in their initial stages conceived on, comparatively speaking, modest lines. The object at the outset was merely (1) to protect the Anglo-Persian oil installations, (2) to occupy the greater part of the Basra vilayet so as to secure possession of the Shatt al 'Arab and the districts immediately round the head of the Persian gulf, and (3) to impress the Arabs and others in this region and in the territories intervening between the Ottoman empire and India. Steps had already been taken before relations between the Entente Powers and the Porte were actually broken off, and a brigade of the 6th Indian Div. had been despatched to an island near the head of the Persian gulf. Then, on Nov. 7, two days after the British declaration of war on Turkey, these advanced troops appeared in their transports at the mouth of the Shatt al 'Arab.

The fort guarding the entrance was taken, and the brigade encamped some miles up the stream on the right bank. On learning this, the Turks hurried all available forces down from Basra; but, the rest of the 6th Div. having arrived under Sir A. Barrett, they were on the 17th attacked and overthrown. Basra fell on the 21st, and Barrett then promptly pushed troops up to Al Qurna, which was taken on Dec. 9. As considerable Turkish reinforcements were arriving from Baghdad, he was not altogether comfortably situated; but the Osmanlis were not in aggressive mood, and the invaders were little interfered with during the first three months of 1915. The Indian Government in March decided to raise the expeditionary force to the strength of an army corps by adding the 12th Indian Div., and early in April Sir J. Nixon took over command from Sir A. Barrett, General Townshend at the same time taking over the 6th Division.

I. THE BRITISH ADVANCE UP THE TIGRIS

During the latter part of April the Turks showed a marked increase of activity; but all their offensive efforts were frustrated, and Nixon, encouraged by these successes, decided to occupy Imara, 60m. north of Al Qurna on the Tigris. The task was entrusted to Townshend, who carried it out by making free use of water transport for moving his troops, and who made himself master of the place on June 3, capturing 17 guns and 1,800 prisoners. Nixon now resolved on a blow against An Nasiriya, on the Euphrates, and the 12th Div. took possession of that town on July 25, capturing another 17 guns and 1,000 prisoners. The expeditionary force could then claim that it had effectually achieved the original object of the campaign.

Occupation of Kut.—The authorities at Simla accepted Nixon's proposal to advance up the Tigris to Kut al 'Amara—180m. into the heart of the enemy's country—and early in August Townshend, with the 6th Div., began pushing forward from

'Amara. On Sept. 15 he drove an advanced Turkish force out of a position on the right bank of the Tigris about 15m. from Kut, and on the 28th completely defeated the enemy a little farther on at Es Sinn, taking 1,650 prisoners, 13 guns, and much war material Kut was occupied, and the cavalry pursued the fleeing Osmanlis as far as Al 'Aziziya, half way to Baghdad.

Kut was a place of strategical importance, because at this point the Shatt al Hai, issuing from the Tigris, created a link with the Euphrates near An Nasiriya and provided the line of communications which would naturally connect Turkish forces on the lower Euphrates with Baghdad. It was furthermore the most populous spot between 'Amara and An Nasiriya on the one hand and Baghdad on the other.

The idea of pushing on as far as Baghdad had already taken shape even before the occupation of Kut. The August discomfiture in the Gallipoli Peninsula (*see* DARDANELLES CAMPAIGN), coupled with a belated realization that the Dardanelles venture would not succeed, had rendered the British Government eager for some dramatic achievement in Mesopotamia. The Indian Viceroy had advocated an advance on Baghdad when the start up the Tigris from 'Amara was materialising, and Townshend's triumph acted as a powerful stimulus to such aspirations. Nixon intimated early in October that he could open a road to Baghdad, under the circumstances then existing, but could not hold the city if it were taken. The military authorities at home, while admitting the possibility of capture, regarded permanent retention as out of the question with the limited numbers available, and they declared that if the place was to be held Nixon must be reinforced by two divisions. But, influenced by political considerations, the Government became insistent. Nixon was told on Oct. 31 that he might advance on the city.

First Baghdad Offensive Fails.—Townshend was unable to begin his advance for a fortnight, even after receiving the order to advance, owing to shortness of supplies and the need of organization for the hazardous effort. He advanced from Al 'Aziziya on Nov. 11, and on approaching Ctesiphon some days later he found the Turks to be assembled there in strong force and expecting reinforcements. He attacked them on the 21st and was at first successful; but additional Ottoman troops arrived during the fight and recovered much of the lost ground, Townshend's losses in the action proved very heavy and on the night of the 25th he moved off. He halted on the 29th. Next day the pursuing Turks came up and delivered a resolute attack, which was, however, beaten off, and after that the sorely tried little Anglo-Indian army was not seriously interfered with on its way to Kut, which was reached on Dec. 3. So, for the moment, ended the ill-advised Baghdad adventure.

II. THE SIEGE OF KUT

With the approval of the Home and Indian Governments, Nixon decided that Townshend was to remain where he was, although if he did so he was bound to be invested. They assumed, too readily, that he would be relieved before his supplies ran out. By Dec. 8 Kut was hemmed in on all sides. Its situation, in a deep loop on the left bank of the Tigris, rendered the place readily defensible against assault or siege approach, and the German Field-Marshal von der Goltz, who had just taken supreme command of the Ottoman forces in Mesopotamia, realized that unless it fell to an early assault the main Turkish task in this region would be to guard against a relief. Nur-ed-Din, the Turkish commander on the spot, had four divisions at his disposal, and on Dec. 10, 11, and 12 he delivered unavailing onsets upon the narrow front that was not covered by the river. After that the siege became a blockade, part of Nur-ed-Din's troops moved down the river some distance so as to confront any relieving force that might try to approach, and fortifications were erected.

Attempts at Relief.—Meanwhile the 7th and 3rd Indian Divisions had been detached from the Western Front in Europe, and began arriving in the middle of December in the Shatt al 'Arab. Gen. Aylmer took charge of the troops who were to undertake the relief of Kut, and units as they disembarked were pushed on to 'Amara with all speed and proceeded thence up the Tigris. In spite of a lack of artillery the Turks were driven out of their advanced position at 'Ali Gharbi, were again defeated at Shaikh Sa'ad and, after a further defeat, fell back to the lines of Umm al Hanna, 20m. from Kut on the left bank of the Tigris. When on Jan. 21 the relieving force essayed the storming of the Umm al Hanna position the effort failed and so numerous were the casualties that Aylmer felt compelled to pause in his offensive and to await reinforcements. About the same date Sir P. Lake succeeded Sir J. Nixon in the chief command.

Improvement of Organization.—Lake set himself to place Aylmer's line of communication on a better footing, to improve the medical arrangements, and to develop the wharves at Al Qurna and Basra. Material of all kinds was, however, deficient, and the Turks were in the meantime developing their lines of defence on both banks of the Tigris below Kut, rendering the task of a relieving force more and more difficult. The British Government had, on receipt of the bad news about Umm al Hanna, ordered the 13th Div. to proceed from Egypt to Mesopotamia; but to move these troops from Suez to the front of the Tigris necessarily took some weeks. Aylmer attempted no forward movement during February, but on the night of March 7–8, without waiting for the 13th Div., he advanced from near Shaikh Sa'ad against the Es Sinn position, intending a surprise.

This was on the right bank of the Tigris, less than 10m. from Kut, considerably higher up than Umm al Hanna and the defile caused by the Suwaiqiya marshes on the farther bank; but owing to the Turks holding that defile Aylmer's flotilla was prevented advancing above Umm al Hanna. When the assailants advanced against the reinforced Turks, they were beaten back and had to retire to Shaikh Sa'ad.

Surrender of Kut.—The garrison of Kut was already on much reduced rations; but Gen. Gorringe, who had succeeded Aylmer, could make no fresh attempt for nearly a month owing to transport and supply problems. On April 5, however, the 13th Div., under Gen. Maude stormed the Hanna lines and penetrated well into the defile on the left bank of the Tigris; but, when first the 7th Div. and then the 13th Div. attacked the Sanniyat lines at its farther end, they were in each case repulsed. A final effort was made by the 7th Div. on the 22nd against Sanniyat, which nearly succeeded. Finally, on the night of the 24th, a steamer loaded with provisions tried to run the blockade but failed, and on the 29th Kut, with its garrison of 9,000 British and Indian troops, surrendered. The efforts to save it had cost 24,000 casualties.

British Opinions.—A Royal Commission was set up a few months later to enquire into the operations that had taken place in Mesopotamia, and its conclusions were to the effect that the undertaking of a campaign on so ambitious a scale without adequate forethought and efficient preparations was worthy of blame; it also animadverted in strong terms on the very unsatisfactory character of the medical arrangements during the early stages of the venture.

III. THE BAGHDAD OFFENSIVE

Great developments took place on the Anglo-Indian line of communications, and at the base, during the summer. A reasonable amount of heavy artillery was gradually accumulated. An additional division arrived from India. Landing facilities at the ports were vastly improved. A change, moreover, took place in the chief command, for, after replacing Gorringe in charge of the forces at the front in July, Gen. Maude a few weeks later became commander-in-chief—*vice* Sir P. Lake, whose health had broken down. By the beginning of December Maude had been furnished with enough river craft, his supply system was sufficiently advanced and he had the necessary war material at his command to justify his embarking on offensive operations of a far-reaching kind, and on Dec. 13 he struck.

Disposition of the Forces.—Von der Goltz had left Mesopotamia and Khalil Pasha was now in command. It must be pointed out that Maude started his offensive with a force four times the strength of that which, under Townshend, had advanced to Ctesiphon a year earlier. His army astride of the Tigris was of necessity disposed in échelon, with its left (the II. Army Corps under

Gen. Marshall) about Es Sinn, and its right (the I. Army Corps under Gen. Cobbe) facing Sanniyat. Maude's plan was to push his left yet farther forward, to clear the right bank of the Tigris to well above Kut, and, when these dispositions should have taken effect, to force the lines of Sanniyat with his right.

Marshall opened the offensive by forcing the Shatt al Hai after a night march, and by capturing some of the Turkish defences which formed a bridgehead south of Kut. During the struggles that ensued, which lasted some weeks, Khalil's troops offered a stout resistance, so that although Maude's operations on the right bank of the Tigris were almost uniformly successful, they proceeded slowly and by successive stages. By the middle of February the whole of the Turkish entrenched camp on that bank was in Anglo-Indian hands, and the Ottoman troops had all withdrawn to the farther side of the great river. No sooner had this part of the programme been accomplished than Cobbe on the 17th attacked Sanniyat. The effort failed for the moment; but when the assault was repeated five days later it proved successful, and after a stern contest the formidable lines were at last carried. On the same day Marshall by a brilliant feat of arms forced a passage across the Tigris at Shumran, and no course was then left open to the Ottoman commander but to abandon Kut and retire in haste up the left bank of the river.[1] Maude's flotilla, hitherto blocked by Sanniyat, pushed up at once past Kut, and the Anglo-Indian army won a victory that went far towards wiping out the discomfitures of the previous year.

Turkish Retreat from Kut.—With his supplies guaranteed by the arrival of the water transport, Maude pressed on along the left bank of the Tigris on the heels of the fugitive Osmanlis. The river channel between Kut and Al 'Aziziya has many loops and bends, making it difficult for a naval force and a military force to act in concert; but on Feb. 26 the British gunboats after a smart action destroyed or captured practically the entire Turkish flotilla. The question of proceeding to Baghdad now arose. The army commander had from the outset contemplated the capture of that city after he should have expelled the enemy from Kut, and now received permission to carry out his plan. He found himself obliged to halt for some days at Al 'Aziziya, however, for fear of outrunning his supplies. On March 4 the Anglo-Indian army resumed its advance, and it was found that the Turks had fallen back behind the Diyala. Maude threw a bridge across the Tigris, and by March 11 Baghdad was in British hands.

The Turks had withdrawn northwards, but Maude allowed no pause in the offensive to take place. Cobbe pushed up the right bank of the Tigris, along which a stretch of railway ran from Baghdad as far as Samarra, heavily defeated an opposing force at Mushahida, while Marshall conducted a most successful campaign on the Shatt al 'Adhaim. Cobbe, moreover, completed the operations on the right bank of the Tigris by the capture of Samarra.

Further Progress Northwards.—The virtual conquest of Mesopotamia in a four and a half months' campaign had been brought about by the resolute execution of a plan of operations that was based on correct calculation of requirements—by a triumph of forethought on the part of a chief who always relentlessly followed up his successes in the field. Neither the stout resistance offered by the Ottoman troops nor the formidable defence works which they had elaborated around Kut had in reality proved the greatest stumbling block in Maude's path.

A railway was constructed from Kut to Baghdad, sanitation and policing were established in the capital, comforts and recreation were provided for the troops, and effective steps were taken to tap the supply resources of the fertile tracts that were in occupation of the army. In the late summer it appeared that the Turks under German instigation were contemplating an effort to recover Baghdad. This made Maude the keener to resume the offensive, and on Sept. 28 he struck his first blow by the capture of Ramadi on the Euphrates. This victory was followed up by successful operations in clearing the Jabal Hamrin, and by the occupation of Tikrit on the Tigris at the beginning of November. A few days later, however, the army commander was struck down by cholera, and he died on the 10th. He was succeeded by Sir W. Marshall.

IV. OPERATIONS IN 1918

The country traversed by the Tigris above Tikrit and extending north for a long distance is a sterile tract, hilly and broken at some points; the ordinary route from Baghdad to Mosul does not therefore follow the river but takes a direction to the east through Kifri and Kirkuk.

Maude's Plan.—Maude had intended to conduct his main advance by this line, but his death just at the moment when the project was to be put in execution created some delay; his successor, however, set troops in motion through the Jabal Hamrin in December, and by these Kifri was occupied in Jan. 1918. Having secured that point, Marshall suddenly set his extreme left wing on the Euphrates in motion in the middle of February, with the result that Hit was captured and the Turkish division which had retired up the river was surrounded, 5,000 prisoners and all its guns being taken. Transport difficulties were hampering the advance beyond Kifri on the other flank, but on April 29 the Ottoman forces were heavily defeated on the road to Kirkuk, losing 3,000 prisoners, and a week later Kirkuk was taken. Marshall, however, decided to withdraw his advanced troops in this quarter to Kifri, and active operations then practically ceased for five months.

An endeavour to preserve Baku from the Turks failed; but it at least prevented the despatch of some of the Ottoman troops in Transcaucasia to confront the Anglo-Indian army in northern Mesopotamia.

Closing Stages of the Campaign.—The fall of Baku occurred just when the season had again become suitable for active operations on and about the Tigris, and Marshall was now directed to occupy Mosul, an undertaking for which he had been preparing all the summer. The best of the Turkish divisions were at this time assembled astride of the Tigris at Al Fatha, the point where the river breaks through the Jabal Hamrin range of hills. Here a naturally formidable position had been strongly fortified, and another position a few miles higher up the river had also been prepared for defence. Marshall decided to throw an adequate force across the Ottoman communications between Al Fatha and Mosul. He entrusted the conduct of the operations as a whole to Gen. Cobbe, and arranged for a column to advance simultaneously from Kifri by Kirkuk towards Mosul.

Surrender of Ismail Hakki.—The final campaign in Mesopotamia began on Oct. 23 and it lasted only one week. Two cavalry columns, that with the shorter distance to cover being accompanied by some infantry, crossed the Jabal Hamrin many miles to the east of Al Fatha, passed the Little Zab a long way above its junction with the Tigris, and hit off that river several miles to the rear of the Turkish positions at and above Al Fatha. In the meantime the 17th Div. operating on the right bank and the 18th Div. operating on the left bank of the Tigris moved forward from above Tikrit. Finding himself threatened by the cavalry forces which were approaching the river between him and Mosul, Ismail Hakki Pasha, who commanded the Turks, now withdrew from the Al Fatha position to the one higher up at the confluence of the Little Zab, followed up by the two Anglo-Indian divisions. But the 18th Div., advancing on the left bank of the Tigris, forced a passage across the Little Zab on the 25th, thus turning Ismail Hakki's left flank, and the Pasha thereupon transferred his troops across the river and broke up his bridge.

On the 27th the 17th Div. was pressing the Turks, who were now all collected on the left bank of the river, and on the same day one of the cavalry columns forded the stream and began moving down that side of the channel against the enemy's rear. The 17th Div. was heavily engaged on the 28th before it finally made itself master of Ismail Hakki's position at the confluence of the Little Zab. That commander thereupon retreated to Sharqat, but on the morrow the last hope of the trapped Turkish

[1]In justice to earlier efforts and to the Turkish resistance, it should perhaps be pointed out that the British had now a four to one superiority of force over the enemy; further, that owing to the failure of the cavalry pursuit the Turkish forces escaped disaster and retreated in relatively good order.

force was destroyed when a relieving column that was approaching from Mosul was defeated by Cobbe's cavalry. All that day Ismail Hakki resisted the advance of the Anglo-Indian forces on Sharqat. On the morning of Oct. 30, however, just as the 17th Div. was about to launch a final attack, the white flag was displayed within the Turkish lines, and the whole of one Ottoman division, together with the bulk of another one, surrendered, 11,000 prisoners, 51 guns, and imposing stores of war material falling into the victor's hands.

The Kirkuk column had in the meantime been steadily working its way forward towards Mosul, almost unopposed, and Cobbe's forces were about to advance on the city from about Sharqat, when tidings came to hand of the signing of the Armistice. Mosul was occupied a week later, but the Ottoman power of resistance in this theatre of war was in any case shattered as a result of Marshall's final blow. Thus the long drawn-out struggle in Mesopotamia, which had proved so consistently favourable to the Anglo-Indian arms since Maude had launched his offensive at the close of 1916, ended in a blaze of triumph two years later, concurrently with what constituted the most sweeping tactical success that had been gained by either side during the course of the campaign.

BIBLIOGRAPHY.—E. Candler, *The Long Road to Baghdad* (1919); C. E. Callwell, *The Life of Sir S. Maude* (1920); L. C. Dunsterville, *The Adventures of Dunster Force* (1920); C. V. Townshend, *My Campaign in Mesopotamia* (1920); F. J. Moberly, *The Mesopotamia Campaign* (Official, 1926). *See* also WORLD WAR: BIBLIOGRAPHY.

(C. E. C.)

MESOXALIC ACID crystallises from water in deliquescent prisms and melts with partial decomposition at 119–120° C. Mesoxalic acid (Dihydroxymalonic acid), $(HO)_2C(CO_2H)_2$, was obtained originally by J. v. Liebig (1838) by alkaline hydrolysis of alloxan (*q.v.*) but the most convenient preparation is from sucrose, dextrose, laevulose, lactose, maltose or starch by oxidation with strong nitric acid. Although this oxidation has attracted attention for 150 years, only recently has it been shown that by this process 100 grams of sucrose yield 11 grams of sodium mesoxalate together with 40 grams of oxalic acid (F. D. Chattaway and H. J. Harris, 1922). Both anhydrous and hydrated esters are known. *Ethyl oxomalonate*, $O:C(CO_2 \cdot C_2H_5)_2$, a golden yellow liquid, boils at 103–108°/13 mm. and is obtained by the action of dry nitrous anhydride, N_2O_3, on ethyl malonate at 0° C. It changes into its colourless hydrate, ethyl dihydroxymalonate, which crystallises from benzene, chloroform and other organic solvents in plates or prisms melting at 57° C (O. Kamm and others, *Organic Syntheses*, New York, 1925). Mesoxaldialdehyde, CHO·CO·CHO, when anhydrous is a pale yellow brittle hygroscopic mass obtained in hydrated form by decomposing phorone diozonide with iced water. (*See* OZONIDES.)

MESOZOA, a small group of minute parasitic animals, comprising two classes: (1) the *Rhombozoa,* which are found only in the kidneys of Cephalopods, and (2) the *Orthonectida,* which infest Ophiurids, Polychaets, Nemertines, Turbellaria and possibly other groups.

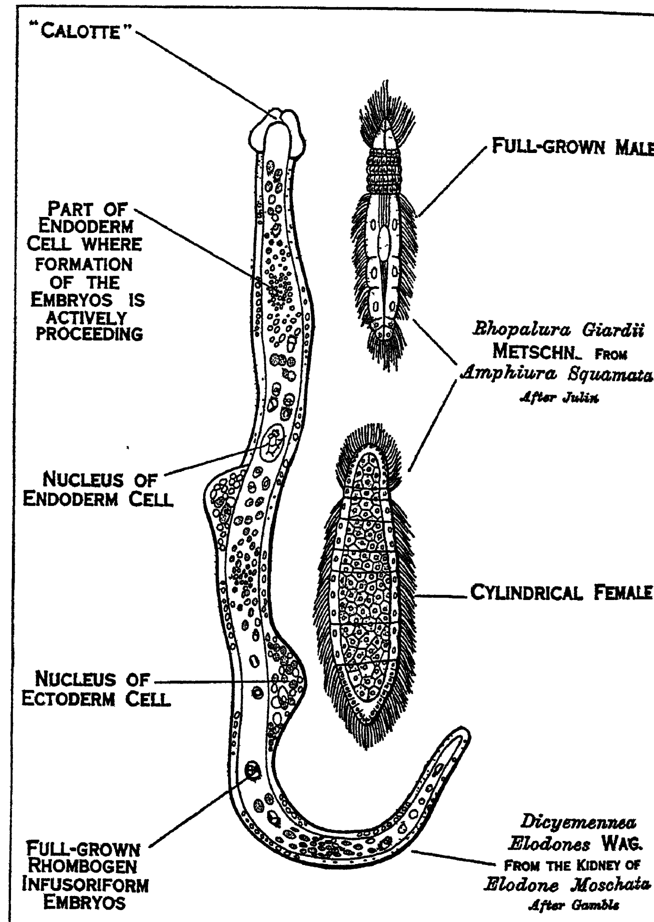
Class I. RHOMBOZOA.—These animals consist of a central cell from which certain reproductive cells arise, enclosed in a single layer of flattened and for the most part ciliated cells; some of them are modified at the anterior end and form the polar cap. There are two orders, the *Dicyemida,* with a polar cap, by which they are fixed in the renal cells of their host; and the *Heterocyemida,* with no polar cap and hence free. There are two phases. The "Nematogen" gives rise to vermiform larvae like itself which never leave their host. The "Rhombogen" gives origin to infusoriform larvae, which escape from their original host and probably infect new ones. A Rhombogen may secondarily develop into a Nematogen.

Class II. ORTHONECTIDA.—The Orthonectida contain animals with a central mass destined to form male and female reproductive cells surrounded by a single layer of ciliated ectoderm cells arranged in regular rings. Muscular fibrils occur between the outer and inner cells. The sexes are separate and unlike, and there are two kinds of females, cylindrical and flat, the latter from parthogenetic eggs. There are two genera, *Rhopalura* and *Staecharthrum*, the latter found in a Polychaet.

See Parker and Haswell, *Text-book of Zoology,* Vol. I. (1928).

MESOZOIC ERA, in geology, the name given to the period of time between the Palaeozoic and Kainozoic eras; it is synonymous with the older and less satisfactory term "Secondary" as applied to the major divisions of geological time. *See* GEOLOGY

MESQUITE or **HONEY LOCUST,** in botany, a tree, native of arid regions in the south-western United States and extending southwards to Chile and the Argentine Republic. It is known botanically as *Prosopis juliflora,* and belongs to the family Leguminosae (suborder Mimoseae). It reaches 40 or 50 ft. in height with a trunk usually not more than 6 to 12 in. in diameter, and divided a short distance above the ground into numerous irregular crooked branches. The remarkable development of its main root in relation to water-supply renders it most valuable as a dry-country plant; the root descends to a great depth in search of water, and does not branch or decrease much in diameter till this is reached. It can thus flourish where no other woody plant can exist, and its presence and condition afford indications of the depth of the water-level. When the plant attains the size of a tree, water will be found within 40 or 50 ft. of the surface;



FROM "THE CAMBRIDGE NATURAL HISTORY" (MACMILLAN)

THE TWO CLASSES OF MESOZOA, AS ILLUSTRATED BY DICYEMENNEA ELODONES, ON LEFT, AND RHOPALURA GIARDII, ON RIGHT. THESE PARASITES INHABIT, RESPECTIVELY, THE KIDNEY OF CEPHALOPODS AND BODY CAVITIES OF AMPHIURA

when it grows as a bush, between 50 or 60 ft.; when the roots have to descend below 60 ft., the stems are only 2 or 3 ft. high. These woody roots supply valuable fuel in regions where no wood of fuel value is produced above ground. The wood is almost indestructible in contact with soil, and is largely used for fence-posts and railway ties. The ripe pods supply a nutritious food; and a gum resembling gum arabic exudes from the stem.

An allied species *Prosopis pubescens,* a small tree or tall shrub, native of the arid regions of the south-western United States, from western Texas to southern Utah, Nevada and California

and south to Mexico, is known as the screw-bean or screw-pod mesquite from the fact that the pods are twisted into a dense screw-like spiral; they are used for fodder and are sweet and nutritious, but smaller and less valuable than those of the mesquite. The valuable fodder grasses of the prairies of the United States known as mesquite grasses, belong to the genus *Boutelona*.

See C. S. Sargent, *Silva of North America* (1892); G. B. Sudworth, *Forest Trees of the Pacific Coast* (1908); and W. L. Jepson, *Trees of California* (1909) and *Manual of the Flowering Plants of California* (1925).

MESS, a dish sent to table (late Lat. *missum*, past participle of *mittere*, to send or place in position). The term is also used of persons who are in the habit of eating their meals together, and thus of the parties into which a ship's company or a regiment is divided. Originally, a mess in this sense was a group of four persons sitting at one table and helped from the same dishes. In the Inns of Court, London, the original number is preserved, four benchers or four students dining together.

MESSAGE. A communication either verbal, written or printed, sent from one person to another. Message is the term generally applied to the official communications addressed by the heads of states to their legislatures at the opening of the session or at other times. These, though written, have the force of a face-to-face speech. The sessional and other messages to Congress of the president of the United States of America are printed State documents. Washington and John Adams delivered them in person, but this was discontinued by Jefferson.

In Scottish law a messenger-at-arms is an official appointed by Lyon-King-at-Arms to execute summonses and letters of diligence connected with the Court of Sessions and Court of Justiciary (*see* WRIT: *Scotland*). Technically the term "messenger" is given to an endless rope or chain, passing from the capstan to the cable so that the latter may be hauled in when the messenger is wound round the capstan; also to a similar contrivance for hauling in a dredge.

MESSAGER, ANDRÉ CHARLES PROSPER (1853–1929), French musician, was born at Montluçon on Dec. 30, 1853; he studied at Paris and in 1874 became organist at St. Sulpice. The production of his comic opera *La Basoche* in 1890 at the Opéra Comique (English version in London the following year) established his reputation, which was increased by the light operas as *Madame Chrysanthème* (1893), *Mirette* (1894), *Les Petites Michus* (1897), and *Véronique* (1898), the latter of which had a great success in London. He was conductor and director at the Opera Comique and was made a Commander of the Legion of Honour in 1927. He died Feb. 24, 1929.

MESSAGERIES MARITIMES, COMPAGNIE DES. This steamship company, the oldest French navigation enterprise, arose first from a Convention passed on Feb. 28, 1851 with the Minister of Finance, "for the establishment and exploitation of a maritime postal service in the Mediterranean." The first sailing under the Messageries flag was the departure of the "Hellespont" for Civita Vecchia on Sept. 9, 1851. On Jan. 19, 1852 the Compagnie des Services Maritimes des Messageries Nationales was constituted and was authorised as an active company by a decree of the President of the Republic, dated Jan. 22, 1852. Its present name was adopted on Aug. 1, 1871.

The first regular lines of the company were from Marseilles by Malta and Italy to Constantinople and Alexandria and in 1853 the company extended its services to different parts of Greece. In the following year the services to Algeria and Tunis were instituted and in 1855, the 16 original ships had grown to 58. In 1860 on the authority of the State, an Atlantic Mail line was inaugurated from Bordeaux to Senegal, Brazil and La Plata. In 1862 services to the chief ports of India, Indo-China, Dutch East Indies and China proper were instituted and two years later Reunion and Mauritius Islands were included. In 1866 the lines were extended to take in Japan. In 1872 the fleet owned by the company numbered 64 ships, in 1912, 62, representing a gross tonnage of 285,161. The earlier ships were not suited to the long voyages undertaken and their replacement was a long and tedious affair. In 1914 there were 60 steamers in the company's service (tonnage 284,000); a little over 10 years later the company had lost 22 ships (117,000 tons) in war and 31 ships from other causes, a total of 258,000 tons. In the same period 55 ships were added to the company (representing 469,000 tons gross).

In 1921 the entire organization of the company was altered. The whole fleet of passenger liners was transferred, by law of July 28, 1921, to a new company, called the Société des Services Contractuels des Messageries Maritimes. This new company runs regular passenger services from Marseilles to all parts of Asia and Africa, to Australia, to the islands of the Pacific via the Panama Canal, to all the important ports of Asia Minor and the Mediterranean, as well as circular tours, and is responsible for the fulfilment of the postal services.

The Compagnie des Messageries Maritimes however still exists, but is now mostly concerned with cargo-boats. These sail regularly from Marseilles or the north of the Continent, to the principal ports in the world, with the exception of those in America. It also possesses several coastal services in Australia, Indo-China and Madagascar. (J. D. DU S.)

MESSAGE-STICKS. Amongst the natives of Australia, a branch of a tree is taken and notches made upon it in the presence of the messenger, who receives his instructions while they are being made. The messenger carries the message-stick in a net bag, and on arriving at the camp to which he has been sent he hands it to the headman at some place apart from the others, saying to him, "So-and-so sent you this," and he then gives his message, referring as he does so to the notches on the stick.

The American Indians used a notched stick to record various incidents, such as the number of days spent on an expedition, the number of enemies slain, and the like.

See B. Spencer and Gillen, *Native Tribes of Northern Australia* (1914).

MESSALLA CORVINUS, MARCUS VALERIUS (64 B.C.–A.D. 8), Roman general, author and patron of literature and art. He was educated partly at Athens, together with Horace and the younger Cicero. In 43 B.C. he was proscribed, but escaped to the camp of Brutus and Cassius. After the battle of Philippi (42) he went over to Antony, and later supported Octavian. In 31 Messalla was appointed consul in place of Antony, and took part in the battle of Actium. He subsequently held commands in the East, and suppressed the revolted Aquitanians; for this he celebrated a triumph in 27.

Messalla restored the road between Tusculum and Alba, and many handsome buildings were due to his initiative. He was a patron of letters after the model of Maecenas, and his immediate circle included Tibullus and the poetess Sulpicia. He was a friend of Tibullus and a patron of Ovid. There are two panegyrics on him by unknown authors, one printed in the poems of Tibullus as iv. 1, the other included in the *Catalepton*, the collection of small poems attributed to Virgil.

As an orator, he followed Cicero instead of the Atticizing school, but his style was affected and artificial. Later critics considered him superior to Cicero, and Tiberius adopted him as a model.

Monographs by L. Wiese (Berlin, 1829), J. M. Valeton (Gröningen, 1874), L. Fontaine (Versailles, 1878); H. Schulz, *De M. V. aetate* (1886); "Messalla in Aquitania" by J. P. Postgate in *Classical Review*, March 1903; W. Y. Sellar, *Roman Poets of the Augustan Age. Horace and the Elegiac Poets* (Oxford, 1892), pp. 213 and 221 to 258; the spurious poem ed. by R. Mecenate (1820).

MESSALLINA, VALERIA, the third wife of the Roman emperor Claudius (*q.v.*). She was notorious for her profligacy, avarice and ambition, and exercised a complete ascendancy over her weak-minded husband, with the help of his all-powerful freedmen. During the absence of Claudius from the city, Messallina forced a handsome youth named Gaius Silius to divorce his wife and go through a regular form of marriage with her. The freedman Narcissus, warned by the fate of another freedman Polybius, who had been put to death by Messallina, informed Claudius of what had taken place, and persuaded him to consent to the removal of his wife. She was executed in the gardens of Lucullus, which she had obtained on the death of Valerius Asiati-

cus, who through her machinations had been condemned on a charge of treason. She was only 26 years of age. By Claudius she was the mother of the unfortunate Britannicus, and of Octavia, wife of Nero.

See Tacitus, *Annals*, xi. 1–38; Dio. Cassius lx. 14–31; Juvenal vi. 115–135, x. 333, xiv. 331; Suetonius, *Claudius*; Merivale, *Hist. of the Romans under the Empire* (1850, etc.) ch. 50; A. Stahr, "Agrippina" in *Bilder aus dem Alterthume*, iv. (1865).

MESSAPII, the name of an ancient tribe which inhabited, in historical times, the south-eastern peninsula or "heel" of Italy, known variously in ancient times as Calabria, Messapia, and Iapygia. Their chief towns were Uzentum, Rudiae, Brundisium, and Uria. They are mentioned (Herod. vii. 170) as having inflicted a serious defeat on the Greeks of Tarentum in 473 B.C. Herodotus adds a tradition which links them to the Cretan subjects of "King Minos." Their language is preserved for us in a scanty group of perhaps 50 inscriptions, of which only a few contain more than proper names, and in a few glosses in ancient writers. Very few originals of the inscriptions are still in existence, though some few remain in the museum at Taranto.

The inscriptions, so far as it is safe to judge from the copies of the older finds and from facsimiles of the newer, are all in the Tarentine-Ionic alphabet. For limits of date, 400–150 B.C. may be regarded as probable. The genitival character of the endings *aihi* and *ihi* and the conjunctional value of *inthi* have been ascertained. Even now, hardly more than a few words can be said to have been separated and translated with certainty—*kalatoras* (masc. gen. sing.), "of a herald" (written upon a herald's staff which was once in the Naples Museum); *aran* (acc. sing. fem.), "arable land"; *mazzes*, "greater" (neut. acc. sing.), the first two syllables of the Latin *maiestas;* while *tepise* (3rd sing. aorist indic.), "placed" or "offered"; and forms corresponding to the article (*ta*-=Greek τὸ) seem also reasonably probable.

Some phonetic characteristics of the dialect may be regarded as quite certain: (1) the change of the original short *ŏ* to *ă*; (2) of final *-m* to *-n;* (3) of *-ni- -ti- -si-* respectively to *-nn- -tθ* and *-ss-;* (4) the loss of final *d*, and probably of final *t;* (5) the change of original *dh* to *d* (*anda*=Gr. 'έθα) and *bh* to *b;* (6) *-au-* before (at least some) consonants becomes *-ā-*. (7) The form *penkaheh* is probably identical with the Oscan stem *pompaio*, which is a derivative of the Indo-European numeral **penque* "5."

The proper names in the inscriptions show the regular Italic system of gentile nomen preceded by a personal praenomen; and some inscriptions show the interesting feature which appears in the Tables of Heracleia of a crest or coat of arms, such as a triangle or an anchor, peculiar to particular families. The same reappears in the Iovilae (*q.v.*) of Capua and Cumae.

For further information *see* W. Deecke in a series of articles in the *Rheinisches Museum*, xxxvi. 576 *sqq.;* xxxvii. 373 *sqq.;* xl. 131 *sqq.;* xlii. 226 *sqq.;* S. Bugge, *Bezzenbergers Beiträge*, vol. xviii.; L. Ceci *Notizie degli Scavi* (1908), p. 86; Professor Viola, *ibid.* 1884, p. 128 *sqq.* and *Giornale degli Scavi di Pompei*, vol. iv. (1878), pp. 70 *sqq.* The place-names of the district are collected by R. S. Conway, *The Italic Dialects*, p. 31; for the Tarentine-Ionic alphabet *see* ibid. ii., 461.

For a discussion of the important ethnological question of the origin of the Messapians *see* W. Helbig, *Hermes*, xi. 257; P. Kretschmer, *Einleitung in die Geschichte der griechischen Sprache*, pp. 262 *sqq.*, 272 *sqq.;* H. Hirt, *Die sprachliche Stellung der Illyrischen* (*Festschrift für H. Kiepert*, pp. 179–188). Reference should also be made to the discussion of their relation to the Veneti by C. Pauli in *Die Veneter*, p. 413 *sqq.*, especially p. 437; and also to R. S. Conway, *Italic Dialects*, i. 15.

MESSEL, RUDOLPH (1848–1920), Anglo-German chemist, was born at Darmstadt on Jan. 14, 1848, and educated at the universities of Zürich, Heidelberg and Tübingen. He came to England in 1870, and took up industrial chemistry, making notable discoveries, especially in connection with the "contact" process for obtaining sulphuric acid (*q.v.*) for use in dye manufacture. He was elected a fellow of the Royal Society in 1912; and died in London on April 18, 1920.

MESSENE, an ancient Greek city, capital of Messenia, founded in 369 B.C., after the battle of Leuctra and the first Theban invasion of the Peloponnese, by the combined Theban and Argive armies and exiled Messenians, invited to found a state independent of Sparta. The site, chosen by Epameinondas, lay on the western slope of the mountain which dominates the Messenian plain. The peak Ithome (2,630 ft.) served as acropolis. Messene remained important under the Romans, but we hear nothing of it in mediaeval times. The hamlet of Mavromati occupies a small part of the site.

Pausanias describes the city, its temples and statues, its springs, its market-place and gymnasium, its place of sacrifice, the tomb of Aristomenes (*q.v.*) and the temple of Zeus Ithomatas on the summit of the acropolis. What chiefly excited wonder were the fortifications of Messene, which excelled all others of the Greek world. Of the wall, some 5½ m. in extent, considerable portions remain. Almost the entire circuit can still be traced. The wall is flanked by towers about 31 ft. high: these have two storeys and are entered by doors on a level with the top of the wall reached by flights of steps. Of the gates only two can be located, the eastern or Laconian, and the northern or Arcadian gate. The theatre, the stadium, the council chamber or bouleuterion, and the propylaeum of the market also remain, while on the shoulder of the mountain are the foundations of a small temple, probably that of Artemis Laphria.

See E. Curtius, *Peloponnesos*, ii. 138 *sqq.;* W. M. Leake, *Travels in the Morea*, i. 366 *sqq.;* J. G. Frazer, *Pausanias's Description of Greece*, iii. 429 *sqq.;* W. G. Clark, *Peloponnese*, 232 *sqq.;* A. Blouet, *Expéd scient. de Morée: Architecture*, i. 37–42, Plates 38–47; E. P. Boblaye, *Recherches géogr. sur les ruines de la Morée*, 107 *sqq.;* C. Bursian, *Geographie von Griechenland*, ii. 165 *sqq.*

MESSENIA (Gr. Μεσσήνη or Μεσσηνία), the S.W. district of the Peloponnese, bounded on the E. by Mt. Taÿgetus, on the N. by the river Neda and the Arcadian Mountains, on the S. and W. by the sea. Its area is some 825,000 acres. Historically and economically important is the great plain, watered by the river Pamisus (mod. Pirnatza), the most fertile tract in Greece, producing oranges, citrons, almonds, figs, grapes and olives. The plain is bounded N. by the Nomian Mountains (mod. Tetrási, 5,210 ft.); W. by the mountains of Cyparissia (4,000 ft.), which attains 3,160 ft. in Mt. Mathía (mod. Lykódimo). Off the south coast of the S.W. peninsula lie the three Oenussae islands and the islet of Theganussa (Venetikó).

At the present day Messenia forms a department with its capital at Kalamata, and a population numbering (according to the census of 1907), 127,991.

HISTORY

The earliest inhabitants of Messenia are said to have been Pelasgians and Leleges (*qq.v.*). Then came an Aeolo-Minyan immigration. In the Homeric poems eastern Messenia is represented as under the rule of Menelaus of Sparta, while the western coast is under the Neleids of Pylos. Dorians under Cresphontes invaded the country from Arcadia and extended their rule over the whole district. The Dorians blending with the previous inhabitants produced a single Messenian race with a strong national feeling. But the fertility of the soil, the warm and genial climate, the mingling of races and the absence of opposition, combined to render the Messenians no match for their hardy and warlike neighbours of Sparta. War broke out which ended in the subjection of Messenia to Sparta (*c.* 720 B.C.). Two generations later the Messenians revolted, and under the leadership of Aristomenes (*q.v.*) kept the Spartans at bay for some 17 years; those Messenians who did not leave the country were reduced to the condition of helots.

Revolt broke out again in 464 B.C.; the insurgents defended themselves for some years on the rock-citadel of Ithome, but eventually they had to leave the Peloponnese and were settled by the Athenians at Naupactus. After the battle of Leuctra (371 B.C.) Epameinondas invited the exiled Messenians to return to their country. The city of Messene (*q.v.*) was founded in 369 B.C. to be the capital of the country and, like Megalopolis in Arcadia, a check on Sparta. A great part of the land remained very sparsely peopled, and Messenia never again became really powerful. After the fall of the Theban power it became an ally of Philip II. of Macedon. Subsequently it joined the Achaean

League, and we find Messenian troops fighting at Sellasia. The Spartan tyrant, Nabis, succeeded in taking the city but was forced to retire by Philopoemen and the Megalopolitans. It again joined the Achaean league, though much weakened by the loss of Abia, Thuria and Pherae, which entered the league as independent members. In 146 B.C. the Messenians were brought under Roman sway by L. Mummius.

In the Middle Ages Messenia shared the fortunes of the rest of the Peloponnese. It was overrun by Slavic hordes, and was one of the battlefields of Byzantines, Franks, Venetians and Turks, who struggled for the possession of the Morea, as recalled by the ruins of the mediaeval strongholds of Kalamata, Coron (anc. *Asine*, mod. Korone), Modon (*Methone*) and Pylos.

Bibliography.—J. G. Frazer, *Pausanias's Description of Greece*, vol. iii.; W. Kolbe, *Athenische Mitteilungen*, 364 *seq.* (1904), and M. N. Tod, *Journal of Hellenic Studies*, xxv. 32 *seq.*; L. Whibley, *Companion to Greek Studies* (1923), with useful bibliography. Physical features: A. Philippson, *Der Peloponnes*, 340–381 (1892).

MESSIAH (Dan. x. 25, 26) and **MESSIAS** (John i. 41; iv. 25). The word answers to the Hebrew *ha-māshīah*, "the anointed." There can be no doubt that magical power was ascribed to the anointing oil; the king was thereby rendered sacrosanct (1 Sam. xxiv. 6 *sqq.*; 2 Sam. i. 14 *sqq.*; iv. 9 *sqq.*), and was considered to be endowed with a special virtue. Thus, whoever cursed the king is stoned as though God Himself had been cursed (2 Sam. xix. 22). In ancient Egyptian cultus the priest, after he had solemnly saluted the gods, began the daily toilet of the god, which consists in sprinkling his image, clothing it with coloured cloths, and anointing it with oil (Erman, *Die aegyptische Religion*). In the magical texts of Babylonia a similar virtue was attached to oil: "bright oil, pure oil, resplendent oil that bestows magnificence on the gods . . . the oil for the conjuration (*siptu*) of Marduk" (Tallquist, *Maklu series*, tablet vii. col. 1, 31, *sqq.*; *cf.* Gressmann, *Der Ursprung der israelitisch-judischen Eschatologie*). We have evidence from the Tell el-Amarna tablets that the anointing of kings was known in Egypt and Syria *c.* 1400 B.C.

On the intimate relation which in primitive times subsisted between the sorcerer and the king, *see* Priest. "Classical evidence points to the conclusion that in prehistoric ages . . . the various tribes or cities were ruled by kings who discharged priestly duties" (Frazer, *Early History of Kingship*). Thus the early kings of Assyria were priests of Assur (Asur), the tutelary deity of Assyria. Tiglath-Pileser I. (*c.* 1100 B.C.) calls his predecessors Samsi-Adad and Ismi-Dagan, *issakku* (pa-te-si) of God Assur. Later kings, *e.g.*, Shalmaneser II. and Assur-bani-pal call themselves by the more definite title of *sangu* of Assur. The Hebrew word with the article prefixed occurs in the Old Testament only in the phrase "the anointed priest" (Lev. iv. 3, 5, 16, vi. 22). But "Yahweh's anointed" is a common title of the king of Israel, applied in the Historical books to Saul and David, in Lam. iv. 20 to Zedekiah, and in Isa. xlv. i. extended to Cyrus.

The definite emergence of the Messianic hope in the strict sense can hardly be traced in the Old Testament with absolute certitude. Perhaps the clearest expression of such an idea is to be found in Isaiah ix. 1–6 and xl. 1–9. Here it is to be noted that the former of these passages apparently gives up the connection of the Messiah with the Davidic dynasty, though the latter reaffirms this.

It is important to notice that what may be called the Messianic age is often represented in the prophets without any personal Messiah. So the great Judaean prophets of the eighth century connect the salvation of Israel with the rise of a Davidic King, full of Yahweh's spirit, in whom all the energies of Yahweh's transcendental kingship are as it were incarnate (Isa. x. 6 *seq.*; xi. 1 *seq.*; Micah v.). This conception, however, is not one of the constant elements of prophecy; other prophecies of Isaiah's look for the decisive interposition of Yahweh in the crisis of history, without a kingly deliverance. Jeremiah again speaks of the future David or righteous sprout of David's stem (xxiii. 5 *seq.*; xxx. 9) and Ezekiel uses similar language (xxxiv., xxxvii.); but that such passages do not necessarily mean more than that the Davidic dynasty shall be continued in the time of restoration under worthy princes seems clear from the way in which Ezekiel speaks of the prince in xli., xlvi. The beginning of the process can probably be traced within the canon itself, in the book of Joel and the last chapters of Zechariah; and if this be so, we see from Zech. ix. that the picture of the ideal king claimed a place in such constructions. In popular expectation the national Messiah was to be a scion of the house of David. Born at Bethlehem (Mich. v. 2) and destined to redeem Israel from the power of its foreign oppressors.

Carefully to be distinguished from the above is the idea of the heavenly Messiah which meets us in certain Apocalyptic books. Though the "Son of Man" of Daniel vii. 14 does not appear to be a strictly Messianic figure, nevertheless it has exercised an important influence on Messianic doctrine. This is a very remarkable development, and one that is of great importance for the proper understanding of New Testament doctrine.

The idea of a heavenly being who thus comes to view as a feature in old apocalyptic tradition is the source of the conception of the heavenly Messiah—the Son of Man—of the Similitudes of the Book of Enoch (1 Enoch xxxvii.–lxx.). The heavenly being "like unto a Son of Man" of Dan. vii. was in all probability identified by the author of Daniel with Israel's angel-prince Michael; this angelic being was later, it would seem, invested with Messianic attributes, and so became the pre-existent heavenly Messiah of the Book of Enoch, who is to judge both men and angels. His standing designation in the Similitudes is "this (or that) Son of Man" seldom "the Son of Man." In other passages he is called "the Righteous One" (xxxviii. 2, liii. 6, etc.), "the Elect One (xxxix. 6, xl. 5, etc.); "the Elect One of righteousness and of faith" (xxxix. 6), and "God's 'Anointed' " (*i.e.*, Christ) (xlviii. 10, lii. 4).

Unlike the earthly Messiah of the national hope, who is born on earth of the seed of David, the angelic Son of Man of the Similitudes has his home in heaven "under the wings of the Lord of the Spirits" (xxxix. 7). He is pre-existent in heaven (xlv. 1, *seq.*); his name was named "before the sun and the signs were created, and before the stars of the heaven were made" (xlvii. 3); he was "chosen and hidden" before the Lord of the Spirits, "before the creation of the world" (xlviii. 6). A real pre-existence of the Heavenly Messiah is here taught. It is noteworthy that emphasis is laid on the pre-existence of his name. The wonderful Name of the Messiah is already dwelt upon in Isaiah ix. 6, and in the LXX. of Psalm lxxi. (=Heb. lxxii.) 17 the same doctrine is unmistakably affirmed: His (Messiah's) Name endures before the sun.

The wonderful and mysterious character of the Name is sometimes dwelt upon (*cf.* Ascension of Isaiah viii. 7, ix. 5), a feature which re-appears in the Johannine Apocalypse, where the Messiah bears a "name written which no man knoweth but he himself" (Rev. xix. 12).

It would seem that in this idea Jesus found the most adequate expression of his own Messianic consciousness but he profoundly modified the conception by combining it with the idea of the "suffering servant" of Isaiah liii. All the evidence suggests that the idea of the heavenly Son of Man was not commonly known or understood in a Messianic sense; *cf.* John xii. 34, where the multitude in Judea are represented as asking in surprise "Who is this Son of Man?" Possibly it originated in Galilee where Jesus and his disciples became acquainted with it.

Bibliography.—J. Drummond, *The Jewish Messiah* (1877); V. H. Stanton, *The Jewish and Christian Messiah* (Edinburgh, 1886); E. Schürer, *Geschichte des Jüdischen Volkes* (1898–1901), Eng. trans. by J. Macpherson and others, as *A History of the Jewish People* (1885–90–91); *see* also art. "Messiah" in *Ency. Bib.*, 4 vol. (1914), and in Hastings, *Dictionary of Christ and the Gospels*; V. Gall, *Basilien Son Theon* (Heidelberg, 1926). (G. H. B.)

MESSINA, city, Sicily, 7 m. south-south-west of the promontory of Faro (anc. *Promontorium Pelorum*) which forms the north-east angle of the island, capital of the province of Messina and seat of an archbishop. Pop. (1921) 114,051 (town); 176,485 (commune). The site curves round the harbour, between it and the strongly fortified hills of Antennamare (highest point 3,707 ft.). The straits, which take their name from the town, are here about 3½ m. wide (over 2 m. at Faro). The passage through them is extraordinarily beautiful. It was a flourishing and beautiful city

when in 1908 early in the morning of December 28 one of the most disastrous earthquakes ever recorded destroyed it totally. At Messina about 84,000 lives were lost: the damage was done chiefly by the shock and by the fires which broke out afterwards. The seismic wave which followed did vast damage elsewhere along the strait, notably at Reggio, Calabria, which was also totally destroyed. (*See* also EARTHQUAKE.)

The façades of buildings at Messina in great part withstood the earthquake, but the remainder of the buildings was destroyed. The cathedral, begun in 1098, had a fine Gothic façade: the interior had mosaics in the apses dating from 1330, and the nave contained 26 granite columns, and a fine wooden roof of 1260. The rest was in the baroque style; the high altar (containing the supposed letter of the Virgin Mary to the people of Messina), richly decorated with marbles, lapis lazuli, etc., was begun in 1628 and completed in 1726. The building is now being carefully restored. The new residential quarters, occupying a far larger space to the south of the old town, have very wide streets and low buildings: while the public buildings are being re-erected rapidly on the old site. A museum has also been formed containing the works of art that were saved. The importance of Messina is due to its harbour, a circular basin open on the north only, formed by a strip of land curving round like a sickle, from which it took its original name, Zancle (*ζάγκλον*, or rather *δάγκλον*, the Sicilian equivalent of the Greek *δρέπανον*, from which Trapani is derived).

Zancle was first founded by pirates from Cumae, and resettled from Cumae under Perieres, and from Chalcis under Crataemenes, in the first quarter of the 8th century B.C. Mylae was occupied very soon afterwards, but the first regular colony of Zancle was Himera (648 B.C.). After the capture of Miletus by the Persians in 494 B.C. Milesians and Samians joined Anaxilas of Regium in occupying Zancle in the absence of its king Skythes, and the name was changed to Messene, which is found on coins of the Samian type. About 480 Anaxilas established his authority at Messene. In 426 the Athenians gained the alliance of Zancle, but failed to obtain it in 415.

Messina fell into the hands of the Carthaginians (397 B.C.). They destroyed the city, but Dionysius recaptured and rebuilt it. Timoleon finally expelled the Carthaginians in 343 B.C. In the wars between Agathocles of Syracuse and Carthage, Messina supported the latter. After Agathocles' death, his mercenaries, the Mamertines, treacherously seized the town about 282 B.C. They came to war with Hiero II. of Syracuse and obtained help from Rome. This led to the first Punic War. At its close (241 B.C.), Messina became a free and allied city. During the civil wars Messina held with Sextus Pompeius; and in 35 B.C. it was sacked by Octavian's troops, but it continued to flourish as a trading port, as the discovery of a large Roman necropolis (1st–3rd cent. A.D.) shows. In the division of the Roman empire it belonged to the East; and in A.D. 547 Belisarius collected his fleet here before crossing into Calabria. The Saracens took it (831), and it was the first permanent conquest of the Normans (1061).

In 1190 Richard I. of England, with his crusaders, passed six months in Messina. He quarrelled with Tancred, the last of the Hauteville dynasty, and sacked it. In 1194, with Sicily it passed to the Hohenstaufen under Henry VI., who died there in 1197; and after their fall was contended for by Peter I., of Aragon, and Charles I., of Anjou. At the time of the Sicilian Vespers (1282), Messina defended itself against Charles; Ruggiero di Loria defeated the French off the Faro; and from 1282 to 1713 Messina remained a possession of the Spanish royal house. In 1571 the fleet fitted out by the Holy League against the Turk assembled at Messina, and in the same year its commander, Don John of Austria, celebrated a triumph in the city for his victory at Lepanto (statue in the Piazza dell' Annunziata). Internal quarrels between the Merli, or aristocratic faction, and the Malvezzi, or democratic faction, fomented by the Spaniards, helped to ruin the city (1671–1678). The French at first came to its aid, but then abandoned it. In 1743 the plague carried off 40,000 inhabitants. The city was partially destroyed by earthquake in 1783. During the revolution of 1848 against the Bourbons of Naples, Messina was bombarded for three consecutive days. In 1854 the deaths from cholera numbered about 15,000. Garibaldi landed in Sicily in 1860, and Messina was the last city in the island taken from the Bourbons and made a part of united Italy under Victor Emmanuel.

Messina was the birthplace of Dicaearchus, the historian (*c.* 322 B.C.); Aristocles, the Peripatetic; Euhemerus, the rationalist (*c.* 316 B.C.); Stefano Protonotario, Mazzeo di Ricco and Tommaso di Sasso, poets of the court of Frederick II. (A.D. 1250); and Antonello da Messina, the painter (1447–1499). During the 15th century the grammarian, Constantine Lascaris, taught in Messina; and Bessarion was for a time archimandrite there. (T. A.)

MESSINA, STRAITS OF. The straits between Sicily and Italy, about 2 m. wide at the north extremity and 8 m. at the south, while the line taken by the trainferry between Reggio di Calabria Villa S. Giovanni and Messina is 5 m. long. At the north end a lowering of the water level of about 300 ft. would produce a small isthmus; and the origin of the separation of Sicily and Italy may be post-palaeolithic. (*See* MALTA.) The straits were much feared by sailors in antiquity, especially owing to the rocks and whirlpools known as Scylla and Charybdis (*q.v.*); and the currents do, as a fact, present considerable difficulties, especially in a strong wind. The main current runs from south to north, and the subsidiary current in the reverse direction. They generally alternate every six hours, and are affected by the sun, the moon, and the winds. When the current runs from south to north, the level of the water in the straits falls from 6 to 8 in. and rises as much with the other current: when they are specially strong, they tear seaward from the bottom, and sometimes throw up fish with atrophied or abnormal eyes, and with organs for the production of phosphorescence. Some 140 kinds of fish are caught in the straits, and they are especially rich in *plankton*. There is an Institute of Marine Biology at Messina, the straits being naturally a very favourable spot for such studies, as so many fish must pass through when migrating. Much damage was done on both sides of the straits by the sea movement produced by the earthquake of Dec. 28, 1908.

MESSINES, BATTLE OF, 1917. This British victory in the World War (*q.v.*), one of the rare examples of an attack conceived and mounted on a true siege-warfare basis, is described under YPRES, BATTLES OF, 1917.

MESSIRIA: *see* BAKKARA.

MESSUAGE, in law, a term equivalent to a dwelling-house, and including outbuildings, orchard, court-yard and garden.

MESTIZO, a term originally meaning a half-breed, one of whose parents was Spanish, and now used occasionally of any half-breed, but especially to denote persons of mixed Spanish (or Portuguese) and American Indian blood (Span. from Port. *Mestiço*, Lat. *miscere*, to mix).

MEŠTROVIĆ, IVAN (1883–), Yugoslav sculptor, was born at Vrpolje in Slavonia, the son of Croatian peasants. The rudiments of his art were taught him by his father and at the age of 13 he was apprenticed to a marble cutter at Split (Spalato), and three years later entered the Vienna Academy where he studied under Hellmer until 1904. He exhibited at the Vienna Secession, at the Austrian exhibition at Earl's Court, London (1906), at Munich, Venice and Paris—where he attracted the notice of Rodin. He was largely responsible for a nationalist artistic movement which included the sculptors Rosandić and Dujan Penić, the painter Rački and the architect Plečnik, and which culminated in the exhibition at Zagreb in 1910 and the Rome international exhibition of 1911.

Meštrović also made a large number of religious reliefs and figures in walnut, of which two Pietà reliefs, one in the National Gallery of British Art and one in private possession, are typical of his bold cutting and great powers of design. His portraits include those of his mother (1908), Madame Banac (1913 and 1915), his wife (1915), Sir Thomas Beecham (1915, in the National Gallery of British Art), Lady Cunard (1915) and Miss St. George (1915). Among his later works the most important are the richly decorated Račić memorial chapel at Cavtat, near Dubrovnik (Ragusa), Dalmatia (1920–22), the designs for the projected mausoleum of Bishop Petar Petrović Njegoš, the Montenegrin poet, to be erected on the summit of Mount Lovćen

(1924), and figures of St. Francis of Assisi and "The Artist's Mother in Prayer" (1925). In 1924 exhibitions of his work were held at the Fine Art Society in London and the Brooklyn Museum.

See M. Curčin, *Ivan Meštrović, a Monograph*, with bibliography and list of works (1919). For details of the Račić Chapel, see *Deutsche Kunst und Dekoration*, LII. (1923).

META, the Latin word for the goal which formed the turning-point for the chariot races in the Roman circus. The metae consisted of three conical pillars resting on a single podium.

METABOLIC DISEASES. All disease is primarily due to alterations, quantitative or qualitative, in the chemical changes in the protoplasm of some or all of the tissues of the body.

Obesity (*see* also CORPULENCE).—It is as fat that the surplus food absorbed is stored in the body; but the power of storing fat varies enormously in different individuals, and in some is pathological. The reasons of this are probably manifold. One undoubted cause is taking a supply of food in excess of the energy requirements of the individual. The amount of food may be *absolutely* large, or large *relatively* to the muscular energy evolved in mechanical work or in heat-production; but in either case, when fat begins to be deposited, the muscular activity of the body tends to diminish and the loss of heat from the surface is reduced; and thus the energy requirements become less, and a smaller diet is sufficient to yield the surplus for further storage of fat. Fat is formed from carbo-hydrates, and possibly indirectly from proteids (*see* NUTRITION). Individuals probably vary in their mode of dealing with these substances, some having the tendency to convert them to fat, some to burn them off at once. Probably the difference is to be sought in endocrine action. In all cases the fat stored is available as a source of energy, and numerous fat "cures" consisted in giving enough proteids to cover the requirements of the body, with fats and carbohydrates insufficient to meet the energy requirements of the individual. This is illustrated by the dietaries of some of the best known of these "cures":—

	In grams per diem			
	Proteid	Fat	Carbo-hydrates	Calories
Banting's cure	172	8	81	1112
Oertel's „	156–170	25–45	75–120	1180–1608
Ebstein's „	102	85	47	1401

In a normal individual in moderate muscular activity about 3,000 calories per diem are required (*see* DIETETICS), and therefore under the diets of these "cures," especially when accompanied by a proper amount of muscular exercise, the fats stored in the body are rapidly used up. At the present time such diets are combined with administration of thyroid extract (*see* MYXOEDEMA, below).

Diabetes (*see* also DIABETES MELLITUS; INSULIN), as distinguished from transitory glycosuria, is produced by an inability of the tissues to use the sugar presented, which thus accumulates in the blood and escapes in the urine. One great source of energy being unavailable, the tissues have to use more fats and more proteids to procure the necessary energy, and hence, unless these are supplied in very large quantities, there is a tendency to emaciation.

The power of storing and using sugar in the tissues is strictly limited, and varies considerably in healthy individuals. Normally, when about 200g. of glucose are taken at one time, some appears in the urine within one hour. In some individuals the taking of even 100g. leads to a transient glycosuria, while others can take 250g. or more and use it all. But even in the same healthy individual the power of using sugar varies at different times and in different conditions, muscular exercise markedly increasing the combustion. Again, some sugars are more readily used than others, and therefore have a less tendency to appear in the urine when taken in the food. Milk-sugar and laevulose appear in the urine more readily than glucose. This power of using sugar possessed by an individual is now known to depend upon a due provision of insulin in ordinary cases, but glycosuria after poisoning by carbon monoxide or phloridzin or after puncture of the fourth ventricle of the brain is susceptible of other explanations.

The disease may be divided into two forms:—

1. *Slight Cases.* The individual can use small quantities of sugar, but the taking of larger amounts causes glycosuria. Supposing that the energy requirements of an individual are met by a diet of—

Proteid	100 g.	410 Calories
Fat	100 "	930 "
Carbohydrate	400 "	1,640 "
		2,980

then if only 100g. of glucose can be used, the energy value of 300g., *i.e.*, 1,230 calories, must be supplied from proteids and fats. To yield this, 300g. of proteids or 132g. of fats would be required. If these are not forthcoming in the diet, they must be supplied from the tissues, and the individual will become emaciated; hence a diabetic on an ordinary diet is badly nourished, and hence the huge appetite characteristic of the disease.

2. *Grave Cases.* From the products of the splitting of proteids sugar can be formed, probably in the liver, and in the more serious form of the disease, even when carbohydrates are excluded from the food, some of the sugar thus formed escapes consumption and may be excreted. Theoretically, 1grm. of nitrogen will be set free for each 7·5g. of glucose formed. In the urine of grave cases of diabetes on a proteid diet, the proportion of nitrogen to sugar is about 1 to 2. This may mean that the theoretically possible amount of sugar is not yielded, or that some of the sugar formed is used in the economy. Both hypotheses may be correct, but the latter is supported by the fact that even in grave cases the decomposition of proteid may be diminished by giving sugar, and that in muscular exercise the proportion of sugar may fall.

In the course of the disease the amount of sugar which the tissues can use varies from day to day. It is in the utilization of glucose—the normal sugar of the body—that the tissues chiefly fail. Many diabetics are able to use laevulose, or the inulin from which it is derived, and lactose (milk-sugar) to a certain extent. Under the administration of these sugars, however, the excretion of glucose may be increased, the tissues, apparently by using the foreign sugar, allowing part of the glucose which they would have consumed to escape.

The increased decomposition of proteid leads to the appearance of a large quantity of nitrogen in the urine—*azoturia*—and to the formation of various acids. Sulphuric acid and phosphoric acid are formed by oxidation of the sulphur and phosphorus in the proteid molecule. Organic acids of the lower fatty acid series β oxybutyric and aceto-acetic acid with their derivative acetone also appear. They are in part formed from proteids and in part from fats. To neutralize them ammonia is developed and hence the proportion of ammonia in the urine is increased. By the development of these various acids the alkalinity of the blood is diminished (acidosis). The development of these acids in large quantities precedes the onset of diabetic coma.

Disease of the Thyroid.—1. *Myxoedema.* The thyroid gland forms a material which has the power of increasing the metabolism of proteids and of fats; and when the thyroid is removed, a condition of sluggish metabolism, with low temperature and a return of the connective tissues to an embryonic condition, supervenes, accompanied by the appearance of depression of the mental functions and by other nervous symptoms. The disease myxoedema, which was first described by Sir William Gull in 1873, was shown by Ord in 1878 to be due to degenerative changes in the thyroid gland. It affects both sexes, but chiefly females, and is characterized by a peculiar puffy appearance of the face and hands, shedding of the hair, a low temperature and mental hebetude. The symptoms are similar to those produced by removal of the thyroid. The nervous symptoms may be in part due to some alteration in the metabolism, leading to the formation of toxic substances. The administration of thyroid gland extract causes the symptoms to disappear. (*See* GOITRE.)

2. *Cretinism* (*q.v.*) may be defined as myxoedema in the infant, and is associated with non-development or degeneration of the thyroid gland. The characters of the disease are due to diminished metabolism, leading to retarded development, and the treatment which has proved of service, at least in some cases, is the administration of various thyroid preparations.

3. *Exophthalmic Goitre* (Graves's Disease or Basedow's Disease) chiefly affects young women, and is characterized by three main symptoms: increased rate and force of the heart's action, protrusion of the eyeballs, and enlargement of the thyroid gland. The patient is nervous, often sleepless, and generally becomes emaciated and suffers from slight febrile attacks. The increased action of the heart is the most constant symptom, and the enlargement of the thyroid gland may not be manifest. The condition is caused by increased functional activity of that gland or by changes in the parthyroids.

Gout (*q.v.*).—The accumulation of urate of soda in the tissues in gout formerly led physicians to believe in a causal relationship between an increased formation of that substance and the onset of the disease. That uric acid is increased in the blood is undoubted, but recent work points to the accumulation being, like the other symptoms of the condition, a result of some unknown modification in the metabolism and a purely secondary phenomenon. The important fact that in leucaemia (von Jaksch), in lead-poisoning (Garrod) and in other pathological conditions, uric acid may be increased in the blood and in the urine without gouty symptoms supervening, is one of the strongest arguments against the older views. The source of the uric acid so widely deposited in the gouty is largely the phosphorus-containing nucleins of the food and tissues. These in their decomposition yield a series of di-ureides, the purin bodies, of which uric acid is one. Their excretion is increased when substances rich in nuclein, *e.g.*, sweetbreads, etc., are administered. While uric acid itself has no injurious action, the closely allied adenin produces toxic symptoms. After the discovery of this source of uric acid, physiologists for a time inclined to regard it as the only mode of production. But it must be remembered that in birds uric acid is formed from the ammonia compounds coming from the intestine and muscles, just as urea is formed from the same substance in mammals. Uric acid is a di-ureide—a body composed of two urea molecules linked by acrylic acid—an unsaturated propionic acid. It is therefore probable that in many conditions the conversion of ammonia compounds to urea is not complete, and that a certain amount of uric acid is formed apart from the decomposition of nucleins.

Rheumatism.—Rheumatic fever was at one time regarded as due to some disturbance in the metabolism, but it is now believed to be of streptococcal origin. Excluding peculiar changes in the joints which occur in rheumatoid arthritis and in Charcot's disease and are almost certainly dependent on affections of the nervous system, a large number of individuals suffer from pain in the joints, in the muscles and in the fibrous tissues, chiefly on exposure to cold and damp or after indiscretions of diet. This so-called chronic rheumatism appears to be a totally distinct condition from rheumatic fever; and although its pathology is not determined, it may be due either to a diminished elimination or an increased production of some toxic substance or substances, but so far we have no evidence as to their nature.

Rickets (*see* Rickets; Medical Research) is undoubtedly a manifestation of a profound alteration of the metabolism in childhood and is now regarded as being in large measure a food deficiency disease (avitaminosis).

See Carl von Noorden, *Metabolism and Practical Medicine* (1907).

METABOLISM, the biological term for the process of chemical change in a living cell (*see* Nutrition; Diet and Dietetics).

METALLGESELLSCHAFT A.G., a German company, was founded in 1881, by Mr. William Merton, as a limited company, taking over the metal business of the private firm Philipp Abraham Cohen established in the beginning of the 19th century. Because of its dealings in metals, ores, pyrites, etc., the Company took interests in mining enterprises as well as in smelting works and metal manufactories. During several years a special company, the Metallbank and Metallurgische Gesellschaft A.G. conducted the technical and financial part of the business, but in 1928 the two companies were amalgamated under the name of Metallgesellschaft A.G.

The Metallgesellschaft with its branch offices and its foreign connections is one of the most important metal concerns in the world. The war caused considerable changes in its foreign relations, and untiring efforts had to be made to regain for the Company its former strength. New connections had to be built up, new fields of business had to be looked for; the industrial activity of the Company is much greater now than before the World War.

Metallgesellschaft A.G. is carrying on wholesale trade in non-ferrous metals, in ores, and in certain chemicals connected with the metal industry. A great deal of the copper, tin, spelter, lead, and aluminium dealt with are produced either in its own smelters or smelters under its control, such as Norddeutsche Affinerie in Hamburg, Berzelius on the Rhine, Hans-Heinrich-Hütte in the Harz, etc. In its own works at Heddernheim, Mannheim, Cologne, Nuremberg, etc., copper, brass, aluminium, and lead are being manufactured. Particular attention is concentrated on the production and propagation of light metals (aluminium alloys). Large research laboratories are keeping up to date the technical processes concerning the concentration and smelting of ores and the refining and manufacturing of metals. Branch ("Lurgi") companies are used for the exploitation of technical processes concerning chemistry and metallurgy.

The present capital of the Company is 76,000,000 Reichsmark. Its headquarters are in Frankfurt-on-Main, and it is represented in all big commercial centres of the world. (S. Au.)

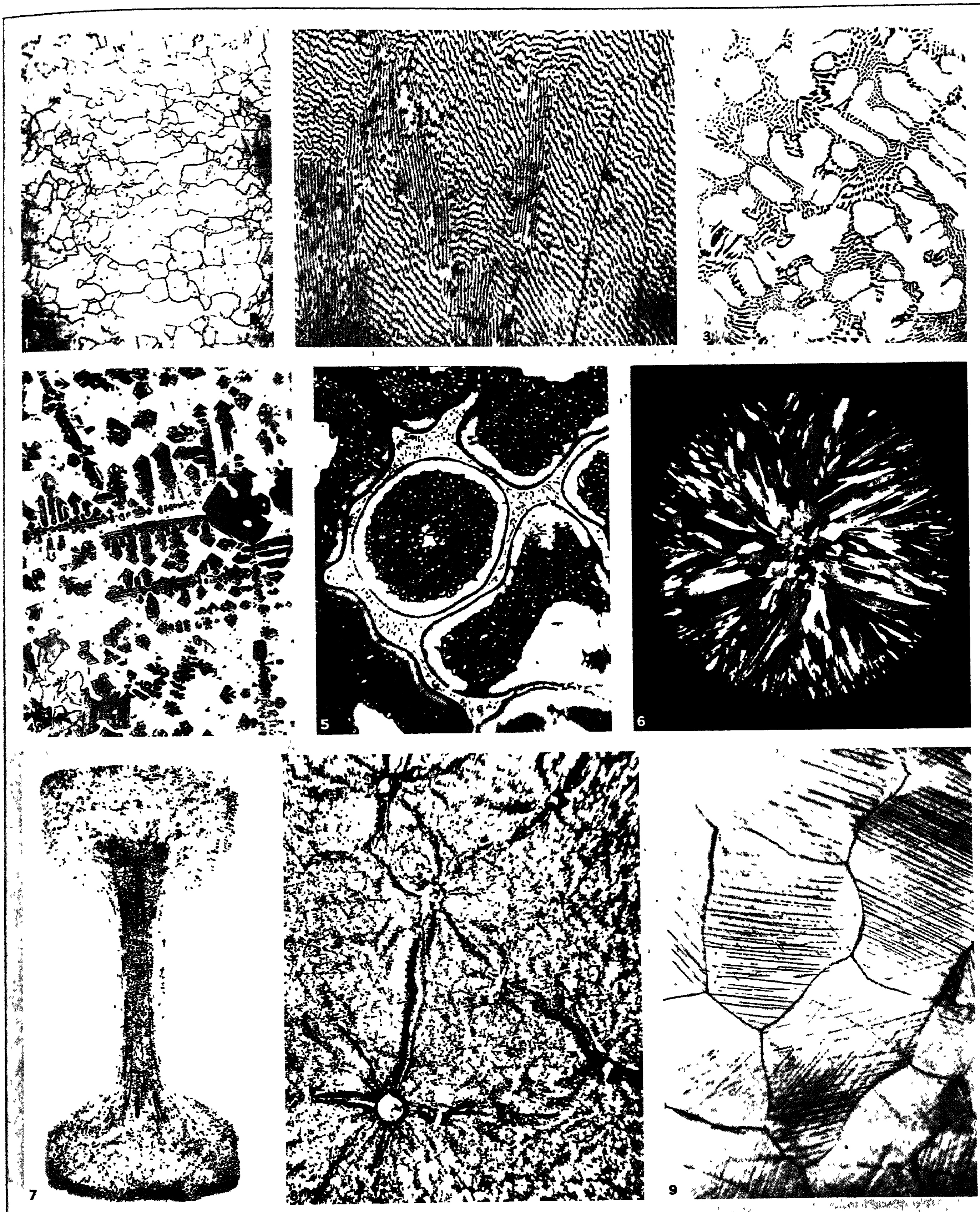
METALLOGRAPHY. A polished piece of metal presents an appearance of complete homogeneity which does not suggest the existence of a complex internal structure. When the metal is broken, however, the fracture indicates a structure or texture capable of microscopic examination. This fruitful method, which forms the foundation of the science of Metallography, was first applied to metals by H. C. Sorby of Sheffield in 1861. It was subsequently developed in Germany by Martens, in France by Osmond and in England by Roberts-Austen and many others.

The microscopic examination of metals cannot well be made by the use of sections thin enough to be transparent. It is therefore made by looking *at* a prepared surface of the specimen, and not through it. Careful preparation of the surface eliminates all accidental markings and scratches. An ordinary "polished" metal surface is much too rough for the purpose. Metallographic surfaces are prepared by rubbing a flat specimen on successively finer grades of special emery papers, the scratches made by one grade being replaced by finer ones made by the next grade. The finest scratches are removed by a revolving disk covered with soft cloth or leather and fed with water and extremely fine polishing material, such as specially washed alumina or magnesia powder.

The featureless mirror, so produced, is covered with a very thin surface layer of "flowed" metal which has been smeared or dragged over the surface during the polishing process. This surface is lightly attacked by an "etching reagent." For many metals a weak solution of nitric acid in alcohol, or of picric acid in alcohol, serves as a useful etching reagent, but a great variety of solutions has been developed. Lists of these are to be found in the textbooks, etc.

Structures of Metals.—The etching reagent, after removing the surface film, differentiates the various constituents which are present in the section so as to make them visible under the microscope by the production of differences in the light-reflecting power of the metal surface. Such differences may result either from the actual "colouring" of the surface by the formation of a coloured film or from a roughening of the surface by partial solution—*i.e.*, the partial "unbuilding" of the structure at certain points.

First we have the simple aggregate of crystals which we find in pure metals and in those alloys which consist of a single solid solution. A typical example is shown in fig. 1, Plate I. The structure, seen under "normal" lighting, presents the appearance of an irregular tesselated pavement; each of the roughly polygonal



PHOTOMICROGRAPHS OF SURFACES OF PURE METALS AND ALLOYS SHOWING STRUCTURE

1. Crystals in pure metal or an alloy consisting of a single solid solution. 2. Finely laminated duplex structure of alloys of lowest melting point ("eutectics") which occur in certain series of alloys. 3. Structure of alloy showing crystals imbedded in laminated matrix. 4. Structure of alloy showing crystals of the chemical compound Mg_2 Si. 5. Complex structure of alloys undergoing changes after solidification. 6. Radiating crystals of cast lead. 7. Sulphur print of steel rail, showing segregation of sulphur. 8. Alloy showing fusion spots or traces of liquid which had not yet solidified when the liquid was chilled. 9. Surface of pure metal showing "slip bands" or cross hatching due to plastic deformation or strain

fields into which the surface is divided is the section of a crystal of metal, the mutual boundaries of these crystals being determined, however, not by their geometrical shapes or properties but by the manner in which adjacent crystals have met. Within their boundaries, however, these crystals possess the typical geometrical regularity of true crystals. Another structure often found in alloys is the finely laminated duplex structure, illustrated in fig. 2, Plate I., which is typical of what are known as "eutectic" alloys. These are the alloys of lowest melting point which occur in certain series of the alloys of two metals. Many alloys consist of simple crystals of the type illustrated in fig. 1, Plate I, embedded in a matrix of the laminated type. An example is shown in fig. 3, Plate I. There are many other types of structure, such as those which occur when a well-defined chemical compound of two metals occurs in the alloy. An example is given in fig. 4, Plate I. Further types of micro-structure are found in alloys which undergo changes—as many alloys do—after they have become completely solid. An example of the complex structures which are sometimes produced in this way is shown in fig. 5, Plate I. Other examples will be found in reference to ALLOYS and in connection with the articles dealing with particular metals and alloys, such as STEEL, COPPER, BRASS, BRONZE, ALUMINIUM and others.

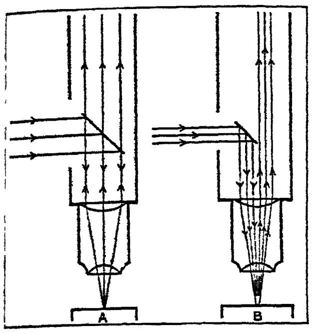


FIG. 1.—DIAGRAM OF VERTICAL ILLUMINATION. A. TRANSPARENT REFLECTOR: B. OPAQUE REFLECTOR

Metallurgical Microscope.—The metallurgical microscope differs from other microscopes mainly in being specially designed for the observation of opaque objects requiring, in some cases, the highest available resolving and magnifying powers. The two typical methods of illumination employed in the examination of metals are indicated in the diagrams in fig. 1. Light from the source or lamp falls upon a reflector placed within the microscope tube, close above the objective. This reflector is, in fig. 1 (a) a small totally reflecting prism or mirror so placed as to cover one-half of the objective; in fig. 1 (b), the reflector is a thin slip of flat glass placed at an angle of approximately 45 degrees above the objective. Either type of reflector sends a portion of the incident light down through the objective on to the surface of the specimen, which reflects some of this light back into the objective. A part is inevitably returned to the lamp, but a part passes upwards through the transparent reflector or through the uncovered half of the objective to form the image at the upper end of the microscope tube. It will be seen that where the surface of the specimen is truly horizontal the incident light is fully reflected back into the microscope, and that portion of the surface will appear bright in the resulting image. Where the surface is roughened, however—for instance by the formation on it of numerous minute facets inclined to the horizontal—the light will be reflected to some extent away from the object lens of the microscope and such roughened areas will appear more or less dark in the resulting image. Where the distance between objective lens and specimen is sufficiently great—as it is with the lenses used for more moderate magnifications—it is possible to vary the mode of illumination by throwing a strong beam of light obliquely upon the surface from one or more sides. This completely alters the character of the image observed, parts previously dark now appearing light and vice versa. When a suitably etched specimen of a pure metal is thus obliquely illuminated and is then slowly rotated, a remarkable effect, known as that of the "oriented lustre" of the crystals, is observed. The same effect can be seen with the unaided eye where specimens of metal having a very coarse crystalline structure are available. An example of this kind, showing the radiating crystals of a piece of cast lead, is illustrated in fig. 6, Plate I.

A typical example of a metallurgical microscope designed for prolonged visual work as well as for photography, is illustrated in fig. 2, which shows the Rosenhain metallurgical microscope. The main feature of an instrument of this kind is that the tube carrying the optical system is fixed and that all focussing, both coarse and fine, is done by movements of the stage. In recent years, however, the inverted or Le Chatelier type of microscope, in which the specimen is placed face downwards on the stage, has become popular owing to its convenience for photomicrographic work. A disadvantage is that while it facilitates photography it renders visual observation difficult and tiring and workers take photographs rather than study their specimens in detail.

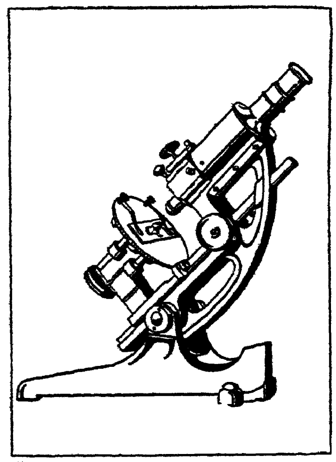


FIG. 2.—METALLURGICAL MICROSCOPE (ROSENHAIN TYPE), WITH FIXED BODY TUBE, HAVING THE ILLUMINATOR INSERTED IN IT, AND MOVABLE STAGE

The magnifications are limited only by the resolving power of the microscope. Classical optical theory places this limit at not much more than 1,000 diameters, but recent American workers have employed much higher magnifications with some measure of success. The attempt is also being made to utilise ultra-violet light of very short wave-length and therefore of correspondingly higher resolving power.

Much depends on the specimen to be examined. It is only in materials of great uniformity that any section cut at random will give a structure typical of the whole. In the early days of metallography doubt was widely felt whether the examination of so small an area as that which can be seen under the microscope could furnish reliable information regarding masses of metal weighing perhaps many tons. It is now, however, recognised that sections cut from properly chosen parts of a mass of metal furnish most valuable information. It is advisable to cut and examine sections taken in at least two directions in each place and often taken from a number of places in the same piece of metal before a true picture can be formed.

"Macroscopic" Examination and Sulphur Printing.—Considerable guidance can be obtained by what is known as "macroscopic" examination. For this purpose a relatively large area of the metal—usually a complete cross-section—is roughly polished, leaving the surface covered with fairly fine emery scratches. This surface is then exposed to the action of a fairly vigorous solvent. In the case of iron and steel, a solution containing slightly acid copper chloride is often used, but there are a number of special reagents for this purpose. These are allowed to act for a much longer time than is required for microscopic etching, and they produce a deep attack on the surface, generally roughening and darkening it. None the less the surface thus attacked shows a pattern which is known as the "macro-structure" which indicates the general arrangement of the crystals. Where the process is applied to a casting, or to an ingot which has not undergone much deformation, the arrangement of the original crystals formed during solidification can generally be clearly seen. In a forging it is possible, as a rule, to trace the lines of flow of the metal. This is particularly the case in regard to iron and steel, where the presence of non-metallic impurities and the persistent segregation of phosphorus make the outlines particularly distinct.

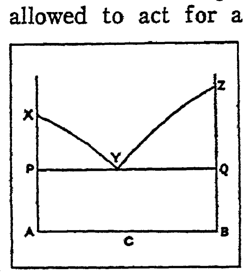


FIG. 3.—EQUILIBRIUM DIAGRAM OF ALLOY SYSTEM OF TWO METALS, A AND B, FORMING A EUTECTIC ALLOY

A method applicable mainly to iron and steel is known as "sulphur printing." It was originated by Baumann in Germany. A roughly polished surface is again prepared but instead of etching it, a piece of photographic silver bromide paper soaked in a 10 per cent solution of sulphuric acid is brought into contact

with the surface. Wherever sulphide enclosures are present they are attacked by the acid and sulphuretted hydrogen is evolved. This immediately forms a spot of silver sulphide on the paper and a print, showing traces representative of all the sulphide enclosures present, is obtained. This is an excellent means of showing the presence of segregation in steel. An example taken from a segregated steel rail, is shown in fig. 7, Plate I.

Equilibrium Diagram.—The micro-structures can only be understood if the formation during the solidification and subsequent cooling of the alloy is studied. The close analogy between alloys and salt solutions was realised and the theory of "heterogeneous equilibria" was applied to alloy systems by Bakhuis, Roozeboom and others. Progress was then made by the determination of the equilibrium diagrams of alloys, at first in rough and very inaccurate ways, but more recently with great accuracy and in much detail.

The equilibrium diagram is a chart, plotted upon the composition of the alloys in percentages as base line and with temperature as ordinate. A series of lines indicate the temperatures at which the alloys undergo changes, which are generally accompanied by evolutions of heat on cooling and absorptions of heat on heating. Starting with a molten alloy, the first change which occurs on cooling is the commencement of solidification or freezing. This is readily determined by means of cooling curves which show thermal irregularities as the alloy cools. The freezing points or, rather, the points where freezing begins, are connected by a curve in the equilibrium diagram which is known as the "liquidus." Similarly, the temperatures at which the alloys become completely solid on cooling are connected by a line or lines known as the "solidus." Beyond these two curves or groups of curves, the diagram is divided into areas or "fields" which delimit the conditions of composition or temperature under which the various possible constituents of the alloys can exist in equilibrium. This state of complete equilibrium, however, is not always, or indeed, often, reached by alloys, although with very slow cooling or after prolonged heating at suitable temperatures, the constitution of the alloys tends to approach closely to the equilibrium condition. Alloys as ordinarily cooled, however, are usually in an intermediate or meta-stable state, the exact condition depending on the rate of cooling. The diagrams as determined for the various alloy systems follow certain well-defined types; only two examples of these types can be given here. Fig. 3 is the diagram of the alloys of a pair of metals which, while completely soluble in one another in the liquid state, separate into distinct crystals on cooling. Alloys of this type are known as "eutectiferous" since a low-melting "eutectic" is formed along the horizontal line PQ of the figure. The structure typical of such an alloy, corresponding to the point *C* of the diagram, is illustrated in fig. 2, Plate I. Fig. 4 represents an alloy system of the extreme opposite type, in which the two metals retain in the solid state the mutual miscibility which exists when they are molten, the alloys forming a continuous series of what are known as "solid solutions." These alloys, when very slowly cooled, exhibit the same structure throughout as a pure metal, although the alloys may differ widely from one another in physical properties, colour, etc. There are intermediate types, and others in which the formation of definite intermetallic compounds is indicated by a break or by a maximum in the liquidus curves.

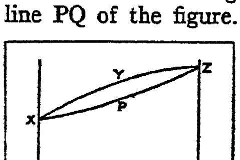


FIG. 4.—EQUILIBRIUM DIAGRAM OF ALLOY SYSTEM OF TWO METALS, A AND B, FORMING A SERIES OF SOLID SOLUTIONS

The equilibrium diagram gives a clue not only to the microstructure and thermal behaviour of the alloys, but also to their physical properties. Conversely, all these properties have been used for the determination of the equilibrium diagram. Reference has already been made to thermal methods whereby the temperatures at which a specimen crosses certain lines of the equilibrium diagram can be determined by irregularities—halts or retardations—in the heating and cooling process. The microstructure, both of slowly cooled specimens and of specimens rapidly quenched from a definite temperature, also affords an insight into the location of the lines of the diagram. Thus, if a specimen of an alloy is quenched from a temperature above the "solidus," *i.e.*, in a condition where traces of liquid are present, these can be recognized as so-called "fusion spots" in the structure. Such spots are illustrated in fig. 8, Plate I.

Dilatometry consists in the measurement of the changes in length of small rods of an alloy when it is slowly heated or cooled. Apart from the normal thermal expansion or contraction, it is found that alloys exhibit comparatively abrupt changes of length when they undergo internal changes such as allotropic transformations or the appearance of a new constituent or the disappearance of one previously present. The points at which such changes begin or end are fairly clearly marked on the dilatometer curves, usually recorded photographically by means of dilatometers of the Chevenard type. This method of studying alloys has the advantage that very slow rates of heating and cooling can be employed so that some approach to equilibrium conditions is obtained. This advantage also applies to the study of alloys by measurement of the changes of electrical conductivity with temperature. If this method is carefully used, with adequate precautions against accidental disturbing factors, it is capable of giving valuable results. It is not, however, certain that changes of electrical conductivity always occur at the precise points which are sought for the purpose of determining equilibrium diagrams.

X-ray Crystal Analysis.—By X-ray spectrometry we can not only determine the exact manner in which the atoms of a given type of crystal are arranged in space, but also identify the presence of a particular type of crystal in an alloy or mixture. For the latter purpose, however, the method is much less sensitive than microscopy or the other methods already mentioned, but has, on the other hand, the great advantage of affording a means of definitely identifying crystals of a particular type. Much more important, however, than its use in connection with equilibrium diagrams, is the application of X-ray crystal analysis to the study of the inner structure of metallic crystals. Not only has this method of examination confirmed the earlier conclusions derived from microscopic evidence, that metals are essentially crystalline aggregates, but it has also shown that they remain crystalline even after the most severe plastic deformation. The proof, however, only shows that a good deal of crystalline metal is present even in severely deformed material, but does not show that the metal is entirely or even mainly crystalline in that condition. (Consult articles on "Strength of Materials" and "Fatigue.") When a previously polished and etched specimen of a pure or nearly pure metal is plastically deformed, the surfaces of the crystals seen in the section become cross-hatched with fine black lines. These lines, known as "slip bands," are illustrated in fig. 9, Plate I. It has been shown that these fine lines are in reality little steps in the surface which have been produced by minute slips occurring on some of the crystal planes. It is by successive slips of this kind, occurring within each of the crystals of a piece of metal, that the material takes up the new shape imposed upon it when it undergoes plastic deformation, as—for instance—when it is stretched when drawn out into wire or flattened during rolling. As a result of the slipping process, the individual crystals become elongated in the direction in which the metal has been extended. On subsequent heating to a sufficiently high temperature (without melting, however) the metal "recrystallises" and the crystals resume their normal shape of approximately equal length in all directions. In some of the softer metals, such as lead and cadmium, the recrystallisation process occurs gradually at ordinary temperatures but in iron and steel there is neither "crystallisation" nor "recrystallisation" at room temperatures, whether the metal be at rest or exposed to violent vibration. (W. Rn.)

METALLURGY, a term formerly defined as "the art of extracting metals from their ores" has now a wider meaning. It is applied by modern metallurgists to the structure of metals and of alloys, to their constitution and its relation to their physical properties and to the thermal and mechanical treatment of metals.

The immense increase in the scale of metallurgical work and the increased scientific knowledge of metals and alloys constitute the most striking features of modern metallurgical development.

Both are accompanied by a great increase in economy in the extraction of metals and in their more efficient use and preservation. Indeed, there are signs that in the case of some metals the increasing rate of consumption may lead to gradual exhaustion if not of the entire world's supply, at least of the best ores. Even in regard to iron there is food for thought in the immense increase of annual production and consumption, coupled with the losses due to corrosion alone. These losses have been estimated at 30 million tons of iron and steel per annum.

The production of metals and alloys in the form in which they are used in the industries and the arts involves a series of processes, beginning at the mine or quarry and ending in the workshop of the engineer or of the manufacturer. These operations differ widely in character according to the nature of the metal, and to some extent—especially in the later stages—to the use to which the metal is to be put.

ORE TREATMENT

Where Metallurgy Begins.—Beginning with the quarry or mine, it is difficult to determine precisely where the province of mining ends and that of metallurgy begins. Metals occur in nature only rarely in the free state, but usually in the form of "ores"—*i.e.,* of minerals in which the metal exists in chemical combination with other elements, chiefly oxygen, sulphur, arsenic and silicon. A great many important ores are sulphides. When a metalliferous deposit is first discovered, the ore—for example in many of the American copper deposits—is of the nature of a carbonate, having been altered by the chemical action of the atmosphere from the original sulphide condition. These "oxidised" surface ores are easily worked and afford an initial advantage in opening up a new mineral region. As the ore is pursued to greater depths, however, its character usually changes and the carbonates and oxides are replaced by sulphides which are much more difficult to work. There are, of course, exceptions to this rule, as in the case of aluminium and of gold. The latter usually occurs in the free metallic state and at an early stage in the working of an auriferous region is generally obtained by the simple process of washing or "panning" the alluvial mud of the rivers. Platinum and osmiridium are obtained in similar ways. Such alluvial deposits, however, indicate the existence of gold-bearing rock at higher levels. In the rock the gold is usually associated with quartz and may occur either in a comparatively massive form as fine veins or streaks, or in a very finely almost colloidal form, as in the quartz lodes of the Witwatersrand.

The extraction of alluvial gold is an example of a very simple type of ore treatment which is, however, typical of the methods adopted. The metal-bearing mineral, whether it be oxide, carbonate, sulphide or free metal, always occurs intimately associated or mixed with non-metalliferous material, often constituting the country rock in which the mineral "lode" or "vein" is embedded. In mining operations efforts are made to separate the mineral as much as possible from the adjacent valueless rock or "gangue," but usually the separation is very incomplete until special processes are applied to the product. These separating or "ore dressing" processes depend on differences of properties between the mineral and the gangue. In the case of gold "washing" the property utilised is the higher density of the gold as compared with the mineral matter of the surrounding mud. Similar gravity separation in flowing water is frequently used, but can as a rule be applied only after the product of the mine has been ground to a fine powder. After grinding, the ore is frequently "graded" by various methods, such as screening or sieving, in order that the product subjected to the next operation may be of a standard degree of fineness.

Apart from the separation of the heavier mineral from the lighter gangue particles by means of water, other methods are also employed. In some cases magnetic separation is possible, when the mineral is either markedly attracted by powerful electro-magnets or—less strongly—repelled by them. Such methods can, however, be used only for minerals, like iron, nickel or cobalt, which possess well-marked magnetic properties.

Flotation Process.—The most important modern development in regard to mineral separation is the "flotation" process, which has rendered possible the profitable treatment of ore bodies, and even of residues from older and less efficient methods of treatment. The flotation process consists in stirring up the finely divided ore in water to which certain additions have been made in order to produce froth when the water is violently agitated or air is blown through it. This froth carries with it to the surface of the water the fine particles of mineral, leaving the particles of gangue at the bottom. In this way it is possible to remove and to concentrate the mineral values out of a very poor ore, the operation being both rapid and cheap.

There is still some divergence of opinion whether flotation phenomena are the result of purely "surface tension" forces or whether electrical effects play the most important part. The operations consist of three steps which may, however, overlap and merge into one another. The first is the "oiling" process and consists in adding to the wet pulp or mixture of water and finely-ground ore some substance of a more or less oily nature. This may be either an essential oil—oil of eucalyptus is largely used—or one of a great range of organic substances The choice of the most suitable "oiling" reagent for a given kind of ore is a matter of great importance and often requires extensive preliminary investigation. Only a very small amount of the "oiling" reagent is used. Its effect is to produce some change in the surfaces of those minerals having a metallic or semi-metallic character. Zinc-blende is a typical example of such a mineral. The surface of the mineral thus "oiled" becomes less easily "wetted" by the water of the pulp. The gangue of the ore, on the other hand, is either not affected at all or affected to a much smaller extent than the mineral, and this brings about the different behaviour of the two kinds of material towards the froth bubbles. In some cases, however, it is necessary artificially to increase the difference in this respect between ore and gangue by the introduction into the pulp of some reagent which renders the gangue particles more readily wetted by the liquor. These "gangue modifiers" are usually either mineral acids or alkalies.

The next step consists in adding to the pulp some substance which assists in the formation of a stiff and lasting froth when the liquid is aerated. The introduction of air may be brought about either by simply agitating the liquid or by blowing air through it. Frequently the "oiling reagent" serves also as froth producer. When the pulp thus prepared is treated so as to produce a froth, the oiled mineral particles adhere very strongly to the froth bubbles. The combined buoyancy of the air-bubble with its mineral burden is sufficient to cause it to float to the surface, where the bubbles accumulate to form a very stiff mineralised froth which can be separated in various ways. There is also flocculation of the mineral particles by the oil emulsion in contact with the air-bubbles. The finest mineral particles thus become attached to the air-bubbles in large and heavy agglomerations—a circumstance which contributes to efficiency.

The flotation process is applied to sulphide ores, such as those of copper, lead and zinc, and in this connection alone it has attained great industrial importance. Its application to other types of minerals is not quite so easy but considerable success has been attained. Minerals having a more or less metallic surface are particularly well adapted to flotation, so that the process is readily applicable to the treatment of ores containing finely divided metallic gold. None the less, for the treatment of ores of this nature at the Rand in South Africa, the older cyaniding processes hold their own, although flotation is used in some cases in combination with cyaniding.

Oxidation.—The methods of ore treatment which have been mentioned above relate to processes of concentration which are "mechanical" in the sense that the chemical composition of the metalliferous minerals is not changed by the treatment. Following on such mechanical treatment, and in many cases preceding it, are a whole series of operations which act upon the chemical composition of the mineral. Some of these are, like the mechanical processes, of an essentially preliminary nature, but they include the processes by which the metal is finally reduced and refined. Among the preliminary treatments, those which exert

an oxidising influence on the mineral may be first considered. The action of atmospheric agencies on sulphide minerals near the surface produces enrichment by converting them into carbonates and oxides. Artificial methods for producing similar effects are widely used. One of the simplest consists in "bedding" the ore, after crushing to a suitable size, in such a way as to expose it to air and water—a process practised among others at the copper mines of Rio Tinto. The sulphide ore thus becomes gradually oxidised but the process occupies many months.

More frequently, oxidation is brought about by the application of heat in the "roasting" process. This constitutes an important part of the treatment of many sulphide and arsenical ores. Appliances for this purpose vary from simple "heap-roasting" to the elaborate sintering and roasting machine of the Dwight-Lloyd type in which the ore is fed on to a long continuous chain, each link of which is in reality a furnace grate. The link or plate only comes into action as a furnace, however, after passing first through an igniting chamber in which a flame plays upon the ore and heats it sufficiently to ignite, when it passes into the next chamber where air is drawn through the mass. Here the greater proportion of the sulphur in the ore is burnt, sulphur dioxide and trioxide being formed. The ore itself, thus purified, is sintered into a porous mass and, as the chain passes on, is tipped out while still hot. The porous mass thus produced is particularly suited for further reduction and purification in the blast-furnace (*see* below).

In other roasting processes, such as that of Huntington and Heberlein, the ore is roasted in a large pot where air is blown through it. In other processes, again, the ore is roasted in furnaces provided with a series of shelves which are heated by a flame passing under them while a separate stream of air is drawn over the layers of ore. The ore is raked down successively from one shelf to the next lower one and the roasting process is complete when the ore reaches the lowest shelf and is raked out of the furnace. In many of these roasting processes the sulphurous gases are utilised for the production of sulphuric acid. This utilisation of one of the waste products of a process is typical of modern economic metallurgical operation. The use of blast-furnace gases for the production of heat and power is another example of the same kind. In many processes the value of such "by-products" is an important factor in determining whether the process can be profitably worked.

Concentration.—In ore treatment the primary object is concentration. The metal occurs in the product of the mine frequently in a widely dispersed or "diluted" form and it is essential to reduce the weight and bulk of the material to the lowest possible amount. This necessity arises first from the need of keeping down the quantity of material which is to be treated in the later stages of metal production, whether in furnaces or in the wet way. There is, however, a further consideration. Mines are often placed in distant parts of the world, far away from the centres of industry where the finished metal is required and this involves relatively costly transport. It is therefore necessary to reduce the weight and bulk of the material to be transported and, in the last resort, this is achieved by carrying the treatment of the ore at or near the mine to the point of the final production of the metal. In a few cases this is done, but in others, where the refining processes are elaborate, the reduction operations are not carried to the final stages but only to a certain degree of concentration. There are, for instance, cases in which it would not be profitable to export, say from the Congo or even from Arizona, the crude sulphide ores. On the other hand it might not be worth while to instal electrolytic copper refineries in those places, partly on account of difficulties of power supply, lack of skilled labour, etc. The intermediate course is frequently adopted and a crude variety of copper, or even the sulphur-bearing intermediate product known as a "matte" is produced at the mine and sent forward to refineries situated near the centres of industry or near the sea. It is obvious that an intermediate product containing, for example, two or three per cent of impurities, will cost very little more for transport than the fully refined metal. On the other hand, it is always the removal of the last traces of undesirable impurities which is most difficult and demands the greatest skill and care. Purely economic factors, such as cost of labour and commercial organisation also play an important part in such matters.

The refining operations which can be applied to ores after they have undergone preliminary concentration processes, depend entirely upon the nature of the concentrate, and upon the facilities available in the locality where the work is to be done. Although the changes to be brought about are essentially of a chemical nature, the methods which can be applied depend to some extent on the physical characteristics of the substance in question. Thus a finely-divided material cannot be treated in blast furnaces, while a strongly sintered product is not so well suited as a finely divided material to treatment with aqueous solvents or "leaching."

Reduction Methods.—Broadly the reduction methods applicable to ores may be divided into two groups involving respectively furnace treatment and wet processes. Processes involving the use of mercury for "amalgamation" are allied to the true "wet" methods. The furnace methods depend upon chemical changes which occur at high temperatures; these may involve the oxidation of impurities which it is desired to eliminate and the oxygen for this purpose may be derived from the air or from oxidised compounds which may be added to the ore or slag during or prior to the treatment. There are also reduction processes, in which oxygen is removed from the ore either partially or completely. Here the oxygen is removed, *i.e.*, the oxides in the ore are "reduced," by the action of such agents as carbon, hydrogen, hydrocarbons or even other metals. It is a frequent sequence to find that at an early stage of a process the actions which take place involve oxidation and that reducing actions, which finally result in the production of the metal itself, are subsequently applied. The heat required for these operations may either be supplied by the combustion of fuel which may be mixed with the ore or burnt separately, or the heat may be generated by the combustion of such substances as sulphur or carbon already present in the ore or intermediate product.

Another method of metal production which is intermediate between the typical furnace processes and the wet-way electrolytic methods is that of "fusion electrolysis." Here the purified metalliferous substance is brought into a state of fusion, usually by admixture with some other substance which serves as flux—*i.e.*, has the function of rendering the mixture much more fusible—while itself remaining as nearly as possible neutral. The "solution" of oxide of aluminium in molten cryolite is perhaps the most important example of this kind. The fused mixture then serves as electrolyte and the pure metal is separated at the cathode exactly as in wet-way electrolysis, except that the reduced metal is frequently formed in the liquid state and is run off periodically into suitable moulds. In other cases—as in the production of magnesium, calcium and other light metals the deposited metal is solid and is formed as a stick on a cathode rod which is steadily withdrawn from the bath. These processes find their application to metals which it is difficult or impossible to reduce satisfactorily by ordinary furnace methods and which cannot be produced by wet-way electrolysis because they react vigorously with water.

The wet methods of ore reduction afford a similarly large variety. In some few cases it is possible to extract the desired mineral direct from the mine by a leaching process. In the majority of cases, however, the solvent solution is applied to the ore after it has been removed from the mine and subjected to preliminary concentration, as, for example, by flotation. In other cases preliminary roasting, either purely oxidising or "chloridising"—in which chlorides are added to the ore with a view to converting the mineral into an easily-attacked chloride—is employed before leaching is applied. In some cases, in fact, the ore is reduced to a crude form of the metal before it is subjected to wet-way (electrolytic) refining.

Gold.—The metallurgy of gold owes its characteristic features to two principal factors:—the chemical inactivity of gold and the high value of the product. It is probable that the most com-

plete recovery of gold could be obtained by smelting methods, *i.e.*, by subjecting the ore to furnace treatment in which, however, the relatively great mass of siliceous and other matter accompanying the gold would have to be fluxed or molten. Less costly methods, although they do not yield so full a recovery, are preferred. This is an interesting example of the factors which determine the choice of metallurgical methods. At every stage of extraction it becomes a matter for careful calculation whether the cost of more complete extraction will be compensated by the value of the metal recovered. The conclusion in each particular case will depend upon the methods of treatment and recovery available. Improvement not only in the nature of the methods available, such as the introduction of flotation, cyaniding, etc., but also improved methods of mechanical handling, design of machines, etc., all of which tend to cheapen the cost of recovery, affect the result so that, as methods are improved, it not only becomes profitable to carry extraction further but to treat poorer ores or even to re-treat the "tailings"—*i.e.*, the rejected matter—from earlier reduction processes. In the case of gold, the amalgamation and cyaniding processes are the most important, although chlorination is also applied.

Amalgamation is the older process but is still widely used for the extraction of the gold from certain types of "free milling" ores in which it occurs in a form readily absorbed by mercury. In other cases amalgamation is used as a preliminary to cyaniding for the purpose of extracting in a cheap manner those portions of the gold which are most readily accessible, at the same time leaving the ore, after this treatment in a more uniform condition so far as gold content is concerned, and thus better adapted to cyaniding. Amalgamation itself is carried out either during actual grinding (pan amalgamation) or during the passage of the pulp produced by grinding over amalgamated copper plates. The amalgam thus formed is heated in retorts, when the mercury is driven off and spongy gold is left behind.

Mercury has the power of forming amalgams with silver, lead and other base metals and if these are present in a gold ore they rapidly contaminate the mercury which is said to "sicken" and becomes incapable of taking up gold from the ore pulp. Mercury is also lost by becoming so finely divided that it is carried off with the ore pulp.

Cyaniding is a wet-way process of the "leaching" type. It depends upon the fact that a well-aerated dilute solution of potassium or sodium cyanide will dissolve gold and, by sufficiently prolonged exposure can be made to extract a very large percentage of the gold present from a finely-divided pulp which is agitated with it. From this solution the gold is afterwards precipitated by means of finely-divided zinc.

Silver.—Both amalgamation and cyaniding are applicable to silver, so far as chemical principles are concerned. Their practical application, however, offers serious difficulties. Silver is much more slowly amalgamated by mercury than is gold, while the presence with it of lead and zinc tends to foul the mercury too rapidly. Further, silver frequently occurs in the form of minerals which do not directly lend themselves to amalgamation. As regards cyaniding, on the other hand, silver requires much stronger solutions of the cyanide and even in these dissolves far more slowly. As a result, the extraction of silver is more frequently carried out by entirely different methods which depend upon the solubility of certain silver salts. The chloride, for instance, is soluble under certain conditions in strong brine, while a solution of sodium thio-sulphate (commonly called "hyposulphite") is capable of extracting certain forms of silver from the ore pulps. From these solutions the silver can be readily precipitated —for example, as the chloride—which is then readily reduced to the metallic state by the action of zinc.

Copper.—While the treatment of copper ores by wet-way extraction processes occupies an important part in the metallurgy of that metal, the most typical processes applied to it come under the heading of "smelting"—*i.e.*, treatment in furnaces. Apart from the roasting processes to which reference has already been made, three types of furnace treatment are applied to copper ores. These are the blast-furnace, the reverberatory smelting and refining furnace and the "converter." In this respect, the metallurgy of copper resembles that of steel but in principle rather than detail. Ferrous metallurgy is on by far the larger scale.

The blast-furnace (*q.v.*) as used for the treatment of copper ores is a much smaller thing than the huge furnaces used for iron. It has also to carry out somewhat different functions. These differ according to the nature of the ore or concentrate to be treated. If this is of the oxidised type then it is fed into the blast furnace together with fuel (coke) and a suitable flux, with the object of bringing about the reduction of the oxides to the metallic state. The carbon of the fuel combines with the oxygen of the ore, while the other constituents of the ore combine with the flux to form a slag. The resulting products are an impure form of metallic copper and a slag containing very little copper. If, on the other hand, the ore contains much sulphur, together with—as a rule—sulphide of iron or iron pyrites, the function of the blast furnace is to burn away the sulphur and to produce a copper "matte" containing only a small proportion of sulphur. This matte is afterwards treated in the "converter" to form crude copper. In the copper blast furnace as used for "pyritic smelting" the minimum amount of fuel is employed to generate the necessary heat, while a large excess of air is blown through in order to oxidise the sulphur. The fluxing materials are designed to combine with the oxides or iron formed by the oxidation of the iron pyrites, so that the iron passes into the slag. This treatment, however, is only practicable when the sulphur content of the material is not too high.

While the copper blast furnace is essentially a vertical shaft into which air is blown by nozzles or "tuyeres" at a suitable point near the bottom, the "converter" is a vessel, either cylindrical or pear-shaped, capable of rotation on trunnions. This is provided with air-nozzles so arranged that the molten charge can—by rotating the vessel—be brought to cover the air-nozzles. When this is done the air is forced through the molten charge and rapid oxidation takes place. The heat of combustion of the sulphur serves to maintain and to raise the temperature of the charge, so that no supply of fuel is required.

At one time it appeared probable that smelting by the blast-furnace and the converter would become the means of production of the great bulk of the world's copper supply; practice tended towards an ever-increasing size of unit. But flotation methods of concentrating copper ores have created a difficulty in the use of the blast furnace. The great rush of air in this type of furnace tends to blow finely-divided ore into the flues, necessitating expensive after-treatment and recovery of the flue dust. This difficulty has to some extent been overcome by the development of the roasting and sintering machines such as those of Dwight-Lloyd which convert the finely-divided product of flotation into a fairly hard and porous sintered product at the same time as roasting it. None the less, there has been a great development in the use of the reverberatory furnace for copper smelting. These furnaces consist essentially of shallow basins which hold the charge and the layer of covering slag while the heating flame plays over the charge and against the furnace crown. In principle, these reverberatory furnaces are similar to the refining furnaces and to the open-hearth steel furnaces used in ferrous metallurgy, although the temperatures to be attained and, therefore, the methods of firing, are different. Another important factor in the development of the reverberatory furnace for copper smelting has been the introduction of pulverised coal firing. For the blast furnace it is necessary to employ coke, since the fuel must be sufficiently hard and strong to bear the superimposed weight of the charge without crushing unduly. Only in this way can the charge be kept sufficiently "open" to allow of the free passage of the gases. The production of coke involves expensive plant, even if the recovery of by-products more or less covers the cost of the coking operation itself. Only certain types of coal, moreover, lend themselves to the production of metallurgical coke. For pulverised coal firing, on the other hand, finely divided coal of very moderate quality, much of which had formerly to be regarded as practically waste, can be used. For furnaces where very high temperatures are required and pre-heating of the air

is essential, the use of coal-dust firing offers some serious difficulties. The ash, which represents anything from about eight to twenty per cent of the powdered coal, is necessarily blown into the furnace with the coal and most of it passes into the flues. In the high-temperature regenerative furnaces the hot products of combustion pass through regenerator chambers which serve the purpose of heating the incoming air, and the ash from the coal-dust tends to clog and destroy the brick-work of these chambers. This difficulty applies with great force to steel melting, but does not arise in the metallurgy of copper, since the temperatures are not high enough to require regenerative furnaces.

The further refining of copper may be carried out either by furnace methods or electrolytically. In the former process—which is much the older—the crude "blister" copper is melted in reverberatory furnaces and subjected first to strongly oxidising influences—as by blowing air through the molten metal. When the impurities have been oxidised as completely as possible and have been removed by scraping away the resulting surface slag, the metal is subjected to a reducing action by the process of "poling." "Poles" of wood—sometimes the trunks of trees of moderate size—are pushed down into the molten mass, while charcoal is sprinkled on the surface. As the wood burns, the products of combustion reduce the cuprous oxide in the molten metal to copper. The process is stopped when the metal has reached a condition known as "tough pitch" which is usually judged by the appearance of a small quantity which is ladled out and allowed to solidify. The examination of the fracture of a small bar is also a good guide. The "tough pitch" condition cannot, in the case of refinery copper, be defined by any specific oxygen content, since the proportion of oxygen required depends upon the amount of other impurities present, notably arsenic. Furnace refined copper is rarely if ever free from the latter impurity.

Electrolytic refining has increased greatly. The process consists in using the crude copper as anode or positive plate in an electrolytic cell. The copper of the anode is dissolved, under the action of an electric current, in the copper sulphate solution which constitutes the electrolyte of the cell, pure copper being deposited on the negative plate or cathode. The impurities present in the crude copper accumulate as a slime at the bottom of the electrolytic cell and this slime is collected and treated for the recovery of other metals, particularly platinum, gold and silver. The recovery of these by-products plays an important part in the economy of the electrolytic refining process.

The product of electrolytic refining, known as "cathode copper" is a metal substantially free from all impurities except a little sulphur, the latter due to the mechanical enclosure of particles of the sulphate solution used in the electrolysis. For some purposes the cathode copper is used in that condition—as, for example, in the preparation of alloys. As produced in the refining cell, however, it is not suitable for mechanical treatment, such as rolling or drawing and where it is to be used as raw material for such purposes, remelting is required. This is done in large reverberatory or open-hearth furnaces, conditions during melting being kept oxidising in order to eliminate any traces of sulphur. This oxidising melting is followed by "poling" in order to lower the oxide content and bring the metal to the "tough pitch" condition.

The relative merits of electrolytic and furnace-refined copper were, for a long time, the subject of acute discussion and there are still a few metallurgists who prefer the "best selected" copper—*i.e.,* the refinery product—to the high-purity material. The choice between electrolytic and refinery copper is now, however, almost solely a question of price.

Much attention has been given in recent years to an accurate study of the effects of impurities in copper, some very thorough work on the subject having been carried on for a number of years for the British Non-Ferrous Metals Research Association at the National Physical Laboratory, England, although much important work on the subject had been done earlier, as for example by Hampe in Germany and by Skowronski in America. All impurities are found to render copper harder and less ductile and to lower the electrical conductivity. Bismuth is particularly potent, while arsenic, on the other hand, appears to make the metal tougher rather than more brittle unless the proportion is very high. In considering these effects of impurities, however, it must be borne in mind that a certain small amount of oxygen in the form of cuprous oxide is always present in copper that has been melted. While the effects of small proportions of oxide both upon the physical and electrical properties of copper are small compared with those of phosphorus or bismuth, these effects must be taken into account when the simultaneous presence of another impurity is considered. Thus it has been shown that arsenic tends to counteract the effects of oxygen and it would not be surprising to find that arsenic has a similar action in regard to the deleterious effects of antimony and even of bismuth. If this is the case it may be found possible to admit proportions of antimony and bismuth which, in the absence of a suitable amount of arsenic, are known to be prejudicial.

The metallurgical processes which have been considered in outline above, serve as illustrations of the processes and methods used in the reduction of non-ferrous metals. Every individual metal, of course, requires the use of special processes and methods, but it will not be possible here to deal with further examples of such processes, except in regard to two metals typical of entirely different conditions. One of these, zinc, owes its interest to the fact that it is volatile at the temperatures required to bring about its reduction by carbon, while the other—aluminium, is a metal whose chemical activity especially with regard to oxygen, is so high that reduction by carbon and heat alone is not possible.

Until a comparatively recent time the whole of the world's zinc supply was produced by distillation in the retort. In this process, oxide of zinc is mixed with finely divided carbon, generally in the form of coal, and heated in long fire-clay tubes or "retorts." The product of the reaction in these retorts is a vapour consisting of metallic zinc and oxygen—probably volatilised zinc oxide. This is caught in receivers, placed at the mouths of the retorts outside the furnace, where metallic zinc is condensed. A certain proportion of the product, however, condenses as a fine bluish-white powder, known as "blue powder" which is a mixture of metallic zinc and zinc oxide. It is not commercially feasible to recover the zinc from this powder and its production constitutes a loss in the process, although for chemical purposes a reasonably satisfactory market for a certain amount of this powder has, in recent years, been found.

The product of the zinc-distillation furnace suffers from a serious disadvantage. The ores of zinc and the concentrates which are treated in the furnace always contain considerable proportions of lead. This lead is rather less volatile than zinc, but sufficiently so to bring about a contamination of the zinc produced which may amount to one or two percent. Formerly no great importance was attached to this impurity, but the effects of impurities in metals and alloys have come to be more fully recognised and there is now an increasing demand for metals of the highest possible purity.

Special interest attaches to the rapid development, during recent years, of electrolytic zinc production both in America and Australia—at Port Risdon in Tasmania. The zinc produced is of very high purity as compared with the product of the distillation furnace. Although the cost is still somewhat higher than that of furnace-produced zinc, the pure electrolytic metal is rapidly winning wide markets, thanks to the absence of lead and the complete regularity of composition. Cadmium is a by-product of Australian zinc production and this metal is now becoming industrially important. It is finding uses in electro-plating, for solders of higher melting point than the ordinary lead-tin solders (alloys of zinc and cadmium) and as an alloying element which, in small quantities, serves to harden and strengthen copper conducting wires without decreasing the electrical conductivity so much as other additions. Electrolytic zinc production is also making rapid advances in America and has attained an output which is about one fifth of the world's total zinc production.

Aluminium.—Brief reference has been made above to the production of aluminium by fusion electrolysis. (*See* also ELECTROMETALLURGY.) It is, in this respect, typical of a group of metals whose oxides cannot be reduced by heating them with

carbon or by the action of ordinary reducing gases. Among these magnesium, calcium, sodium and potassium, and latterly, beryllium may be mentioned. The processes differ widely in detail, but are all based on similar principles. The essential features are the use of a sufficiently fusible electrolyte in which an oxide or a salt of the metal can be dissolved and from which the pure metal is separated by electrolysis. The whole technique of fusion electrolysis differs widely from the aqueous process as practised in the refining of copper. The necessity of keeping the electrolyte in the molten condition requires the application of heat which may be furnished separately or by the electrolysing current itself. Heavy currents and relatively high current densities are consequently required. Usually, these electrolytic processes are only feasible where very cheap power is available, usually from water power. Alternatively, very cheap fuel may serve the same purpose, as at the great works at Bitterfeld, Germany, where cheap brown coal fuel is now employed mainly for the production of magnesium. This is produced by the electrolysis of a chloride electrolyte from which chlorine gas is also evolved, and this gas is itself an important product.

The production of aluminium is carried out on a much larger scale than any of the other fusion-electrolysis processes and has been brought to a high degree of efficiency. The electrolyte, like most of those used in processes of this type, is of a halide character. It consists of double fluorides of aluminium and sodium (cryolite) which have the power to dissolve aluminium oxide. This oxide is decomposed during electrolysis and is replaced by fresh oxide fed to the furnaces. In the fusion electrolysis of other metals it is usually necessary to convert the metal from the ore into a chloride or fluoride before it can be incorporated in the electrolyte, which is usually also a double fluoride.

Another important feature which applies to most of the metals produced by fusion electrolysis is that they are of low density—so-called "light metals." This has an important effect on the methods which have to be employed in their production, since there is a strong tendency—unless the relative densities are carefully regulated—for the metal to rise to the surface of any molten bath and there to become rapidly oxidised or burnt away. Even in the case of aluminium, great care has to be taken to maintain the electrolyte at a density sufficiently low to allow the fluid metal to accumulate at the bottom of the bath. In the case of the very light metals such as magnesium and beryllium this would be almost impossible and instead of carrying out the electrolysis at such a temperature that the resulting metal is fluid—as is done in the case of aluminium—the temperature employed leaves the deposited metal just solid. Deposition occurs at the end of a rod cathode which, as it is built up by deposited metal, is gradually raised out of the bath. The result is the production of a solid stick or rod of the metal attached to each of these rising cathodes. Even with such readily oxidisable metals as calcium and beryllium this method has proved successful. It entails, however, the task of finding an electrolyte sufficiently fusible to be liquid at a temperature at which the metal itself is solid. In the case of beryllium, with a melting point above 1,250° C this is not difficult, but the problem is more serious with metals of relatively low melting points like magnesium or calcium.

Two other methods of reducing metals from their oxides to the metallic state deserve mention. The first is applicable to metals which, while themselves reasonably fusible, are difficult to reduce and have a strong tendency to form carbides. Chromium and manganese are examples of this type. In some cases the method of "alumino-thermic" reduction invented by Goldschmidt is applicable. This depends upon the powerful reducing action of metallic aluminium. The process consists in mixing the pure oxide of the metal with finely divided aluminium metal and igniting the mixture by the local application of intense heat. The reaction once started, sufficient heat is as a rule generated not only to melt the resulting metal but even to bring the aluminium oxide which is produced into fusion. The process, when iron oxide is used with aluminium, is in fact employed as a means of generating molten iron at a temperature high enough to serve for welding purposes. With chromium and manganese, also, the heat generated is sufficient to melt the resulting metal. On cooling after the reaction, a solid mass of the desired metal is found in the bottom of the crucible in which the operation has been carried out—or alternatively, the molten metal can be poured out into moulds. The resulting metals are free from carbon or carbides, but they contain an appreciable quantity of aluminium and the impurities derived from that metal, viz.: iron and silicon, while impurities derived from the containing vessel may also be present. For many purposes, however, these aluminium-reduced metals are sufficiently pure and their use makes it possible to prepare alloys free from carbon.

In the case of a few very refractory metals—notably tungsten and molybdenum, another method of reduction has to be employed. Here the oxide is first reduced to the metallic state, generally by the action of hydrogen gas at a high temperature. The metal is thus obtained in the form of a finely-divided powder which is useless except for the preparation of alloys. To bring the metal into the massive form sintering and swaging processes are employed. The metal powder is strongly compressed mechanically and the rather fragile rods thus produced are raised to a very high temperature in an atmosphere of hydrogen and are then submitted to prolonged and vigorous hammering in a swaging machine, the metal being kept surrounded by hydrogen throughout. Finally, the swaged rods are strongly heated by the passage of an electric current, when the particles of the original powder coalesce to such an extent that the rod presents the external appearance and the internal micro-structure of a solid piece of metal. The large quantities of tungsten used in the manufacture of electric lamp filaments are produced by this method. The process, it may be remarked, as a resemblance, in principle, to that by which wrought iron is produced without the fusion of the purified iron, while certain modern processes of reducing iron from the ore by a "direct" process of gas reduction without fusion come into the same category.

Iron and Steel.—Our survey of metallurgical processes has been illustrated so far with references exclusively to the non-ferrous metals. The same principles apply to the metallurgy of iron and steel but their application differs in important respects. These differences arise mainly from the fact that the value per ton of iron and steel is much lower than that of the non-ferrous metals and very low cost of production is therefore essential. This factor, together with the immense quantities and large sizes in which ferrous products are required have led to the development of processes on a scale much larger than that generally employed in connection with non-ferrous metals.

In the preliminary treatment of iron ores considerations of cost do not allow of elaborate concentration methods, while the relatively widespread and plentiful occurrence of suitable ores tends rather to the selection of those best fitted for a particular purpose than to special pre-treatment. The raw material of ferrous metallurgy may therefore be regarded as some form of iron oxide, contaminated in varying degrees by silicates and compounds of sulphur and phosphorus. The beginnings of modern ferrous metallurgy were located at points where coal and iron ore were both available. The relation to coal-fields has been maintained, but modern facilities of transport now make it possible to use ores derived from distant sources—such as the Spanish and Swedish ores which are largely used in England. Further, while in the earlier days of steel production ores containing more than a small amount of phosphorus could not be used, the development of the "basic" processes, following the discoveries of Thomas and Gilchrist, has rendered available great deposits of phosphoric iron ore, such as the "minette" ores of Lorraine.

In modern practice the oxide of the iron ore is reduced to the metallic state by the action of carbon; the crude and impure product is known as "pig iron." This corresponds to some extent with the matte or at most to "blister copper" in copper smelting and is also carried out in blast furnaces, but the iron blast furnaces are of very great size. The blast furnace is a vertical shaft or tower which is fed from the top with alternate layers of ore (iron oxide), coke (carbon) and limestone. A blast of pre-heated air is driven into the tower at the sides near the bottom by means

of water-cooled nozzles or "tuyeres" and the coke in the charge is burnt, with the formation of a large amount of carbon monoxide. At a higher level in the furnace, part of this gas, and also to some extent the solid carbon of the charge, react with the iron oxide, metallic iron being liberated. This gradually falls to the bottom of the furnace and accumulates as liquid iron at the bottom. Meanwhile, most of the silica present in the ore combines with the lime of the limestone and with other oxides, to form a fairly fusible slag which also runs down to the bottom of the furnace and forms a layer above the molten iron. From time to time the furnace is "tapped"—*i.e.*, molten iron is allowed to run from an opening made at the base of the furnace tower. The molten iron flows into a sand-bed.

Efforts have been made to improve the efficiency of the blast-furnace by treating the air which is blown into it. The first step, which has long since passed into universal practice, is the pre-heating of the blast. More recently it has been suggested to remove the moisture from the air of the blast. Extensive trials, especially in America, have shown that the furnace works better with dry air, but the methods of drying available some years ago—mainly by refrigeration—were too expensive. More recently the remarkable drying powers of "silica gel" which is obtained by drying gelatinous precipitated silica, have been utilised and it seems probable that the application of this drying process to blast furnaces may find large-scale application. Another improvement can be effected by enriching the air of the blast with oxygen. Undoubted advantages can be obtained by this means, but its economy depends upon the cost of oxygen.

Since large volumes of air are blown into the blast furnace, corresponding volumes of gas must pass through the top. Formerly these were allowed to burn at the top of the furnace. This waste of valuable fuel is now avoided by closing the top of the furnace. The gas is collected and used in a variety of ways. It supplies the heat required for pre-heating the blast for the furnace and it may be burnt under steam boilers to generate the power required for the blowing engines that produce the blast while the surplus may produce electric power for other purposes.

Certain difficulties arise in the utilisation of blast-furnace gas from the fact that the gas carries with it a large volume of dust. Even if the gas is to be burnt almost immediately under a steam boiler, the bulk of this dust must be removed, otherwise the boiler and its flues rapidly become choked. If the gas is to be used for burning in large internal combustion (gas) engines then still more complete cleaning from dust is essential. Gas-cleaning appliances are installed in many blast-furnace plants. They either operate by passing the gas at fairly low speeds through a large number of sacks of finely-woven material (Halberg-Beth system) or else the dust is removed by the Lodge-Cottrell method of electrical precipitation. This method of precipitating dust from fumes is used in a number of other metallurgical processes. It depends upon the fact that fine particles of dust or moisture suspended in air, when electrified rapidly coalesce into particles which are heavy enough to settle. Electrification is produced by a high-tension discharge from a point. This requires special appliances, but the process is now widely used. In the case of blast-furnace gas, however, it only appears to become economical where the degree of cleaning which can be achieved by sack filtration is insufficient.

The quality of the pig-iron produced by the blast furnace depends upon the character of the ore with which the furnace is fed and also on the way in which the furnace is run. The pig iron always contains a considerable amount of carbon—of the order of 3 or 4 per cent. and different amounts, according to circumstances, of silicon, sulphur and phosphorus, as well as other impurities. The silicon of the iron is mainly derived from the siliceous "gangue" material which is always present, more or less, in the ore. Sulphur is derived, usually, from pyrites (iron sulphide) in the ore and phosphorus from phosphate minerals in the ore. The coke also contributes to the impurities of the iron, principally to the sulphur and for that reason iron made with wood-charcoal, as fuel in Sweden, is of higher purity than coke-made iron, although the high purity of the Swedish ores has much to do with the result.

The composition of the pig iron determines the uses to which it can be put. These are, broadly, of four kinds:—the production of iron castings in the foundry; the production of wrought iron by the puddling process and the third and fourth are the production of steel by the acid and basic processes respectively, although further distinctions exist between irons suited for Bessemer as distinct from open-hearth steel-making. In iron founding—*i.e.*, the production of iron castings, the requisite composition is obtained by a judicious blending of different varieties of pig-irons of different composition. The cast-iron must have a sufficient content of silicon to render it grey and soft by the formation of graphite, and frequently the presence of a considerable amount of phosphorus is considered desirable in order to render the iron easily fusible and fluid. Formerly the scientific aspects of iron founding were much neglected, but a good deal of research work on the subject has been done recently, particularly in Germany where methods for the production of special and superior qualities of cast iron have been worked out. In England the subject has also received attention from the British Cast Iron Research Association.

Wrought Iron.—The pig iron required for conversion into wrought iron must meet special requirements arising from the nature of that ancient process. The conversion of pig into wrought iron by puddling is one of the oldest of the processes of ferrous metallurgy. It has lost ground to the modern steel-making processes, but appears to hold its own for certain special purposes. For example, the best qualities of welded chain are still made of wrought iron although some degree of competition is now arising from electrically welded mild steel chain. Wrought iron differs from mild steel both in mode of origin and in constitution and structure. Steel is always made by the oxidation of the molten pig iron carried out in furnaces at temperatures high enough to maintain the purified metal in the fully liquid state. In the puddling of wrought iron, on the contrary, although the initial charge of pig iron is molten, as oxidation proceeds by the absorption of oxygen from the air and from the iron oxide with which the furnace is lined, the metal becomes increasingly pasty and, when the elimination of the carbon is nearly complete the resulting iron is fully solid although very soft. It is, however, intimately mingled with the slag or cinder, consisting mainly of iron oxide and silicate, together with a certain proportion of phosphoric compounds, which is produced during the puddling process. Much of this is pressed out during the shingling and forging operations to which the hot, pasty metal is subjected, yet a considerable amount of cinder remains behind in the finished product. The true metallic structure of the iron is thus interrupted frequently by veins of non-metallic matter. This structure gives to the material a pseudo-fibrous texture, but it is well to bear in mind that the individual "fibres" of the iron are, like all other iron and steel, aggregates of minute crystals and not strictly "continuous" fibres.

Steel.—The steel-making processes at present in extensive use for the production of mild steel consist essentially of a process of oxidation by which the carbon and certain of the impurities of pig iron are eliminated. The oxidising process, however, usually leaves the metal in an over-oxidised condition and subsequent reduction of the excess of oxide is necessary. It will be seen that this procedure is analogous to that adopted in the treatment of copper mattes, which are first over-oxidised and then subjected to a reducing treatment by "poling." In the case of steel, reduction by the direct action of carbon or by the equivalent of "poling" is not used, but de-oxidation is effected by the addition to the steel, just before it is tapped from the furnace, or even in the ladle after tapping but before the metal is run into the moulds, of certain "ferro-alloys." These usually contain a considerable amount of carbon to serve for re-carburising the steel to the desired degree, and also either or both manganese and silicon. Sometimes aluminium is also used as a de-oxidant. These substances have a sufficiently strong affinity for oxygen to rob the iron of that element, although this de-oxidation is never complete. The products of this reaction—oxide of manganese

and silica, or—more probably—a silicate of iron and manganese—form more or less fusible slag particles and, if the steel is given time to settle, these rise to the surface and are eliminated. As a rule, however, they remain in suspension in the steel and form undesirable non-metallic enclosures.

Two methods of oxidising the molten pig-iron are employed. In one, known as the Bessemer process, air is blown through or over the molten iron until the character of the resulting flame shows that oxidation has been carried far enough. The burning of the silicon and carbon content of the pig iron generates enough heat to raise the molten metal to a very high temperature, sufficient to allow it to be run out of the converter into a ladle and then into moulds. In the "Open Hearth" process on the other hand, the pig-iron, usually mixed with a considerable amount of steel scrap, is melted on the hearth of a large furnace regeneratively fired so as to maintain a very high temperature. It was, in fact, the invention of the Siemens regenerative furnace which, by making it possible to produce and maintain steel-melting temperatures easily and economically, made this type of process possible. Once the charge is molten it is oxidised by the addition of an iron-oxide ore, the oxygen of this ore combining vigorously with the carbon and silicon of the pig iron in the charge. A slag layer is formed above the layer of molten metal and protects it from direct interaction with the atmosphere of the furnace.

The reactions which occur in both types of oxidation process depend upon the material with which the furnace is lined. At the high temperatures employed the composition of the slag must be adapted to that of the lining, otherwise rapid attack would result. In the "acid" processes the lining of the open-hearth furnace or of the Bessemer converter is siliceous in character: the name "acid" refers to the acidic character of the silica which predominates in these linings and which must, therefore, be kept high in the slag also. Under such a slag it is possible to remove or lower the silicon and the carbon content of the charge, but it is not possible to purify the resulting steel in regard to its content of phosphorus or sulphur. It follows that, for the production of high-class steel in the acid process the pig-iron employed must itself be sufficiently low in sulphur and phosphorus, and this stringent condition—in view of the fact that the finished steel is frequently required to carrry less than 0·05% of these impurities—sets a limit on the range of pig-iron and therefore of ores which can be employed.

Basic Steel.—In the "basic" processes the furnace linings are made of magnesia and lime, bonded together with tar or similar material and containing very little silica. The slags used with these basic linings must also be correspondingly basic, *i.e.*, low in silica. A mixture of lime and magnesia, even with a small amount of iron oxide would not be sufficiently fusible, but the acidic element is provided by phosphoric acid, derived from the phosphorus of the charge. The basic slag is thus a highly basic lime-magnesia phosphate and tends to absorb phosphorus from the iron so long as oxidising conditions are maintained—for instance, by the frequent addition of iron oxide in the form of ore. Under reducing or less strongly oxidising conditions, however, there is a tendency for phosphorus to be reduced by the iron and to be returned from the slag to the charge. In the basic process, any silicon present in the charge rapidly forms silicates with the bases of the slag and would, if present in sufficient amount, attack the furnace lining. It will thus be seen that while in the acid process phosphorus is extremely undesirable, while silicon is needed, the reverse holds for the basic processes where pig-irons can be used which have a high phosphorus content, while high silicon is undesirable. There is one other point of general importance in which the two processes differ; it is much more difficult—on account of the danger of returning phosphorus to the molten steel—to effect thorough de-oxidation in the basic process than in the acid. Badly made basic steel, therefore, is liable to be over-oxidised and unsatisfactory, although when properly operated produces material of excellent quality.

Besides the four main processes various operations are employed in the treatment and production of steel for special purposes. Of particular interest from the comparative point of view are the processes for decarburising and carburising, by which the carbon content of the iron alloy can be changed without actual melting. The treatment of certain types of cast-iron by prolonged heating, generally in oxidising surroundings, leads to a profound change in the condition of the carbon. In the "white" iron as cast for this purpose the carbon is present as the compound Fe_3C—known as "cementite." In this condition the iron is very hard and brittle. If, however, a "white" iron of suitable composition, which has solidified without separation of graphite, is subjected to prolonged heating in oxidising surroundings, part of the carbon is oxidised and removed entirely, while the remainder is deposited in the form of nodules of finely-divided carbon. Unlike the graphite flakes of "grey" cast iron, these do not seriously interfere with the strength or ductility of the metal, and the iron is thus rendered "malleable." It is considerably inferior to true wrought iron or steel, since it still contains the finely divided graphite and the other impurities, but it is sufficiently strong and ductile for many purposes for which untreated iron castings would be too weak and brittle.

Cementation.—The converse of this process is that of carburising or "cementation." If bars of wrought iron or very low-carbon steel are packed in a carbonaceous material, such as a mixture of charcoal and barium carbonate, and are heated for some time at temperatures near 900° C the iron absorbs carbon. If this process is carried to a moderate extent, the iron or mild-steel article is left at the end with an outer layer or case of high-carbon steel. This, unlike the soft low-carbon core, can be hardened by quenching and in this way "case-hardened" articles are produced. Instead of a plain iron or low-carbon steel, a special type of nickel steel can be employed and this allows the final heat treatment to be much simplified. A surface hardening process depending on the formation of iron nitride has recently been worked out in Germany. Prolonged heating in a nitrogenous atmosphere at moderate temperatures is employed, and no final quenching or other heat-treatment is required, the core of the steel retaining its original high quality while no distortion can occur. The process is only applicable to steels of special composition, in which a certain content of aluminium is important.

The simple carbon cementation process has, however, another use which was formerly very important. Before the modern processes of steel-making were developed, high-carbon steel, such as is used for tools and weapons, was for a long time prepared almost exclusively by the cementation of wrought iron. For this purpose the carburising process is prolonged until the entire thickness of the bars is penetrated by the carbon, so that the whole of the material is converted into high-carbon steel. The product is known as "blister steel" and could, to some extent, be used direct in that condition. Preferably, however, the cemented bars were melted in small crucibles and the molten high-carbon steel cast into small ingots or other moulds—the product being "crucible" or "cast" steel. For a long time this product, when prepared from the purest Swedish wrought iron was regarded as the highest grade of steel. In recent times, however, the high degree of purification which can be applied to steel by melting it in a basic-lined electric furnace has made electric steel—when properly prepared—a serious rival to crucible steel.

Electric Steel Processes.—The application of electric processes to iron and steel differs markedly from its use in non-ferrous metallurgy. The electro-deposition of iron in the wet way is possible and yields a product of high purity; the cost, however, is too high to allow the process to compete with the large-scale furnace methods. Fusion electrolysis of iron is also possible, but the process has not been used. The electric furnaces employed in steel making, and—to a much lesser extent—for the reduction of iron from its ores—serve essentially as electrical generators of heat—*i.e.*, they are melting and not electrolytic appliances. As a rule alternating current, usually of the three-phase type, is employed, thus precluding all electrolytic effects. The electric furnace is used mainly for the remelting of scrap steel which can be successfully purified with very little loss. The production of alloy steels of accurately-determined composition is also facilitated in the electric furnace because of the exact control of composition which it per-

mits. On the other hand, the electric furnace has the disadvantage that the source of heat is costly so that in spite of the efficient way in which the heat is generated within the furnace itself, the electrical method of melting proves more costly than the fuel-fired furnace except perhaps in localities where very cheap water-power is available. For this reason the use of the electric furnace has not extended as much as was at one time expected.

"Cast" and "Wrought."—The preparation of the metal in the pure or approximately pure form, generally in the liquid state, is a distinct stage in most processes. It is only the beginning of the series of operations by which the metal is brought into its finished form. Those operations vary widely according to the form in which the metal is to be finally used. Broadly, however, metallic objects may be divided according to their mode of production into two types: "cast" and "wrought." The "cast" material is brought into its final shape, so far as metallurgical operations are concerned, by allowing the molten metal to fill and to solidify in a mould of suitable shape. "Wrought" material, on the other hand, begins its career by solidification in a mould of simple shape and the resulting solid ingot, slab or other shape is then brought into the desired form by working, which may be done either in the cold or at an elevated temperature, by rolling, pressing, forging, stamping, drawing, etc. There are many metals and alloys which cannot be "wrought" because they are, even when hot, too brittle to withstand plastic change of shape. Such materials—of which cast iron is a typical example—can only be used in the cast state. Finally, the finished or nearly finished material may be subjected to certain forms of heating and cooling known as "heat treatment," which improves its properties to a marked extent.

The first step in bringing metal into the desired finished state consists in causing the liquid metal to fill a mould, where it solidifies as a solid casting which has the shape of the interior hollow of the mould. Although superficially simple, this process offers many difficulties. These are greatest where the metal melts at a very high temperature and in those cases where the liquid metal absorbs large volumes of gas which are liberated during solidification.

A large proportion of the liquid metal produced throughout the world is required for future mechanical working, such as rolling or forging and is therefore cast into moulds of very simple shape. The most striking example is the production of steel ingots, which range in size from a small rectangular block weighing a few pounds to huge tapered octagonal masses weighing over a hundred tons. Except in the case of crucible-melted steel, the liquid metal is first run from the refining furnace into a large "ladle"—generally a steel box open at the top and provided with a refractory lining. These ladles are sometimes capable of holding considerably more than 100 tons of liquid steel and are moved about the furnace building by powerful overhead cranes. For filling they are brought in front of the furnace, from which the liquid steel is allowed to escape through a tap-hole at the base. From this hole the liquid steel runs along a gutter or "lander" lined with refractories and falls into the ladle as a cascade from which great showers of sparks arise. A photograph of this striking spectacle, taken at the proper moment, makes a picture at once impressive and inspiring. From the ladle the liquid steel is afterwards allowed to flow into the cast-iron ingot moulds.

The solidification process is comparatively simple in a pure metal free from gas, but as steel is a complex alloy of iron with carbon and other elements, and contains dissolved gas as well as oxides, sulphides and silicates in suspension, the process becomes complex. In spite of an immense amount of laborious investigation the details of the solidification of steel are neither fully understood nor entirely under control. The principal factors which play a part in the process of ingot solidification are briefly as follows:

(a) **Contraction.**—The steel after solidification occupies a smaller volume than in the liquid state. Since the layer of metal next to the wall of the mould solidifies first, and successive layers of solid metal are formed on the solid crust thus initiated, the last liquid portions are left at or near the centre of the ingot. A funnel-shaped contraction cavity or "pipe" is formed which may extend well down the centre of the ingot. This "pipe" must, for most purposes, be eliminated and a large part of the upper portion of the ingot must be cut off and discarded. This can be partly avoided by using containers, usually of fire-clay and known as "sinkhead" or "hot-tops" placed on top of the open end of the mould. The molten steel is allowed to fill these as well as the mould proper, and little or no solidification takes place in these "heads." They consequently provide a reservoir of liquid steel from which the contraction in the ingot proper can be made good. This method confines the pipe more or less to the "feeder head" of the ingot, and the amount which has to be cropped is much reduced.

(b) **Gas Liberation.**—Liquid steel, like most liquid metals, is capable of dissolving large quantities of gas, especially hydrogen. Most of this gas is driven out of solution when the liquid metal crystallizes and then partly escapes to the surface. A considerable amount, however, fails to escape unaided and forms cavities or bubbles in the solidified metal. It is contended that in steel which is to be rolled or forged such gas cavities are harmless because their surfaces, when subsequently pressed together at a high temperature during rolling or forging, unite by welding. Such welding, however, does not always occur; a great many of these cavities can never weld, because their walls become coated with impurities, such as silicates and sulphides, gathered from the adjacent steel during the pasty stage of solidification. These can be traced as long lines of "non-metallic enclosures" in the finished steel. The formation of gas cavities or "blow holes" in steel can be to a great extent regulated by the manner in which the oxidising processes in the steel furnace are conducted. If the reactions between oxide of iron and carbon are allowed to complete themselves so that the agitation or "boiling" of the steel in the furnace ceases, the product is a "dead melted" steel in which gas cavities will be comparatively few. Such steel, however, shows marked "piping" as described above. Even if the process is stopped at a point where there is still some oxide of iron present in the bath, the steel can be "killed" by the addition of a relatively small quantity of aluminium. Steel killed in this way "pipes" like "dead melted" metal. If, on the contrary, the steel is brought into the ingot mould while still actively generating gas—so-called "wild" steel—this process continues to some extent during solidification. A good deal of the gas there liberated is trapped in the solidifying steel which, consequently, contains a large number of "blow holes." The formation of these holes counteracts the effects of the normal contraction of the steel, and the steel does not appear to shrink while solidifying—it may, indeed, appear to rise in the mould. Such steel is called "rising" or "rimming" steel. It is also—perhaps more frankly—described as "unsound" steel. It has, from the point of view of mass-production, the advantage that as there is no definite "pipe" almost the whole of the ingot can be rolled, thus affording a larger yield of finished steel.

(c) **Segregation.**—As steel is a complex substance and the rate of solidification of any but the smallest ingot is necessarily slow the constituents have time to undergo separation or "segregation" which results in non-uniformity of chemical composition in different parts of the ingot. This subject cannot be adequately discussed in a general article but it is important to mention it because segregation plays a very important part in affecting the quality of large steel ingots. It is, of course, a natural process which, under conditions of slow undisturbed cooling in large masses, cannot be prevented except, possibly to some extent, by a careful choice of the composition of the steel itself. At the same time it has to be regarded to some extent as imposing a limitation on the size of the ingot, and consequently of the forgings or plates, which it is desirable to use where high and uniform quality is essential.

(d) **Contraction Stresses.**—Since the outer portions of an ingot necessarily solidify while the inner portions are still liquid, the latter—on subsequent solidification and contraction—exert a powerful inward pull on the outer portions. Masses of large size are therefore apt to be under severe internal stress and may, sometimes, crack spontaneously or when placed in a re-heating furnace. The formation of such cracks or "clinks" can be largely

avoided by correct design of the ingot moulds. Part of the difficulty is also avoided by the practice—adopted also with a view to economy—of drawing the ingots from the moulds while the steel is still very hot, so that the interior may still be partially liquid, and placing them in so-called "soaking pits"—a kind of pit furnace in which the temperature throughout the ingot has the opportunity to become equalized and the steel is, moreover, kept at a temperature suitable for forging or rough rolling.

The production of ingots or slabs of the non-ferrous metals and alloys, while subject to the same general laws and phenomena as steel, differs in regard to the conditions which have to be met. Non-ferrous ingots are never very large so that many of the problems which arise from large size, very slow cooling and extensive segregation, do not enter into the corresponding non-ferrous problem. On the other hand the non-ferrous ingot has frequently to meet special conditions. The quality of the surface of the cast slab is often important. In steel, so long as there are no cracks or foldings, smoothness of the surface is not essential. Brass, on the contrary, has frequently to be rolled out into a finished product with a smooth surface, so that the nature of the ingot or slab surface is very important. In the same way, blow-holes lying just under the ingot skin, which are often regarded as normal in steel, are not permissible in non-ferrous metal which is to be rolled into strip or sheet, since these cavities tend to open out during the annealing process following cold-rolling, and to cause defects known as "spill" and "blister." Much more attention is therefore paid in non-ferrous ingot casting to the details of mould surface, dressing, etc., and also to the method of filling the moulds. In steel practice this is very frequently done by allowing the fluid metal to run into the mould from an opening in the bottom of a large ladle. In non-ferrous practice, where the masses to be handled are much smaller, the molten metal is often poured direct from the crucible, or even from the furnace, pouring being done "over the lip" of the crucible and into the open top of the mould. For certain special purposes a process has recently been developed in France (the Durville process) in which the molten metal is first poured into a ladle or receptacle which is connected by a channel or short "runner" with a number of parallel small ingot or bar moulds. Ladle, runner and moulds are mounted together on trunnions about which the whole assembly is slowly rotated so that the ladle rises and the moulds are lowered. The metal then flows steadily from ladle to moulds. The resulting bars have remarkably perfect surfaces, but the process is readily applicable only to copper alloys containing a small amount of aluminium. Many other processes for filling ingot moulds have been developed, some working by gravity with or without the interposition of funnels or separators of various kinds, others by pressure applied to the liquid metal that forces it into the mould.

In regard to dissolved gases, while non-ferrous metals do not undergo a "boiling" process in which gas is generated during refining and melting, as in steel, they yet absorb considerable quantities of gas from the atmosphere of the furnace and from other sources. In some cases this leads to difficulty in securing soundness whether in ingots or in shaped castings. Copper is an example of this kind, but the phenomenon is encountered to a marked extent also in aluminium and its alloys and in certain kinds of bronze. Two methods have been recently evolved for freeing non-ferrous metals from dissolved gas. The most positive of these is that of "pre-solidification." It consists in allowing the molten metal or alloy to solidify very slowly, preferably in the crucible and in the furnace where it has been melted. During this slow solidification the crystallizing metal expels the gas, which has time to escape to the surface. As soon as solidification is complete the metal is rapidly re-melted and cast.

Another method of gas-expulsion consists in bubbling through the molten metal a more or less inert gas which, by local reduction of the partial pressure of the dissolved gas, leads to the removal of the latter. This method is successful when nitrogen is bubbled through molten aluminium alloys. Nitrogen, however, is itself slightly soluble in many metals, so that this process is not universally applicable. In some alloys, on the other hand, one of the constituent metals is itself volatile and escaping bubbles of its vapour serve to expel other gases in the same manner as bubbles of an inert gas. This is, perhaps, the reason why brass—with its large content of volatile zinc—readily yields sound castings.

The production of shaped castings entails processes and problems widely different from those of ingot production, but it is impossible to discuss them even in outline here. They vary according to the nature of the metal to be cast. Some reference has already been made to cast iron. Steel offers much greater difficulty in regard to casting. The tendency of the metal to liberate gas during solidification is one of these: another is the high temperature of molten steel which makes severe demands on the materials used as moulds. Castings are made in two types of mould—sand moulds and "permanent" or "chill-moulds." The former have to be specially prepared—sometimes by means of machines—from patterns for each casting. The "moulding sand" of which they are made must be carefully adapted to the needs of the metal to be cast. For steel it must be highly refractory so that it may not melt and "burn" on to the steel. Sand for moulding, however, must be sufficiently plastic to form moulds of adequate strength and cohesion, while the mould must remain sufficiently porous to allow the rapid escape of air, steam and other gases.

The use of metal or "permanent" moulds offers many advantages where the process is applicable. The constantly repeated cost of sand moulding is eliminated, but against this must be set the high first cost of the metal mould or "die." The latter is usually only justified where the same casting is required in great numbers. For many metals there is also a distinct advantage in regard to structure and strength which results from the relatively rapid solidification which takes place in a metal or "chill" mould. For steel it is not easy to use metal moulds but they have in recent years found application in regard to certain kinds of cast iron. For the non-ferrous metals chill casting is extensively practised, especially in the case of some aluminium alloys. For the lower-melting non-ferrous metals the process known as "die-casting" has found extensive application on account of the accuracy of dimensions which can be attained. Die-castings can be used for many purposes without subsequent machining and are widely employed in the cheaper kinds of light machinery, domestic and office appliances, etc.

Die-casting consists essentially in producing castings in metal "dies" or moulds, but as a rule the process is carried out by forcing the molten metal into the mould rapidly under pressure. This is done in machines which also open the die and eject the casting, the operation being rapidly repeated. The widest use of this method is made in castings of low-melting alloys of zinc, tin and lead. It has recently been extended to many aluminium alloys and even to certain types of brass and bronze. The difficulties of the process, however, increase rapidly as the melting point of the alloy rises.

Reverting to the ingots in which a great part of the world's metal production is cast, we have to consider briefly the principal processes by which the finished products are produced. In these the metal is forced to assume new shapes by the application of large mechanical forces, which may be applied to the material while it is either hot or cold.

Mechanical Working.—The purpose of subjecting metal to the mechanical working is not merely that of bringing it into a desired shape. Mechanical work affects the structure and properties of most metals and alloys in a markedly favourable manner. When metal solidifies from fusion, especially if it does so in large masses and therefore slowly, it forms a crystalline structure which is relatively coarse—sometimes very coarse indeed. While it is true that, whatever the treatment to which metal may be subjected, it remains essentially crystalline, yet the size or scale of that structure is highly important as affecting physical behaviour. Mechanical working always breaks down the original "cast" structure and replaces it by a much finer and more satisfactory structure. In some metals, of which steel is the most important example, it is possible to produce a "refined" structure, comparable in scale with that of wrought metal, by heat treatment alone, but this is only practicable for pieces of moderate size because larger masses cannot be cooled rapidly enough to bring about the desired changes. In addition, mechanical working, particularly in the case

of steel, serves to close up, and perhaps to bring about welding of cavities existing in the cast material. It also brings about a redistribution of the non-metallic impurities. These become elongated in the direction in which the metal is caused to flow under mechanical treatment and in some cases confer upon the material something which has the appearance of grain or fibre. There is, however, no true fibre in any metal, although "fibrous" fractures are frequently obtained and are often rightly regarded as indications of good quality.

Forging and Rolling.—The process of forging may be carried out under hammers or presses. The former range in size from the hand-sledge of the blacksmith to the largest steam-hammers delivering blows of many foot tons. For much of the heaviest forging great hydraulic presses are used in which the heated metal is quietly pressed or kneaded into the desired shape. Forging, particularly on the large scale, is mainly applied to steel and in that material very large pieces are sometimes handled. The tubes of heavy naval guns are probably the largest of these, but parts of large ships are also very heavy forgings. These very large forgings are always made from the ingot itself, but for much of the smaller work the steel is first brought into the form of bars by rolling and is only then forged. Work of this kind merges into what is known as "drop forging" in which a carefully proportioned piece of steel bar is forged between heavy dies to assume a designed shape. Stamping and pressing may also be regarded as allied to forging, but while true forging is always applied to highly heated metal, stamping and pressing may be done either hot or cold. Here the metal is used in the form of bar or sheet and is forced into the desired shape, usually without much change of section or real flow of metal, but rather by bending accompanied by a certain amount of "drawing." Metal to be used in this way must, of course, possess an ample degree of ductility. The rolling process is used to convert ingots into forms which are small in cross-section in comparison with their length. Bars and sheets, rods and wire, rails and girders and all kinds of structural sections are produced in this way. Rolling is carried out in successive stages. In the early stage the purpose is, while gradually bringing the metal towards the desired shape, to improve its quality—especially its ductility—so that it can better stand the more severe subsequent treatment. Yet for this very purpose it is, in many cases, found necessary to make the first deformations of the metal very drastic. It is found that at almost any stage of mechanical working, if the change of shape or size forced on the material at any one stage is not sufficient to penetrate and affect the entire thickness, there is risk of damage. Accordingly, where an ingot of large size has to be "broken down" very large forces and correspondingly heavy deformations are applied. This occurs mainly in the rolling of steel and is carried out in very powerful machinery. The ingots are so large and heavy that they are handled by automatic appliances which take them from the furnace, feed them backwards and forwards through the great rolls and finally eject the finished billet from the rolling train. Some recently-erected rolling mills of this kind, which are employed for dealing with nickel ingots as well as for steel, are operated electrically and are controlled by two or three men from a control platform—there is no heavy manual labour. For smaller work, however, and in most of the non-ferrous industries, the metal is put through the rolls by hand.

While steel is always "broken down" hot, some of the softer non-ferrous metals and alloys can be safely treated cold. The essential nature of the process does not differ as between hot and cold rolling. The effect of cold rolling, however, is always to produce hardening so that, after a time, the metal has to be "annealed" in order to soften it prior to further cold-rolling. Such annealing usually consists in placing the metal in a suitable furnace and heating it to a temperature correctly chosen for each metal.

The details of rolling practice vary widely according to the metal employed and the purpose for which the product is required. Heavy plates and extremely thin sheets naturally demand entirely different treatment. Strip metal is sometimes rolled in so-called "continuous" mills and these are especially applied to the production of wire. In these mills, which are mainly used for steel, the hot metal is fed into the first set of rolls rotating at a moderate speed. The material emerging from the first rolls is fed directly into a second set which—since the length is increased by the passage through the first rolls—must run at a considerably higher speed. A number of sets of rolls are used in series in this way, the finished product, such as wire, leaving the last rolls at a very high speed. Other types of rolling result in the production of "sections" —*i.e.*, of material having the form of H or I beams, channels, angles, railway rails, etc. These are produced by the action of suitably shaped grooves cut in the rolls, but the differences in the rate of movement at the bottom of such grooves and near the top require careful consideration. Successive passes in such rolls must provide for the easy flow of the metal from one shape to the next.

Extrusion.—Another method of manipulating metals, more especially non-ferrous alloys, for the purpose of bringing them quickly and easily into the form of bars or rods having any desired section or into the form of tubes, is that of extrusion. Here the heated billet of metal, previously produced of the correct size and shape, is placed in a heavy steel cylinder and a steel ram is forced down into the cylinder from one end. At the other end there is an aperture or "die" through which the metal is forced to escape in the desired form. Rods or bars produced by this process are sometimes found to possess an interior defect. This is believed to be due to the manner in which the flow of the metal in entering the die from the chamber causes the outer portions of the billet, including the skin, to flow into the centre of the extruded bar. A means of avoiding this difficulty has been devised recently, by a modification of the extrusion press. It is possible to extrude many alloys which are not sufficiently ductile, in the cast state, to stand rolling. In other cases, rolling is still possible if the internal structure of the metal has first been modified either by previous extrusion or by preliminary forging.

Heat Treatment.—While the great majority of metallic products are put into use in the condition—so far as their inner structure and strength are concerned—in which the final stages of production have left them, an increasing number of articles (more particularly those intended for important engineering uses) are now subjected to some form of heat-treatment for the purpose of improving their internal structure and mechanical properties. In the case of steel castings, for example, annealing is almost universally applied for the purpose of removing some of the impurities from the inter-crystalline boundaries, where they tend to form embrittling cell-walls, and bringing them into the shape of small scattered globules which are comparatively harmless. The treatment breaks up the original coarse casting structure and a further improvement is effected by either "normalizing" or "quenching and tempering" the steel.

Simple annealing is also used for softening metal hardened by cold working, as in rolling, stamping, pressing, wire-drawing, etc. If carried out at a high temperature or for a long time this may result in the formation of a coarse and brittle structure. Fortunately this occurs only rarely in the non-ferrous metals, but in very mild steel it is frequently encountered. In this material, however, it is possible to produce a refining of the structure by "normalising." This consists in raising the steel to a temperature just above the critical range, maintaining it there only long enough to ensure that the whole of the piece has reached the desired temperature and then removing the steel from the furnace and allowing it to cool rapidly in still air. The result is a marked refining of the crystal structure with a corresponding improvement in the mechanical properties. If, however, the steel is of a very soft variety and is required to possess the greatest ductility without much regard to strength, the final heat-treatment may be simply annealing at a much lower temperature, such as 680° C, which is just below the critical range of the steel. This causes the carbide of the steel to become "balled up" into little spherical masses making the material very soft and relatively weak.

The most important forms of heat-treatment applicable to steel, whether a plain carbon steel or an "alloy steel" containing nickel, chromium, manganese, etc., is a double treatment known as "hardening and tempering." In some cases the first stage of this treatment is a true "hardening," but in a great many cases it can only be called "hardening" by analogy. A full discussion of these

transformations could only be given after an explanation of the metallography of steel and especially of the equilibrium diagrams of carbon steels and of alloy steels. Since space will not permit of such treatment, the subject can only be treated in the broadest outline. The general nature of the changes involved in heat-treatment of steel can, however, be explained in an approximate manner if it is realized that the metal iron, which constitutes the great bulk of all steels, even of the more complex alloy steels, can exist in at least two allotropic states, known as the α and γ states respectively. In pure iron, the γ state exists at temperatures between 900° C and 1,450° C. It is a soft non-magnetic substance which crystallizes with the face-centred cubic lattice. Below 900° C. pure iron assumes the α form, which is also relatively soft and ductile, but is—below 750° C—strongly magnetic. The two kinds of iron differ most widely, however, in their power of absorbing carbon in the condition which is known as "solid solution." Gamma iron has a considerable power of holding carbon in solid solution—up to about 1·2 per cent—while in alpha iron carbon is only soluble in very minute amounts. "Soluble" as here used simply means that the metal—in this case iron—can take up a certain proportion of the other element into its own crystal structure without the formation of a second constituent or kind of crystal. Thus a carbon steel at a high temperature consists of γ iron crystals holding carbon in solid solution, while on cooling through the transformation range—if the cooling is slow—the carbon is separated. As the iron itself undergoes transformation into the α form, crystals of iron carbide (Fe_3C) are separated. This is the condition of slowly cooled or annealed steel. By very rapid cooling—chilling or quenching—the transformation can be more or less suppressed or delayed. If certain alloying elements are present, particularly chromium and nickel, the retardation of the transformation is much facilitated and if enough nickel or manganese is present the transformation may be entirely suppressed. In that case the iron retains the γ condition, the steel is non-magnetic and soft. It is in the intermediate condition, where the transformation has been retarded rather than entirely suppressed that the steel becomes hardened.

The capacity of hardening was at one time believed to be a unique property of steel but it is now known in the alloys of other metals also. It was long regarded as mysterious and controversy still turns on its theoretical explanation. Here, however, we are mainly concerned with the fact that by suitable quenching, from a temperature above the "critical range"—*i.e.,* above the temperature at which the $\gamma\,\alpha$ transformation occurs—all but the very softest steels can be more or less strongly hardened. In the high-carbon tool steels hardening is utilized to provide cutting tools, cutlery, etc. Even for these special purposes, however, where the greatest hardness is desirable, it is not possible to use the steel in the fully hardened state produced by direct quenching if that quenching has been drastic, as in water. The steel in that state is too brittle. The steel is therefore slightly heated and thereby becomes "tempered." When quench-hardened steel is gently heated, as the temperature rises the suppressed transformation gradually takes place to a slight but progressive extent. The steel is thereby rendered tougher but at the same time slightly softer. The degree of tempering applied is adjusted to suit the purpose for which the implement is required.

High Speed Steels.—In recent years special alloy steels have been introduced for machine cutting tools which render much better service than ordinary carbon steels. The action of these "high speed steels," which generally contain a considerable amount (sometimes up to 18 or 20 per cent) of tungsten, depends upon the fact that in ordinary carbon steels the hardness is rapidly reduced by rising temperature. When a tool is taking a heavy cut, its temperature rises rapidly and the amount of loading which can be applied to a tool made of carbon steel is limited by the comparatively low temperature which brings about softening. In the "high speed" steels the temperature which must be attained to cause softening is very much higher: the steels are for this reason said to possess "red hardness." They owe this valuable property to the peculiar manner in which the transformation temperatures are altered by the presence of the alloying elements.

In structural steel of lower carbon and alloy content, the purpose of heat-treatment is not to produce a material of high hardness but one possessing high tensile strength combined with reasonable ductility and good behaviour in the notched-bar impact test. For this purpose the steel is first "hardened" by quenching, but this is more frequently done in oil than in water. The subsequent tempering or "drawing" may be carried out at temperatures which usually lie between 400 and 600° C. Two serious difficulties have arisen in applying this heat-treatment particularly to larger masses of steel. Owing to their large heat content and the relative slowness with which heat flows from the interior to the exterior of a mass of steel, it is not possible to secure in the inner portions of a steel forging a rate of cooling sufficiently rapid to bring about hardening. The heat-treatment of large masses—and for this purpose pieces exceeding two inches in thickness must be regarded as "large"—thus presents grave difficulties in simple carbon and nickel steels. By the addition of suitable amounts of chromium, however, the transformations of the steel are rendered more sluggish so that even the moderately rapid rates of cooling which can be attained in large masses are sufficient to bring about hardening. Such steels can, therefore, be hardened and subsequently tempered, in relatively large masses. Here, however, the second difficulty arises. Steels of this type, especially the nickel-chromium steels, exhibit the phenomenon known as "temper brittleness" which makes itself felt most strongly under the notched-bar impact test. When such steel has been tempered to show the desired degree of high ductility, it gives very low values under the impact test. This type of brittleness can be prevented by accelerating the cooling of the steel immediately after it has been tempered. Rapid cooling, however, is difficult or impossible in large masses. Fortunately it has been discovered that the presence of a small percentage of molybdenum in the steel prevents the development of temper-brittleness even if the material is slowly cooled after tempering.

The heat-treatment of non-ferrous metals and alloys was, until quite recently, confined to simple annealing at various temperatures, for the purpose of softening metal hardened by cold working. To this must now be added forms of heat-treatment which, while they differ in detail, are closely analogous in principle to those applied to steel. The first non-ferrous alloy known to undergo hardening by heat-treatment is "duralumin," the well-known aluminium structural alloy discovered by Wilm in Germany about 1913. This alloy is treated by heating it for a short time to 480° C and then quenching it in water. Immediately after quenching, the material is quite soft—slightly softer than in the ordinary untreated condition. In the course of four or five days, however, at room temperature, or in less than an hour at about 190° C, hardening sets in. Although this hardening is not comparable in its results with that of steel, it leads to a doubling of the strength and hardness of the material—a fact which has made the alloy extremely important in practice, particularly as the age-hardening at room temperature is not accompanied by any loss of ductility.

Some years after the first discovery of duralumin, the nature of the age-hardening process was discovered independently in England and in America and subsequently it was further recognized that a similar mechanism for potential hardening might exist in many other non-ferrous alloys. As a result, a series of aluminium alloys capable of hardening by heat-treatment has made its appearance—perhaps the most important of these is the British "Y" alloy which has the valuable property that it will respond to heat-treatment in the cast state. In addition, still more recently, a number of copper alloys have been developed both in America and Germany which undergo marked hardening after quenching from suitable temperatures, but in these cases the subsequent hardening only occurs on moderate heating. The most striking example of this type of copper alloy is that containing about 3% of beryllium. The Brinell hardness of this alloy rises from 80 to 400 with a rise of tensile strength from 14 to over 90 tons per sq. inch as a result of heat-treatment.

In the whole of this wide range of non-ferrous alloys the mechanism of hardening is the same; the discovery of these alloys has, in fact, been based upon a theoretical study of their constitution. The hardening depends in every case upon the fact that the

base metal can, at a high temperature, hold in solid solution a larger proportion of the alloying element than it can hold at lower temperatures. Quenching brings down to the ordinary temperature a solid solution which is, at that temperature, heavily super-saturated. This solid solution is not hard so long as it remains in that super-saturated condition, but becomes hard as soon as break-down or transformation begins, whether at room temperature or on slight heating. There is a close analogy between these phenomena and what we believe to occur in the hardening of steel.

In regard to iron and steel, reference has been made to the "high speed" steels used for cutting tools. To these must be added two types of special alloys which furnish tools of still greater hardness and cutting power than the steels. The "stellite" type of alloy contains chromium, cobalt and tungsten. It can only be brought to the desired shape by casting, as it remains hard and non-ductile at all temperatures. The final shaping of the tool is done by grinding. The tools can be used to cut rapidly and up to higher temperatures than the steels, but are apt to break under a blow. Still harder and capable of resisting still higher temperatures are a group of substances whose most important constituent is tungsten carbide. Only thin strips or plates of these expensive substances are used as facings brazed to the front of a steel "tool" but with these tools it is possible to cut at fairly high speeds materials, such as toughened manganese steel, which resist all steel cutting tools. Even glass has—as a demonstration—been "machined" with one of these tools. The materials themselves are known under a variety of proprietary names such as "thoran," "widia," etc. Important advances have also been made in regard to steel for magnetic purposes. For permanent magnets tungsten steels are most widely used, but a Japanese discovery has shown that cobalt steels are markedly superior and these magnet steels are used where permanent magnets of minimum weight are important. The high cost of cobalt, however, sets a limit to the application of these steels. On the other hand, in the development of very soft magnetic steels, for transformer cores and for the inductive winding of submarine cables, special alloys have also been developed. Steel containing very little carbon with about 4% of silicon has a lower magnetic hysteresis loss combined with a higher electrical resistance than ordinary soft steel, and its extensive use has had wide effects in improving the economy of electric current transformers. For the sheathing of submarine cables a magnetic material having the highest possible permeability under very low magnetic fields is required. A remarkable material for this purpose is the American alloy of iron with about 79% of nickel. This alloy, known as "permalloy" and a British modification known as "mumetal" are, however, highly sensitive to slight plastic deformation and only attain their best properties after careful annealing.

The immense losses caused by corrosion have led to much research on this subject both in regard to ferrous and non-ferrous metals. The addition of small amounts of copper to steel has been found to reduce corrosion in many circumstances, but very great resistance to corrosion has been attained by the addition to steel of considerable amounts of chromium. "Stainless steel" was developed in Sheffield by Brearley; it contains about 13% of chromium and, with a moderate carbon content can be satisfactorily hardened and tempered. When properly hardened, tempered and polished, this steel resists corrosion extremely well, although there are certain conditions, such as prolonged exposure to sea-water, which cause attack. For purposes where softness and ductility are required, "stainless iron" has been developed with a very low carbon content. This is, however, being largely displaced by a type of rust-resisting steel of which "staybrite" and "anka" are typical. These contain still higher proportions of chromium than ordinary "stainless" steel, together with a high proportion of nickel. These steels retain the austenitic structure on cooling, whether fast or slow, and are thus soft, ductile and non-magnetic, but they cannot be hardened by heat-treatment and are difficult to machine. They are extremely resistant to corrosion and chemical attack of all kinds and widely applied in chemical engineering and elsewhere. The cost of these rust-resisting steels is, however, too high to allow of their use for general structural purposes so that methods of preventing or reducing corrosion in ordinary steel are still required. Apart from paints and other organic coatings, protection of steel by coating with another metal, such as zinc and tin, is widely used. Galvanized iron—really steel coated with a thin layer of zinc—is used in immense quantities. Perhaps the most striking development in protective coatings is the application of metallic chromium to this purpose. When properly deposited by electrolysis, this metal furnishes a coating of brilliant bluish-white colour which is incorrodible and untarnishable, while it is also so hard that it cannot be readily scratched. These promising properties have led to wide-spread attempts at immediate industrial application and, while some success has been attained, many difficulties and defects have been encountered. The process is therefore still in course of development but may well be expected to gain ground in the future.

In non-ferrous metals the problems of corrosion, although different, are equally important. In regard to the alloys of copper, the production of condenser tubes immune from failure by pitting still offers a problem although much important progress has been made. In regard to aluminium alloys, the corrosion problem stood for some time in the way of their wider application. The difficulty, has, however, been met by the development of protective coatings. Aluminium owes its natural resistance to corrosion to a thin transparent coating of oxide which forms on the metal immediately it is exposed to the air and to a great extent prevents further attack. As naturally formed, however, this is neither strong enough nor impervious enough to prevent corrosion under more difficult conditions, such as exposure to sea-water, etc. It has, however, been found that the natural oxide coating can be strengthened and thickened by making the metal the anode in a bath containing chromic acid or potassium bichromate and gradually raising the voltage. Aluminium and many of its alloys, when treated in this way, become very resistant to corrosion and this resistance can be further increased by saturating the "anodic oxidation" film with fatty matter such as lanoline. While the value of this process has been very fully demonstrated and recognized in England it is curious that reports upon it both from American and German sources are less satisfactory, but this is perhaps due to inadequate attention to important details.

Among further recent developments in the production and treatment of metals, the great expansion of welding operations in the jointing of steel may be mentioned. The two principal processes are oxy-acetylene and electric welding. An advanced technique for both methods has been developed and welded joints are finding increasing application. While it is admitted that the strength of steel—and especially of heat-treated steel—is locally impaired by the high temperatures applied in welding, yet the great convenience of the process and the saving in weight and labour which it allows as compared with rivetting, outweigh these disadvantages wherever satisfactory allowance for the impaired properties of the steel in the neighbourhood of the weld can be made. It must further be borne in mind that the correct basis of comparison in estimating the value of a welded joint is not the strength of the solid metal but of any alternative joint such as a rivetted seam. The most serious defect of welding is the difficulty of being sure that a given joint is sound. Reliance must be placed on the skill and conscientiousness of the workman. The examination of welds by means of X-rays is slow and costly and not entirely certain of showing up defective places. In England there is still some hesitation in using welded joints in structures exposed to severe stresses. In France the process has been very widely used even for boiler construction, but a few serious failures have occurred.

Important advances have also been made in regard to materials for use at high temperatures. The demand for these arises from the effort to improve the thermal efficiency of heat engines—stimulated by the struggle, which has been in progress for a number of years, between the steam-turbine and the internal combustion engine. The result is a demand for steels and non-ferrous alloys capable of withstanding stress and oxidation at temperatures sometimes as high as 800° C. Ordinary steel becomes too weak to be used at these temperatures, and even materials which show a reasonably high strength under an ordinary tensile test carried

out at the high temperatures have been found to fail under much lower stresses if exposed to them for a sufficiently long time. This has led to the conception of the "limiting creep stress" which is measured by determining the highest stress which the material can bear, at a constantly maintained high temperature, for long periods of time without undergoing measurable changes of length. At 800° C some of the best materials yet available commercially show a creep stress limit of little more than two tons per square inch. For so high a temperature, however, this constitutes a marked achievement and has only been attained by a few special "heat-resisting" steels and by one type of non-ferrous alloy. These steels contain relatively large proportions of nickel, chromium and tungsten, the combined presence of all three being essential. The non-ferrous alloys suitable for high temperature use consist mainly of nickel and chromium. For less extreme conditions, such as those encountered in the construction of high pressure steam boilers, turbine blading, etc., where 400° C is not likely to be exceeded in the near future, less expensive types of material are available.

See also ELECTROMETALLURGY; IRON AND STEEL; BLAST FURNACE; FURNACES, METALLURGICAL; ELECTRIC FURNACE; STEEL ALLOYS; ALLOYS; TOOL STEELS; RUSTLESS STEEL; BESSEMER STEEL; OPEN HEARTH STEEL; COPPER; ZINC; TIN; LEAD; BRASS; BRONZE; NICKEL, etc.

BIBLIOGRAPHY.—For iron and steel metallurgy, industrial as well as scientific, the *Journal of the Iron and Steel Institute*, London, should be consulted for original publications and abstracts which cover the literature of the whole world on this subject. In addition, excellent abstracts will also be found in the metallurgical section of the journal of the *Society of Chemical Industry*, and in such journals as *Stahl und Eisen*, the *Revue de Metallurgie* and *The Metallurgist* (supplement to *The Engineer*). In addition *The Iron Age, The Iron and Coal Trade Review* and similar journals may be mentioned. For general metallurgy, *see* the annual volumes of *Mineral Industry* and *The Journal of the Institution of Mining and Metallurgy*. For the non-ferrous metals, see *The Journal of the Institute of Metals* (abstracts as well as original papers), *Revue de Metallurgie* and several German journals, *Zeitschrift fur Metalkunde, Metall und Erz, Zeitschrift fur Anorganische Chemie*, and the appropriate section of the *American Institute of Mining and Metallurgical Engineers* (American Institute of Metals). The publications of the U.S. Bureau of Standards (Washington) and of the National Physical Laboratory (Teddington, England) are important. The Faraday Society (London) has published in its *Transactions* several "general discussions," including particularly one on *The Failure of Metals under Internal and Prolonged Stress*, another relating to metallurgical microscopy, one on the application of X-rays and one on *The Physical Chemistry of Steel Making*.

(W. RN.)

See besides: A. I. Hewitt, *A Century of Mining and Metallurgy in the United States* (Philadelphia, 1876); G. W. Danforth, *An Elementary Outline of Mechanical Processes* (Annapolis, 1917); C. F. Burgess and H. B. Pulsifer, *Applied Electro-chemistry and Metallurgy* (Chicago, 1920); F. H. Thorp and W. K. Lewis, *Outlines of Industrial Chemistry* (3rd ed., 1920); W. W. Scott, *Technical Methods in Analysis of Metallurgical and Allied Products* (New York, 1923); N. W. Lord and D. J. Demorest, *Metallurgical Analysis* (5th ed., 1924); S. Daniels, *Metallurgy in Aircraft Construction* (Dayton, 1925); B. Stoughton, *Engineering Metallurgy* (New York, 1926); Donald M. Liddell, editor-in-chief, *Hand-book of Non-Ferrous Metallurgy* (New York, 1926).

METALS. It is extremely difficult to find a satisfactory definition for a metal but it is probably best specified as a body which possesses many of the following properties: it is solid at ordinary temperatures; it is opaque; when polished it is a good reflector of light; it is a good, or fairly good conductor of heat and electricity; when melted and allowed to cool, it solidifies as a compact mass of crystals. These crystals are generally invisible as such to the unaided eye, but in suitably prepared specimens can be seen under the microscope (*see* METALLOGRAPHY). It is by no means true to say that every metal possesses all these properties, while many of them, *e.g.*, opacity and crystalline form, are shared with some of the non-metals, and mercury is a liquid.

Metals may be divided into two classes: elemental metals and alloys. The former are chemical elements (*q.v.*), whilst the latter are made by mixing intimately (generally by melting together) two or more elemental metals. (*See* ALLOYS.)

Metals are only rarely found native in the earth; platinum and gold are usually, and silver is frequently found thus, whilst copper and iron occasionally occur in the native state. The majority of metals, however, are found in the form of ores, which are chemical compounds of the metal with one or more elements such as oxygen, sulphur and carbon. These compounds are generally mixed with other minerals known to the miner as gangue (*see* MINING). After separating the ore from the gangue, the metal has to be obtained by breaking up the compound, either by chemical means or, more usually, by heat. Examples of the processes used will be found in the articles dealing with the individual metals.

Density.—The density of a metal is usually expressed in terms of the weight of water. Thus if a metal is three times as heavy as an equal volume of water, it is said to have a density of 3. The heaviest known materials are metals, but on the other hand some metals exist which are among the lightest of solid materials. The densest material is osmium which is 22·5 times heavier than water, whilst at the other end of the scale is lithium which is little more than half the weight of water. Among the more common metals attention may be drawn to aluminium and magnesium which have densities of 2·7 and 1·7 respectively, whilst lead, mercury, gold and platinum have densities of 11·3, 13·5, 19·3 and 21·5. (Col. 3 of the Table gives the densities of most of the known metals.)

The property of density is often used in the commercial world. Thus the high density of mercury (which is the only metal that is liquid at ordinary temperatures) renders possible the mercury barometer. The high density of lead is useful when heavy weights are required. On the other hand the low density of aluminium has given it a considerable value both in the pure state and alloyed with other metals. Its uses range from the construction of airships to manufacture of frying pans.

Colour.—The vast majority of metals are of a greyish colour, varying from the blue grey of lead to the so-called white colour of silver. There are, however, certain exceptions to this, such as gold, which is yellow, and copper, which is reddish in appearance.

The colour of a metal can be seen much better if it is viewed by means of light which has been reflected many times off its surface. Thus, the inside of a smooth gold vase appears much richer in colour than the outside.

Melting and Boiling Points.—Pure metals, being chemical elements, melt at a constant temperature. Mercury is liquid at ordinary climatic temperatures, though arctic explorers have to use spirit thermometers, as the temperature to which they may be exposed is often below that at which mercury freezes (—38·9° C). At the other end of the range we have the metal tungsten, which does not fuse until it reaches a temperature of about 3,380° C. (The temperature of the surface of the sun is calculated to be about 6,000° C.) For this reason tungsten is used in the form of fine wires for the filaments of incandescent electric lamps (Col. 5 of the Table gives the melting points of metals.) All metals will boil if the temperature is high enough. Mercury boils at a temperature of 367° C, not much above the melting point of lead, whilst tungsten is said to boil at 5,900° C.

Many metals have an appreciable vapour pressure at temperatures considerably below their boiling points—a property which is made use of in certain industrial processes. Thus it is possible to coat iron objects with zinc by placing them in a mixture of zinc dust and zinc oxide and heating to a temperature below the melting point of zinc. The zinc condenses onto the iron.

Thermal Expansion.—As the temperature of a metal is raised the metal expands. This expansion with temperature has been used for many purposes; for example, the tyres of locomotives are sometimes shrunk on to the wheels, by making the tyre slightly smaller than the wheel and expanding it by heat till it can just be forced on to the wheel. On cooling it contracts and grips firmly. In the ordinary mercury thermometer use is made of the expansion of a metal with temperature.

On the other hand, a metal with a zero coefficient of expansion would be invaluable for the construction of apparatus which must keep accurately to size, such as standards of length, pendulum rods, etc.; although no pure metal approaches this condition, an alloy of iron and nickel (known as Invar) has an extremely low

coefficient of expansion.

Thermal and Electrical Conductivity.—All metals are more or less good conductors of heat and of electricity and in the case of pure metals these properties are closely related. There is little doubt that it is impossible to raise the electrical conductivity of a metal by alloying it and consequently all the metals used for conductors in industry are as pure as is possible consistent with price and strength. The best conductor is silver, closely followed by the cheaper and much used copper, the resistances respectively being 1·62 and 1·69 microhms per centimetre cube. In a few cases, such as trolley wires for electric trams and trains, a small amount of cadmium is added to the copper, as the increase in tensile strength thus gained more than compensates for the lowering of the conductivity. Next to copper, aluminium is most widely used as a conductor; its resistivity is considerably greater, being about 2·6 microhms per cu.cm., but its low density renders it preferable in certain cases.

The resistivity of metals falls as the temperature is lowered and in the neighbourhood of absolute zero it drops enormously. It has been shown that lead at the temperature of liquid helium has a resistance only 1/1,000,000,000 of that at 0° C. If a current is started in a ring of lead at this temperature it will continue for many hours with but a small decrease in intensity. The resistivity of lead at ordinary temperatures is 22 microhms per cu.cm. (this is the highest value obtained in the more common metals), but by alloying various metals together it is possible to produce material with resistivities very many times this value. (Values for the resistivities of most of the metals are given in the Table, Col. 6.)

Magnetic Properties.—The vast majority of metals are practically non-magnetic; indeed it requires very sensitive apparatus to discover that they have any magnetic properties at all. A few, however, which are known as the ferro-magnetic elements, are strongly magnetic; these are iron, nickel and cobalt. It is, however, a remarkable fact that certain mixtures of the non-magnetic metals copper, aluminium and manganese are also magnetic.

Crystalline Habit.—Most metals crystallize in what is known as the cubic system (*see* CRYSTALLOGRAPHY). This means that the atoms, which may be regarded as the bricks out of which the metal is constructed, are so arranged as to be built up into cubes. There are three varieties of this arrangement known as the simple cube, the body-centred cube and the face-centred cube. In the first case the atoms are arranged so as to occupy the corners of a cube; in the second case there is, in addition, one atom occupying the middle of each cube; whilst the face-centred variety has, in addition to the atom at the corners of the cube, an atom in the middle of each cube face.

No metals are known to crystallize in the simple cubic form, but the majority form either body-centred or face-centred cubes. Several of the metals crystallize in the hexagonal system, which is somewhat more complicated than the cubic, whilst a few assume a tetragonal arrangement which is still more complex. If the metals are arranged in their correct place in the periodic classification (*q.v.*) it will be seen that those in the same sub-group crystallize in the same habit.

The systems in which metals crystallize are given in the Table, Col. 7. It will be noticed that some of the metals are shown as crystallizing in more than one form, so that they are spoken of as having different allotropic modifications. This means that the metal can exist in two or more forms which may differ from each other in their mechanical or physical properties as much as two completely separate metals differ (*see* ALLOTROPY). Allotropic changes in metals may not be quite as pronounced as with the non-metals, but they are often very marked and are accompanied by a change in the crystalline arrangement. Thus pure iron below 900°C is a highly magnetic material which crystallizes in the face-centred cubic form, whilst above 900°C it is non-magnetic and the atoms are arranged in a body-centred cubic "lattice." Another interesting example is to be found in tin which at ordinary temperatures is a soft ductile metal; at low temperatures, however, it changes into a grey material which breaks into a powder.

Mechanical Properties.—Among the most remarkable properties of metals is their power of resisting deformation of various kinds. This is studied under the heading of elasticity, tensile strength, hardness, ductility, etc. In most cases these properties are found to differ considerably between a single crystal of a metal and an aggregate of crystals of the same metal, showing that the crystal boundaries have an appreciable influence.

The hardness of metals—not easy to define—is usually measured either by the pressure required to force a ball or other object to a definite distance into the metal, or by the depth of scratch made in the metal by a diamond point under a given load. Of the ordinary metals of commerce lead is the softest although lithium is the softest metal of all, whereas possibly manganese is the hardest metal. Chromium was long considered to head the list, but it is now known that this hardness is mainly due to the presence of hydrogen.

Closely related to hardness is the property known as tensile strength. This is measured by finding the weight required to break, by means of a straight pull, a rod of metal of known diameter. Probably the strongest pure metal is tungsten, which

Table of Metals

1 Metal	2 Chemical symbol	3 Density	4 Coeff. of expansion	5 Melting point	6 Electrical resistivity	7 Crystalline system
Silver	Ag.	10·5	18·9	961	1·62	C f
Aluminium	Al.	2·702	23·03	660·	2·62	C f
Arsenic	As.	{5·7, 2·0}	4·7	..	35	H C
Gold	Au.	19·3	14·2	1,063	2·4	C f
Barium	Ba.	3·5	..	850	..	..
Beryllium	Be.	1·8	..	1,350	18·5	H
Bismuth	Bi.	9·8	13·3	271	115	H
Calcium	Ca.	1·5	25	810	4·6	C f
Cadmium	Cd.	8·6	29·8	321	7·5	H
Cerium	Ce.	6·9	..	640	78	C
Cobalt	Co.	8·9	12·3	1,480	9·7	H ?
Chromium	Cr.	7·1	8·2	1,615	2·6	C b
Copper	Cu.	8·92	16·6	1,083	1·69	C f
Iron	Fe.	7·9	11·7	1,535	10·0	C f C b
Mercury	Hg.	13·54	18·2	−38·9	95·8	..
Iridium	Ir.	22·4	6·5	2,350	6·0	C f
Potassium	K	0·86	83	62	7·0	C
Lithium	Li.	0·53	56	186	9·3	C
Magnesium	Mg.	1·74	25·6	651	4·5	H
Manganese	Mn.	7·2	23·0	1,244	5	C T
Molybdenum	Mo.	10·2	4	2,620	4·8	C b
Sodium	Na.	0·97	71	97·5	4·6	C
Nickel	Ni.	8·9	12·8	1,452	6·9	C f
Osmium	Os.	22·5	6·1	2,700	9·0	H
Lead	Pb.	11·34	29·1	327	21·9	C f
Palladium	Pd.	12·0	11·8	1,555	10·8	C f
Platinum	Pt.	21·45	8·9	1,755	10·5	C f
Rhodium	Rh.	12·5	8·4	1,955	5·1	C f
Antimony	Sb.	6·7	11·4	630	39	H
Selenium	Se.	{4·8, 4·5, 2·4}	37	220	1·2	T H C
Tin	Sn.	{7·3, 5·8}	20	231·8	11·4	T C
Tantalum	Ta.	16·6	7	2,850	15	C b
Tellurium	Te.	6·2	16·8	452	..	..
Thorium	Th.	11·2	..	1,845	18	C
Titanium	Ti.	4·5	..	1,800	3	C
Thallium	Tl.	11·8	28	303	18·1	T
Vanadium	V.	5·9	..	1,710	..	C b
Tungsten	W	19·3	4	3,380	5·48	C b
Zinc	Zn.	7·14	33	419·4	6	H

Notes.

Col. 3. Where there are allotropic forms, the density of each is given when possible.

Col. 4. For the expansion for 1° C, these figures must be multiplied by 10^{-6}; *e.g.*, for platinum, 0·0000089.

Col. 5. The melting point is given in degrees Centigrade.

Col. 6. The figure given is the resistance, expressed in millionths of an ohm, of a cube of the metal, each side of which is one centimetre long.

Col. 7. Crystalline system:—C = cubic, whether body- or face-centred unknown; C b = body-centred, C f = face-centred; H = hexagonal; T = tetragonal.

as drawn wire has a tensile strength of over 300kg. per sq.mm.

Many metals possess the property of ductility to a high degree, *i.e.*, when subjected to a tensile load they elongate to a very considerable extent before breaking. Use is made of this property to produce wires, the metal being first rolled into thin rods which are then drawn through holes in a steel plate, known as a die. Each hole through which the wire is drawn reduces its diameter. For very thin wires the dies are made of diamond.

Several metals can also be "extruded," *i.e.*, forced to flow through a hole by means of pressure or they can be rolled or hammered into thin sheets. Gold has been beaten into sheet only 1/3,800mm. thick, whilst, by a very special process platinum has been reduced to a wire 1/20,000mm. in diameter.

BIBLIOGRAPHY.—There are no non-technical books on metals, but these are useful to students or specialists. C. H. Desch, *Metallography;* W. Rosenhain, *Introduction to the Study of Physical Metallurgy;* S. L. Hoyt, *Metallography, Metals & Common Alloys;* F. Robin, *Traité de Metallographie;* Guillet & A. Portevin, *Précis de Metallographie.* (J. L. HA.)

METAL WORK. The processes of working metals are so varied that it has been found necessary to treat them under separate headings. Bronze and brass (*q.v.*) have been handled together, the technique being almost identical. Silversmiths' and goldsmiths' work (*q.v.*) are brought under one heading for similar reasons. Lead (*q.v.*) and pewter (*q.v.*) are handled in separate articles, giving the methods of working each metal and the history of the development of these methods. Related articles are: ARMS AND ARMOUR; ENAMELS; SCULPTURE TECHNIQUE; *Casting and Finishing,* and *Patina.* Discussions of the theory of metalwork technique will be found under TECHNIQUE IN ART and IRON IN ART: *Modern Theory.*

METAMORPHISM, in petrology, denotes the sum of the processes effecting fundamental alterations in composition, mineral or chemical, structural or textural in solid rock masses, the alterations determining completely the character of the rock mass.

The term (from Gr. μετὰ, change of, and μορφή, shape) is now very generally used to exclude those alterations of decomposition, disintegration and cementation taking place in the upper parts of the lithosphere under the influence of the atmosphere and surface waters (weathering, cementation). *See* METASOMATISM and PNEUMATOLYSIS. Metamorphic rock types treated separately include QUARTZITE, SLATE, PHYLLITE, SCHIST (including MICA-SCHIST) and GNEISS (in part)—also AMPHIBOLITE, ECLOGITE (in part), EPIDIORITE, EPIDOSITE, GRANULITE, HORNFELS, MARBLE, MYLONITE and the SCAPOLITE rocks. The original materials upon which metamorphic processes have operated are either sediments, igneous rocks or mixtures of these (as tuffs and other pyroclastic aggregates). Rocks may, however, be subjected to more than one epoch of metamorphism. Such rocks have been termed polymetamorphosed rocks, and the process *polymetamorphism.* Metamorphic rocks are thus to be regarded as a group of rocks of coordinate importance with sedimentary and with igneous rocks; they are formed in the wide temperature and pressure region existing between the region of formation of sedimentary rocks (low temperature, low pressure), and that of igneous rocks (high temperature sometimes accompanied by high pressures).

According as metamorphism takes place without appreciable change in chemical composition, or with addition or exchange of material, two types of metamorphic rock may be broadly distinguished, viz., (*a*) products of *normal* metamorphism, in which the chemical composition remains unchanged except for loss of such volatile constituents as water or carbon dioxide, and (*b*) products of *metasomatic* metamorphism, where fundamental changes are brought about by the introduction of new materials. In normal metamorphism, the chemical analysis of the rock is usually sufficient to determine its origin.

Sandstones yield quartzites and quartz schists, limestones are converted into marbles, shales into mica-schists, without their bulk composition being greatly modified. The simple loss of water or carbon dioxide, as in the conversion of a calcareous sandstone into a rock composed of wollastonite ($CaSiO_3$) is not usually considered a case of metasomatic metamorphism. Metasomatism, in its relation to metamorphism, implies addition of new material, which reacts with the original components of the rock. The formation of skarn rocks from carbonate sediments, whereby iron compounds from magmatic sources react with carbonate to form andradite- and hedenbergite-bearing rocks, is a case of metasomatic metamorphism. Except in the vicinity of igneous intrusions, metamorphism is accomplished without significant change in composition.

Differences of metamorphism can be distinguished, viz., (*a*) *contact* or *thermal* metamorphism, in which the chief factor is temperature. It embraces all those processes which operate on solid rock under the influence of magmatic heat, and from its localized occurrence around igneous intrusions is sometimes referred to as *local* metamorphism; (*b*) *load* metamorphism (Ger. *Belastungsmetamorphose*), affecting rock masses buried deep within the crust. The operating factors are pressure due to the weight of superincumbent material and temperature appropriate to the depth. This type is frequently referred to as *geothermal* metamorphism; and (*c*) *dynamo-thermal* metamorphism, in which the operating factors are stress, uniform pressure and temperature in varying degree.

Contact or Thermal Metamorphism.—Any kind of rock—igneous or sedimentary—which has come into contact with molten magma, is likely to show alteration of this type. Heat is the principal agent of metamorphism and is conveyed from the magma principally by the process of conduction. Other factors, however, are important. Volatile materials, principally water, pass into the surrounding rocks from the magma and assist in the processes of solution and reaction. The medium in which the operative processes take place is the interstitial liquid occupying the capillary pores and fissures in the rocks. A rise in temperature facilitates diffusion and reaction. Chemical reactions which proceed at an infinitesimal rate at low temperatures are enormously accelerated by rise of temperature, a rise of 100° C being sufficient in many cases to increase the rate of reaction a thousandfold. The net result of these processes is eventually a recrystallization of the whole rock, which is now built up of a mineral assemblage adjusted to, or approaching adjustment to, the new temperature conditions. The extent and intensity of the alteration effected depends chiefly on two factors—(*a*) the nature of the rock, and (*b*) the magnitude of the igneous mass.

A great granite batholith, which may be many miles in diameter, is often surrounded by a wide aureole of contact alteration, varying from a few hundred yards to two miles in breadth. This variation may have structural causes dependent on the underground contour of the intrusion.

Crystalline schists which are already recrystallized may show little sign of alteration, or are affected only at the immediate contact, and the same remark applies to fresh igneous rocks which have consolidated at high temperatures. If, however, they have been subject to alteration by weathering, or contain amygdales filled with hydrated minerals such as zeolites, chlorite, etc., fundamental changes may be produced. The altered rocks of such aureoles are known as hornfelses (*q.v.*), and are typically fine-grained compact rocks devoid of fissility and cleavage. Argillaceous sediments give rise to dark lustrous hornfelses full of minute scales of red-brown biotite and cordierite, limestones to marbles; impure limestones become grey, yellow or green calc-silicate hornfelses rich in diopside, grossular garnet, wollastonite and vesuvianite; while dolerites, basalts and andesites are transformed into dark granular hornfelses with a large development of new pyroxene, hornblende, biotite and recrystallized felspar. Cherts, flints and fine sandstones are converted into quartzites, consisting of small close-fitting grains of quartz.

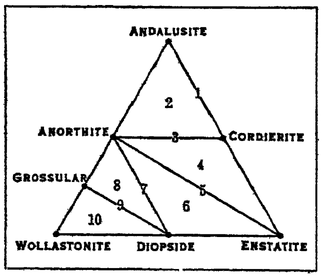
The progressive changes that take place in an aureole may be determined by studying the effects observed at the outer edge of the aureole, and tracing these changes inwards to the contact. Argillaceous rocks are very suitable for this purpose on account of their common occurrence and homogeneity. In most aureoles the first signs of alterations in shales or slates is seen in an induration or hardening of the rock, accompanied by the development of minute spots, which consist either of new-formed minerals or a new distribution of minerals. Considerable alteration may be

effected without deleting other structures. Fossils may be in part preserved and are not destroyed till the whole rock has been recrystallized. This variation in the nature of the incipient changes is probably to be ascribed to the mineralogical nature of the argillaceous rocks themselves. All shales and slates are built up of varying amounts of quartz, sericite, chlorite, iron oxides, kaolin or other hydrated aluminium silicates. Where the last named minerals are abundant, an early formation of andalusite and cordierite is to be expected. Where they are scarce or absent, the first signs of change are seen in the rearrangement of the original minerals or the development of new-formed biotite.

Regarding a metamorphic rock as a mineral assemblage formed within a given temperature and pressure range, it is clear from physico-chemical principles that the number of co-existing mineral phases in equilibrium must be limited by the number of components. It is to the completely recrystallized products of the hornfels zone that the phase rule of Willard Gibbs may be applied. The measure of success obtained by its application to metamorphic mineral assemblages, and so the utility of an ideal classification of metamorphic rocks developed with its aid, are largely dependent on the approach towards equilibrium of the final products. Actual experience, indeed, has afforded a very considerable degree of confirmation of the results to be expected.

Briefly, the phase rule states that the number of phases plus the number of degrees of freedom exceeds the number of components by 2, $p+f=c+2$. For example: if one takes into consideration a three-component system, five solid phases can at most co-exist. Under such conditions both temperature and pressure are fixed. Metamorphic processes, however, take place over a range of temperatures and pressures, and the random conditions attendant upon particular examples of metamorphism imply a divariant system, so that the maximum number of solid phases in a three component system will not exceed three. As expressed by Goldschmidt, the phase rule applied to mineralogical systems can be stated as "the maximum number of solid minerals that can co-exist in stable equilibrium is equal to the number of individual components that are contained in the minerals if the singular temperatures of transition points are excluded." This important rule has been a very useful guide in the study and classification of metamorphic rocks, and it will be of interest to note its application to some simplified rock systems.

Consider the system built up of the four components—CaO, MgO, Al_2O_3, SiO_2. Apart from their polymorphic modifications the number of possible minerals constituted of these oxides or their combinations approximate 20. The phase rule simply states that the maximum number of phases found together is limited at equilibrium, but gives no information as to the particular mineral associations. In the case before us, the maximum number is four. This system is of great importance in metamorphic petrology, for the group of sediments ranging from pure shales to limestones is largely constituted of these four oxides. A study of the hornfelses derived from shale-limestone sediments shows that a number of well defined assemblages can be recognized as constantly recurring types. Pure shales give rise to andalusite-cordierite hornfelses, certain marls to diopside-plagioclase hornfelses, etc. Apart from the alkali minerals, orthoclase, albite and biotite, limefree shale hornfelses have the composition andalusite-cordierite-quartz, a three phase assemblage built up of three components (MgO, Al_2O_3,SiO_2). If now, to this system lime is added, a fourth phase enters, namely, anorthite, and we have the combination andalusite-anorthite-cordierite-quartz. By successive increments of lime a series of mineralogical combinations can be derived which correspond to the hornfelses formed from the continuous shale-limestone series of sediments. As first recognized from the aureoles of the Devonian intrusions of the Oslo region, these mineral assemblages are as follows, quartz and orthoclase being possible phases in all:—

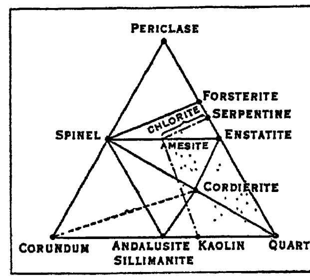


FROM THE "GEOLOGICAL MAGAZINE"

FIG. 1

1. Andalusite cordierite albite (biotite)
2. Andalusite cordierite plagioclase (biotite)
3. Andalusite cordierite plagioclase (biotite)
4. Andalusite cordierite plagioclase (biotite) enstatite
5. Andalusite cordierite plagioclase (biotite) enstatite
6. Andalusite cordierite plagioclase (biotite) enstatite, diopside
7. Andalusite cordierite plagioclase (biotite) enstatite, diopside
8. Andalusite cordierite plagioclase (biotite) enstatite, diopside grossular
9. Andalusite cordierite plagioclase (biotite) enstatite, diopside grossular
10. Andalusite cordierite plagioclase (biotite) enstatite, diopside grossular wollastonite.

The composition of these assemblages may be represented in a triangular diagram. Such a diagram (fig. 1) represents the quartz-bearing hornfelses of the four-component system lime-magnesia-alumina-silica. Each of the classes is represented by the numerals within or on the sides of the triangles, any point representing a mineral assemblage composed of the minerals represented at the apices of the individual triangles. In a similar way fig. 2 represents the three-phase mineral assemblages of the three-component system $MgO-Al_2O_3-SiO_2$. The various associations are characteristic of thermally altered sediments, periclase-spinel-forsterite, of metamorphosed dolomites and the remainder (with the exception of the assemblage forsterite-enstatite-spinel) of argillaceous sediments, those rich in enstatite corresponding to magnesia-rich types, those rich in corundum or spinel to silica-poor types. The dotted area represents the bulk compositions of shales whose constituent minerals are indicated by the points for quartz, kaolin and chlorite. The foregoing assemblages are characteristic of the highest grades of thermal metamorphism and are presumably those stable at the highest temperatures to which the rocks are subjected. Other components such as H_2O, Na_2O, Cl, B, F, introduce new phases such as biotite, orthoclase, and albite among argillaceous sediments, scapolite, vesuvianite, chondrodite and axinite among carbonate rocks. That we are able to study at ordinary temperatures such systems formed at high temperatures, naturally implies that a great lag effect accompanies the cooling of the rock. Reactions of adjustment to the conditions of lower temperature are, however, by no means altogether absent. The process of retrograde metamorphism is known as *diaphthoresis*. In contact aureoles it is commonly seen in the conversion of diopside or augite to tremolite or hornblende and the formation of epidote or clinozoisite from anorthite. Hornfelses bearing amphibole in place of pyroxene are also commonly met with in the outer portions of contact aureoles. Clearly, here the amphibole is developed under the conditions of lower temperature. On the other hand, certain assemblages are characteristic of the highest temperatures. They are commonly met with as inclusions or xenoliths in the igneous mass itself or at the immediate contact. Mullite ($3Al_2O_3{\cdot}2SiO_2$) appears in place of sillimanite as in buchites, sanidine in place of orthoclase tridymite, or cristobalite in place of quartz, and the combination wollastonite-anorthite in place of grossular garnet. Such high temperature assemblages are known as *pyrometamorphic* rocks. An intense metasomatic action often accompanies the formation of such rocks. They are typically represented in the xenolithic assemblages of volcanic centres such as the Eifel, Vesuvius, etc.



FROM THE "GEOLOGICAL MAGAZINE"

FIG. 2

Load Metamorphism.—The metamorphism incident upon the deep burial of rocks in geosynclines, where the operating factors are vertical stress due to the weight of superincumbent material, and the temperature appropriate to the depth, is referred to as *load* metamorphism or *static* metamorphism, in contrast to *dynamic* metamorphism, in which tangential stresses are operative.

The geothermic gradient may be taken as 3° C for every 100 metres of covering strata. Consider a series of strata accumulated

to a depth of 13,000 metres; the temperature at the base would approximate 400° and the pressure 3,500 atmospheres. Some geologists, as Milch, Dawson, Daly and others, have attributed great powers of metamorphism to geothermal agencies of this kind and the common parallelism between stratification and schistosity seen in some terranes is attributed to superincumbent load. Oceanic salt deposits undoubtedly have suffered profound metamorphism in this way, for they contain hydrated minerals which are stable only over a narrow temperature and pressure interval. For silicate rocks, however, a very great cover of sediment would be necessary to induce reaction and recrystallization, principally for the reason that such reactions proceed with great tardiness at these temperatures and pressures; indeed, clear evidence that deep burial is insufficient to produce notable metamorphic effects in detrital sediments is provided in the great Palaeozoic geosynclines where the underlying strata can be studied in an almost unaltered condition.

The metamorphism of salt deposits is beyond the scope of this article, but reference may be made to E. Jänecke, *Die Entstehung der deutschen Kalisalzlager* (1915), and F. Rinne, *Die geothermische Metamorphosen und die Dislokationen der deutschen Kalisalzlagerstätten. Fortschritte der Mineralogie* . . . vol. vi. (1920), where the subject is discussed at length.

Dynamo-thermal Metamorphism.—Unlike contact metamorphism, *dynamo-thermal* or *regional* metamorphism is not directly connected with the intrusion of igneous magma. While the breadth of a contact zone seldom exceeds 2 m. the effects of regional metamorphism may be traced over hundreds or thousands of square miles.

Metamorphic rocks of this type constitute the greater part of continental shields (Fennoscandia, North America, West Australia, etc.). Where such rocks occur there is generally much evidence of earth movement, accompanied by crushing and folding. They are very characteristic of the central axes of great mountain chains, especially when these have been denuded and their deeper cores exposed. Most geologists believe that this connection is causal, holding that the contraction of the outer layers of the earth's crust, due to shrinkage of the outer shell upon a cooling and contracting interior, has bent and folded the rocks, and at the same time has crushed and largely recrystallized them.

In extreme cases where dynamic action is localized, the ultimate stage of intense crushing and pulverization is the production of flinty crush rocks or pseudotachylytes, in which mylonization is accompanied by an incipient fusion of the rock mass, due to the generation of great heat by friction. Analogous effects are sometimes obtained in rock drills, where the cores are found to contain slag-like masses, produced by the heat of friction. In these cases it is shown that the temperature attained may approximate 1,100° C, sufficient to fuse arkoses or felspathic sandstones. Flinty crush rocks have now been recognized from a number of areas from the north-west Highlands of Scotland, the Outer Hebrides, and the Vredefort area of the Southern Transvaal. The trap shotten gneisses of southern India are similar rocks. In Eriskay and South Uist (Outer Hebrides), the flinty crush rocks are extensively developed along great thrust planes in the Archaean gneiss, while in the Vredefort area rocks of this character occur on a grander scale than elsewhere.

In areas of regional metamorphism, whole complexes consisting of intermixed sediments, tuffs and igneous extrusions and intrusions may be converted into a great series of schists and gneisses. Although recrystallization may be complete the original masses still retain their identity in their new state, though their structural relations may be rendered excessively complex by intense folding and overthrusting. The effects of stress in regionally metamorphosed rocks are revealed in their foliated or schistose textures. This consists in a definite arrangement of the minerals, so that such as are platy, prismatic or fibrous (*e.g.*, mica hornblende or sillimanite) have their longest axes arranged parallel to one another. For that reason many of these rocks split readily in one direction. Contortion or crumpling of the foliation is by no means uncommon, and the splitting faces are then undulose or puckered. Recrystallization under the influence of stress gives rise to the very characteristic *crystallization-schistosity*. On solid minerals at low temperatures the effects of stress are seen in crushing and shearing, and the development of glide planes or secondary twinning (as seen in calcite, diallage, kyanite, etc.), but at higher temperatures in the presence of interstitial liquid such as pervades all rocks, the most important effect is the raising of the solubility of the material stressed. Wherever an appropriate stress is reached, material is dissolved at the points of greatest stress, and redeposited at points where the stress is less. This principle (sometimes referred to as Riecke's principle) is obviously of fundamental importance in explaining the foliated textures of crystalline schists. Not only so, the material dissolved is capable of reaction and may be redeposited as new minerals. Stress thus facilitates chemical reactions and may be considered as a kind of catalyst, promoting reactions but also having influence on the nature of the products formed. Stress may thus influence fundamentally the stability range of a given compound; on the one hand, the range may be extended or contracted; on the other, reactions which can proceed only very slowly under uniform pressure may be greatly facilitated under stress. The possibility that thereby *new* phases may be precipitated in stressed systems while others are totally excluded is now to be envisaged. It is consequently not surprising that we find among the minerals of crystalline schists types which are unknown amongst contact rocks or are not synthesized in ordinary melts at uniform pressure. Minerals such as kyanite, chloritoid, lawsonite, glaucophane and staurolite are almost wholly restricted to stressed rocks, and are conveniently styled stress minerals. On the other hand, minerals such as orthoclase anorthite, andalusite and olivine are restricted to systems formed under uniform pressures and are referred to as *anti-stress* minerals. In contradistinction to thermal metamorphism, where many of the minerals are characteristically anhydrous, the lower grades of regional metamorphism are characterized by the hydroxyl-containing minerals like sericite, chlorite, some amphiboles, and the epidote-zoisite group.

The effects of stress on reactions accompanied by a gas or vapour phase are very great. The mere grinding of calcium carbonate in a mortar leads to the evolution of some carbon dioxide. Reactions which are inappreciable in the absence of stress may thus be greatly facilitated by application of stress. The reaction $CaCO_3 + SiO_2 \rightleftarrows CaSiO_3 + CO_2$ is an important one in rock metamorphism. Under high uniform pressure the left side of the equation represents the stable assemblage, and calcite and quartz are found together. On the other hand, at high temperatures the reaction proceeds with the formation of wollastonite. The approximate equilibrium curve for this reaction has been calculated on the basis of the Nernst heat theorem. From the standpoint of the phase rule, a mixture of calcium carbonate and silica represents a three-component system and therefore under the conditions of metamorphism only three phases are possible. Below the transformation curve the possible three phase assemblages are $SiO_2 - CaCO_3 - CO_2$ and $SiO_2 - CaCO_3 - CaSiO_3$. Above the transformation curve the assemblages are $CaSiO_3 - CaCO_3 - CO_2$ and $CaSiO_3 - SiO_2 - CO_2$ (fig. 3). The occurrence together of calcite and quartz might therefore be used to indicate that the rock assemblage had not been heated above the transformation temperature, and in this way the mineral constitution of such a rock might be used as a geological thermometer. The effects of shearing stress are of a different order if the vapour phase is allowed to escape, for the reaction is driven in one definite direction leading to the production of wollastonite. In the choice of transition points adapted for the purposes of a geological thermometer it is clear that much care is necessary and the conditions of metamorphism realized.

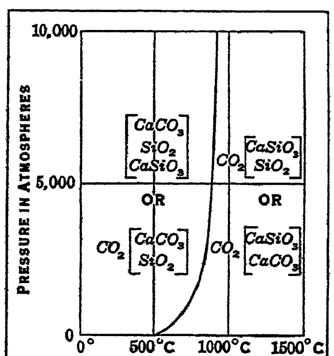


FIG. 3

The effects of temperature on reversible reactions are usually of a different order of magnitude from those of pressure. A large increase of pressure may be less effective in displacing equilibrium than a small increase of temperature. Nevertheless the effects of pressure are by no means negligible. In such reactions increase of pressure tends to displace the equilibrium in the direction in which the reaction is accompanied by decrease of volume. Thus, in a reacting system, high pressure favours the production of phases of greater density. This well known law of Le Chatelier (1885) was first applied to metamorphic processes by Lepsius (1893), but its importance was first clearly enunciated by Becke, whence it is frequently referred to as Becke's volume law. The knowledge of the specific volumes of minerals is largely gleaned from observations at ordinary temperatures, and under the conditions of reaction the change in volume is not necessarily the same in magnitude, nor even in sign; moreover some of the reactions to which the law is applied are not definitely known to be reversible. Its application to mineralogical systems requires the exercise of considerable caution. Undoubtedly it is in the rocks of higher grades of metamorphism where enormous pressures are involved that the volume law is operative. Such minerals as jadeite, pyrope, almandine, grossular, kyanite and staurolite are dense minerals represented only in rocks formed at high pressures, and arise under the operation of the volume law. The combination wollastonite-anorthite appearing in limestone xenoliths at volcanic centres, under the conditions of contact metamorphism or deep-seated alteration, appears as a grossular-quartz assemblage:

$$2CaSiO_3+CaAl_2Si_2O_8 \rightleftarrows Ca_3Al_2(SiO_4)_3+SiO_2.$$

In dry melts, a system of the bulk composition of grossular consolidates as a mixture of the phases anorthite, wollastonite and gehlenite. Regarded as a reversible action:

$$\underset{\text{Grossular}}{2Ca_3Al_2(SiO_4)_3} \leftrightarrows \underset{\text{anorthite}}{CaAl_2Si_2O_8}+\underset{\text{gehlenite}}{Ca_2Al_2SiO_7}+\underset{\text{wollastonite}}{3CaSiO_3}$$

the formation of grossular is accompanied by a large decrease of volume. The sum of the molecular volumes of the phases of the right hand side of the equation is 310, the molecular volume of grossular 260. Clearly, pressure favours the formation of the garnet mineral.

Again glaucophane or jadeite appears in place of nepheline and albite under high pressure:

$$\underbrace{NaAlSiO_4+NaAlSi_3O_8}_{\text{molec. vol.}=156} \rightleftarrows \underbrace{2NaAlSi_2O_6}_{\text{molec. vol.}=123.}$$

Similarly, olivine and anorthite are represented by garnet:

$$Mg_2SiO_4+CaAl_2Si_2O_8 \rightleftarrows CaMg_2Al_2(SiO_4)_3,$$

the formation of garnet being accompanied by a diminution in volume of 17%.

In the more deep-seated regions metamorphism is effected under the influence of widespread magmatic activity. An intimate commingling of igneous and metamorphic rock is therefore characteristic of these regions. Injection gneisses are produced by the *lit par lit* intrusion of igneous magma between the foliation planes of metamorphic rocks. The process is not always limited to a mechanical injection of material, but may be accompanied by an intense metasomatic action, in which solutions emanating from the magma react with the country rock to produce metasomatic schists and gneisses.

Recrystallization processes in metamorphic rocks take place in an essentially solid environment, and in distinction from igneous rocks no definite sequence or order of separation of crystals is to be traced. The characteristic structures and textures of metamorphic rocks have, therefore, a distinct significance. The term "structure" is used to express the genetic relationship of the component minerals, while "texture" refers more explicitly to their stereometric arrangement. The typical structure produced by the growth of crystals in a solid environment is known as the *crystalloblastic structure* (Gr. *βλαστάνειν*, to sprout). Since each grain grows in intimate contact with its neighbours, the form-development of the individual crystals tends in general to be poor. Rounded crystals are thus very common. Different minerals, however, possess varying crystallization force, and some are able to assert their proper crystalline form against the resistance of their solid environment. The experiments of Becke and Day on the growth of crystals of alum under load, show that the force of crystallization may be very great, and indicate that the internal stresses set up during growth are of the same order of magnitude as the crushing strength of crystals themselves, and, indeed, as the forces brought into play during orogenic movements.

For the common metamorphic minerals the series is as follows: Titanite, rutile, hematite, ilmenite, garnet, tourmaline, staurolite, kyanite, epidote, zoisite, pyroxene, hornblende, dolomite, albite, mica, chlorite, talc-calcite-quartz, plagioclase, orthoclase, microcline. In general, this order is one of increasing molecular volume and decreasing density. Any particular member of this series is able to assert its own crystal form against that of any other member following it in the series. Where crystal form is developed, only facies with simple crystallographic indices are developed, and these are commonly cleavage facies. Hornblendes have prominent development of (110) faces, garnet (110), kyanite (100) and (010). Crystals showing a well developed form are known as *idioblasts,* and those characterized by absence of crystal form—*xenoblasts.* Where the stresses developed by the growth of crystals in a solid rock are not offset by stresses imposed from without, being in random directions they tend to be neutralized by mutual compensation. The directionless hornfels structure of contact rocks is produced in this way, but the various schistose and foliated structures are the result of the imposition of shearing stress from without by which the internal stresses are reduced.

It is to be expected, therefore, that those minerals which occur as idioblasts in metamorphic rocks are members high in the crystalloblastic series—as rutile, garnet, etc. They are known as strong minerals, in contradistinction to weak minerals, such as quartz and the potash felspars. The structures given by inclusions, relative form, development and size of crystals, have thus no direct analogy with the apparently similar features observed in igneous rocks. Whereas, in the latter, inclusions are older and tend to have better crystal shape than their host, in metamorphic rocks both host and inclusion may be developed simultaneously, and not infrequently inclusions are xenoblastic and the host idioblastic. The porphyritic crystals of igneous rocks are an early generation, but in metamorphic rocks the corresponding large crystals are pseudo-porphyritic. They are known as *porphyroblasts.* Frequently they are strong minerals, as garnet, ilmenite, hornblende, etc., and though formed at the same time as the ground mass minerals, they are not infrequently aligned across the common schistosity or foliation planes. Many porphyroblasts are characterized by multiple twinning (kyanite, chloritoid, cordierite), or show the typical sieve structure, being crowded with the ground-mass constituents (cordierite, chloritoid, staurolite, chiastolite); again, many of them are unrepresented among the ground-mass minerals. The large size of porphyroblasts is, doubtless, in large measure to be accounted for by their relatively greater crystallization force and crystallization velocity. Indeed, it is not improbable that many of them grow rapidly from supersaturated solutions; their twinning inclusions and orientation point to rapid growth. While for the elements of the ground-mass, nuclei are usually originally present, with porphyroblasts it is frequently otherwise; garnet, staurolite and chloritoid are new phases developing in a medium free from the crystal nuclei of these minerals. In the absence of the latter, spontaneous crystallization from supersaturated solutions is rendered possible. In the highest grades of metamorphism porphyroblast structure is less in evidence than in medium grades, owing to a tendency towards equalization of the size maxima of different minerals under very high temperatures and pressures. At the same time sieve structures tend to be abolished. Where the structures of the original rocks are incompletely effaced during metamorphism, they are known as relict or palimpsest structures. Some amphibolites may thus preserve the porphyritic or ophitic structures of the dolerites from which they are derived, conglomerate-schists or quartzites the psephitic or psammitic structures of sediments. These relict features are usually referred to by prefixing the term

"blasto" to the specific structure, as blastophitic, blastopsephitic, etc.

CLASSIFICATION OF METAMORPHIC ROCKS

Metamorphism being the response to change of condition in respect of temperature and pressure, the diversity in mineral composition of metamorphic rocks can be regarded as the resultant of two independent variables, viz., (*a*) the ultimate composition of the rocks, and (*b*) the physical conditions operating during metamorphism. These two variables may well form the basis of a classification of the products of metamorphism.

In Grubenmann's well known classification of the crystalline schists these two variables occupy the dominant positions, and are the foundation upon which the classification is erected. The composition variable is expressed in the 12 groups recognized, six of which correspond to sedimentary types, these being the shales, sandstones, limestones, marls and the weathering residuals represented by laterites and bauxites, and six corresponding to igneous rocks, granites, diorites, gabbros, ultrabasic and alkali rocks, the latter including the syenites, nepheline syenites, theralites, lamprophyres, etc. The physical factors of pressure and temperature are recognized as a threefold division into zones, *epi, meso* and *kata.* In a general way the factors temperature and pressure are a function of depth and the divisions *epi, meso* and *kata* thus correspond to bathymetric zones, each with its distinctive types of mineral paragenesis.

In the uppermost or epi zone, temperatures are low, hydrostatic pressure is low, while shearing stress may be high. The mineral products of this zone are those rich in H_2O, OH or H, and are characteristically those of low density, such as chlorite, zoisite, sericite, hornblende, chloritoid, etc.

The rock products are those of mechanical deformation with little recrystallization, cataclastic rocks of all types and the rocks of a low grade metamorphism such as phyllites, chlorite and talc schist, epidote schists, etc. In the second or meso zone the temperatures are higher, while stress probably reaches the maximum value. Owing to the increase of temperature the imposition of shearing stress results in recrystallization without mechanical rupture. Hydroxyl-containing minerals are now less prominent. The type minerals are kyanite, staurolite, almandine, anthophyllite, muscovite, biotite, etc., while the assemblages appear in such rocks as biotite, garnet, staurolite, kyanite and actinolite schists, marbles and quartzites. In the deepest, or kata zone, the high stress of the meso zone under the influence of the very high temperature, is replaced by high uniform pressure. Reactions take place pre-eminently in response to the volume law leading to the generation of anhydrous minerals of high density. Pyroxenes, olivine, pyrope, sillimanite, spinel, anorthite, jadeite, potash felspar, etc., are the type minerals, while the resulting rocks are gneisses, granulites, eclogites, etc., characterized by these minerals.

It is not to be concluded that natural assemblages can be fitted into such a simple scheme without serious difficulties. The factors of temperature and pressure are not dependent simply on depth below the surface, but may be subject to wide variation locally. These physical factors include among themselves at least two independent variables: the intrusion of igneous magma brings into play the factor of high temperature without the incidence of pressure and local intense orogenic movement, the factor of high stress without necessarily the incidence of temperature. Thus in this system we find no well-defined place for assemblages of contact metamorphic origin. The range of possibilities thus opened up is, however, to a large extent diminished by the fact that the maximum value of shearing stress is a function of the temperature, and the possible range of stress is therefore decreased as the temperature rises. Where metamorphism is of the regional type, it may be expected that stresses are maintained close to their maximum value, and to this degree the changes effected are in response to a single variable. The ease with which the rock assemblages originating under higher temperatures can be fitted into the meso and kata zones, finds its explanation in this dependent relationship between maximum stress and temperature. In rocks of the epi zone, the great variety of rock products is a direct reflection of the widely variable stress maxima of different materials. The peripheral areas of a mountain tract that has undergone metamorphism are usually of a low grade of metamorphism, and as zones of weakness are prone to be cut off from observation by subsequent dislocation, or covered by the overlap of later sediments. Frequently, therefore, the metamorphism over a wide tract may be of nearly uniform (but high) intensity. In some areas of regional metamorphism, however, these marginal zones are preserved for observation, and a continuous passage from unaltered sediments to schists and gneisses of high metamorphic grade can be traced.

Such areas are of paramount importance in metamorphic studies, for the gradational changes in structure, texture and mineral composition which their rocks spatially display are the resultant of the imposition of continuously varying temperatures and pressures. Two such model metamorphic regions are the Highlands of Scotland and the Caledonian mountain chain of southern Norway.

The detailed examination of such regions reveals a progression of metamorphism in which—selecting one particular sedimentary type—a series of zones can be mapped out according to the entry of new-formed metamorphic minerals. Successive zones are thus characterized by special index minerals. Study along these lines was first carried out by Barrow (1893) in the south-east highlands of Scotland. Argillaceous rocks, owing to their ubiquity, are the foremost types in which such zones can be recognized. In them, successive zones of increasing metamorphism are characterized by the index minerals, chlorite, biotite, almandine, staurolite, kyanite and sillimanite. The boundary surfaces of these zones are at once isothermals and isodynamics, and as referred to the grade of metamorphism imposed, their intersections with the earth's surface have been termed *isograds.* Other sediments show corresponding zones, limestones for example have as index, minerals, zoisite, tremolite, diopside and wollastonite.

A complete study of such a metamorphic region would include the laying down upon the map of all the zones distinguishable among the varied sediments, and it is clear that from studies of this kind the data for the development of an ideal classification should be realized. In place of the three depth zones of Grubenmann's classification, we should recognize many zones. In this sense the *facies* classification suggested by Eskola is a refinement of the existing classificatory scheme. A facies is defined to designate a group of rocks characterized by a definite set of minerals which, under the conditions obtaining during their formation, were in perfect equilibrium with each other. The quantitative and qualitative mineral composition in the rocks of a given facies varies gradually in correspondence with variation in the chemical composition of the rocks. The number of facies expresses the variable physical environment under which rocks have been formed and any given facies may include assemblages (isofaciel) of widely different bulk composition. A distinctive facies is the hornfels facies characteristic of the inner zones of thermal aureoles. Other facies are recognized by the name of some important constituent assemblage, as green schist, amphibolite, eclogite or sanidinite facies. The number of facies is not limited by *a priori* considerations, and may be increased as advancement of knowledge may require. The elucidation of the different zones in a region of progressive metamorphism is clearly a first step towards the determination of the facies of metamorphic rocks, and thus a guide—apart altogether from experimental study—to the goal of deeper understanding of metamorphic processes.

BIBLIOGRAPHY.—The subject of metamorphism is treated in most elementary text books of petrology. (*See* PETROLOGY: *Bibliography.*) The principal detailed treatises are C. R. Van Hise, *A Treatise on Metamorphism,* Monograph U.S. Geol. Survey, No. 47 (1904); U. Grubenmann, *Die Kristallinen Schiefer* (2nd ed., 1910); C. K. Leith and W. J. Mead, *Metamorphic Geology* (1915). The more recent advances are incorporated in U. Grubenmann and P. Niggli, *Die Gesteinsmetamorphose,* vol. i. (1924). Reference may also be made to R. A. Daly, "Metamorphism and its Phases," *Bull. Geol. Soc., America,* vol. xxviii. (1917); A. Harker, *Presid. Address Geol. Soc., London,* vol. lxxiv. (1918). On the classification of metamorphic rocks *see* U. Grubenmann, *Fortschritte der Mineralogie . . .,* vol. iii. (1913); P. Eskola, "The Mineral Facies of Rocks," *Norsk. Geol. Tidskr.* vol. vi. (1920). On the structure and texture of metamorphic rocks *see* especially F. Becke, "Mineralbestand und Struktur der

Kristallinen Schiefer," *Denkschrift d. Wiener Akad. d. Wiss.* (1903); and for a summary of the more recent advances, F. Becke, *Struktur und Klüftung, Fortschritte der Mineralogie . . .*, vol. ix. (1924).

(C. E. T.)

METAMORPHOSIS, a Greek word meaning change of shape, is applied in zoology. (*See* INVERTEBRATE EMBRYOLOGY.) All animals begin their existence as undifferentiated cells and attain their characteristic features by growth which entails changes of shape. If we were to magnify the model of a baby to the size of a man we should discover how striking are the changes in the proportions of the human figure as manhood is attained and yet these changes are not regarded as metamorphosis. The best definition of metamorphosis is "a conspicuous change in shape and mode of life in an animal occurring in a comparatively short time without any increase in size or even with a decrease in size." In the common English frog, the tadpole stage lasts from two to four months, during which the animal increases very much in size but retains the same general appearance and proportions. The rudiments of the hind limbs gradually increase in length whilst the fore-limbs break through the skin of the breast region. The creature then ceases to feed and begins to crawl out of the water, though it remains within reach and takes to it if alarmed. In about four days the tail is reduced to a vestige and finally disappears and the young frog takes up land life. The froglet is smaller than the completely grown tadpole and requires four years to attain sexual ripeness and full size.

In the development of the butterfly, the caterpillar, like the tadpole, requires about two months to grow to full size. Then in a day or so it constructs its cocoon and changes into a chrysalis or pupa. The pupal stage may last as long as the entire growth of the caterpillar, or longer, for a whole winter may be passed in this state, but the emergence of the perfect insect from the pupal skin only occupies an hour or two. The adult life may last only about three weeks.

The term metamorphosis is not applied to embryos, only to larvae. Since the change in shape is accomplished without increase in size, it always involves the casting off or absorption of certain larval tissues. In the case of the tadpole's tail, wandering cells (phagocytes) carried by the blood-stream attack and devour the contained muscles, nerve-cord and notochord, the skin is thrown into internal folds and these folds in turn are attacked by phagocytes and so the whole skin area shrinks in size, till the tail is reduced to a stump.

Metamorphosis is found only in those life-histories where the larva and the adult have very different habits. Among vertebrates it only occurs in Cyclostomes in certain groups of fish and in Amphibia (frogs, toads and newts). Below the level of vertebrates, however, it is found in every great division of the animal kingdom. The newt is especially interesting. This creature differs from a frog in having the fore- and hind-limbs of approximately equal size and in retaining the tail throughout life. The larva differs from the tadpole in retaining during the whole of its aquatic existence the external feather-like gills which the tadpole at first possesses but later casts off when they have been covered by the growth of the gill cover. This cover in the tadpole hides the fore-limbs which are only revealed a short time before the little frog leaves the water, but in the newt larva this cover is rudimentary and the fore-limbs appear in development first, to be followed later by the hind-limbs so that in the older larvae all four limbs are obvious and fully formed. Now in certain species of newt such as the Mexican axolotl the habit has been acquired of spending the whole life in water. In normal circumstances the larvae of these newts never metamorphose but develop their genital organs and eventually lay eggs. For reasons discussed below it is possible to induce metamorphosis in these newts by feeding them with thyroid gland. No more startling phenomenon can be witnessed than this. In a week or two in the writer's laboratory a large fat axolotl lost its gills, closed up its gill slits, lost the blade-like fin on its tail, darkened in colour, shrunk considerably in size and emerged from the water as a rather small black newt.

Among fishes metamorphosis is comparatively rare, because both young and adult swim in the water and get their food in much the same way. The best examples are the flatfishes (Heterosomata), in which the adult swims lying on one side. The eye belonging to this side is twisted on to the upper side; and the mouth is distorted towards the lower side, for the fish feeds on the animals (worms and molluscs) which burrow in the sand and mud beneath it. The young fry swim upright in the water and the eyes are on opposite sides of the head. When they have reached a certain size they fall to the bottom and rest on one side. Darwin, quoting Malm, says that they make violent effort to twist the lower eye on to the upper side and that as the skull is soft these efforts meet with considerable success. In a comparatively short time both eyes are on the upper side and the metamorphosis has been accomplished.

The lamprey (*q.v.*) (*Petromyzon*), is separated by such a deep gap from all fish that it is placed in a different class, Cyclostomata (*q.v.*). No true jaws exist; the mouth is surrounded by a circular cartilage and the animal lives by attaching itself by suctional action to a larger animal and then rasping a hole in its victim's flesh by means of horny teeth which are developed on a piston like tongue. The larval form, known as ammocoetes, lives in a totally different manner. The mouth is overhung by a hood-like upper lip separated by a lateral cleft from a small straight underlip. The gill-sacs open directly into the oesophagus instead of into a special tube as in the adult. But the greatest peculiarity of the ammocoetes is that the organ from which the lamprey's thyroid gland is later developed is a sac-like structure with a permanent opening into the throat, through which the mucous secretion escapes in the form of a cord. This entangles any minute organisms in the water which the animal swallows. The mucus with its contained food is passed back into the oesophagus whilst the surplus water escapes through the gill openings.

After living like this for two or three years the ammocoetes undergoes a rapid transformation into the adult form. In 1912 the writer received a consignment of "young lampreys" from the Severn. They were about six in. long and half of them were full grown ammocoetes larvae and half young fully metamorphosed lampreys. They were equal in size.

The animals known as Tunicata (*q.v.*) are also primitive members of the phylum Vertebrata. The egg develops into a tadpole-like larva with a hollow spinal cord expanding into a brain-vesicle in front. There is a notochord in the tail and the alimentary canal consists of a pharynx, opening above by a mouth in front of the brain, and at the side by a pair of gill-pouches. The pharynx is succeeded by a loop of intestine leading to an anus high up on the left side. This larva after swimming for some hours attaches itself to the substratum by three adhesive papillae on the chin beneath the mouth. Metamorphosis occurs within a few minutes. The tail and notochord are cast off. The spinal cord shrivels and the brain vesicle is replaced by a little solid ganglion, whilst the mouth by the elongation of the chin is elevated above the substratum.

When we descend to Invertebrata, we find the classical example of metamorphosis in the life-histories of the Echinodermata. In this phylum the larva and the adult are so unlike each other that the change from one stage to the other was formerly supposed to be an alternation of generations. To render our ideas more definite consider the case of the common British sea-urchin *Echinus miliaris*. The larva is a beautiful transparent free-swimming form with outwardly perfect bilateral symmetry. It has a scoop-like mouth leading into a narrow gullet. This is followed by a globular stomach from which a short straight intestine leads back towards the mouth to end in the anus. The alimentary canal forms a loop in the median plane. The skin is drawn out into four symmetrical pairs of long arms supported by transparent calcareous rods. These arms are covered by cilia—are in fact prolongations of a lobed, ciliated band which crosses in front of the mouth, passes down the sides and then crosses on the under-surface in front of the anus. Behind the ciliated band the larva has a circle of four crescents carrying powerful cilia.

This general form characterizes larval life for six weeks, gradually increasing in elaboration as the larva grows older. The arms are at first four, then six, and finally eight, and the ciliated

crescents are cut off from the ciliated band. Then the larva sinks to the bottom and extends from its left side the first adult tentacles or "tube-feet" which have been formed under a screen of skin. As soon as the larva has thus come to anchor a marvellous and rapid change supervenes, which, in the case of another species, the writer has seen completed in about half an hour. The long ciliated arms literally melt away, the protoplasm of the skin covering them seems to gather up into drops and flow backwards off the spines into the body. A large part of the fluid in the primary body-cavity is expelled by osmosis into the stomach, and the globular body of the larva becomes compressed into a flat disc which then crawls away as the young sea-urchin. The mouth becomes cut off from the gullet, shallows out and disappears and a new mouth is formed on the left side in the middle of the circle of tentacles. Similar rapid changes accompanied by shrinkage in size and loss of larval tissues characterize the life-histories of other echinoderms, but in no case are these changes accomplished in so short a time as in the case of the sea-urchin. Consider, for example, the life history of the common starfish *Asterias rubens*. Its larva shows a general similarity to the larva of the sea-urchin. But this larva, the bipinnaria, differs from the sea-urchin larva in two important points: first, its paired arms are more numerous and are unsupported by calcareous rods, and secondly it possesses a long forehead or preoral lobe in front of the mouth, over which a loop of the ciliated band bends back. When its free-swimming life terminates it attaches itself to the substratum not by the adult tentacles but by a sucker which is developed at the apex of this preoral lobe. This lobe is thus converted into a stalk and this attached stage lasts a week or ten days, during which the adult organs are developing at the hinder end of the larva, and the stalk is reduced to a mere knob. The starfish then wrenches itself loose and walks away.

The larva of *Asterias* must find firm rock or at any rate seaweed to which to attach itself, but there is another British starfish, *Astropecten*, which habitually lives on sandy ground. When the bipinnaria of this starfish reaches the age at which it should attach itself, this is impossible; so it continues to swim until the locomotor organs of the future starfish are so far developed that they are capable of functioning. Then the great ciliated preoral lobe is suddenly amputated; the hinder part of the body falls to the bottom and crawls away as the young starfish.

The comparison of the development of *Asterias* and *Astropecten* gives the clue to the meaning of metamorphosis; it is always a period of rapid change of structure during which the animal does not feed, which bridges over the transition from one set of habits to another. Always this involves the casting off of organs required by the earlier set of habits—and this casting off is the principal element in the change of structure. For in most cases the structures required for the second set of habits have already begun to form whilst the first set of habits persists, but these new structures are, as it were, sketched out in embryonic tissue and packed away under a fold. Metamorphosis is therefore a secondary falsification of the ancestral record embedded in a life-history. *See* INVERTEBRATE EMBRYOLOGY. (E. W. MACB.)

EXPERIMENTAL WORK

The crisis of metamorphosis, by which an organism wholly changes its structure and mode of life, is not only of great interest as a phenomenon of general biology, but offers the most interesting opportunities of research in the field of developmental physiology. Gudernatsch in 1911 demonstrated that tadpoles could be caused to metamorphose precociously by feeding them with thyroid gland. He thus showed that amphibian metamorphosis was due to a hormone (*q.v.*) circulating in the blood, which would explain the synchronization of all the numerous changes which occur together at metamorphosis. Since then a number of important facts have been elicited. All Amphibia which normally metamorphose can be made to do so precociously by the thyroid of any vertebrate, whether fresh or dried, given as food or injected. The effect is a quantitative one up to a point. The greater the dose, the more rapid and abrupt the metamorphosis; after a certain threshold value has been reached, however, increase of dose has no further effect. The rapidity of thyroid-induced as of normal metamorphosis is also affected by external factors. A protein-rich diet accelerates it, one rich in fat slows it down. Heat hastens, while cold may actually inhibit it.

Further experiment showed that larvae whose thyroids were removed never metamorphosed, but continued to grow as tadpoles. It is now certain that the secretion of the animal's own thyroid is the main agency in producing normal metamorphosis.

As the thyroid secretion is exceptionally rich in iodine, the natural supply of this element must constitute a limiting factor, and in waters exceptionally poor in iodine, we should expect a retardation or suppression of metamorphosis. There are certain lakes where newts never metamorphose: it is probable that these will be found to lack iodine. Iodine will also induce precocious metamorphosis, but only in frog and toad tadpoles, not in those of tailed Amphibia. The metamorphosis due to iodine is much more gradual than that induced by thyroid since what is provided is not so much ready-made metamorphosis-producing substance, but raw material which enables the animal's own thyroid to grow more quickly. Iodine even causes thyroidless frog tadpoles to metamorphose, but much more slowly than unoperated animals. Some at least of the body-cells of frog tadpoles must thus have some power of synthesizing the metamorphosis-producing substance.

In tailless amphibia (Anura) the thyroid is passing secretion into the blood throughout larval life. In tailed amphibians (Urodela), the thyroid appears to be entirely devoted to storage during larval life; when a certain stage of development is reached, the gland suddenly begins secreting its stored substance into the blood, so inducing metamorphosis. It would be of great physiological interest to discover what is the "releasing factor" which brings about this change in the thyroid.

This difference between anuran and urodele is correlated with another. The growth of limbs is not affected by thyroid in urodele tadpoles, but is in Anura. In frog tadpoles whose thyroids have been removed, limb-growth, though not absent, is very slow; in thyroid-treated specimens it is more rapid than normal, the rapidity varying with the dose.

This introduces us to an important general principle—the specific reactivity of tissues to hormones. Thyroid from any vertebrate will act upon Amphibia; but corresponding tissues in frog and newt will react differently to the same thyroid. The same is true of the tail; in Anura thyroid causes its total resorption, in Urodela only that of its fin-membrane. The tail of Amphibia also illustrates the principle of differential susceptibility. The limbs of frog tadpoles begin excess growth when the least trace of thyroid extract is to be found in the blood: the tail is not resorbed until a considerable threshold-concentration is attained.

Specific reactivity is also illustrated by the neotenous Amphibia, *i.e.*, those which normally live their whole lives and reproduce while retaining larval form and aquatic habit. Most of these cannot be artificially metamorphosed even by the heaviest doses of thyroid: their tissues no longer react to the hormone. In Amblystoma matters are different. Most species metamorphose normally. The well-known axolotl of Old Mexico, however, is neotenous. It has now been shown that thyroid will always metamorphose axolotls. There is, however, a threshold dose below which only minor, reversible changes occur. A dose just near the threshold causes metamorphosis to advance rather more than half-way and then stop, leaving the animal neither aquatic nor terrestrial. Metamorphosis is thus not an "all-or-nothing" phenomenon. Neoteny here is apparently due to three co-operating factors: (1) failure of the thyroid's "release mechanism," (2) reduced thyroid-size, (3) reduced tissue-sensitivity.

The thyroid, however, is not the only ductless gland concerned in metamorphosis. The pituitary also plays an important, if secondary, role. Its secretion is indeed necessary for the development of the thyroid; tadpoles with pituitary removed never metamorphose, and their thyroid-size is less than $\frac{1}{20}$ of normal. Its own secretion can also produce metamorphosis, in axolotls as well as tadpoles, even in animals deprived of their own thyroid and pituitary. However, the hormone is not so potent as that of

the thyroid. These effects are all due to the anterior lobe. The posterior lobe produces a hormone which if injected in sufficient quantity will antagonize small doses of thyroid or moderate doses of anterior pituitary, and so prevent metamorphosis.

We must briefly mention some points concerning the time-relations of metamorphosis. The common European frog, *Rana temporaria,* normally takes about four months to metamorphose; some toads only four to six weeks; the American leopard-frog over a year; and several bull-frogs over two years. The thyroid of leopard-frog or bull-frog tadpoles contains the metamorphosis-hormone, since if engrafted into tadpoles of other species it induces rapid metamorphosis. Apparently the prolongation of larval life in these animals is due to an alteration in the relative rates of thyroid-growth and body-growth. A definite concentration of thyroid hormone in the blood must be reached before metamorphosis can occur. If the thyroid grows relatively more slowly, metamorphosis will be postponed. The same postponement could equally well be effected by diminished sensitivity of the tissues to thyroid. Thus the relative rate of thyroid-growth and the absolute degree of tissue sensitivity between them decide the date of metamorphosis.

The compensatory reactions of the thyroid are interesting. At high temperatures, a tadpole's thyroid diminishes in size and activity, at low temperatures it increases. Similarly, after a small dose of thyroid, the animal's own gland is not called upon, and shrinks. Interesting results have been obtained by utilizing these facts. If tadpoles are kept at high temperatures till half-grown, and then placed at low temperature, they fail to metamorphose. This is because their thyroids, first much reduced by heat, are unable to respond to the extreme demands made on them by cold, and can only react by forming a goitre which vainly tries to compensate by quantity of tissue for lack of quality of secretion.

Again, if half-grown normal tadpoles are put at very low and very high temperatures after receiving a small dose of thyroid, those at high temperature will metamorphose in under 48 hours, but those at low will proceed half-way with metamorphosis, and remain thus even if put at medium temperature. The dose of thyroid was sufficient to cause their own thyroid to shut down its activity, but not sufficient to counteract the cold.

It should be mentioned that Romeis claims to have achieved a definite influence on the date of metamorphosis by immersing frog eggs or sperm in thyroid solutions.

Little work has been done on metamorphosis in other animals. In caterpillars the brain produces some chemical substance necessary for pupation (Kopec). Certain treatments will cause the meal-worm beetle to develop large wing-rudiments while still in the grub stage; apparently the relative growth-rate of the wings has been altered. In sea-urchins J. S. Huxley has secured precocious metamorphosis by immersing moderately-advanced larvae in very dilute poisons for some hours. The larval tissues are much more affected by the poison, undergo dedifferentiation (*q.v.*) and can then be absorbed by the urchin-rudiment. Here it is probable that no hormone is concerned with metamorphosis. Ascidian larvae metamorphose precociously under thyroid treatment (Weiss), but lamprey larvae do not. Metamorphosis is thus accomplished in different ways in different animals. (J. S. H.)

METAPHOR, a figure of speech, which consists in the transference to one object of an attribute or name which strictly and literally is not applicable to it, but only figuratively and by analogy. It is thus in essence an emphatic comparison, which if expressed formally is a "simile"; thus it is a metaphor to speak of a ship ploughing her way through the waves, but a simile when it takes the form of "the ship, like a plough, moves," etc.

METAPHYSICS. The systematic study of the fundamental problems relating to the ultimate nature of reality and of human knowledge. It naturally falls into two divisions, namely, Ontology or the systematic study of the ultimate problems of Being or Reality, and Epistemology, or Theory of Knowledge, the systematic study of the ultimate problems of human knowledge. These constitute between them the principal departments of Philosophy, which, however, also includes certain other branches of inquiry which are commonly known as philosophical studies or sciences (Ethics, Logic, etc.). (*See* PHILOSOPHY.) Few systems of philosophy do even justice to both departments of Metaphysics. With rare exceptions, like Plato, the Sceptics, Descartes and Locke, philosophers before the time of Kant's *Critique of Pure Reason* (1781) were mainly interested in ontology. Since the time of Kant, however, metaphysical interest has shifted to a very large extent to Epistemology. For sceptics and agnostics of course, there can be no such thing as ontology, and even Kant and his school are essentially agnostic in relation to ontology, except as a matter of faith based on moral postulates. These facts may help to explain the vacillating use of the term Metaphysics. Some writers use it as synonymous with Ontology, others make it synonymous with Epistemology. But if due regard is paid to the whole history of the subject there can be no reasonable doubt that the correct use of the term is to make it include both Ontology and Epistemology, or Theory of Being and Theory of Knowledge, as its two intimately related branches. Metaphysical speculations are the outcome of what is called sometimes a "religious impulse" and sometimes a "metaphysical craving" to find something permanent behind or beyond the changing appearances of daily observation, and to acquire a knowledge that shall be better founded than the shifting opinions usually encountered.

The first introduction of the term Metaphysics was a mere accident. When the writings of Aristotle were first collected and arranged by Andronicus of Rhodes (in Rome, about 70 B.C.), or possibly by some earlier Peripatetic already, the treatises on what Aristotle had called "First Philosophy" (also "Theology") were placed after the treatises on physics, and so came to be known as "the treatises after the physical treatises" (τὰ μετὰ τὰ φυσικά). In course of time this designation was applied to the subject matter of these treatises, and so the Scholastics used the term *transphysica* for studies which come after the ordinary physical studies of natural phenomena. The term *Metaphysica* occurs already in Boetius (A.D. 480–525). To some people the term "metaphysical" rather suggests the "supernatural." This is partly responsible for the growing unpopularity of the term, and for the increasing tendency to use the wider terms "philosophy" and "philosophical" in place of "metaphysics" and "metaphysical."

As the principal types of epistemological theory are dealt with in the article on KNOWLEDGE, THEORY OF, it is only necessary to set out here the main types of ontological theory (*see* ONTOLOGY). Briefly, these are:—

(1) One of the first questions, probably the first question, raised in the history of Western philosophy was, Is there anything permanent at the basis of the changing phenomena of Nature? The earliest Greek philosophers (Thales, Anaximander, etc.) assumed that there is; so did many subsequent philosophers (the Eclectics, Plato, Aristotle, Spinoza, etc.). On the other hand, Heraclitus, among the ancients, and Bergson and James, among the moderns, maintain that there is nothing permanent, that the "ever rolling stream" of changing phenomena or of experiences is the only and ultimate reality. We may call a philosophy of the former type *Ontological Substantivalism;* one of the latter type *Ontological Phenomenalism.* The latter view implies *epistemological phenomenalism,* but is not necessarily implied by it.

(2) The second question is as old as the first, and may be put in this way. Is there only one ultimate reality or more than one? The possible answers to this are obvious. They may be expressed by the familiar terms, *Monism* and *Pluralism,* corresponding respectively to the views that ultimate reality is just one, or more than one. Thales, the Eclectics, Plato, Spinoza may be classed as Monists. Democritus and the Atomists, Descartes and Leibniz may be classed as Pluralists. To avoid confusion with the other uses of these terms, it may be advisable to call these views *Substantival Monism,* and *Substantival Pluralism* respectively.

(3) The third problem, also old, is whether ultimate reality is all of one *kind* only or of more kinds than one. Here, too, the possible answers are obvious. Moreover, Substantival Monism clearly implies the former alternative. On the other hand, Substantival Pluralism may or may not adopt the same alternative. Leibniz, *e.g.*, was a pluralist, but the monads in which he believed

were all supposed by him to be of the same (spiritual) kind, only different in degree. Similarly with the Atomists. On the other hand, Descartes (if one can really be sure about his views) believed in a plurality of material substances, and a plurality of souls or mental substances entirely different from the material substances, and in God besides. To name these distinctions suitably is not easy. Since they affect Pluralism only, one might distinguish between *uniform pluralism* (like that of Leibniz) and *multiform pluralism* (like that of Descartes); Substantival Monism being necessarily *uniform*.

(4) The fourth question relates to the number of fundamental or irreducible attributes which pertain to the real or reals. To this question likewise the answer may be "one," or it may be "more than one." If "one," we have *Attributive Monism* (Leibniz, on the one hand, the Materialists, on the other, also the Voluntarists); if "more than one" then we have either *Attributive Pluralism* (Spinoza, for instance) which recognizes a multiplicity or even an infinity of such attributes, or *Attributive Dualism or Natural Realism* (like that of Descartes and of some modern realists) which recognizes only two such attributes, and may associate each of them with a different kind of substance. Attributive Monism is known as Materialism, if materiality or extension or some form of physical energy is the only irreducible character admitted; it is called *Ontological Idealism* or Intellectualism or Spiritualism if thought or reason or some sort of intelligence is the only irreducible attribute that is acknowledged; it is called *Voluntarism* if the irreducible attribute is identified with will (*e.g.*, Schopenhauer and Nietzsche); it is known as *Neutral Monism* if the ultimate attribute is regarded as different from both mentality and materiality, but as the source of the emergence of both (*e.g.*, W. James, B. Russell and some of the New Realists). E. von Hartmann's philosophy of the unconscious must probably be classed as a form of Attributive Dualism because the "Unconscious" is conceived by him apparently as a combination of will and unconscious or subconscious cognition. Materialism usually regards mentality (or consciousness in the widest sense of the term) as a mere epiphenomenon or by-product of matter or physical energy; and Ontological Idealism as commonly treats so-called material objects and events as mere appearances to, or creative images of, some consciousness or other. It should be remarked, however, that there is a very modern type of Idealism which is not primarily epistemological nor ontological, but axiological, maintaining simply that it is the "ideal" or rational part of reality which is the most valuable. Such a view is, of course, compatible with most ontological theories.

(5) The next ontological problem concerns the mode of interrelation between the various parts or modes or units of reality. Is each in turn absolutely determined by the others, or is there room in this universe for a measure of what is variously called spontaneity, novelty, originality, freedom or self-determination? The Mechanistic theory, or simply "Mechanism," is the view that the world is a "block-universe," in which everything is once for all causally predetermined, so that a sufficiently clever demon could accurately read the future and the past from the present condition of things. Such a view is usually linked with Materialism, though it may also be found in conjunction with other ontological theories. The opposed views are variously named according to the different points which are especially stressed. The philosophy of *Creative Evolution* (Bergson) and the theory of *Emergence* (Lloyd Morgan and Alexander) lay stress on the originality of natural events and on the utter impossibility of anticipating the character of most results from a mere knowledge of the laws of matter and motion—especially so in the case of vital phenomena and the higher activities of human beings. *Teleology* vindicates the reality of purposiveness in Nature—the direction of processes to the realization of certain ends in front of them, as distinguished from their determination entirely by mechanical forces behind them, and *Libertarianism* is the view which vindicates more particularly the freedom of man's will. An extreme form of anti-Mechanism is known as *Tychism*, according to which everything just happens by chance. The view which upholds "Necessity" in Nature is in one of its forms at least (Spinoza, for example) essentially a denial of Tychism and a defence of the prevalence of law and order throughout the universe, without, however, denying the reality of freedom as self-determination. Such *"Necessitarianism"* must be distinguished from Mechanism and its offspring, Determinism.

(6) Lastly, there is the question whether there is anything in the universe which may be called divine. *Atheism* gives a negative answer to this question. The principal forms which the affirmative answers assume are known as Theism, Deism and Pantheism respectively; there are also less articulate forms. *Theism* is the belief in a personal God, the Creator in some sense of Nature and Man, distinct from both yet in some ways in or near them. *Deism* and *Pantheism* endeavour to avoid the anthropomorphic tendencies of Theism by conceiving God as impersonal or, more correctly, as supra-personal. But whereas Deism, like Theism, separates God from the world, Pantheism identifies them—"the One and All" is at once God and the universe. All the historic churches are theistic; many of the so-called freethinkers of the 17th and 18th centuries were deists; the leading Stoics, in ancient times, and Spinoza, in modern times, are among the classical pantheists. Materialism is usually associated with Atheism. Other forms of Monism usually tend towards Pantheism. Idealistic Pluralism is usually associated with Theism. Other forms of Pluralism may be either theistic or deistic, but as a matter of fact are mostly theistic.

BIBLIOGRAPHY.—*See* the articles on the subjects and the philosophers mentioned above. Also the *Introduction to Philosophy* by O. Külpe (1901, etc.), W. Jerusalem (1917), F. Paulsen (1898), B. Russell (1927), W. Windelband (1923) and J. S. Mackenzie, *Elements of Constructive Philosophy* (1917); A. E. Taylor, *Elements of Metaphysics* (1903). (A. Wo.)

METAPONTUM, ancient city, Magna Graecia (Gr. Μεταπόντιον, mod. Metaponto), on the Gulf of Tarentum, near the mouth of the river Bradanus, about 24 m. from Tarentum and 13 m. from Heraclea. It was founded by an Achaean colony from Sybaris and Croton about 700 B.C. At Metapontum Pythagoras died in 497 B.C. His tomb was still shown in the time of Cicero.

Its support of the Athenian expedition to Sicily (415 B.C) was trifling. In 332 B.C. it allied itself with Alexander of Epirus. After the battle of Cannae (216 B.C.) it declared in favour of Hannibal, and became his headquarters. After the defeat of Hasdrubal at the Metaurus (207 B.C.), the inhabitants of Metapontum followed him in his retreat. From this time the city sank; Pausanias says that a theatre and the walls alone remained.

Metapontum has the remains of two temples, both of 510–480 B.C. One of them, which was probably dedicated to Apollo Lycius, was a peripteros, decorated with finely painted terra-cottas, measuring 186 by 91¾ ft., of which only the foundations are left. The capitals were 3⅓ ft. in diameter. Of the other temple, the so-called Tavole Paladine, outside the area of the ancient city, a peripteros with 6 columns, 3⅓ ft. in diameter, in front, and 12 at the sides; 15 columns are standing, with the lower portion of the epistyle. It measured 105 ft. by 49 ft. without the steps. There are also traces of the town walls. An archaic treasure-house dedicated at Olympia by the people of Metapontum has been discovered there. The railway station is the junction of the line from Battipaglia (and Naples) with that from Taranto to Reggio.

METASOMATISM, in petrology a process of alteration of rocks which involves enrichment of the rock by new substances introduced from without (μετά, change, σῶμα, body). Substances originally present are partly or wholly removed in solution, the newly introduced material entering as gas or in aqueous solution. Usually the enrichment takes place by definite chemical reactions, but this is not always so; the conversion of limestone into siliceous chert though recognized as a metasomatic process is not directly governed by any definite chemical reaction. Precipitation of material may result from changes in solution rendering insoluble a substance foreign to the mineral acted upon. Replacement may be partial or complete, with or without preservation of original structures and textures. Metasomatic processes take place over a wide range of temperatures and pressures and may be accompanied by a volume change; in general they obey the law of mass action, and in order to effect replacement the

introduced solutions must attain a minimum concentration.

This minimum concentration of solutions or minimum vapour pressure in the case of gas reactions varies both with different reactions and the temperatures and pressures at which the replacement is effected. Among the common examples of metasomatism may be noted the dolomitization and conversion into siderite of iron oxides of limestones. Phosphatization of limestones is a further example. These replacements probably take place at low temperatures, as do also the metasomatic changes in salt deposits, such as the conversion of anhydrite into glauberite or polyphalite (*see* PNEUMATOLYSIS).

Metasomatism is widespread in silicate rocks and is especially characteristic of contact zones of igneous intrusions. These replacements affect, however, not only the intruded rocks but also the crystallized magma from which the emanations are derived. Metasomatism involving addition of alkalis is represented by such processes as albitization, analcitization and the formation of felspar in certain contact zones of injected rocks.

The production of tourmaline, topaz and lithra-mica as seen in tourmaline and topaz-hornfelses, greisens, etc., is a metasomatic process involving enrichment of the rocks in boron, fluorine and lithium. Similarly the formation of chloride-marialite (scapolite) at the expense of felspars, serpentine from olivine, sericitization of felspars and felspathoid minerals are common examples of metasomatism occurring around igneous intrusions.

Many ore deposits and the regions in their vicinity show evidences of widespread chemical replacement leading to enrichment, as in sulphide deposits.

Limestones are particularly prone to metasomatic alteration. Their conversion to dolomite, siderite and iron oxide has already been referred to. Around igneous contacts they are not infrequently locally changed to andradite garnet or hedenbergite rocks, processes involving great enrichment in iron and silica. These garnet and pyroxene rocks are known as "skarns." Probably iron is introduced in the gaseous form as fluoride or chloride.

Valuable ore deposits are frequently associated with rocks of this character. In many parts of western North America (Nevada, Arizona, etc.), great deposits of copper, lead and silver ores are worked in crystalline limestones and are often clearly replacement products of the limestones themselves. The constant presence of igneous rocks in their vicinity indicates that they are connected with the introduction of the metals, and the deposits are often of such a kind as to show that post-volcanic discharges or magmatic gases and water were the mineralizing agents.

(C. E. T.)

METASTASIO (1698–1782). Pietro Trapassi, Italian poet, better known by his assumed name of Metastasio, was born in Rome on Jan. 13, 1698. His father, Felice Trapassi, a native of Assisi, who had served in the Corsican regiment of the papal forces, kept a grocer's shop in the Via dei Cappellari.

In 1709, Gian Vincenzo Gravina and Lorenzini, a critic of some note, heard the boy improvising verse to a crowd in the street. Gravina adopted him, hellenized his name into Metastasio; and gave him a good education. Metastasio soon found himself competing with the most celebrated improvvisatori of his time in Italy, and almost wrecked his health. Gravina had the good sense to place the boy in a quiet seaside place in Calabria.

At the age of twelve Metastasio translated the *Iliad* into octave stanzas; and two years later he composed a tragedy in the manner of Seneca upon a subject chosen from Trissino's *Italia liberata*—Gravina's favourite epic. In 1718 Gravina died leaving his protégé a fortune. Metastasio was now twenty and an abbé. In two years, having spent his money, he apprenticed himself to a lawyer in Naples. He composed an epithalamium, and his first musical serenade, *Endimione*, on the occasion (1721) of the marriage of his patroness the Princess Pinelli di Sangro to the Marchese Belmonte Pignatelli. In 1722 the viceroy asked Metastasio to compose a serenata for the empress's birthday. He produced *Gli orti esperidi*. It was set to music by Porpora, and the great Roman prima donna, Marianna Bulgarelli, called La Romanina from her birthplace, played the part of Venus. La Romanina forthwith took possession of Metastasio, and in her house he became acquainted with the greatest composers of the day—with Porpora, from whom he took lessons in music; with Hasse, Pergolese, Scarlatti, Vinci, Leo, Durante, Marcello, all of whom were destined in the future to set his plays to melody. Here too he studied the art of singing, and won the friendship of the great singer Carlo Broschi (*see* FARINELLI). His plays, while beautiful in themselves, judged merely as works of literary art, became masterpieces as soon as their words were set to music which justified the conventionality of his plots, the absurdities of his situations, the violence he does to history in the persons of some leading characters and his "damnable iteration" of the theme of love in all its phases.

Metastasio resided with La Romanina and her husband in Rome. The generous woman took the whole Trapassi family—father, mother, brother, sisters—into her own house. She fostered the poet's genius and pampered his caprices. Under her influence he wrote from 1721 onwards in rapid succession the *Didone abbandonata Catone in Utica, Ezio, Alessandro nell' Indie, Semiramide riconosciuta, Siroe* and *Artaserse*. But she was growing older; she had ceased to sing in public; and the poet felt himself more and more dependent in an irksome sense upon her kindness. He gained 300 scudi (about £60) for each opera; this pay, though good, was precarious, and in Sept. 1729 he accepted the offer of the post of court poet to the theatre at Vienna, with a stipend of 3000 florins. La Romanina took charge of his family in Rome, and in the summer of 1730 Metastasio settled at Vienna in the house of a Spanish Neapolitan, Niccolò Martinez, where he resided until his death. Between the years 1730 and 1740 his finest dramas, *Adriano, Demetrio, Issipile, Demofoonte, Olimpiade, Clemenza di Tito, Achille in Sciro, Temistocle* and *Attilio Regolo*, which he himself considered his masterpiece, were produced for the imperial theatre. Poet, composer, musical copyist and singer did their work together in frantic haste. Metastasio understood the technique of his peculiar art in its minutest details. Metastasio's *liaison* with the Countess Althann, sister-in-law of his old patroness the Princess Belmonte Pignatelli, became so close that it was even believed they had been privately married. In 1734 La Romanina asked Metastasio to get her an engagement at the court theatre, but he did not want her in Vienna. The tone of his letters alarmed and irritated her. It is probable that she set out from Rome, but died suddenly upon the road. She left him her fortune after her husband's life interest in it had expired, but Metastasio renounced the legacy.

Metastasio's later cantatas and the canzonet *Ecco quel fiero istante*, which he sent to his friend Farinelli, rank among his popular productions. In 1755 the Countess Althann died, and Metastasio was more than ever reduced to the society which gathered round him in the bourgeois house of the Martinez. He died on April 12, 1782. During the long period of 40 years in which Metastasio outlived his originality and creative powers his fame went on increasing. In his library he counted as many as 40 editions of his own works. They had been translated into French, English, German, Spanish, even into modern Greek. But with the changes effected by Gluck and Mozart, with the development of orchestration and the rapid growth of the German manner, a new type of libretto came into request. Metastasio's plays fell into undeserved neglect. Farinelli, whom he styled "twin-brother," was the true exponent of his poetry; and, with the disappearance of the school to which Farinelli belonged, Metastasio's libretti suffered eclipse. Collected editions of Metastasio's works published at Genoa (1802) and Padua (1811) will probably be found most useful by the general student. An edition of the letters, by Carducci, was published at Bologna in 1883. Metastasio's life was written by Aluigi (Assisi, 1783); by Charles Burney (1796); and by others; but the most vivid sketch is in Vernon Lee's *Studies of the 18th Century in Italy* (1880).

METAURUS (Mod. Metauro), a river of Italy which flows into the Adriatic a little south-east of Fanum Fortunae (mod. Fano). In 207 B.C. (*see* PUNIC WARS and HANNIBAL) Hasdrubal had marched from Placentia to the aid of his brother Hannibal, and, on reaching the Cesano, the next stream south of the Metaurus, halted and encamped. The forces of Livius Salinator and the praetor Porcius Licinus, the latter of whom had previously

been watching his movements, were encamped near Sena Gallica (mod. Sinigaglia) only about half a mile away from him (no doubt on the opposite bank of the Cesano). He was about to attack them, when he discovered that the other consul, Nero, who had been watching Hannibal's movements at Canusium had brought his army to swell the Roman forces, having, as a fact, intercepted Hasdrubal's message to Hannibal that he would meet him "in Umbria" *i.e.* at this very place—for the name Umbria extended to the coast before the time of Augustus. Hasdrubal then attempted to retreat to the Metaurus and cross it, but his guides deserted him, and he was unable to hit on the ford without them; he then marched up the tortuous stream to find another, but had only reached the hills of Sant Angelo, some two or three miles from the coast, where he tried to pitch his camp, when he found the Romans, who had started their pursuit at dawn, too close on his heels, and was obliged to halt and give battle. His left wing was protected by the terrain, but there was room for fighting on the right, where he drew up his Spanish troops in deep formation, with his ten elephants in front of them, taking position himself in the centre. He then attacked the advancing Romans and the clash was a violent one; but the fighting was indecisive, until Nero, who at first remained inactive on the right wing, with a deep streambed in front of him, decided to pass behind Livius' position and advance on his left, thus taking the enemy on their right flank; the distance he had to traverse was less than a mile, and the move was a decisive one. Hasdrubal, who had seen that he must win or perish, sought and found the death of a hero. Livy's statement that 56,000 of his army fell and only 5,400 prisoners were taken, is probably an exaggeration; and if we reckon his whole force very roughly at 30,000, we may accept Polybius' figure of 10,000 killed, and assume 10,000 prisoners; while the other third of the army, the Gauls and Ligurians, who had either taken no part in the battle or escaped, was allowed to make off undisturbed. The defeat ended Hannibal's hopes of success in Italy.

See Kromayer, *Antike Schlachtfelder* iii. 1. (1912) 424 *sqq.* for an authoritative treatment of the whole question. (T. A.)

METAXAS, ANDREAS (1786–1860), Greek politician, was born in the island of Cephalonia. When Capo d'Istria was murdered in 1831 Metaxas, who had been war minister, became a member of the provisional government which held office till the accession of King Otho in 1833. He subsequently represented Greece at Madrid, Lisbon and Constantinople, with an interval (1843–44) in which he was premier. He died at Athens on Sept. 19, 1860.

METAYAGE SYSTEM. The cultivation of land for a proprietor by one who receives a proportion of the produce. The system has never existed in England and has no English name, but in certain provinces of Italy and France it was once almost universal, and is still very common. It is also practised in the United States, in Portugal, in Greece, and in the countries bordering on the Danube. In Italy and France, respectively, it is called *mezzeria* and *metayage,* or halving—the halving, that is, of the produce of the soil between landowner and landholder. These expressions merely signify that the produce is divisible in certain definite proportions, which must obviously vary with the varying fertility of the soil and other circumstances. Sometimes the landlord supplies all the stock, and sometimes only part—the cattle and seed perhaps, while the farmer provides the implements; or perhaps only half the seed and half the cattle, the farmer finding the other halves—taxes too being paid wholly by one or the other, or jointly by both.

English writers were unanimous, until J. S. Mill adopted a different tone, in condemning the metayer system. They judged it by France where under the *ancien régime* all direct taxes were paid by the metayer, the noble landowner being exempt, which taxes, being assessed according to the visible produce of the soil, operated as penalties upon all endeavours to increase output. Also, there was no fixity of tenure without which metayage cannot prosper. French metayers in Arthur Young's time were "removable at pleasure, and obliged to conform in all things to the will of their landlords," and so in general they are still. Yet even in France, although metayage and extreme rural poverty usually coincide, there are provinces where the contrary is the fact, as it is also in Italy. Indeed, Lombardy is a triumphant vindication of metayage in the abstract. The contrasts may be explained. Metayage, to be a success, must be a genuine partnership, one in which there is no sleeping partner, but in the affairs of which the landlord, as well as the tenant, takes an active part.

In France there is also a system termed *metayage par groupes,* which consists in letting a considerable farm, not to one metayer, but to an association of several, who work together for the general good, under the supervision either of the landlord himself, or of his bailiff. This arrangement avoids the difficulty of finding tenants possessed of capital enough for any but very small farms.

See further LAND TENURE and the section *Agriculture* in the articles FRANCE, GREECE, ITALY, etc.; and consult J. Cruveilhier, *Étude sur le metayage* (Paris, 1894).

METAZOA, a zoological term, the equivalent of the old Enterozoa (*q.v.*) for all animals other than Protozoa (*q.v.*). The sponges are also sometimes separated from this group and termed Parazoa. Metazoa are multicellular animals with at least two cell-layers and one or more body-cavities. (*See* ZOOLOGY).

METCALF, WILLARD LEROY (1858–1925), American artist, was born in Lowell (Mass.), on July 1, 1858. He was a pupil of the Boston Normal Art school, of the Boston Art Museum school, and of the Académie Julien, Paris. After early figure painting and illustration, he became prominent as a landscape painter. He was one of the "Ten American Painters" who in 1897 seceded from the Society of American Artists. For some years he was an instructor in the Woman's Art school, Cooper Union, New York, and in the Art Students' League, New York. He died in New York city on March 9, 1925.

METCALFE, CHARLES THEOPHILUS METCALFE, BARON (1785–1846), Indian and colonial administrator, was born at Calcutta on Jan. 30, 1785. Having been educated at Eton, in 1800 he sailed for India as a writer in the service of the East India Company. Four years later, he was appointed political assistant to General Lake, who was conducting the final campaign of the Mahratta war against Holkar. In 1808 he became envoy to the court of Ranjit Singh at Lahore, where in April 1809, he concluded the treaty securing the independence of the Sikh states between the Sutlej and the Jumna. Four years afterwards he was made resident at Delhi, and in 1819 appointed secretary in the secret and political department. In 1822 he succeeded his brother in the baronetcy, and in 1827 obtained a seat in the supreme council. In March 1835, after he had acted as the first governor of the proposed new presidency of Agra, he provisionally succeeded Lord William Bentinck in the governor-generalship. His liberation of the press so complicated his relations with the directors that he resigned the service of the Company in 1838. In the following year he became governor of Jamaica, where the difficulties created by the recent passing of the Negro Emancipation Act called for tact. Ill health compelled him to return to England in 1842, but six months afterwards he was appointed governor-general of Canada. He was raised to the peerage in 1845. He died at Malshanger, near Basingstoke, on Sept. 5, 1846.

See J. W. Kaye, *Life and Correspondence of Charles Lord Metcalfe* (1854), and *Selections from Lord Metcalfe's Papers* (1855); also Wakefield's paper, *Sir Charles Metcalfe in Canada,* reprinted in E. M. Wrong's *Charles Butler and Responsible Government* (Oxford 1926).

METCHNIKOV, ILYA: *see* MECHNIKOV, ILYA.

METELLUS, the name of a distinguished family of the Caecilian (plebeian) gens at Rome. The most important individuals are given separate notices below. For their history *see* M. Wende, *De Caeciliis Metellis* (Bonn, 1875); P. Gröbe's edition of Drumann's *Geschichte Roms,* ii.; and the article "Caecilius" in Pauly-Wissowa's *Realencyklopädie.*

METELLUS, LUCIUS CAECILIUS, general during the first Punic War. Consul in 251 B.C., he was sent to Sicily, and gained a decisive victory over Hasdrubal, who had the larger force. Metellus's victory was in great measure due to a panic caused amongst the Carthaginian elephants by his clever manoeuvring. A number of them figured in his triumph, and from this time the elephant frequently occurs on the coins of the Metelli. The story

that in 241 he rescued the Palladium from a fire in the temple of Vesta at the cost of his eyesight is not to be found in the extract from his funeral oration in Pliny (*Nat. Hist.* vii. 43 [45]).

METELLUS, QUINTUS CAECILIUS, son of Lucius Caecilius Metellus, became consul in 206 B.C. as a reward for his services at the Metaurus. In 205 he was dictator for holding the comitia; in 201 one of the commissioners for dividing the public land in Samnium and Apulia amongst the Roman veterans; in 186 he conducted an embassy to Macedonia, afterwards proceeding to Peloponnesus to investigate the quarrel between Sparta and the Achaeans. He is the Metellus who caused the poet Naevius (*q.v.*) to be imprisoned and exiled for having attacked him on the stage.

METELLUS CELER, QUINTUS CAECILIUS, legate of Pompey in Asia 65 B.C., praetor 63, was despatched to cut off the retreat of Catiline to the north by blocking the passes, and in 62 went into the province of Cisalpine Gaul with the title of proconsul, although he did not become consul till 60. A supporter of the optimates and an enemy of Pompey, he successfully opposed the agrarian law that was to provide for Pompey's veterans. He also tried, though fruitlessly, to obstruct Caesar's agrarian law in 59. He died suddenly in the same year—it was usually supposed from poison administered by his wife Clodia.

METELLUS CRETICUS, QUINTUS CAECILIUS, Roman general. Consul in 69 B.C., he was appointed to the command of the war against Crete, the headquarters of the pirates of the Mediterranean. In 67 Pompey demanded the control of the campaign under the Gabinian Law. The Cretans offered to surrender to Pompey, who instructed Metellus to cease operations. Metellus refused, and himself annexed the island. His triumph was delayed by Pompey's partisans, and he joined the opposition in the Senate and helped to defeat the ratification of Pompey's Asiatic settlement. He was one of a commission of three sent (60) to investigate the state of affairs in Gaul where disturbances were apprehended. He appears to have been alive in 54.

METELLUS MACEDONICUS, QUINTUS CAECILIUS (d. 115 B.C.), praetor 148 B.C., defeated the usurper Andriscus (*q.v.*) in Macedonia and forced him to surrender. Under his superintendence the country was made a Roman province. In 146, he attacked the Achaeans to avenge an insult offered to a Roman embassy at Corinth. He was superseded during a successful campaign by L. Mummius. On his return to Italy he received a triumph and the title of *Macedonicus.* Consul in 143, he subdued the Celtiberians in northern Spain. In 131, when censor with Q. Pompeius (they were the first two plebeian censors), he proposed that all citizens should be compelled to marry. He was an opponent of the Gracchi, although not averse from moderate reform. He built a colonnade in the Campus Martius, and two temples dedicated to Iuppiter Stator and Juno.

METELLUS NUMIDICUS, QUINTUS CAECILIUS, consul 109 B.C. and commander in the Jugurthine War, defeated Jugurtha (*q.v.*) by the river Muthul, and after a difficult march through the desert took his stronghold, Thala. Marius had him superseded, and himself received the command for the next year. Metellus received a triumph and the title of *Numidicus.* Saturninus, whom as a censor he tried to remove from the senate, passed in 100 B.C. an agrarian law, inserting a provision that all senators should swear to it within five days. All complied but Metellus, who retired to Asia. After Saturninus was killed he returned, and died (probably in 91). He was one of the chief leaders of the aristocratic party. Cicero speaks highly of him as an orator.

METELLUS PIUS, QUINTUS CAECILIUS, son of Numidicus, was one of the commanders in the Social War, and defeated Q. Pompaedius Silo, the Marsian leader (88 B.C.). Sulla, on his departure for Asia, gave him proconsular command over south Italy. When Marius returned to Italy and joined Cinna, the soldiers wished Metellus to take command, but he refused. The soldiers deserted in large numbers, and Metellus retired to Africa and afterwards to Liguria, resuming his proconsular command on Sulla's return. In the war against Marius he gained several important successes, and after his victory over C. Norbanus at Faventia (82) he subdued the whole of upper Italy. Consul in 80 with Sulla, he went to Spain next year against Sertorius, who pressed him hard till the arrival of Pompey in 76. Next year Metellus defeated Sertorius's lieutenant Hirtuleius at Italica and Segovia, and joining Pompey rescued him from the consequences of a check at Sucro. In 71 Metellus returned to Rome and triumphed. He became pontifex maximus, and died probably at the end of 64.

METELLUS PIUS SCIPIO, QUINTUS CAECILIUS, son of P. Scipio Nasica, was adopted by Metellus Celer. He was accused of bribery in 60 B.C., and defended by Cicero. In August 52, he became consul through the influence of Pompey, who had married his daughter Cornelia. In 49 he proposed that Caesar should disband his army within a definite time, under pain of being declared an enemy of the state. His first command during the civil war was the province of Syria. He commanded the centre at Pharsalus, and afterwards went to Africa, where by Cato's influence he received the command. In 46 he was defeated at Thapsus; while endeavouring to escape to Spain he fell into the hands of P. Sittius, and put himself to death.

METEMPSYCHOSIS. The theory of the transmigration of souls is usually associated with the ancient Egyptians, who are said to have practised embalming to prevent or delay reincarnation; with the teaching of Pythagoras and the Buddha (*q.v.*); and was also held by a sect of early Christian heretics spoken of by Jeremy Collier as "Metempsychi." The idea, however, much older than any of these creeds, exists throughout the world. Where the passage of the soul, or the vital essence, into some particular form is associated, as by the Garos of Assam, with ideas of retribution for the sins or accidents of this life, the influence of Buddhism or Hinduism has probably been at work. The primitive idea, independent of moral teaching, is bound up with the conception of an objective soul, and often with ideas as to a plurality of souls in a single individual, one of which is separable and able to go in and out through the mouth or nostrils. Thus the Poso-Alfures of Celebes believe in three souls, the *inosa* or vital principle, the *angga,* or intellectual, and the *tanoana* or divine element which leaves during sleep, and which is of the same nature in many plants and animals. This separable soul is clearly a conception based on the phenomena of dreams taken to be actual experiences undergone during sleep, and postulating some sort of embodiment able to roam while the body sleeps. This soul must be small enough to leave by the mouth, and it appears as a manikin in India and in Celebes, as a snake, a weasel or a mouse, in Germany, or as an insect in further India. Thus the soul is commonly spoken of as "flying" in Greek, and represented as a butterfly, as, indeed, all over Europe, from Ireland to Lithuania, in China, Assam, Burma, Japan, and the Pacific. So, too, the soul appears as a bird—in Europe the dove is the commonest and poles bearing pigeons were erected over Lombard graves; but the soul also appears in the form of ducks, ravens, owls or hawks, and as a hawk again it appears in Egypt and in Assam.

This belief in a separable soul with an insect or other form must obviously influence beliefs in the eschatology of the soul. We find accordingly that the soul is believed to pass into an insect on the decease of the body. Thus the Angami Naga credits the soul with a number of subsequent existences in insect form, while the Chang holds that the souls of those who can sing become cicadas, but the souls of others dung beetles. Thus the Bakongs of Borneo believe that their dead are reincarnated in the bear-cats which frequent their raised coffins; wood-boring wasps and hornets take up their abode in the wooden soul figures put up by some tribes of Assam, and we find Nagas and Lusheis regarding wasps and hornets (among other insects) as souls.

If the soul can leave an individual during sleep and re-enter him, it should be able to enter and be reborn in another individual. In Germany, a dying man's heart passes into his brother, whose courage is doubled; in the Garo hills the soul, after a sojourn in the abode of the dead, returns for another incarnation. The range of this conception of reincarnation is indicated by the frequency of tabu on giving children names already borne by living members of the family. (*See* NAMES.) The notion is that identity of name implies identity of personality and that one of

the two bearers would die. Hence the Lhotas, for instance, never give the child the name of a living relative. A belief in reincarnation within the family would naturally be strengthened by the recurrence of marked family resemblances. In any case a belief in the reincarnation of human souls is indicated by such rites as those of the Akikuyu women of East Africa, who, in order to have children, worship at a *ficus* tree inhabited by the souls of the dead, or of the Konyak Nagas of Assam, who perform ceremonies over phallic cists containing skulls of deceased persons, in order to secure a birth of corresponding sex to that of the skull.

Reincarnation is not confined to animal forms. The stories of trees that grow up from the graves of lovers, such as Tristram and Iseult, and twine themselves together are familiar in Europe; and the human soul also reappears in a flower growing on the grave. In the case of flowers springing from drops of blood, as from that of Ajax, the soul is possibly regarded as located actually in the blood itself. In further Asia and elsewhere the soul goes into the crops, and by preserving the corpse, which is smoke-dried, funeral ceremonies are accommodated to the agricultural year, so as to afford the crop the full benefit of the soul matter from those who have died recently; and in the case of the Karens of Burma a specific theory is evolved of a cycle of life on these lines. (*See* HEAD-HUNTING.) The Lushei theory that the soul takes the form of dew and is reincarnated in the body on which it descends, may be a version of the Karen theory.

The idea of transmigration has been influenced and inevitably confused by ideas as to the external soul, generally associated with magicians, where the vital principle depends on a soul kept in an animal in the forest, or in an egg below the sea, etc., which has to be secured before the magician can be killed, by ideas as to totemism and lycanthropy (*qq.v.*), and beliefs in the reincarnation of the soul in predatory forms such as tigers (India and Sumatra), sharks (Melanesia), or alligators (Africa), have perhaps arisen in connection with those ideas.

BIBLIOGRAPHY.—Stallybrass, *Grimm's Teutonic Mythology* (1888); Sir J. G. Frazer, *The Belief in Immortality* (1920–23). (J. H. H.)

HISTORICAL ASPECT

Metempsychosis is also important to philosophic thought. Apparently, Greece did not borrow the doctrine from Egypt or India but used savage ideas for religious and philosophic purposes. The Orphic religion, which held it, first appeared in Thrace upon the semi-barbarous north-eastern frontier. Orpheus, its legendary founder, is said to have taught that "soul and body are united by a compact unequally binding on either; the soul is divine, immortal and aspires to freedom, while the body holds it in fetters as a prisoner. Death dissolves this compact, but only to re-imprison the liberated soul after a short time: for the wheel of birth revolves inexorably. Thus the soul continues its journey, alternating between a separate unrestrained existence and fresh reincarnation, round the wide circle of necessity, as the companion of many bodies of men and animals. To these unfortunate prisoners Orpheus proclaims the message of liberation, that they stand in need of the grace of redeeming gods and of Dionysus in particular, and calls them to turn to God by ascetic piety of life and self-purification: the purer their lives the higher will be their next reincarnation, until the soul has completed the spiral ascent of destiny to live for ever as God from whom it comes." Such teaching appeared in Greece about the 6th century B.C., organized itself into mysteries at Eleusis and elsewhere, and produced a copious literature.

The earliest Greek thinker with whom metempsychosis is connected is Pherecydes; but Pythagoras, who is said to have been his pupil, is its first famous philosophic exponent. Pythagoras probably made his reputation by bringing Orphic doctrine from North-eastern Hellas to Magna Graecia.

The importance of metempsychosis is due to Plato. In the eschatological myth which closes the *Republic* he tells the story how Er, the son of Armenius, miraculously returned to life on the twelfth day after death and recounted the secrets of the other world. There are theories to the same effect in other dialogues, the *Phaedrus, Meno, Phaedo, Timaeus* and *Laws*. In Plato's view the number of souls was fixed; birth therefore is never the creation of a soul, but only a transmigration from one body to another. Plato's acceptance of the doctrine is characteristic of his sympathy with popular beliefs and desire to incorporate them in a purified form into his system. Aristotle, a far less emotional and sympathetic mind, has a doctrine of immortality totally inconsistent with it. In later Greek literature the doctrine appears from time to time; it is mentioned in a fragment of Menander (the *Inspired Woman*) and satirized by Lucian (Gallus § 18 *seq.*). In Roman literature it is found as early as Ennius, who in his Calabrian home must have been familiar with the Greek teachings which had descended to his times from the cities of Magna Graecia. In a lost passage of his *Annals*, a Roman history in verse, Ennius told how he had seen Homer in a dream, who had assured him that the same soul which had animated both the poets had once belonged to a peacock. Persius in one of his satires (vi. 9) laughs at Ennius for this: it is referred to also by Lucretius (i. 124) and by Horace (*Epist. II.* i. 52). Virgil works the idea into his account of the Underworld in the sixth book of the *Aeneid* (vv. 724 *sqq.*). It persists in antiquity down to the latest classic thinkers, Plotinus and the other Neoplatonists.

Attempts have been made with little success to find metempsychosis in early Jewish literature. But there are traces of it in Philo, and it is definitely adopted in the Kabbala. Within the Christian Church it was held during the first centuries by isolated Gnostic sects, and by the Manichaeans in the 4th and 5th centuries, but was invariably repudiated by orthodox theologians. In the middle ages these traditions were continued by the numerous sects known collectively as Cathari. At the Renaissance we find the doctrine in Giordano Bruno, and in the 17th century in the theosophist van Helmont. A modified form of it was adopted by Swedenborg. During the classical period of German literature metempsychosis attracted much attention: Goethe played with the idea, and it was taken up more seriously by Lessing, who borrowed it from Charles Bonnet, and by Herder. It has been mentioned with respect by Hume and by Schopenhauer. Modern theosophy, which draws its inspiration from India, has taken metempsychosis as a cardinal tenet; it is, says a recent theosophical writer, "the master-key to modern problems," and among them to the problem of heredity. (H. ST.)

BIBLIOGRAPHY.—A. Bertholet, *The Transmigration of Souls* (trans. from the German by H. J. Chaytor); E. Rohde, *Psyche*.

METEOR, a term used by the Greeks to denote atmospheric phenomena in general, such as clouds, halos, rainbows, etc., as well as shooting stars (Gr. μετέωρα, literally "things in the air," from μετά, beyond, and ἀείρειν, to lift up). This usage survived even into older English literature. To-day the term meteor is restricted to those cosmical bodies which, entering the earth's atmosphere from without and shooting across the sky, give the appearance of a star in rapid motion, often leaving a bright train behind. (*See* METEORITE.)

As indicated by the name, in ancient times meteors were considered to be atmospheric in origin and hence not cosmical bodies. It is true that accounts of the fall of stones from the sky are found in Chinese and classical literature, running back 2,600 years. The Chinese also recorded single brilliant meteors as well as showers of shooting stars. In Europe many of these latter have also been recorded for the past 1,500 or more years. But not until 1803 were contemporary scientists convinced that meteorites came from space, and not until 1833 was it proved that ordinary meteors or shooting stars also had a cosmical origin. From then on they have been considered true astronomical bodies. In ancient and mediaeval times the passage of a brilliant fireball or fall of a meteorite was considered an omen, and viewed with superstitious dread. Great meteoric showers filled mankind with terrible fear, and in 1833 it is certain that the ignorant thought the end of the world had come. To-day such phenomena are viewed with keen delight and every effort is made to observe them in the interest of science.

Beginning of Systematic Study.—The study of meteors started in 1833. On Nov. 13 of that year there occurred a meteoric shower of the greatest brilliance that was seen from all parts of

eastern North America. It was estimated that more than 200,000 shooting stars were seen at one place between midnight and dawn. Many of the meteors were very bright, leaving persistent trains, yet there was no record of one of them having reached the earth.

Several men who observed this shower noted that the meteors seemed all to shoot out or radiate from a certain fixed point, that happened to be in the constellation Leo. This point is known as the radiant, and the meteors as Leonids. It was soon proved that the radiant was merely the direction in space from which the Leonids came, and, as this radiant was in the same position as seen from many widely separated places, the Leonids must come from without our atmosphere. The radiant is an effect of perspective, due to the meteors actually moving in practically parallel straight lines when they meet the earth. An excellent illustration is the effect when the sun's rays are seen shining through spaces between clouds. The rays are parallel, yet they appear to radiate.

Early Theories.—These discoveries were the foundation of meteoric astronomy. It was later found that the Leonids revolved around the sun in a period of 33 years, and a search of ancient documents showed records of brilliant showers coming in October or November extending back to A.D. 902. In 1866 the further notable discovery was made that the orbit of the Leonids was practically coincident with that of Tempel's Comet. A similar connection between the Perseid meteors, which come to a maximum in every August, and Tuttle's Comet had just been shown. One case might be a coincidence, two could hardly be. The intimate connection between comets and meteor streams was thus established. Soon after similar connections were found between the Lyrids of April and Comet 1861 I, and the Andromedes of late November and Biela's Comet. In recent years a few more have been found, the most notable being those between Halley's Comet and the May Aquarids, and Pons-Winnecke's Comet and a shower that came to a maximum late in June, 1916.

For many years the discovery of these intimate connections led astronomers to believe that most, if not all, meteors were merely the débris of comets, and hence originated in our Solar System. Strong evidence has, however, been accumulating that this view is only partially correct, and that a very large percentage of all classes of meteors must come to us from the depths of space and hence have originated elsewhere. It has been proved that a body, falling from rest at an infinite distance from the sun towards it, would move with a velocity of 26m. per second as it passed the earth's orbit. This is called the parabolic velocity. In general if a meteor has a heliocentric velocity of less than this value, then it originated in our system; if a greater, then in some other stellar system. The observing of such velocities, with a high degree of accuracy, is a most difficult problem, and the whole future of meteoric astronomy must rest largely upon its successful solution. The difficulty is due to the visible life of the average meteor lasting much less than one second. Velocities in our atmosphere as low as 8m. per second and as high as 50m. per second have been observed.

The Leonids.—The Leonids being the best known of all meteor streams, their history will be briefly traced. The following table gives the dates of appearances of bright showers:

902 Oct. 13	1101 Oct. 17	1602 Oct. 27	1833 Nov. 13
931 Oct. 14	1202 Oct. 19	1698 Nov. 9	1866 Nov. 14
934 Oct. 14	1366 Oct. 23	1799 Nov. 12	1867 Nov. 14
1002 Oct. 14	1533 Oct. 24	1832 Nov. 13	1868 Nov. 14
			1901 Nov. 15

It is apparent that while the showers certainly come at intervals of about 33 years, still there are long gaps. These may be explained in two ways; first that no record survives due to mere chance, second that the meteor stream missed the earth in these years. A fine return was hoped for in 1899, but very few Leonids were seen. It was, however, proved that the main group of Leonids, which normally would have met the earth in November 1899, had passed near the giant planet Jupiter *en route* towards us, and so had been switched aside somewhat by its attraction. This caused them to miss the earth. By the time the part of the stream that met us in 1901 passed Jupiter's orbit, the planet had passed on too far to disturb appreciably these meteors, so they appeared in considerable numbers. Indeed a few Leonids are met every November, so some must be scattered all around their orbit, but the dense part that can give us a really fine shower is condensed into a relatively small part of the whole circumference.

That the Leonids are not yet uniformly distributed, but are mostly included in a small group, seems to prove that they were comparatively recently turned into their present orbit. Uranus has been credited with having accomplished this in A.D. 126. It is impossible as yet to predict the chances for another great shower in 1932–34.

Biela's Comet suddenly divided into two parts in 1845. On its next return in 1852 the two parts were seen to be about equally bright and were a million miles apart. The comet was not found at the predicted return of 1859 or 1866, but on Nov. 27, 1872, a splendid display of meteors was seen. Calculation showed that these Andromedes, as they are now called, followed the same orbit as the lost comet which had had a period of $6\frac{2}{3}$ years. Another fine display, notable in that during it a piece of meteoric iron fell at Mazapil in Mexico, occurred on Nov. 27, 1885, and another lesser one on Nov. 23, 1892. On Nov. 24, 1899, a fair shower was seen, but, from then on, the earth has never encountered any considerable number of these meteors. Nor has Biela's Comet reappeared. Older records show showers that were probably due to this group on Dec. 6, 1741, Dec. 7, 1798 and Dec. 7, 1838. The main groups have either been broken up or switched so far from the earth's orbit that we no longer meet them.

Lyrids, Perseids and Others.—There is an annual shower of Lyrids, with a radiant near the star Vega, which in most years is inconspicuous, but occasionally abundant. For instance, on April 20, 1803, it furnished a very brilliant display, and a fair one on April 21, 1922. Ancient annals give us nine other great showers on corresponding dates, the earliest being in 687 B.C. The best known stream that is practically sure to give us a good annual display is the Perseid. These meteors, which are seen late in July and through the first half of August, have been extensively observed for the past hundred years. Their maximum comes on Aug. 11 or 12, when as many as 120 per hour sometimes may be counted. Definite daily motion of a radiant point was first proved for the Perseids. Many of these meteors leave persistent trains, and owing to their appearing in the summer for northern observers, they may be specially recommended to the amateur.

The Orionids which appear during the last half of every October, and the Geminids which appear the first half of every December, complete the list of really conspicuous meteor streams. The Orionids have been the subject of much controversy as to whether their radiant was in motion or stationary. The preponderance of evidence now points to daily motion. For the Geminids motion of the radiant has been generally conceded. At the maxima of both of these streams from 20 to 40 meteors per hour may be expected when conditions are favourable. Others worthy of mention are the Quadrantids, Jan. 1–3; the Eta Aquarids, May 1–11; and the Delta Aquarids, July 27–31. The Eta Aquarids, connected as they are with Halley's Comet, are the most important of the three.

Orbits and Perturbations.—Meteor showers cannot be expected to return an indefinite number of times. From their very nature they are not permanent, and we have already noted the case of the Andromedes, which, after furnishing several fine showers, seem to have died out, as it were. There are several known reasons for this; the most obvious that the stream misses the earth entirely, owing to its having been pulled aside by the attraction of some planet, the second that being at best a very loose aggregation of solid particles, their mutual gravitation is small. Hence when a group passes near a planet those nearest are more pulled aside by its attraction than those farther off, and as this must continually recur, eventually the group is widely scattered.

Meteor Radiants.—The possibility of a radiant remaining fixed in the same apparent place in the heavens has been seriously investigated. The existence of numerous so-called "stationary radiants" has been insisted upon by several experienced observers, and as firmly denied by many others. The reason why a radi-

ant should shift daily is, that even if all meteors from it for many days or weeks are moving in practically parallel paths, yet the earth in its orbital motion around the Sun changes its direction about 1° daily. The position of the apparent radiant depends upon the directions of motion of both earth and meteors. Hence if either changes, in general the radiant must shift. It has been proved, indeed, that a radiant, which lies near the ecliptic, can remain nearly stationary for some weeks.

The Numbers of Meteors.—It is hence impossible at present to give even an approximate estimate of how many meteor streams have so far been observed, more than to say that the number is large. Better data can be given as to hourly or monthly numbers of all meteors visible to the eye. It is found that nearly twice as many are seen per hour during the second half of the night as in the first half. Also meteors are twice as numerous from July to January as from January to July. The second phenomenon is due simply to the earth meeting more meteor streams in that part of its orbit; the first to the fact that in the evening hours the meteors must overtake the earth to become visible, while in the morning hours the meteors meet the earth head-on. Of necessity, therefore, we see more after midnight than before. From January to July, for the whole night, an hourly average of six or seven should be seen by one observer with a clear, moonless sky; from July to January an average of 12 to 15. Excluding telescopic meteors, of which there must be tens of millions, it is estimated that 20 million meteors enter our atmosphere daily, and a minimum of one meteorite per day reaches the earth's surface.

Fireballs and Bolides.—These bodies, which are merely super-meteors, owing to their larger mass, are able to penetrate lower before destruction. Also when they overtake the earth before midnight with low velocity, they sometimes have paths many hundred miles long in our atmosphere, which often do not make large angles with its surface. These circumstances permit them a relatively longer survival. Such bodies may give every variety of phenomenon mentioned above. When they come quite near the earth's surface their passage is frequently accompanied by very loud sounds, which are sometimes said to be like explosions but more properly may be compared to the "shock-wave" of a great projectile. Many compare them also to distant thunder. Such fireballs of very long paths may actually cross from horizon to horizon for one observer and pass far beyond.

The most remarkable example of this type of phenomenon is furnished by the "Meteoric Procession" of Feb. 9, 1913. This wonderful group of bright meteors or fireballs was first seen over Canada, and having travelled about 5,700 miles was last seen over the Atlantic, but still going towards the south-east. It consisted of four or five groups of 40 to 60 members each. Along the observed part of their path their height was only about 35 miles. At many of the Canadian stations their passage produced sounds like thunder, and at eight stations even houses were shaken. A similar phenomenon was seen at Cairo, in 1029 A.D., although unhappily the record is brief.

The brightness of most fireballs will vary greatly, generally increasing towards the end of their path. Minor explosions are often seen before the great final outburst that ends the career of so many of them. It is not unusual for such objects to have an apparent diameter equal to that of the moon, and to give about as much light as that body. Occasionally one has been reported as making the night as bright as day, but we may well consider this an exaggeration. As such bodies are never expected, all observers suffer the serious disadvantage of surprise.

Heights and Velocities.—The heights of meteors in the atmosphere may be determined by observation and calculation, following well-known rules. The same object must have the coordination of its end points observed from at least two places whose distance apart is known. How a meteor is actually observed is described later. With the data mentioned it is relatively a simple matter to calculate the heights at which it began and ended as well as its length of path. During the last century and a quarter this has been done for many hundred such objects, varying from the smallest meteor observable to the naked eye to the largest fireballs. The following table gives the average results:

No.	Beginning.	Ending.	Notes.
109	67·4m	53·6m	Magns. 1–5
121	86·1		Large meteors and
213	..	30·9	meteorites
147	..	37·4	Fireballs
57	..	19·3	Detonating meteors
16	..	13·7	Meteorites
49	71·4	54·7	Perseids by Weiss
			Authority: von Niessl
39	69·8	56·0	Perseids in 1863
78	96·3	60·7	Leonids in 1863
			Authority: Newton
107	73·6	45·3	Misc. meteors and fireballs
			Authority: Denning (1896)

If it is asked why the Leonids appear at higher altitudes than the Perseids, it is due to the fact that they strike the earth more nearly head-on. This gives them a greater relative velocity and hence they can begin to glow in a less dense part of our atmosphere.

Luminosity, Mass and Size.—It is obviously impossible that dust, gas or solid particles could continue to glow, merely from having been heated, in the intensely cold upper air for periods of many minutes. The part of a meteor's path that seems to give long enduring trains is from 60 to 50m. above the earth's surface. Study with the telescope has shown them to be tubular in shape. Suggested explanations are that the trains are due to phosphorescence, possibly connected with electric discharges; or that part of the energy being stored up in the molecules is later released as a gradual emission of light.

All reliable calculations of the masses and diameters of meteors lead to surprisingly small values. Meteors of the first and second magnitude are thought to be not more than one- or two-tenths of an inch in diameter, nor weigh more than a few milligrams. All such bodies undoubtedly appear larger owing to the envelope of heated and glowing gas that surrounds them in their flight, as well as to irradiation. There appears no sound reason for thinking small meteors different in constitution from their larger brothers, the meteorites. Analyses of the latter give us the usual elements, iron and nickel being very prominent in the metallic ones. But many are wholly composed of stone. We may safely infer that smaller meteors have a similar constitution and are merely smaller fragments. That different elements predominate in individual meteors is further proved by their different colours. In a few cases the spectra of meteors have been photographed. These spectra also show familiar elements, such as hydrogen, calcium, magnesium, carbon, helium and sodium, but this analysis gives no conclusive evidence as to their source.

Meteor Observing.—The actual observation of meteors forms one of the branches of astronomy best suited to amateurs. The only equipment needed is a star chart on which to plot the paths, a notebook and watch. Observations are made by noting carefully the points among the stars at which the meteor begins and ends, and plotting this path upon the map. Records of the time, colour, magnitude, etc., are made in the notebook at the same time. Societies for this work, largely composed of amateurs, now exist in several countries. Such work is of real scientific value and is the basis for advances in meteoric astronomy.

For more than 30 years attempts have been made to apply photography, but progress has been slow. It has been proved, however, that only short-focus instruments of considerable light-gathering power are of real service. Lenses four to six inches in diameter with a focal ratio of about 1:4 have been most used. Even with these only bright or very slow-moving meteors register themselves, and as no great shower has come of late the total number of trains photographed has not exceeded a few hundred. In some cases enough have been photographed on one night to give a radiant, but most are isolated. Attempts to obtain heights and velocities by photography have met with some success, but progress has been painfully slow. Nevertheless this method holds out great promise for the future. Some of the few radiants so derived were found with gratifying exactness.

Theories of Origin.—The question of the origin of meteors

carries us inevitably to that of the origin not only of our Solar System, but to that of other similar systems in space. It has been shown that there is an intimate connection between orbits of comets and some meteor streams, and it is inferred on sound grounds that the nuclei of comets consist of solid masses—*i.e.*, meteors of various sizes.

Accepting the Planetesimal Hypothesis, or some modification of it, as the true one, we may look upon all meteoric bodies as the débris of evolution—as fragments left over, or as parts of planetesimals that were destroyed before achieving full growth. But a study of the orbits and velocities of numerous fireballs and meteorites proves that they originated outside the Solar System. Analyses of some such meteorites prove beyond controversy that they once formed part of larger solid bodies of planetary dimensions. Hence we must infer an origin for these similar to those we know originated here. This brings us to one of the most important results of recent meteoric astronomy: if a catastrophic origin must be assumed for our Solar System, similar origins must be assumed for innumerable others, and hence we must admit that many other stars have systems of planets which were evolved in a manner similar to our own.

Bibliography.—O. C. Farrington, *Meteorites* (1915), Chas. P. Olivier, *Meteors* (1925). (C. P. O.)

METEORA, a group of monasteries in Thessaly, north of the Peneius valley, near the village of Kalabaka (the ancient Aeginium, mediaeval Stagus or Stagoi), not quite 20 m. N.E. of Trikkala. From the Cambunian hills two masses of rock project southward into the plain, eroded into isolated columns 85 to 300 ft. high, "some like gigantic tusks, some like sugar-loaves, and some like vast stalagmites," all of iron-grey or reddish-brown conglomerate of gneiss, mica-slate, syenite and greenstone. The monasteries stand on the summit of these pinnacles; accessible only by rope and net worked by a windlass from the top, or by a series of almost perpendicular ladders. The peak on which St. Stephen's is built does not rise higher than the ground behind, and the deep, narrow chasm is spanned by a drawbridge. Owing to the confined area, the buildings are closely packed, but each monastery contains beside the monks' cells and water-cisterns, at least one church and a refectory, and some also a library. At one time they were 14 in number, but now not more than four (the Great Monastery, Holy Trinity, St. Barlaam's and St. Stephen's) are inhabited by more than two or three monks. The present church of the Great Monastery was erected, according to Leake's reading of the local inscription, in 1388 (Björnståhl, the Swedish traveller, had given 1371), and it is one of the largest and handsomest in Greece. A number of the mss. from these monasteries are now in the National Library at Athens. Aeginium is described by Livy as a strong place and Stagus appears in Byzantine writers.

See W. M. Leake, *Northern Greece* (4 vols., 1835); Prof. Kriegk in *Zeitschr. f. allg. Erdk.* (1858); H. F. Tozer, *Researches in the Highlands of Turkey* (1869); L. Heuzey and H. Daumet, *Mission archéologique de Macédoine* (1876), where there is a map of the monasteries and their surroundings; *Guide-Joanne; Grèce*, vol. ii. (1891).

METEORITE, a mass of matter from outer space, which has fallen upon the earth's surface. These masses are made up usually of stony matter with varying amounts of metallic iron containing nickel; more rarely of nickeliferous iron alone; and much more rarely of stony matter with little or no metal.

Before coming in contact with the earth, these bodies have been travelling through space with planetary velocities of many miles a second. It is not surprising, therefore, that their arrival in the earth's atmosphere is heralded by very startling phenomena of light and sound. Owing to the resistance of the air, the meteorite becomes incandescent and is then seen as a scintillating ball of fire, sometimes with an apparent diameter greater than that of the moon. The fireball leaves behind it a trail of luminous matter, like a gigantic shooting-star of which the duration of flight has been much prolonged. The period of incandescence, however, is still only a matter of seconds for, as a result probably of the sudden condensation of the air in front of the moving mass and the accumulating pressure, the meteorite soon loses its planetary speed and eventually bursts into fragments. As a consequence partly of this shattering, but mainly of the sudden explosive shock and rise of temperature given to the air by the rapid passage of the meteorite, a short time after the disappearance of the fireball, loud detonations like thunder are heard, and these are generally followed by weird sounds which have been likened to the bellowing of oxen, the roaring of a fire in a chimney, the tearing of calico, etc. Owing to the rapid reduction in speed of the meteorite, the fragments reach the ground like ordinary falling bodies with velocities not greater than a few hundred feet a second. They, therefore, penetrate the soil to a depth of only a few feet, and in one particular fall, which took place in 1869 at Hessle in Sweden, stones which fell upon ice only a few inches thick rebounded from the surface. Moreover, in spite of the fact that the original mass had been rendered incandescent, the time of flight is too short for any real penetration of heat beneath the surface. Accordingly, the stones, when they reach the ground, are generally only slightly warm to the touch, and the sole evidence of the intense heat to which they had been subjected is a black fused crust which covers them (occasionally only partially), but is rarely more than a millimetre thick. The characteristic feature of most stony meteorites is this black crust, contrasting so remarkably with the white to grey interior scattered through which can usually be seen bright specks of metallic iron and often curious rounded bodies known as chondrules. In these respects meteoric stones are very different from the rounded nodules of sulphide of iron which weather out of the chalk on the S.E. coast of England and are often called "thunderbolts" and mistaken for meteorites. The term "thunderbolt" indeed as applied to meteorites is a misnomer since they have no connection with thunderstorms, and reports of the fall of "thunderbolts" during storms really refer to lightning-strokes. It is only under favourable conditions that such phenomena have been observed in their entirety. At the actual place of fall often only detonations have been heard, although the fireball may have been seen at places miles away, and when on March 9, 1923, a small stone of about 3 lb. fell a few yards from a labourer at Ashdon, Essex, only the whizzing of its flight was heard.

Occurrence of Falls.—That the advent of these bodies is an event of somewhat rare occurrence is evident from the fact that the number of falls of which specimens have been preserved is only about 1,000, and that of these no more than 15 have taken place in the British Isles. The number of new falls recorded for the whole world in any one year is generally less than ten, though doubtless others occur in sparsely populated regions and escape human observation. One of the earliest falls to be recorded took place about 644 B.C., strange to say, in China, for until quite recently no meteorite in that country appears to have been preserved. Other ancient falls of stones, some of which were made objects of worship, are recorded by Plutarch and Pliny. The stone referred to in the Acts as the image of Diana of the Ephesians "which fell down from Jupiter" was probably a meteoric stone, as is also doubtless the sacred stone built into the Kaaba at Mecca. The earliest known meteoric stone still preserved and of which details were placed on record is that weighing about 260 lb. which, after a loud crash like thunder, fell at Ensisheim in Alsace about noon on Nov. 16, 1492, and was seen by a child to strike the ground, where it buried itself to a depth of 5 ft. In later years several other falls were as definitely recorded, including that of a 56 lb. stone (now in the Natural History Museum) which fell within 10 yd. of a labourer at Wold Cottage in Yorkshire in 1795. Nevertheless it was not until after the publication of the detailed report made by the French physicist Biot on the marvellous fall of about 2,000 stones which took place at L'Aigle in France on April 26, 1803, that the fact of solid bodies falling from outer space was finally accepted by scientists.

Many years before this, however, the German philosopher Chladni had collected all the evidence for such events then available, and had laid particular stress, curiously enough, upon the occurrence in various parts of the world of masses of iron which had not actually been seen to fall but had been found in places where their presence could not be accounted for except on the supposition of an extra-terrestrial origin. One of these masses

weighing over 1,500 lb. was found on the top of a mountain 145 m. south of Krasnoyarsk in Siberia and was seen by the traveller Pallas in 1772; while other masses, of which one weighing 1,400 lb. is now in the Natural History Museum, had been found in the desert of the Gran Chaco, Argentina. Since Chladni's time, many other masses of iron meteorites, some of enormous size, have been recorded from different localities. One of the largest is the 36½ ton mass brought from Cape York, Greenland to New York by the Arctic Explorer R. E. Peary and now in the American Museum of Natural History. It is the largest meteorite preserved in a Museum, though in size it may perhaps be rivalled by the mass about 13 ft. long which is still lying where it fell on the farm El Ranchito near Bacubirito in Mexico, and also by a mass found in 1921 near Cinquetti in the desert of Adrar, Mauretania, although the original statement that it measured 100 metres in length still lacks confirmation. All these masses, however, would fall into insignificance beside the mass the impact of which it has been maintained by some must have given rise to that curious crater-like depression near Cañon Diablo in Arizona known as Coon Butte which is 4,000 ft. across and some 550 ft. deep, with walls of limestone and sandstone rising over 100 ft. above the plain. Several tons of meteoric iron have been found in the neighbourhood of the "crater," but borings have failed hitherto to locate any large mass within it. The largest mass of meteoric iron in the British Natural History Museum is the 3½ ton mass which was found in 1854 at Cranbourne near Melbourne, Australia.

Although specimens of iron meteorites bulk largely in museum collections and have resulted from as many as about 250 distinct falls, of only about 20 has the fall been actually witnessed. On the other hand, the great majority of stony meteorites (some 600) have been seen to fall, for if not recovered soon after they reach the ground they are more liable to suffer disintegration and escape notice than large masses of iron. Of these no specimens compare in size with the iron meteorites. The largest mass known was a 1,200 lb. stone found in fragments at Long Island, Kansas. The largest unbroken stone preserved in a museum (the Natural History Museum, Vienna) is one weighing 645 lb. which fell at Knyahinya in Czechoslovakia and is said to have made a hole in the ground 11 ft. deep. This was the largest stone of a shower of about 1,000 which fell near that place on June 9, 1866. The number of stones which fall at any one time and place is usually small and occasionally, as in 12 of the 15 falls recorded in the British Isles, only a single stone is recovered. In some falls, however, as in that of Knyahinya and that of L'Aigle already referred to there are showers of hundreds and thousands of stones. Besides these two showers, the most remarkable are the fall of some 100,000 stones near Pultusk, Poland, on Jan. 30, 1868, of 3,000 at Mocs, Transylvania, on Feb. 3, 1882, of 500 at Hessle, Sweden, on Jan. 1, 1869, 100 near Homestead, Iowa, on Feb. 12, 1875, and 14,000 near Holbrook, Arizona, on July 19, 1912. The stones of such showers are distributed over elliptic areas up to 16 m. in length and the largest stones of greatest momentum travel the farthest before reaching the ground. In the Holbrook shower thousands of the individuals were very small, some not much larger than grape seeds, but each one was covered with the characteristic thin black fused crust.

General Appearance.—Besides the crust, which is usually dull black but in stones containing little metal often glossy, other distinguishing features of meteoric stones are lines of flow, on the crust, of molten material which was directed from the front to the back of the stone as it flew through the air; and also curious pittings, up to 1 in. in diameter, which have been likened to "thumbmarks." In shape meteorites are generally irregular, indicating that they are only fragments of the larger masses from which they have been torn. A roughly pointed conical form is the most common. One of the large iron masses, that weighing about 1,500 lb. found at Tucson in Arizona and now preserved in the National Museum in Washington, is remarkable as being ring-shaped, while jaw-shaped masses like that found at Kokstad in South Africa are supposed to be parts of original ring-shaped masses.

There are few if any really authentic records of death or injury to man being inflicted by meteoric stones, but several—as at Benares, Kilbourn, Pillistfer, etc.—have struck buildings or fallen through roofs. Of these occurrences the most startling, perhaps, was the fall of a mass of iron at Braunau, Bohemia on July 14, 1847, which penetrated the roof of a house and covered with debris the bed in which three children were sleeping; one of the most recent is the crashing through the roof of a house of one of the four stones which fell on Dec. 3, 1917, in the Strathmore district, Scotland.

Composition.—As these bodies come from beyond the skies, it is naturally of interest to see how far they resemble and in what respects they differ from the rocks which compose the earth's crust. Stony meteorites certainly have the character of igneous and not of sedimentary rocks, and as they consist largely of pyroxene and olivine they approach in mineral composition basaltic rocks and more particularly, since felspar is in subordinate amount, the ultra-basic group of peridotites and pyroxenites. As compared with terrestrial rocks, however, they differ in various ways, suggesting that they were formed under conditions of lower oxidation than obtain on the earth's surface. Thus, whereas native iron is of the rarest occurrence in terrestrial rocks, it is an almost invariable constituent of meteorites. Both iron and stony meteorites also contain occasionally minerals such as the sulphide of calcium, *oldhamite,* and the phosphide of iron and nickel, *schreibersite,* which are unknown as minerals of the earth's crust since they could not exist for long in the presence of oxygen and moisture.

No new element has been found up to the present in meteorites, and, on the other hand, some common elements, including the strongly radioactive ones, have not yet been detected in them. The elements of which they are mainly composed are those of low atomic weight such as occur commonly in the earth's crust, viz.:—in approximately their order of abundance (according to W. A. Wahl) iron, oxygen, silicon, magnesium, aluminium, calcium, nickel, sodium and sulphur. In smaller amounts occur potassium, cobalt, phosphorus, carbon, hydrogen, chlorine, chromium, manganese, titanium, nitrogen, platinum metals and copper; while traces of iodine, bromine, argon, helium and radium, and doubtfully gold, tin and vanadium have been recorded. Carbon in meteorites is mostly in the form of graphite, but from the Cañon Diablo iron and the Novo-Urei stone chips having the hardness of diamond are recorded to have been isolated, and in the Youndegin iron was found a cubic form of graphite which has been called cliftonite. A few meteoric stones, including those of the small shower which fell at Cold Bokkeveld, South Africa, on October 13, 1838, are remarkable as containing small amounts of solid hydrocarbons which can be extracted from them by alcohol and ether. According to the relative amounts of nickeliferous iron and stony matter, meteorites have been grouped into three main divisions, viz:—*meteoric irons* or *siderites,* consisting almost wholly of nickeliferous iron; *meteoric stony-irons* or *siderolites,* of metal and stony matter in about equal amounts; and *meteoric stones* or *aerolites,* of stony matter, usually with nickeliferous iron scattered through it in small grains.

The metallic constituent of meteorites (both irons and stones) is not uniform in composition, for the percentage of nickel in it varies widely (from about 3 to 40) in different falls. In by far the greatest number of meteoric irons, however, the percentage of nickel lies between about 7 and 15. These irons are made up mainly of two different alloys of iron and nickel, and are characterized by a peculiar structure which is revealed upon polished surfaces by the etching action of dilute nitric acid or bromine water. These structures, which are known as Widmanstätten figures from their discoverer, consist of bands of a nickel-poor alloy, called *kamacite* and containing about 7% of nickel, bordered by narrower and more brilliantly reflecting bands of another alloy called *taenite* which is much richer in nickel (from 14% to nearly 50%) and less soluble than kamacite. These bands are the edges of plates which are arranged parallel to the faces of an octahedron. Hence these irons are known as *octahedrites* and where the bands are "medium" and "fine," there is usually a third material called *plessite* which is probably an intimate mixture of the same two alloys.

Classification of Meteorites

Group→		1	2	3	4
Class ↓	Nickel-iron→ Magnesium silicates→ Felspar→	Fe: Ni=13 and over. Enstatite (and Clinoenstatite). MgO : FeO very high to ∞. Oligoclase.	Fe: Ni=13−8. Bronzite (and Clinobronzite) and Olivine. MgO : FeO over 4. Oligoclase.	Fe: Ni=8−2. Hypersthene (and Clinohypersthene) and Olivine. MgO : FeO=4−2. Oligoclase.	. . Pyroxene (mostly monoclinic) and Olivine. MgO : FeO less than 2. Anorthite.
Irons 1	SIDERITES→ Mainly nickel-iron.	Nickel-poor Ataxites. Hexahedrites. Coarsest Octahedrites. Coarse Octahedrites.	Medium Octahedrites to Finest Octahedrites.	Nickel-rich Ataxites.	
Stony-Irons 2	SIDEROLITES→ Nickel-iron in large amount.		Most Pallasites. Siderophyre. Lodranite. Mesosiderites.*	A few Pallasites.	
3	CHONDRITES→ Nickel-iron generally in decreasing amount from left to right.	*Enstatite-chondrites.* Daniel's Kuil (Hvittis) type.	*Bronzite-olivine-chondrites.* Cronstad type.	*Hypersthene-olivine-chondrites.* Baroti and Soko-Banja types.	
Stones (Aerolites) 4	ACHONDRITES→ (Non-chondritic stones.) Nickel-iron in small amount or absent.	*Enstatite-achondrites.* Aubrites. (Aubres, Bishopville, and Bustee.)	*Clinobronzite-olivine-achondrites.* Ureilites.	*Hypersthene-olivine-achondrites.* (dites). Amphoterites (& Ro- *Hypersthene-achondrites.* Diogenites (Shalka, etc.). *Olivine-achondrites.* Chassignite.	*Calcium-rich Achondrites.* Angrite, Nakhlite. Eucrites, Sherghottite, Howardites.

*As regards the felspar and the pyroxene, mesosiderites conform to Group 4.

Meteoric irons often contain nodules and crystals of various minerals scattered through them. Of most common occurrence is *troilite,* the monosulphide of iron similar to, if not identical with, the terrestrial pyrrhotite. Frequently associated with the troilite nodules are inclusions of schreibersite and of graphite. Other minerals less frequently found in irons are *daubreelite,* a sulphide of iron and chromium, the sulphur analogue of chromite; *cohenite,* a carbide of iron and nickel similar to the cemenoite of steel; and *moissanite,* a silicide of carbon similar to the artificial carborundum. Chromite is present in small amount in most irons, while in some the presence of the deliquescent chloride of iron called *lawrencite* is the cause of their liability to quick rusting and disintegration.

Gases included in small amount in meteorites have been found to consist mainly of hydrogen, carbon monoxide, carbon dioxide, nitrogen and marsh gas; carbon dioxide predominating in the stones, and hydrogen and carbon monoxide in the irons.

The stony-irons, of which about 30 are known, form a distinct group and are only intermediate between irons and stones as regards the amount of nickel-iron. In many of them (*pallasites*) the stony matter consists of olivine alone as rounded or fragmental crystals. In most of the other stony-irons (*mesosiderites*) the stony matter consists mainly of pyroxene with fragmental anorthite-felspar and only little olivine. Of exceptional composition is the stony-iron which was found at Steinbach in Saxony in which the stony matter consists of bronzite and tridymite (asmanite), for it is the only meteorite known containing an appreciable amount of free silica.

The great majority (about 90%) of meteoric stones are known as *chondrites* since they consist largely of curious rounded bodies (chondrules) which are embedded in a fragmental groundmass made up of irregular grains of pyroxene and olivine with scattered particles of nickel-iron and troilite. Chondrules are mostly of the size of millet seeds though occasionally as large as a walnut. They are formed of the same minerals, pyroxene and olivine with sometimes felspar and glass, as the rest of the stone. Some are of pyroxene alone in fibrous form, with the fibres often radiating from the edge and not from the centre.

The above tabular classification gives the names and mineral composition of the different kinds of meteorites. This classification is based on the hypothesis that meteorites have been derived from a single magma which has passed through successive stages of progressive oxidation.

The following is a list of the meteorites known to have fallen in the British Isles:—

Place	Date	Weight
England		
Wold Cottage, Yorkshire .	Dec. 13, 1795	One stone 56 lb.
Launton, Oxfordshire . .	Feb. 15, 1830	„ „ $2\frac{1}{2}$ lb.
Aldsworth, Glos. . . .	Aug. 4, 1835	„ „ $1\frac{1}{2}$ lb.
Rowton, Shropshire . .	April 20, 1876	„ „ $7\frac{3}{4}$ lb.
Middlesboro, Yorks. . .	March 14, 1881	„ „ $3\frac{1}{2}$ lb.
Appley Bridge, Lancs. . .	Oct. 13, 1914	„ „ 33 lb.
Ashdon, Essex . . .	March 9, 1923	„ „ $2\frac{3}{4}$ lb.
Scotland		
High Possil, Glasgow . .	April 5, 1804	„ „ 10 lb.
Perth	May 17, 1830	„ „ $7\frac{1}{2}$ in. in diameter, mostly lost.
Strathmore, Perthshire .	Dec. 3, 1917	Four stones of $22\frac{1}{4}$, $2\frac{1}{2}$, $2\frac{3}{8}$, $2\frac{1}{4}$ lb.
Ireland		
Mooresfort, Tipperary .	Aug., 1810	One stone of $7\frac{3}{4}$ lb.
Limerick (Adare) . . .	Sep. 10, 1813	A small shower of stones, the largest 65 lb.
Killeter, Tyrone . . .	April 29, 1844	A small shower of stones, only a few fragments preserved.
Dundrum, Tipperary . .	Aug. 12, 1865	One stone of 5 lb.
Crumlin, Antrim . . .	Sep. 13, 1902	„ „ of $9\frac{1}{2}$ lb.

Origin.—Little can be said of a definite character concerning this. The prevailing and orthodox view which dates from the time of Chladni is that the detonating meteoritic fireball and the ordinary shooting star or meteor (*q.v.*) are only variations of one phenomenon. According to this theory meteorites are large enough to survive their fiery transit through the air, meteors are not; and moreover, since the orbits of some comets have been shown to be the same as those of some star-showers, meteorites are supposed to be identical with the material of comets and in that case to be moving through space in swarms having definite orbits. It has been objected to this theory that meteorites, with one exception, have not been known to fall during displays of star-showers and do not fall most frequently during that period of the year when shooting stars are prevalent. The general similarity of meteorites in chemical composition, and the

evidence they afford of consanguinity or derivation by progressive oxidation from a common type, certainly indicate that they belonged originally to a single celestial body. Such a body may have suffered some catastrophic disruption, and if so, it has been argued, this must have taken place in fairly recent geological time since, with the one exception of a meteoric iron found in Pliocene gravels in Klondike, "fossil" meteorites are unknown.

No meteorite which has been seen to fall approaches in chemical composition the acid granitic rocks which occur so plentifully on the earth's surface. In various parts of the world, however, namely in Bohemia and Moravia, the East Indies and Australia, have been found peculiar small glassy bodies resembling obsidian and containing as high a percentage of silica. As these curious bodies, which have been called *tektites*, occur in no obvious connection with recent volcanoes or with ancient volcanic rock, a meteoritic origin has been suggested.

The most important collections of meteorites are in the Natural History Museums of Chicago, London, Vienna and Paris. The number of falls represented in the British Museum (Natural History) collection is about 710, and the weight of the specimens amounts to just over 6 tons.

BIBLIOGRAPHY.—E. F. F. Chladni, *Ueber Feuer-Meteore, und über die mit denselben herabgefallenen Massen* (Vienna, 1819); G. Tschermak, *Die Mikroskopische Beschaffenheit der Meteoriten* (Stuttgart, 1883–85); A. Brezina u. E. Cohen, *Die Structure und die Zusammensetzung der Meteoriten* (Stuttgart, 1886–87); E. Cohen, *Meteoritenkunde* (Stuttgart, 1894–1903); E. A. Wulfing, *Die Meteoriten in Sammlungen und ihre Literatur* (Tübingen, 1897); L. Fletcher, *An Introduction to the Study of Meteorites*, 11 ed. (1914); O. C. Farrington, *Meteorites* (Chicago, 1915) and *Catalogue of the Meteorites of N. America* (Washington, 1915); G. P. Merrill, *Handbook and Descriptive Catalogue of the Meteorite Collections in the United States National Museum* (Washington, 1916); G. T. Prior, *Catalogue of Meteorites* (1923) and *Appendix* (1927), and *Guide to the Collection of Meteorites in the British Museum* (1926). (G. T. P.)

METEOROLOGICAL SOCIETIES. The *Royal Meteorological Society* of London, founded in 1850, incorporated in 1866, publishes a *Quarterly Journal* (1873 etc.). The *Scottish Meteorological Society* was incorporated with the *Royal Meteorological Society* in 1921. The *Österreiche Gesellschaft für Meteorologie* of Vienna, and the *Deutsche Meteorologische Gesellschaft* of Munich issue a joint journal, the *Meteorologische Zeitschrift* (1866 etc. Vienna). Paris, *Société Météorologique de France* publishes *Annuaire Météorologique de France* (1849, etc.) and *La Météorologie* (1926 etc.). Turin, *Societá Meteorologica Italiana,—Bolletino Bimensile* (1865 etc.). Madrid—*Sociedad Española de Meteorologia,—Anales* (1927 etc.). Tokio,—*Meteorological Society of Japan,—Journal* (1903 etc.). Worcester, Mass.,—*American Meteorological Society,—Bulletin* (1920 etc.). Brussels,—*Société Belge d'Astronomie, de Météorologie et de Physique du Globe,—Ciel et Terre.*

METEOROLOGY, the science of the atmosphere (Gr. μετέωρα and λόγος, the science of things in the air). In its widest sense the term includes the study of weather, climate, optical phenomena in the atmosphere and atmospheric electricity.

HISTORY

The beginnings of the study of weather are lost in antiquity. Some of the earliest writings extant contain fragmentary references to weather phenomena, but the earliest known effort at systematic discussion was the *Meteorologica* of Aristotle (384–322 B.C.). Theophrastus, a pupil of Aristotle, wrote treatises on winds and on weather signs. Then for two thousand years meteorology stood still.

The Beginning of Meteorology as an Exact Science.—Advances were made with the invention of the thermometer (*see* HEAT) by Galileo in 1607, the invention of the barometer (*q.v.*) by Torricelli in 1643, the discovery of Boyle's law (*q.v.*) in 1659, and the invention of the wheel barometer by Hooke about 1670. Halley (1656–1742) attempted to explain the trade winds as a direct consequence of the distribution of solar radiation over the earth, but the true explanation was given by George Hadley in 1735, in a paper in which for the first time allowance was made for the effect of the rotation of the earth. In 1742 Celsius invented a Centigrade thermometer. Later de Saussure (1740–1799) perfected the thermometer and hygrometer, and showed that damp air is lighter than dry air at the same temperature and pressure. The true nature of atmospheric air was established by Lavoisier in 1783, and the laws of pressure of water-vapour in air were given by Dalton in 1800. Dalton also wrote an epoch-making paper on the effects of rarefaction and condensation, which laid the foundation of modern physical meteorology.

The First Weather Charts and Systematic Observations.—The Chevalier de Lamarck (1774–1829) working with Laplace, Lavoisier, and others established a réseau of observing stations, and published a series of *Annuaires Météorologiques* from 1800 to 1815. In 1820 Brandes produced a series of daily weather charts, one for each day of the year 1783, and later published charts of the great storms of 1820, 1821 and 1823. He explained these storms as due to barometric depressions advancing from west to east over the earth's surface. In America, Espy (1785–1860) carried out similar researches, and published a book *Philosophy of Storms* (Boston 1841). Espy established a service of daily synchronous observations and studied in detail the behaviour of depressions. The work of Lamarck, Brandes, Espy, Loomis, and others led to the establishment of networks of stations in several countries within the years 1850–56, the Meteorological Office in London being established in 1854. International co-operation was first established by an international conference held in Brussels in 1853, and was put on a sound basis by an international congress in Vienna in 1873. The exchange of information was at first by telegraph, later by wireless telegraphy.

The Study of the Upper Air.—A classification of clouds was made by Luke Howard in 1803. Temperatures in the upper air were first measured by Dr. Alexander Wilson at Glasgow in 1749, by means of thermometers sent up on kites. Later observations in manned balloons by Jeffries and Blanchard in 1784, Roberts in 1803–4, Biot and Gay-Lussac in 1804, and by John Welsh at Vauxhall in 1852, the last of these attaining a height of 23,000 feet. Self-recording thermometers were first used on kites by Rev. George Fisher and Sir Edward Parry in the Arctic in 1822–23.

Small free rubber balloons carrying self recording instruments (Sounding balloons) were first used by Hermite and Besançon in 1893, and in 1899–1902 Teisserenc de Bort and Assmann established the fact that above a height varying from 18 km. at the Equator to about 11 km. in latitude 50°, and to 6 km. or less at the poles, the temperature remained sensibly constant with height. (*See* section on Vertical Distribution of Meteorological Elements.) Upper air temperatures and humidities are now obtained daily from wet and dry bulb thermometers placed on the wing struts of aeroplanes.

THE COMPOSITION AND SOME PHYSICAL PROPERTIES OF THE ATMOSPHERE

General Composition.—The atmosphere is a simple mixture of gases, of which nitrogen and oxygen account for a little more than 99%. The proportions of the usual constituents of dry air are given in a table in the article ATMOSPHERE.

Constitution at High Altitudes.—In view of its bearing on theories of the origin of aurorae, magnetic storms and other phenomena, considerable interest attaches to the constitution of the atmosphere at higher levels, say from 20 km. to 200 km. Computation of the constitution of the atmosphere at these levels is based on the effects of diffusion, the convective mixing which is effective in producing constancy of composition in the lower layers having no effect at the higher levels. Each constituent is assumed to follow its own law of variation of density independently of the others, in accordance with Dalton's law. (*See* CHEMISTRY: *Physical.*) The lighter constituents will therefore tend to predominate more and more with increasing height. Hence it is of the utmost importance to ascertain what are the normal constituents of the atmosphere. If hydrogen is assumed to form a normal constituent of the atmosphere, then at great heights hydrogen will be the predominating constituent of the atmosphere.

In Wegener's scheme nitrogen ceases to be measurable at about 100 km. and beyond this level the composition of air by volume is

about 5% helium, and 95% hydrogen and geocoronium. Chapman and Milne (*Q.J.R. Met. Soc.* vol. xlvi.) regard the hydrogen observed at low levels as accidental, so that the lightest normal constituent of the atmosphere is helium. Experimental data are insufficient to decide between the different schemes of constitution of the high level atmosphere. According to Dobson (*Q.J.R. Met. Soc.*, 1923) meteors indicate that oxygen and nitrogen are the chief constituents up to about 160 km. McLennan attributes the green auroral line, of wave-length $\lambda = 5577{\cdot}35$ A.U. ($5{\cdot}57735 \times 10^{-5}$ cm., or $\cdot 557735\ \mu$) to *atomic* oxygen. These results appear to conflict with those derived from the assumption of Dalton's law.

Aqueous Vapour in the Atmosphere. Humidity.—The amount of aqueous vapour present in unit volume of air varies within wide limits from place to place, and from time to time in a given place. It may account for anything from 0 to 2·5% of the weight of a specimen of air. The saturation vapour pressure of air depends only on the temperature of the air, and is independent of the total pressure. If e is the saturation vapour pressure at temperature $t°$ C, then it should be possible to represent e as a function of t. No general formula has ever been discovered, though a large number of empirical formulae have been proposed by various writers. (*See* T. Preston *Theory of Heat*, v., 3rd ed. 1919.)

The relative humidity, vapour pressure, etc., are normally determined by observations of wet and dry bulb thermometers. If t and t' are the readings of the dry and wet bulb thermometers respectively, p the pressure, e' the saturation vapour pressure at the temperature of the wet bulb t', and e is the vapour pressure of the air under observation, these quantities are related by the formula

$$e - e' = Ap\ (t - t').$$

where A is a constant. The value of A depends upon the degree of ventilation of the thermometers, and care must be exercised to use the value of A appropriate to the conditions.

Tables will be found in Jelinek's *Psycrometer Tafeln*, in the *Smithsonian Meteorological Tables*, and in the *Humidity Tables* published by the Meteorological Office, London (M.O. 265).

Physical Constants for Air.—*The density of dry air* containing no CO_2, as determined by Regnault at the Collège de France, is 1·29321 kg. per cubic metre, at 0° C and at a pressure of 760 mm. At a pressure of 1,000 millibars and 0° C, the corresponding figure is 1·27590. Dry atmospheric air at a temperature of 0° C and 1,000 mb. has a density of 1·27617. The ratio of the density of water vapour to that of dry air at the same temperature and pressure is 0·6221, approximately $\frac{5}{8}$.

The Gas Constant, R.—The equation of condition for gases is

$$pv = RT,$$

where p is the pressure, v the volume of unit mass, T the absolute temperature, and R is a constant. If the pressure is expressed in millibars, and v is in cubic metres per kilogram the value of R for dry air is 2·8703.

The Density of Damp Air. Virtual Temperature.—For damp air at a total pressure p and vapour pressure e, the total density is the sum of the densities of the dry air and water vapour. The density is therefore

$$\frac{1}{RT}(p-e) + \frac{0{\cdot}6221}{RT}e \quad \text{or} \quad \frac{0{\cdot}34839}{T}(p - 0{\cdot}378e)$$

$$= \frac{0{\cdot}34839}{T}(p - \tfrac{3}{8}e) \text{ approximately.}$$

This is equal to the density of dry air at the same pressure p and a temperature T^v, where T^v is defined by

$$T^v = \frac{T}{1 - \frac{3}{8}\frac{e}{p}},$$

T^v is called the "virtual temperature." Tables of virtual temperature will be found in Bjerknes' *Dynamical Meteorology and Hydrography*, vol. ii. (Smithsonian Institution).

Absorption and Radiation.—In discussing meteorological processes we have to take account of (a) radiation from the sun, of relatively short wave-length, and of (b) radiation from the earth and portions of the atmosphere itself, of longer wave-length, having a maximum intensity at about 10 μ. (a) The amount of absorption of short wave solar radiation by "dry air" is so slight as to be almost negligible, but there is an appreciable absorption by water vapour, sufficient according to Abbot and Fowle to diminish the solar beam by one-tenth in its passage through the atmosphere. (b) Long wave radiation is not absorbed by oxygen or nitrogen, which, according to Burmeister (*Berlin Verh. Phys. Ges.* 1913) have no absorption bands at wave-lengths longer than 1 μ. Carbon dioxide shows absorption bands at 2·4 to 3·0 μ, at 4·2 to 4·5 μ and at 12·5 to 16 μ; and Schlaefer concluded that the amount of carbon dioxide in the atmosphere was sufficient to produce complete absorption within the bands mentioned. Water vapour absorbs long wave radiation in bands which are distributed through a considerable range of wave-length. The most exhaustive study of water vapour absorption is that of Hettner (*Ann. d. Phys.* 1905), who found that there is very marked absorption between 4·4 μ and 8 μ and above 12 μ, while there is a band from 8 μ to 11 μ within which there is only slight absorption by water vapour. Radiation from the earth at normal temperatures has a maximum intensity at about 10 μ, and so the existence of the band of relative transparency from 8 μ to 11 μ is of fundamental importance. The elementary gases absorb no radiation at atmospheric temperatures.

Thermodynamical Constants for Air.—*The potential temperature* of a mass of dry air is defined as the temperature which it would attain by adiabatic expansion or compression to a standard pressure, usually taken as 1,000 millibars.

The concept of potential temperature is particularly useful in dealing with conditions of vertical stability in the atmosphere. It was first introduced by von Bezold (*Sitz. Ber. Akad*, 1888).

Entropy.—A definition of entropy will be found in the article THERMODYNAMICS. If a small amount of heat dQ is communicated isothermally (*i.e.*, without changing the temperature) at a temperature T to a mass of air, then the ratio $\frac{dQ}{T}$ represents a small change of entropy, and is denoted by $d\phi$ (ϕ being the symbol for entropy). Thus, in an isothermal process, the gain or loss of heat is represented by $Td\phi$. Entropy remains constant for any adiabatic changes (*i.e.*, changes where heat is neither lost nor absorbed by the system). If we take zero of ϕ as corresponding to a potential temperature of 100° on the absolute scale,

$$\phi = 2{\cdot}30 \times 10^7 \times \log_{10} \frac{\theta}{100} \text{ ergs per degree per gram}$$

$$= 2{,}300 \log_{10} \frac{\theta}{100} \text{ joules per degree per kilogram.}$$

Geopotential.—It has been suggested that the height of a point above the surface of the earth should be defined by the geopotential, or the potential energy of unit mass at that height due to its elevation above the surface of the geoid. Surfaces of equal geopotential are "level surfaces" and are horizontal in the technical sense.

The geopotential being the potential energy of unit mass, has the dimensions of (velocity)^2. On the c.g.s. system the unit is 1 cm.^{2}/sec.^{2} A convenient unit for ordinary working purposes is the dynamic metre, equal to 10^5 cm.^{2}/sec.^{2} The approximate relation of the dynamic metre to the metre for latitude 50° is 1 dynamic metre = 1·0209 metre. Tables of geopotential are given in Bjerknes, *Dynamical Meteorology and Hydrography.*

INSTRUMENTAL OBSERVATIONS

For full details of the types of instrument which are in normal use in meteorological observations, reference should be made to the *Meteorological Observers Handbook* of the Meteorological

Office, or any standard textbook on the subject. (*See* also BAROMETRY, THERMOMETRY, etc.)

Air temperature does not readily permit of accurate determination. Difficulties arise through the necessity for ventilation of the instruments, combined with adequate protection from direct radiation from the sun or surrounding objects, combined with the variability of temperature between adjacent masses of air. The accuracy of determination of air temperature is therefore much inferior to the accuracy of the determination of the temperature of a liquid in the laboratory. This is but one example of the very real difficulties of accurate meteorological observation, and the existence of these difficulties must be borne in mind in what follows.

The methods which have hitherto been developed for upper air observations are only applicable in relatively fine weather, and so little is known from actual observation of the conditions at high levels above cyclones. This is probably the main reason for the slow advance made in meteorology during the last half-century.

GEOGRAPHICAL DISTRIBUTION OF METEOROLOGICAL FACTORS

The standard observations carried out at any meteorological station consist of measurements of: (1) Pressure at the time of observation, and the change in pressure during the past three hours if a barograph is available. (2) Temperature of dry bulb and wet bulb thermometers, so that both temperature and humidity can be derived from the readings. (3) Wind direction and velocity, the latter being estimated on the Beaufort scale, or read from an instrument in some convenient unit such as metres per second, miles per hour, or feet per second. (4) Weather and state of sky; *i.e.*, number of tenths of the sky clouded, and nature of the cloud; whether rain or snow, hail, etc., is falling or not, whether there is fog, or mist present. (5) Visibility, usually given a numerical value by noting the most distant object visible among a number of previously selected standard objects at known distances from the observing point. (6) Maximum day temperature noted in the evening, and minimum night temperature noted in the morning. (7) Amount of precipitation since previous time of observation. (8) Amount of bright sunshine during the day. (9) Motion of cloud.

All these observations are carried out at most meteorological stations reporting by telegraph, telephone or wireless to a central meteorological office. For details of the use of such data for forecasting, *see* the standard textbooks on the subject.

In addition to the above observations, some or all of the following observations are made at a restricted number of stations in practically all countries of the world: (10) Upper wind measured by means of pilot balloons. (11) Upper air temperatures and humidities observed by means of instruments suspended on wing struts of aeroplanes. (12) Upper air temperatures and humidities at different heights by means of self-recording instruments carried by free balloons. (13) Amount of atmospheric pollution. (14) Electric potential gradient in the atmosphere. (15) Various magnetic factors. When observations are made on board ship, to these are added: (16) Temperature of the sea surface, and state of the sea.

Diurnal Variations.—The most fundamental cycles in the atmosphere are those associated with the differences between day and night, and the differences between summer and winter. We shall consider these only briefly, dealing first with the former.

Temperature.—The factor which is most obviously related to solar radiation is the temperature of the air. In fig. 1, (a) gives the curve for diurnal variation of temperature at Aberdeen for August. This curve is typical of the curves obtained over the whole world at levels not much above mean sea level. This curve is definitely only the average over the month, and any one individual interval of 24 hours may give widely differing forms for the curve of temperature, since the phenomenon may be complicated by changes in wind direction, bringing up supplies of air from widely varying altitudes.

The effect of height upon the form of the variation of temperature is shown by curves (b) for Parc St. Maur, Paris, 50 metres above sea level, and (c) for Eiffel tower, 335 metres above sea level, both for the month of July. The low-level station has a mean diurnal variation of over 9° C, while the higher station has a mean diurnal variation of a little over 5° C. There is a further noteworthy feature, that the time of maximum is about 2 hours later at the top of the tower. It is probable that

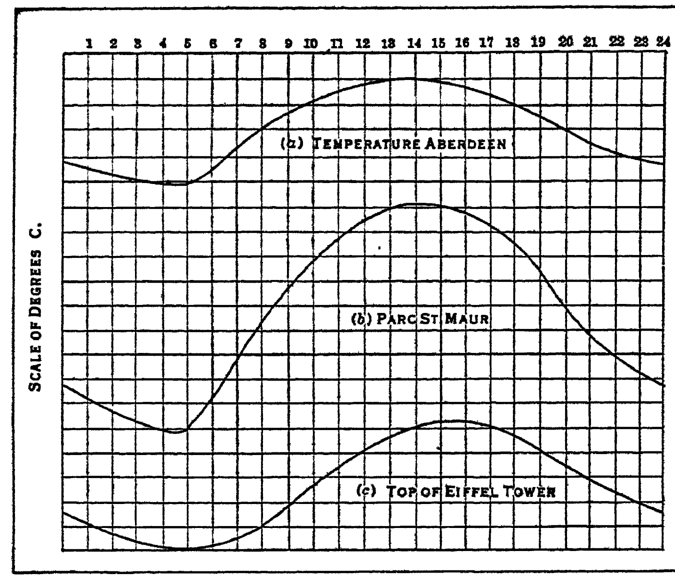


FIG. 1.—DIURNAL VARIATIONS OF TEMPERATURE

at still greater heights the diurnal variation of temperature rapidly diminishes. (Hergesell, *Lindenberg Publications*, vol. xiv.)

The temperature of air over the sea is subject to no considerable diurnal variation except possibly over shallow water. Observations made on board the *Challenger* indicated a diurnal range of about 1° C, and this value has been confirmed (*Q.J.R. Met. Soc.*, 1927) by observations made in the Mediterranean sea by N. K. Johnson. The changes of temperature are so slight that it is not possible to say with certainty how far they are vitiated by the changes of wind direction.

The diurnal variation of the temperature of the surface of the sea is probably very slight, but the difficulty of obtaining a fair sample of the surface water of the sea makes any accurate estimate of the true surface temperature impossible.

Lapse-rate of Temperature.—In overcast weather there is little or no variation of the lapse rate between day and night. In clear weather, however, for the lowest layers, there is a pronounced maximum in the middle of the afternoon, its value exceeding many times the dry adiabatic lapse rate. The lapse rate diminishes rapidly in the evening, giving place to a pronounced inversion. Over the sea there is no appreciable diurnal variation of the lapse rate.

Pressure.—In fig. 2, (a), (b) and (c) give for July the diurnal variations of pressure (from data in *Manual of Meteorology*, vol. ii.) at Aberdeen, Batavia and in the Arctic, the times being Greenwich mean time in (a) and local times in (b) and (c). It will be noted that within the tropics there is a very strongly marked pressure wave of 12 hours' duration, with maxima at 9 A.M. and 9 P.M., superposed on a 24 hourly wave. Some further details of these diurnal variations are given later in the section *Dynamical Aspects*. Curve (d) in the same figure shows the diurnal variation for July on Ben Nevis, 1343 metres above mean sea level, a single ill-defined maximum at 2 P.M.

Wind.—The surface wind velocity shows a maximum about 2 P.M. and a minimum in the early morning. The direction shows a corresponding change, the wind backing as it diminishes. At the top of the Eiffel tower the diurnal variation of wind velocity is the reverse of that observed at the ground, the maximum velocity occurring during the early morning and the minimum during the afternoon. At intermediate heights the nature of the diurnal variation is to some extent dependent on the strength of the wind. Hellmann (*Met. Zeit.*, Jan. 1915) set up three anemometers at

heights of 2, 16 and 32 metres above the ground, in a flat meadow at Nauen. He found that when strong winds were blowing, all three anemometers yielded maxima during the day, and minimum during the night. With light winds the anemometer at 2 metres showed a day maximum and a night minimum, but those at 16 metres and 32 metres showed two maxima, one about mid-day, and the other about midnight. At 16 metres the maxima were

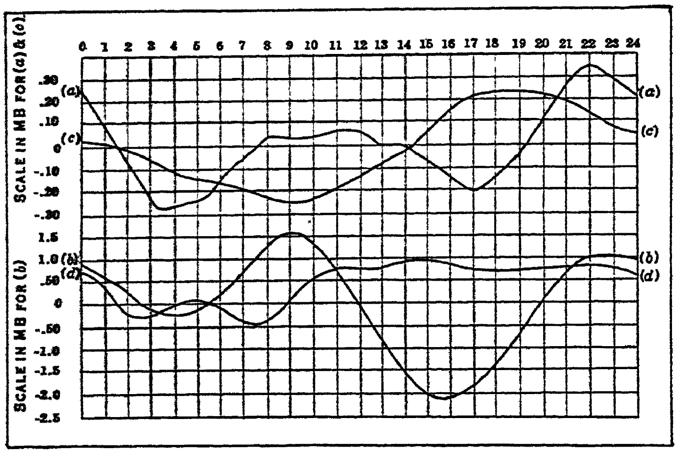


FIG. 2.—DIURNAL VARIATIONS OF PRESSURE; (A) ABERDEEN, (B) BATAVIA, (C) ARCTIC REGIONS, (D) BEN NEVIS

approximately equal in winter, but in summer the day maximum was slightly the greater. At 32 metres the night maximum was the greater in winter and summer. With light winds the height at which the night maximum becomes equal to the day maximum is thus about 16 metres in winter, and between 16 and 32 metres, in summer. With strong winds this height exceeds 32 metres.

Durward (*M.O. Professional Notes*, No. 15) investigated the diurnal variation of winds at 1,000 to 6,000 ft. by an examination of 1,736 pilot balloon ascents, made by the meteorological service with the British Armies in France during March 1917–Sept. 1918. The winds at 1,000 ft. showed a maximum about midnight, and a well marked minimum between 9 A.M. and 10 A.M. in reasonably good agreement with the Eiffel tower observations. The variation at 2,000 ft. and 3,000 ft. was of the same general character, but when all wind directions were taken together no appreciable diurnal variation was found at 4,000 and 6,000 feet.

At sea, the diurnal variation of wind is much less marked. Galle[1] (*K. Ned. Met. Inst.*, No. 102) states that from May to October the maximum velocity of the south-east trade-winds of the Indian ocean occurs during the night-hours. No detailed observations at one place are available, and it is not at present possible to give any definite statement of the variation of winds over the sea.

Land and Sea Breezes.—At places on a coast there is usually a pronounced tendency for a wind to blow from the sea to the land in the morning, and from the land to the sea in the evening. In some places, this wind follows the sun in the course of the day. For example, at Aberdeen, the sea breeze sets in suddenly in the morning as a wind from sea to land at right-angles to the coastline, but during the day it veers until it blows parallel to the coast.

Vapour Pressure and Humidity.—The vapour pressure remains substantially constant during the 24 hours, at land stations. At Kew observatory, England, there is no appreciable diurnal variation of vapour pressure during any month of the year, and the same holds at nearly all stations for which data are available. Since temperature normally varies considerably between day and night, it follows that relative humidity varies in the opposite sense to temperature.

Cloudiness.—No simple rule can be stated for the diurnal variation of cloudiness. The wind-direction is of considerable importance in this respect, and different types of cloud vary in different ways. The diurnal variation of cloudiness at Kew observatory has been investigated by Brunt (*M.O. Professional Notes*, Nos. 1 and 14), who showed that with all wind directions there is

[1] Vide also *Arbeiten Preuss. Aeronaut. Obs., Lindenberg*, Bd. XIV.

a well-marked tendency for the amount of cloud to diminish in the evening. Similar results were derived for a number of stations in the Rhine valley. At Batavia, 6° S. of the equator, cloudiness attains its maximum in the evening or early night, and its minimum about 4 A.M. local time (*Observations*, Batavia, xxxviii.). At Helwan cloudiness attains its maximum during the afternoon, and its minimum during the evening.

Thunderstorms.—The observations made by the "Challenger" showed that the frequency of thunderstorms at sea had a pronounced maximum between 2 A.M. and 4 A.M., while the occurrence of "lightning only" showed a maximum between 8 P.M. and 10 P.M. Over the land, heat thunderstorms occur most frequently during the afternoons, but certain types of thunderstorms, associated with the line of separation between warm and cold air currents, show no special preference for any hour of day or night.

Electric Potential Gradient.—The typical variation of potential gradient has a minimum in the early morning, and a maximum in late afternoon, the maximum being about twice the minimum; but at many stations there is a subsidiary maximum about 8 A.M. and a minimum in early afternoon.

Seasonal Variation of Meteorological Elements.—While it is possible to consider the diurnal variation of the meteorological elements separately, it is not possible to treat the seasonal variations in the same way. As is shown later, the whole of the circulation of the atmosphere and the distribution of pressure over the surface of the earth, with which this circulation is closely associated, are both subject to changes on a large scale during the course of the year. A noteworthy point which emerges from the discussion of the diurnal variations is the difference in the phenomena over land and sea, the former showing the greater variability. The same is true of seasonal variations. The land heats up more rapidly than the sea in the summer, and cools more rapidly than the sea in winter. Hence the marked distinction between continental and oceanic climates, the former being subject to extremes of heat and cold, and the latter being relatively equable. The centres of large land masses are associated with excessive heat in summer and excessive cold in winter, the lowest temperatures in the northern hemisphere occurring in northeast Siberia. In this region the seasonal change of temperature exceeds 60° C, while over the major part of the Eurasian continent and North America the seasonal variation exceeds 30° C. In the tropics the seasonal variation of temperature becomes relatively small, with the result that the change of temperature with latitude is greater in winter than in summer. All phenomena which are in any way related to or dependent on the horizontal gradient of temperature are therefore accentuated in winter.

Along the seaboard of a continent, the nature of the seasonal variations will depend upon the direction of the prevailing wind, since winds from the interior of the continent and winds from the ocean will carry with them the characteristics of their region of origin. Rainfall again depends largely upon the interaction of different currents of air and on the form of the land, and it is not possible to give any general rules as to the nature of the seasonal variations of rainfall over the whole globe, except such as will arise in the course of the following brief discussion of the general circulation of the atmosphere. The general question of seasonal variation of meteorological factors is closely bound up with climatology, and a large amount of information on this topic will be found in any standard text book on the latter; *e.g.*, Kendrew's *Climates of the Continents*, contains numerous tables giving seasonal variations of temperature, pressure and rainfall.

THE GENERAL CIRCULATION OF THE ATMOSPHERE

The Distribution of Temperature over the Earth.—The distribution of temperature over the earth is usually represented by two charts, one of the mean temperature for January and one of the mean temperature for July. These two months represent the extremes of winter and summer, the other months being intermediate between them. (*See* any physical atlas.)

We shall consider first the chart for January. It will be seen that in the southern hemisphere the isotherms, or lines of equal temperature, run across the chart in a regular manner, indicating

approximate symmetry of distribution of temperature about the poles, except that over South America, South Africa and Australia, the isotherms sweep downward over the land, indicating that the land is warmer than the sea in the same latitude. In the northern hemisphere there are two centres of extreme cold, one in northeast Siberia and one over Greenland. If in middle latitudes we restrict our attention to any one parallel of latitude, we note that the temperature is higher over the western coast of a continent than over the eastern coast of the same continent. This difference is associated with the fact that prevailing westerly winds bring with them the conditions of their region of origin.

The chart for July shows again in the southern hemisphere an approximately symmetrical distribution of temperature about the South Pole. In the northern hemisphere there are centres of high temperature over North Africa, over the southern portion of North America, and to the north of India, but the run of the isotherms is irregular. The land is, however, distinctly warmer than the sea, the difference being especially well marked over the north Pacific ocean and the contiguous continents.

The Distribution of Surface Pressure over the Earth.—Charts giving the distribution of pressure show in the southern hemisphere a belt of high pressure encircling the earth about latitude 30°, with somewhat higher pressures over the oceans than over the continents. These belts are known as the "sub-tropical anticyclones" or the "sub-tropical high pressure belts." Over the northern hemisphere the extensive land masses complicate the phenomena. The January chart shows the sub-tropical anticyclonic belts over the north Atlantic and north Pacific oceans, but in addition to these there is an intense anticyclone centred over Asia, and another over North America. Over the northern portion of the North Pacific, and also just south of Greenland, there are centres of low pressure.

In July, the anticyclonic centres over the north Atlantic and north Pacific persist, and extend somewhat further north. A shallow centre of low pressure is situated over north-east Canada, and a much deeper centre of low pressure is centred to the north-west of India, extending over the whole of Asia, and even over a part of north-east Africa. The subtropical anticyclonic belt is no longer traceable over southern Asia.

The Distribution of Winds over the Globe.—There is a simple relation between the direction of the wind and the distribution of pressure, which is known as Buys Ballot's law, after the Dutch meteorologist who first enunciated it. It may be stated as follows: "In the northern hemisphere an observer who stands with his back to the wind will have lower pressure to his left than to his right. In the southern hemisphere the reverse holds." In terms of isobars on a chart, this amounts to saying that the wind tends to blow round the isobars keeping low pressure to the left in the northern hemisphere, and to the right in the southern hemisphere. In practice the wind at the surface is found to blow slightly across the isobars into low pressure, at an angle of 20° to 30°.

Keeping this law in mind, we can interpret the pressure charts for January and July in terms of the prevailing winds. We shall first consider the chart for January. The equator is marked by a shallow belt of low pressure, to each side of which the pressure increases with distance towards the pole. The region on the equatorial side of the subtropical anticyclonic belts is therefore marked by easterly winds having a component towards the equator. These winds known as the *trade winds* are north-easterly in the northern hemisphere and south-easterly in the southern hemisphere. Between them is the equatorial belt of low pressure, known as the *doldrums*, with calms or light variable winds. It is situated slightly north of the equator in the northern winter, and moves slightly further north in the northern summer. The centres of the sub-tropical anticyclonic belts are regions of light winds. On the poleward sides of the anticyclonic belts the winds are westerly, especially in the southern hemisphere, where there is only slight disturbance by land masses. Over the north Atlantic the prevailing winds are westerly. The circulation over Asia is clockwise round the centre of high pressure, and over the China seas the winds are north-easterly. The regions of prevailing westerly winds on the poleward sides of the sub-tropical anticyclones are not regions of steady winds. Here the depressions of middle latitudes produce intermittent variations of conditions, yielding considerable local variations of wind, temperature and rainfall.

The July chart of mean pressure shows no fundamental difference from the conditions which prevail in January, so far as the southern hemisphere is concerned. In the northern hemisphere, however, the distribution of pressure has changed fundamentally. The Asiatic anticyclone has disappeared, and its function as the chief controller of conditions over Asia has been taken by a depression centred to the north of India. There is a continuous increase of pressure southward from the centre of the depression as far as the sub-tropical anticyclonic belt of the southern hemisphere. As a result, there is over the whole Indian ocean a broad current of air which blows into the southern edge of the depression as a south-west wind, known as the south-west *monsoon* of India (Simpson, "The South West Monsoon," *Q.J.R. Met. Soc.*). This current, having passed over warm ocean during a journey some thousands of miles in length, reaches India as a warm and very damp current. On reaching India it is forced by the configuration of the land to rise over the coastal ranges of mountains, and so gives rise to copious rainfall, which is known as the monsoon rainfall. It may be noted in passing that the word *monsoon* denotes seasonal, so that it might be applied to any seasonal changes of wind. The winds which blow around the south-eastern edge of the Asiatic anticyclone in winter are known as the north-east monsoon. An examination of charts of mean pressure month by month shows that the Asiatic anticyclone begins to diminish rapidly in intensity in April, and by early June the depression is formed. The monsoon winds, with the associated rainfall, develop during June, and usually persist until late September.

No verbal description of the distribution of temperature, pressure and wind over the earth's surface can take the place of an examination of the charts. The reader who desires fuller information is referred to Sir Napier Shaw, *Manual of Meteorology*, vol. ii., where maps are given showing the distribution of these elements, and some others, for each month of the year.

Rainfall.—In many respects rainfall (which for our present purposes will be taken to include all forms of precipitation, snow, hail, etc.) is the most important of all the meteorological elements. It is at the same time the most difficult of these elements to treat in a satisfactory manner, on account of its extreme variability with place, and the fact that an hour of torrential rain associated with a thunderstorm may affect in a marked manner the representation of both the mean diurnal and mean seasonal variations. What is known as the "normal" seasonal variation of any element is the average form of the annual cycle of that element taken over a number of years, but it is only over very restricted areas of the globe that the variation of rainfall in any one year will resemble at all closely the "normal" variation. The outstanding case where this is possible is that of the Indian peninsula, whose heavy rainfall in June to September is associated with the monsoon winds. The maximum rainfall in any year will occur within the period of the monsoons, and never outside it. Even in the British Isles averages taken over many years point to a definite maximum of rainfall in a particular month of the year. This month is October at Greenwich, December at Aberdeen and July at Edinburgh, but it would be extremely hazardous to apply this result to forecast the rainfall of any particular year.

Within the tropics rainfall usually has a well marked maximum and occasionally two maxima.

World Weather.—Under this title may be grouped a number of very extensive statistical investigations of the correlation between meteorological factors over different parts of the world. Among the most notable of these are two papers by G. T. Walker in the *Indian Meteorological Memoirs* (1923 and 1924) one by Walker and Bliss in the *Memoirs of the Royal Met. Soc.* vol. ii. No. 17, several papers by Exner in the *Sitzungsber. Akad. Wiss. Wien* (1913, 1924 and 1926); and a valuable general discussion of the work of other writers by Defant in the *Meteorologische Zeitschrift* (1926). Results of considerable value have been derived

by these writers, and an idea of the type of result obtained may be gathered from the following extract from a paper by Walker in the *Indian Meteorological Memoirs*, vol. xxiv. part 4: "We can best sum up the situation by saying that there is a swaying of pressure on a big scale backwards and forwards between the Pacific ocean and the Indian ocean, and that there are swayings, on a much smaller scale, between the Azores and Iceland, and between the areas of high and low pressure in the north Pacific: further, there is a marked tendency for the highs of the last two swayings to be accentuated when pressure in the Pacific is raised and that in the Indian ocean lowered."

VERTICAL DISTRIBUTION OF THE METEOROLOGICAL ELEMENTS

Temperature.—The rate of change of temperature with height is of fundamental importance in determining the processes of weather. The observations of Teisserenc de Bort showed that up to considerable heights the temperature decreases steadily with height, at an average rate of about 6° C per km., or 3° F per 1,000 ft., but that a limit is eventually reached beyond which the temperature remains constant, or even increases slightly at first. The lower region in which the temperature decreases with height is known as the *troposphere*, the upper region of vertically uniform temperature is known as the *stratosphere*, and the surface separating the two is known as the *tropopause*. Observations have now been obtained from a sufficient number of stations distributed over the earth to show that the tropopause is higher at the equator than at the poles, being on the average about 18 km. high at the equator, 6 km. high at the pole in summer, and coming down nearly to the earth's surface in winter. In intermediate latitudes, the height has intermediate values, the average height over southern Europe being given as 10·5 to 11 km. by W. H. Dines "The Characteristics of the Free Atmosphere," *M.O. Geophysical Memoirs*, No. 13.

A considerable amount of statistical work has been carried out by Dines (*M.O. Geophysical Memoirs*, No. 13), Schedler (*Beiträge Phys. fr. Atmos.* Bd. vii.) and others, into the relations which exist between the temperature at different heights, the pressures at different heights, the height of the tropopause, the temperature of the stratosphere, the total water-vapour-content of the atmosphere, and various other factors.

Diurnal Variation of Temperature in the Upper Air.—Reference has already been made to the diurnal changes of temperature on the Eiffel tower. Numerous observations have been made at greater heights, particularly a long series of kite soundings by Assmann in Berlin from Oct. 1, 1902, to Dec. 31, 1903, and of kite balloon ascents at Lindenberg. (*See Lindenberg Publications*, vol. xiv., 1922.) Temperature is far more variable at a height of 6 or 7 km. than it is at the ground, but we can draw no conclusion as to diurnal variations at different heights from this result. (*See* also W. H. Dines, *Q.J.R. Met. Soc.*, 1919; and *K. Mag. en Met. Obs. Batavia, Verhand* No. 4, 1916.)

Water Vapour.—Since temperature decreases with height, the saturation pressure of water vapour also decreases with height, and there is a finite limit to the amount of water vapour which the atmosphere can contain. The saturation pressure is independent of pressure, but on account of the rapid decrease of the density of dry air with decreasing pressure, we find that in saturated air the proportion of water to air is greater in the free air than it would be at the ground when at the same temperature.

The Variation of Wind with Height.—The variation of wind with height depends upon the horizontal distribution of temperature. It is therefore easy to realize that this variation cannot be summarized in a few words for the whole of the atmosphere. It is found that to a reasonable degree of approximation the motion of air is such as to produce a balance of the forces called into play, and this involves the motion of the air along the isobars, at all heights removed from the effects of surface friction. Near the ground the effect of friction is to diminish the velocity of the wind, causing the air to drift across the isobars from high to low pressure. It follows that in the lower layers the wind speed increases with height above the ground, while its direction veers (in the northern hemisphere). In the lowest layers, next to the ground, the wind speed increases rapidly, while the direction changes slowly, but at greater heights the increase of wind becomes slower, while the direction changes rapidly. The variations of wind in the lowest 2,000 ft. are nearly always in the sense indicated above. At greater heights the nature of the changes of wind depends upon the horizontal distribution of temperature, and upon the wind direction.

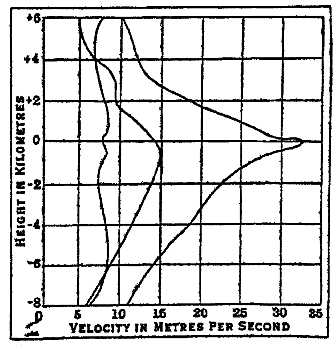


FIG. 3.—DIAGRAM SHOWING VARIATION OF WIND WITH HEIGHT

The variation of wind with height in the lowest layers can be represented with considerable accuracy by a formula $V=a+b \log (h+c)$, where h is height and a, b and c are constants (E. H. Chapman, *M.O. Professional Notes* No. 6). *Fig.* 3 (Dobson *Q.J.R. Met. Soc.*, 1920), shows the variation of wind with height in the upper part of the troposphere and the lower stratosphere. The heights are relative to the base of the stratosphere, and the data are classified according to the wind velocity in the highest two kilometres of the troposphere, the groupings being (a) less than 13 metres per sec., (b) 13 to 19 metres per sec., (c) greater than 19 metres per second.

The direction of the winds considered above showed no marked changes within the troposphere apart from the usual changes at the ground, and no appreciable change of direction was usually noted on passing into the stratosphere. The most noteworthy feature of fig. 3 is the steady increase of winds within the troposphere and the equally steady and rapid decrease within the lower stratosphere. The rapid falling off of wind in the stratosphere denotes that the stratosphere is warmer over low than over high pressure.

The general distribution of wind at different heights can be most readily summarized by reference to the distribution of pressure at different heights. Shaw (*Manual of Meteorology*, vol. ii., figs. 164–172) gives diagrams of isobars at the surface, and at heights of 4 km. and 8 km.

Further details of the variation of wind with height in different regions will be found in *Manual of Meteorology* vol. ii., 6. *See* also: van Bemmelen *Proc. K. Akad. Wet. Amst.*, (1918), Harwood, "The Free Atmosphere in India," *Memoirs Indian. Met. Dept.* (1924); *Arbeiten Preuss. Obs. Lindenberg*, especially vol. xiii.; Cave, *Structure of the Atmosphere in Clear Weather* (1912); Alfred de Quervain, *Schweizerische Gronlande Expedition 1912–13* (Zurich, 1920); E. Gold, "Barometric Gradient and Wind Force," M.O. 190, and "The International Kite and Balloon Ascents," *Geophysical Memoirs*, No. 5, M.O. 210.

STATICAL RELATIONS

The Fundamental Gas Equation.—The pressure p, the temperature T, the density ρ or the specific volume v, are connected by the relations:

$$p=R\rho T, \text{ or } pv=RT,$$

where R is a constant. If the pressure is in millibars, the temperature on the absolute centigrade scale, and the density in grams per cubic centimetre, or the specific volume in cubic centimetres per gram, the constant R is equal to $2{\cdot}8703\times10^{-3}$. When the air contains water vapour, but not sufficient to saturate it, an equation of the same form may be used with a slightly different value of R; but this equation must then be used only at temperatures which are sufficiently high to ensure that the air is not saturated.

The Variation of Pressure with Height.—The variation of pressure in the vertical is given by $\frac{\partial p}{\partial z}=-g\rho$. This equation is readily derived by the consideration of the vertical forces acting on a cube, two of whose faces are horizontal. It may be written in the form

$$\frac{\partial p}{\partial z}=-\frac{gp}{RT}, \text{ or } \frac{1}{p}\frac{\partial p}{\partial z}=-\frac{g}{RT}.$$

This equation cannot be integrated unless we know the manner in which temperature is related to height. If the temperature is constant the equation can be seen to yield on integration

$$\log\frac{p}{p_0}=-\frac{gz}{RT}, \text{ or } p=p_0\epsilon^{-\frac{gz}{RT}},$$

or

$$z=\frac{RT}{g}(\log p_0-\log p),$$

giving the height at which the pressure p is attained. If the relation of pressure to height is given by $T=T_0-\beta z$, so that

$$\frac{1}{p}\frac{\partial p}{\partial z}=-\frac{g}{R(T_0-\beta z)}, \text{ then } \log\frac{p_0}{p}=\frac{g}{\beta R}\log\frac{T_0}{T_0-\beta z},$$

These equations form the basis of barometric altimetry.

The Reduction of Pressure to Mean Sea Level.—When the pressure is measured at a station z metres above mean sea level, it is reduced to mean sea level by the addition of an amount equivalent to the weight of a column of air extending from the level of observation down to mean sea level; it being assumed that the mean vapour pressure through this column is equal to the vapour pressure at the point of observation, and that the mean temperature can be computed from the temperature at the level of observation, together with a lapse rate of 0·5° C per 100 metres. Moreover it is found that if the height of the station does not exceed 500 metres results well within the assigned limit of accuracy are obtained when we ignore the humidity of the air, and the variations of gravity with latitude and height, and adopt the dry bulb reading at the time of observation as the mean temperature of the column. For fuller details of these methods see *Computer's Handbook*, Section I.

Adiabatic Changes in Ascending or Descending Dry Air.—Let the state of the atmosphere be specified by the variables p, ρ, T, at height z, and let p', ρ', T' denote the state of any displaced mass when it is at height z. The accented letters will therefore refer to air which has been displaced from its normal environment. We denote specific heat of air at constant volume by c_v and at constant pressure by c_p. Let $v'=\frac{1}{\rho'}=$ specific volume of the moving air. In moving from height z to height $z+dz$, the loss of heat is equal to the work done by the moving mass in expanding against the action of the pressure due to the environment:

$$c_v dT'=-apdv',$$

where a is the reciprocal of the mechanical equivalent of heat

$$\frac{dT'}{dz}=-\frac{ag}{c_p}\frac{T'}{T}.$$

Thus the rate of decrease of temperature of air ascending adiabatically is proportional to the ratio of the temperatures of the moving air and of the environment at the same level. In all practical problems, this ratio may be taken as unity. Then $\frac{dT'}{dz}=-\frac{ag}{c_p}=0{\cdot}986°$ C/100 metres, or almost exactly 1° C per 100 metres.

Stability of Dry Air.—If a small mass of air originally at level z be displaced vertically to height $z+dz$, its temperature will change to $T+dT'$, where $dT'=-\frac{ag}{c_p}dz$. In its displaced position it will be lighter or heavier than its environment according as $\frac{dT'}{dz}$ is less or greater than $\frac{dT}{dz}$, *i.e.*, according as $\frac{dT}{dz}$ is $>$ or $<\frac{ag}{c_p}$. Hence the air is stable or unstable according as the lapse rate is less or greater than the adiabatic lapse rate of 1° C per 100 metres. It can be readily verified that the condition for stability is that the potential temperature shall increase with height.

Adiabatic Changes in Moist but Unsaturated Air.—The argument used above is applicable to moist unsaturated air, provided we give to R and c_p the appropriate values. The adiabatic lapse rate is given by $\frac{ag}{c'_p}$ where c'_p is now interpreted as the specific heat of the mixture of air and water vapour; but since the water vapour only accounts for a small fraction of the constitution of normal air, c'_p cannot differ by an appreciable amount from c_p, and the lapse rate for unsaturated air is only slightly less than that of dry air.

Adiabatic Changes in Saturated Air.—When saturated air rises through its environment the cooling produced by expansion causes condensation, and the latent heat so liberated becomes available for maintaining the temperature of the air. Let the air be composed of x kg. of water vapour to 1 kg. of dry air. When $(1+x)$ kg. of the mixture rises from a height z to height $z+dz$, a quantity dx of water vapour condenses, and an amount rdx of latent heat is liberated, and used in heating the mixture and the resulting water-drops. It will be assumed that the heating of the water-drops may be neglected. In practice most of the condensed water is eliminated, and the neglect of the heating of water-drops is in any case justified.

Near the ground $\frac{dT}{dz}$ has the value of 0·56° C per 100 metres. The saturated adiabatic lapse rate increases slowly with height, and at very low temperatures at which x has become very small, it approaches asymptotically the value of the dry adiabatic lapse rate.

The values of the adiabatic lapse rate for saturated and unsaturated air are of fundamental importance in meteorology. The mean lapse rate observed in the atmosphere is slightly greater than the saturated lapse rate, indicating stability for dry air, but instability for saturated air. In these conditions any mass of saturated air which rises becomes increasingly warmer than its environment at the successive levels which it attains.

Further, saturated air which is caused to descend immediately ceases to be saturated, and its temperature rises at the unsaturated or dry adiabatic lapse rate. Thus damp winds which rise over mountain ranges descend on the other side as very warm dry winds (*föhn winds*). The physical process involved in the consideration of the saturated adiabatic lapse rate is not in reality an adiabatic process, since, as we have seen, it is not reversible. For this reason it is frequently referred to as a *pseudo-adiabatic* process.

DYNAMICAL ASPECTS

The Equations of Motion in Three Dimensions.—The motion of an element of mass situated in latitude ϕ, longitude λ, at a distance r from the centre of the earth, may be represented by the following equations:

$$-r\cos\phi\ddot{\lambda}-2(\dot{\lambda}-\omega)(\dot{r}\cos\phi-r\sin\phi\,\dot{\phi})=X \qquad (1)$$

$$r\ddot{\phi}+2\dot{r}\dot{\phi}+r\cos\phi\sin\phi\dot{\lambda}(\dot{\lambda}-2\omega)=Y \qquad (2)$$

$$\ddot{r}-r\dot{\phi}^2-r\cos^2\phi\dot{\lambda}(\dot{\lambda}-2\omega)=Z-g, \qquad (3)$$

where ω is the angular velocity of the earth, g is the acceleration due to gravity, and X, Y, Z, are the components of the external forces resolved along axes drawn to east, to north, and vertically, respectively, but not rotating with the earth. In practice it is frequently more convenient to use cartesian co-ordinates referred to axes drawn as above, but rotating with the earth. The appropriate equations are:

$$\frac{du}{dt}-2\omega v\sin\phi+2\omega w\cos\phi=X \qquad (4)$$

$$\frac{dv}{dt}+2\omega u\sin\phi \qquad =Y \qquad (5)$$

$$\frac{dw}{dt}-2\omega u\cos\phi \qquad =Z. \qquad (6)$$

The derivation of these equations will be found in any standard textbook on dynamics; *e.g.*, Routh's *Rigid Dynamics*, vol. i. p. 205.

Equation (1) can be immediately integrated for the case of "no forces." Putting $X=0$, it may be written

$$\frac{1}{r\cos\phi}\frac{d}{dt}(r^2\cos^2\phi[\dot\lambda-\omega])=0,$$

$$\text{whence } r^2\cos^2\phi(\dot\lambda-\omega) = \text{constant.} \tag{7}$$

This equation simply states that when there are no forces the angular momentum about the axis of the earth is constant. If therefore we know the east to west component of velocity of a moving mass when in one latitude, we can compute the east to west component of velocity of that mass when it has moved to any other latitude. Care is needed in the use of this equation, since it represents only one aspect of the motion of the mass in question. By its use some highly questionable results have been derived in meteorology.

When there is no vertical velocity, there are only two equations

$$\frac{du}{dt}-2\omega v\sin\phi=X \tag{8}$$

$$\frac{dv}{dt}+2\omega u\sin\phi=Y. \tag{9}$$

The effect of the rotation of the earth is therefore allowed for by including in the statement of accelerations a term $2\omega\sin\phi\times$velocity, and it is readily seen that this acceleration is at right-angles to the direction of motion. This is known as the "deviating force due to the earth's rotation." The complete set of equations (4), (5), and (6) includes in addition an acceleration along the east-west line, which is positive to east when the motion is downward, and a vertical component of acceleration proportional to the east-west component of velocity. Equations (8) and (9) hold for any rectangular axes in the horizontal plane. The forces X, Y, Z include all forces other than gravitation, such as viscous or frictional forces, or the components of the gradient of pressure. The part of these forces due to the pressure distribution may be written

$$-\frac{1}{\rho}\frac{\partial p}{\partial x},\ -\frac{1}{\rho}\frac{\partial p}{\partial y},\ -\frac{1}{\rho}\frac{\partial p}{\partial z}$$

Equations of Horizontal Motion. Steady Motion.—The terms $\frac{du}{dt}$, $\frac{dv}{dt}$, $\frac{dw}{dt}$, above, represent the total acceleration of a given element of mass, or $\frac{d}{dt}$ is differentiation "following the fluid." In terms of the velocity at a given point, the equations become

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}-2\omega v\sin\phi=X, \tag{10}$$

$$\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+2\omega u\sin\phi=Y. \tag{11}$$

In the special case of steady motion, $\frac{\partial u}{\partial t}=\frac{\partial v}{\partial t}=0$; and the terms, $u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}$, $u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}$ represent the centrifugal acceleration, plus the tangential acceleration. The deviating acceleration due to the earth's rotation is always at right angles to the path, and therefore cannot produce any change of velocity, but can influence the direction of motion. Any particle projected on the earth's surface, free from friction, will execute a circle, if we neglect variations of latitude. This circle is known as the *circle of inertia*. Its radius is proportional to the velocity of projection.

Horizontal Motion Under Balanced Forces. The Gradient Wind.—Equations (10) and (11) above form an algebraic statement of the balance between the accelerations relative to the earth and the deviating force, together with any other impressed forces. If V be the total velocity in the path, at a point where the radius of curvature is r, the accelerations relative to the earth are $\frac{V^2}{r}$ normal to the path, and $\frac{V\,dV}{ds}$ along the tangent to the path. Observational evidence points to the second of these terms being small by comparison with the other (Durward, *Professional Note No. 24, M.O. London,* and Shaw and Lempfert, *Life History of Surface Air Currents*), and it is usually left out of further consideration. Equations (10) and (11) then state that the centrifugal acceleration balances the sum of (a) the pressure gradient, which acts at right angles to the isobar, and is directed towards low pressure; (b) the deviating acceleration $2\omega V\sin\phi$ at right angles to the path; and (c) the viscous or turbulent resistance.

In the first consideration of the problem, we neglect the effect of friction and turbulence which are considered later. The centrifugal acceleration which acts at right angles to the path must then balance (a) and (b) above. Since however the centrifugal acceleration is along the same line as (b), it follows that (a), which balances the two, must act along the same line, and the motion under balanced forces must be along the isobars. The equation of motion then becomes

$$\frac{\text{pressure gradient}}{\text{density}}=2\omega\sin\phi\times V\pm\frac{V^2}{r} \tag{12}$$

The upper sign is used if the concave side of the isobar has low pressure, and the lower sign in the opposite case. These two cases correspond to cyclonic and anticyclonic curvatures of isobars.

It is convenient to represent the pressure gradient symbolically by $2\omega\rho G\sin\phi$, where ρ is the density of the air. Equation (12) then becomes

$$2\omega G\sin\phi=2\omega V\sin\phi\pm\frac{V^2}{r}. \tag{13}$$

The solution of equation (13) is called the gradient wind, and equation (13) is generally referred to as the gradient wind equation. The gradient wind is the wind which, blowing around the isobars, calls into play a centrifugal force and a deviating force exactly sufficient to balance the pressure gradient. When the isobars are not much curved, the term $\frac{V^2}{r}$ is small by comparison with $2\omega V\sin\phi$, and may therefore be neglected, and $V=G$. This particular solution is known as the *geostrophic* wind. Equation (13) may also be written

$$2\omega\sin\phi(V-G)=\pm\frac{V^2}{r}, \tag{14}$$

in which the upper sign is taken when the curvature of the isobars is anticyclonic, the lower sign when the curvature is cyclonic. It is readily seen from this that the geostrophic wind is an underestimate of the gradient wind in an anticyclone, and an overestimate in a cyclone.

The Solution of the Gradient Wind Equation.—For anticyclonic motion the solution of the quadratic equation (13) becomes

$$V=r\omega\sin\phi\left\{1\mp\sqrt{\left(1-\frac{2G}{r\omega\sin\phi}\right)}\right\} \tag{15}$$

Expansion of the radical gives

$$V=r\omega\sin\phi\left\{1\mp\left(1-\frac{G}{r\omega\sin\phi}-\frac{1}{2}\frac{G^2}{r^2\omega^2\sin^2\phi}-\text{etc.}\right)\right\}. \tag{16}$$

The upper sign gives a solution which is continuous near straight isobars, where $V=G$, while the second solution would demand indefinitely high velocities near straight isobars. Thus the only physically appropriate solution of (16) is

$$V=r\omega\sin\phi\left\{1-\sqrt{\left(1-\frac{2G}{r\omega\sin\phi}\right)}\right\}. \tag{17}$$

The corresponding solution for cyclonic motion is obtained

changing the sign of the radius of curvature r, and is therefore

$$V=r\omega\sin\phi\left\{\sqrt{\left(1+\frac{2G}{r\omega\sin\phi}\right)}-1\right\}. \qquad (18)$$

Equation (17) gives a system of winds blowing clockwise round a centre of high pressure, but everywhere with a velocity less than $r\omega\sin\phi$. The anticyclone therefore has a slower rate of rotation than the earth beneath it, and is therefore a counterclockwise circulation in space. Equation (18) gives a system of winds blowing counterclockwise round a centre of low pressure, both when considered relative to the earth and as motion in space. Thus both cyclone and anticyclone have in space the same direction of rotation as the earth beneath them. It can be readily verified that the second solution shown in equation (15) is a clockwise rotation in space, for both cyclone and anticyclone. Large scale systems conforming to this solution do not occur in nature, and the solution is to be regarded as an algebraic accident rather than as having a physical meaning. Some evidence has been adduced by Brunt (*Proc. Roy. Soc.*, A., 1924) to show that such systems would be unstable if they could be produced momentarily.

The geostrophic wind is readily evaluated by the use of a scale of reciprocals to measure the distance apart of consecutive isobars. The scale is graduated for standard density, and the small correction required for deviations from standard density is readily made. A detailed comparison of observed winds with winds computed from synoptic charts was carried out by E. Gold (*Barometric Gradient and Wind Force,* M.O. 190), and it was found that the geostrophic wind gives a close approximation to the wind observed at a height of 2,000 to 3,000 feet.

The computation of the gradient wind requires the solution of equation (13), which demands the evaluation of the curvature of the isobars, denoted by r. The gradient wind is therefore an inconvenient quantity to use, and the geostrophic wind is adopted as the most useful first approximation to the actual wind. The nature of this approximation is here emphasised because the major part of modern dynamical meteorology assumes the geostrophic wind as equivalent to the actual wind.

In low latitudes, where $2\omega\sin\phi$ is small, the term V^2/r usually exceeds $2\omega V\sin\phi$. Equation (13) then becomes meaningless for anticyclonic curvature, *i.e.* with the negative sign on the right hand side, showing that closed anticyclonic isobars are not physically possible as a steady state in low latitudes.

Effect of Changing Pressure Distribution.—The use of the gradient wind equation is, strictly speaking, restricted to regions where the pressure distribution is not changing. Brunt and Douglas (*Memoirs R. Met. Soc.* No. 22, 1928) have shown that in a region where the pressure distribution is changing the wind is approximately made up of the geostrophic wind with an added component blowing across the isallobars into the isallobaric low, and of intensity proportional to the gradient of isallobars. The magnitude of this component is readily evaluated from the chart of isallobars by the use of the geostrophic wind scale.

The hydrodynamical equation of continuity may be written

$$\frac{\partial\rho}{\partial t}+\frac{\partial}{\partial x}(\rho u)+\frac{\partial}{\partial y}(\rho v)+\frac{\partial}{\partial z}(\rho\omega)=0. \qquad (19)$$

If the effect of changing density be neglected it can be shown that systems of steady geostrophic winds satisfy the equation of continuity with no vertical velocity w. There can therefore be no convergence, and consequently no rainfall, in a system of geostrophic winds. The isallobaric components of winds discussed by Brunt and Douglas give convergence into regions of low values and divergence from regions of high values on the isallobaric charts, and so explain the rainfall associated with the low values, and fine weather associated with the high values.

The Nature of Wind. Turbulence.—On account of friction at the surface of the earth the air is always in turbulent motion, eddies being formed in much the same way as in a stream of water moving over an uneven bed. The pattern of the eddies is made visible by smoke from a chimney or other fire, but the fact that the motion of air is not steady motion is clearly shown by any anemometer chart on which the instantaneous velocity or direction of the wind differs considerably from the mean value over an interval of time. Since eddies formed in an air current are of finite size they must cause mixing of adjacent layers of air, and they therefore act as agents in diffusing momentum, heat, water vapour, dust, carbon dioxide, and other properties or constituents of the atmosphere.

G. I. Taylor (*Phil. Trans.* A, 1915) showed that the power of eddies for diffusing momentum, heat, or other constituents, may be represented by a constant K, the eddy diffusivity, which is roughly proportional to $\frac{1}{2}wd$ where w is the mean vertical component of velocity in the eddies, and d the mean diameter of the eddies. The value of K on any particular occasion will depend upon a number of factors, notably the nature of the surface of the ground and the lapse rate of temperature. Values of K have been estimated varying from 3×10^3 c.g.s. units in inversions over the Great Banks of Newfoundland, to 10^5 over Paris.

The theory elaborated by Taylor gives the flow of heat, etc. across unit area of a horizontal plane, moving with the mean motion of the air. This mean motion will depend upon the size of the area over which the mean is taken, since in the atmosphere there are eddies of widely varying sizes. The value of K which we adopt in a particular problem should therefore be a function of the size of the parcel of air with which we are concerned.

Taylor has approached the problem from a different standpoint in a paper in Proceedings London Mathematical Society 1921. Richardson (*Phil. Mag.*, 1925) has discussed the relation which must subsist between the vertical gradients of temperature and wind if turbulence is to increase. Richardson has also given a more general treatment of the question of turbulence, allowing for the possibility of K varying with height (*Proc. Roy. Soc.* A, 1919). In this connection *see* also a paper by Jeffreys in *Proc. Camb. Phil. Soc.*, 1929. An extension of these ideas to the general circulation, treating the cyclones and anticyclones as eddies, has been given by Defant *Geografiska Annaler*, 1921. A useful summary of the work of Richardson, Taylor and others is given by C. G. Rossby (*Monthly Weather Review,* 1927). The effect of turbulence upon evaporation from large sheets of water has been discussed by Giblett (*Proc. Roy. Soc.*, 1921) and Ångström (*Archiv. för Mat. Astr. och Fysik,* 1921).

The Variation of Wind with Height in the Lowest Layers.—If in fig. 4, $O\ G$ represents the geostrophic wind G in magnitude and direction, and $O\ P$ the wind at height z in magnitude and direction, then P sweeps out an equiangular spiral, and the line OS, representing the surface wind, is a tangent to this spiral. The spiral summarizes the distribution of wind with height in a convenient form. It attains the geostrophic velocity at a lower height than the geostrophic wind direction, and as was shown by G. I. Taylor (*Q.J.R. Met. Soc.*, 1914), this fits the observed facts with reasonable accuracy. The geostrophic wind should give a good approximation to the actual conditions at a height of about 1 km. It follows that the effect of turbulence due to the ground only extends to heights of 500–1,000 metres.

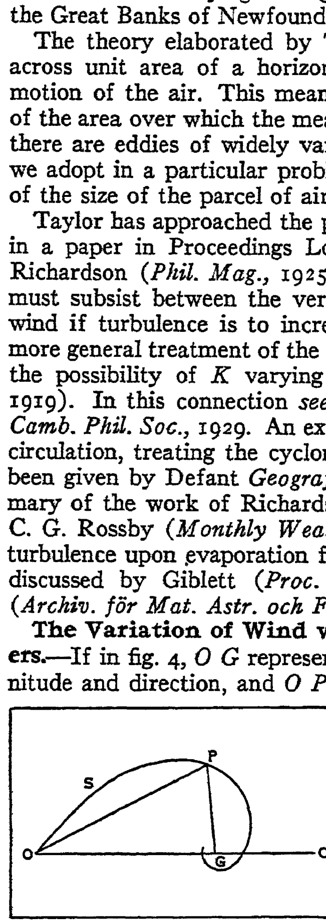


FIG. 4

Taylor's treatment of turbulence in terms of a coefficient K which is assumed to be independent of height thus enables us to account for the general nature of the variations of wind and temperature in the lower layers of the atmosphere, though the uncertainty as to the contribution of direct radiation and absorption to the temperature changes, renders uncertain any estimate of K from the temperature variations alone. The use of Taylor's coefficient K has led to a clearer physical understanding of the processes associated with turbulence in the atmosphere, yet it is certain that no theory at present available is capable of explaining all the facts. In this connection *see* also papers by L. F. Richardson in *Memoirs R. Met. Soc.* vol. i. No. 1, and *Proc. Roy Soc.* A, 1926.

A theoretical discussion of the form of clouds of smoke emitted from point and line sources, based on an extension of Taylor's method of treatment, has been given by O. F. T. Roberts in *Proc. Roy. Soc.* A, 1923. The subject of turbulent motion in the atmosphere has been discussed by Schmidt in a number of papers published in the *Sitzungberichte d. Wiener Akad. d. Wiss.* from 1917 onwards, by Sverdrup in papers in the publications of the Geophysical Institute, Leipzig, and elsewhere, and by Hesselberg in *Geofisiske Publ.* vol. iii. A discussion of this and many kindred subjects, together with full references to the work of English and Continental writers will be found in *Weather Prediction by Numerical Process* by L. F. Richardson, 1922.

Variation of Wind with Height in the Upper Layers.—The turbulence produced at the ground only affects the wind distribution in the lowest kilometre or so. Beyond these heights the variations of wind with height are to be ascribed to the horizontal distribution of temperature. For the wind at any level beyond the reach of turbulence will approximate to the geostrophic wind computed from the isobars at that level, and the distribution of pressure at any level depends not only on the distribution of pressure at mean sea level, but also on the distribution of the temperature in the intervening layers. Assuming the wind to be geostrophic mathematical analysis seems to indicate that when there is no horizontal gradient of temperature the wind is at all heights proportional to the absolute temperature. When there is a horizontal gradient of temperature the wind at a level z_2 can be derived from the wind at level z_1 by first reducing the wind at the lower level in proportion to the absolute temperature, and then adding to it a component blowing around the isobars of mean temperature in the intervening layer, keeping low temperature to its left, just as the geostrophic wind blows round the isobars, keeping low pressure to its left. The *Computer's Handbook* Section ii., Subsection 3, finds the magnitude of the horizontal temperature gradients corresponding to a given distribution of velocity.

The Transformation of Energy in the Atmosphere by Turbulence.—The effect of the vertical transfer of horizontal momentum by eddies can be represented as a virtual frictional force. Brunt has shown (*Phil. Mag.*, 1926) that the loss of energy of the winds due to turbulence is roughly equal to 5×10^{-3} kw. per square metre, amounting therefore to the equivalent of a little over 2% of the incoming solar radiation. In the same paper it is shown, with certain assumptions, that if there were no incoming solar energy, the effect of turbulence would reduce the winds to one-tenth their original value in six days. No such annihilation of the atmospheric circulation occurs, and the average conditions persist year after year. The loss of kinetic energy by turbulence is therefore continually compensated by the transformation of roughly 2% of the energy of the incoming solar radiation into kinetic energy. The compensation is not however to be regarded as a process which is always adjusted with precision. It probably proceeds by a kind of trial and error method, and this lack of smoothness must, in part at least, account for the variability of terrestrial weather.

The Classification of Winds.—If the motion of air be referred to three axes x, y, z, of which z is vertical, and x and y in the horizontal plane, drawn to east and north respectively, the equations of motion may be written in the forms

$$\frac{du}{dt}-2\omega v\sin\phi+2\omega w\cos\phi=-\frac{1}{\rho}\frac{\partial p}{\partial x}+K\frac{\partial^2 u}{\partial z^2} \qquad (1)$$

$$\frac{dv}{dt}+2\omega u\sin\phi=-\frac{1}{\rho}\frac{\partial p}{\partial y}+K\frac{\partial^2 v}{\partial z^2} \qquad (2)$$

$$\frac{dw}{dt}-2\omega u\cos\phi=-\frac{1}{\rho}\frac{\partial p}{\partial z}-g. \qquad (3)$$

Jeffreys (*Q.J.R. Met. Soc.*, 1924) has given a classification of winds based on the relative magnitude of the different terms in these equations. He points out that the pressure terms must always be important, since the contrary would mean that each portion of the fluid was free to pursue its own path independently of the remainder of the fluid, and unaffected by impacts with the surrounding portions. It could only be unaffected by the effect of impacts if the free path of a molecule were great when compared with the horizontal displacement of the fluid, a condition which is never satisfied in the portions of the atmosphere accessible to observation of any kind.

It can readily be shown that the left-hand side of equation (3) is usually negligible, and is always small by comparison with gravity. The acceleration $\frac{dw}{dt}$, even in thunderstorms, in which it probably attains its maximum value, never exceeds 5% of the gravitational acceleration. Equation (3) will therefore be replaced by

$$\frac{1}{\rho}\frac{\partial p}{\partial z}=-g \qquad (4)$$

and in equation (1) the term involving the vertical velocity w will be neglected. Since the pressure term is always important, at least one of the other terms must be comparable in magnitude with it. Jeffreys distinguishes three cases.

Eulerian Winds.—Case (1). The rotational and frictional terms are here small by comparison with the accelerational term. The winds satisfying these conditions are called "Eulerian," after Euler, who first found their equations.

Geostrophic Winds.—Case (2). The rotational terms far exceed both the accelerational and frictional terms.

The winds are everywhere along the isobars, with a velocity proportional to the gradient of pressure and to the secant of the latitude. Jeffreys calls such winds "Geostrophic," following Sir Napier Shaw.

Antitriptic Winds.—Case (3). The frictional terms exceed the rotational and accelerational terms, and the wind is driven by the pressure gradient, but its velocity is limited by friction, provided the journey is sufficiently long. Jeffreys calls these winds "antitriptic" (Gr. τρίψις = friction).

In applying this classification Jeffreys reaches the general conclusions that: (a) world-wide phenomena, including the general circulation and its seasonal variation, (b) phenomena on a continental scale, including the disturbance of the general circulation in the interior of continents, and (c) phenomena on a scale comparable with the British Isles, including the moving cyclone of temperate latitudes, all satisfy the condition that the rotational terms exceed the accelerational terms, so that they belong to classes (2) or (3) above. To distinguish between the two possible alternatives, Jeffreys appeals to observations of winds, which do not deviate more than four points from the isobar at the surface, and which at a height of a kilometre and above follow closely the direction of the isobars. These winds are thus at least approximately geostrophic. In tropical storms, whose average diameter may be taken to be comparable with 80 km., and in which the wind velocities may attain 70 metres per second, the accelerational terms are not negligible, so that the tropical storm is not geostrophic. Since the time of revolution of the tropical storm is only a few hours, while the storm might last for several days, the effect of friction must be relatively small, and the tropical storm, and *a fortiori* the tornado, must be Eulerian in character.

Jeffreys' detailed analysis of land and sea breezes, and of mountain breezes, show that they are mainly antitriptic.

The General Circulation.—The main features of the distribution of pressure and winds over the earth are best shown by maps. (*See* section on *Distribution of Winds over the Globe.*)

When we come to consider the theoretical explanation of the main features of the earth's circulation, we find that no satisfactory theory has been advanced to explain these phenomena. Two papers by Jeffreys in the *Q.J. of the R. Met. Soc.*, Jan. 1926 and Oct. 1927, indicate the most hopeful lines of future attack upon the problem. Jeffreys shows that no circulation which is completely symmetrical about the poles could maintain itself against friction, and concludes that the cyclones of middle latitudes are to be regarded as essential features of the general circulation rather than as disturbances superposed upon the general circulation.

Surfaces of Discontinuity.—The possibility of having two

currents of different densities flowing side by side with different velocities, separated by a definite surface of discontinuity, was first demonstrated by von Helmholtz. The slope of the surface of discontinuity to the surface of the earth can be derived from the equations (4), (5), (6) of the section *Dynamical Aspects*. The lines of the discussion would follow those laid down by Helmholtz and Margules. The two currents are assumed to be separated by a clearly defined surface of negligible thickness. In the atmosphere, however, this condition is never accurately reproduced, and the mathematical surface of separation is replaced by a layer of transition in which both the velocity and temperature change over gradually from one set of conditions to the other. Pilot balloon observations frequently display this layer of transition, whose thickness is usually of the order of 500 metres. It is not probable that the slope of the layer of transition differs much from the computed slope of the mathematical surface of discontinuity. The chief limitation met in the application of the formulae consists rather in the fact that the motions of the two currents are not always parallel to the surface line of separation, so that the warm current climbs up over the cold current.

THE ORIGIN OF CYCLONES OF MIDDLE LATITUDES

The Convection Theory.—The so-called convection theory of the origin of cyclones supposes that thermal causes produce a strongly localized ascending current in one place, and that the convergence of air from the surrounding regions to take the place of the air removed by the ascending current brings into existence a circulation of winds round the centre, in the counter-clockwise direction. The resulting cyclone is effectively to be regarded as a disc of revolving fluid. The nature of the circulations produced when fluid is removed from a disc of fluid revolving with a constant angular velocity ζ, was first given by Rayleigh (*Proc. Roy. Soc.* A., vol. xciii.) who showed that the resulting transverse velocity v at distance r from the centre is given by the equation

$$v=\zeta r+\frac{B\zeta}{r},$$

where B is proportional to the amount of fluid removed. It was shown by Brunt (*Proc. Roy. Soc.* A., vol. xcix.) that the original velocity of rotation ζ might be merely the rotation of the air with the earth, in which case the subsequent motion relative to the earth became

$$v=\frac{B\omega\sin\phi}{r}.$$

Thus intense localized convection in air originally still should give rise to a cyclonic circulation, provided it is possible for the air which rises to be carried away from the region in question, so as to provide for the diminution of pressure at the centre. The most obvious method of removal of the ascended air is by means of a strong current in the upper air. It is readily seen that unless there is somewhere in the upper air a current sufficiently strong to carry the ascended air quickly away from the region of ascent, there is no possibility of forming a cyclone. For if air is removed vertically from the lower layers, there is a converging flow of air from the surrounding region to take the place of the air removed, and the net result will be to increase the pressure over the region. This in turn will set up a pressure gradient opposing the inward motion, and must rapidly check the motion of convergence.

On this theory the cyclone consists of a column, or rather of a disc of revolving fluid, rotating about the centre of lowest pressure, and having a system of circular isobars. If the convection is set up in a moving current, the cyclone has the general motion of the current (Shaw, *Geophysical Memoir* No. 12 and *Proc. Roy. Soc.* A., 1917). This theory and some of its consequences have been discussed in some detail by Sir Napier Shaw in *The Air and its Ways*.

Shaw describes the cyclone as originating in the ascent of a mass of air which is lighter than its surroundings. The ascending mass of air has no inviolable boundary, and as it rises through its environment the turbulent motion set up at its boundaries causes a partial mixing with the environment, with the result that an increasing mass of air has its temperature raised above that of its immediate environment. This process is called the "eviction" of air.

The Polar Front Theory.—Dove developed in some detail the idea that a cyclone could be regarded as a region of opposition of warm and cold currents, and a number of later writers supported this same view. The work of Shaw and Lempfert (Shaw, *Forecasting Weather*, chap. 7) in the *Life History of Surface Air Currents* led them to the view that the air currents in a cyclone could be represented diagrammatically by fig. 5, and that the rain which fell in the cyclone could be explained by the forced ascent due to convergence, or by the ascent of warm air over cold air.

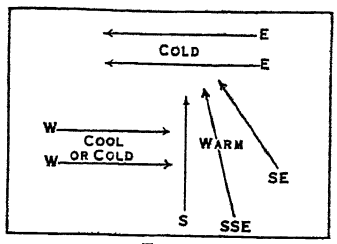


FIG. 5

Later V. Bjerknes combined this picture of the cyclone with the ideas of Helmholtz. The latter had shown that it was possible for two currents of different temperatures and different velocities to flow side by side, separated by a surface of discontinuity, the arrangement being entirely stable. Bjerknes ("The Dynamics of the circular vortex," etc., *Geofysiske Publikationer*, Oslo, vol. ii. No. 4 and "The Structure of the Atmosphere When Rain Is Falling," *Q.J.R. Met. Soc.*, 1920) suggested that the cyclone should be visualized as a wave on the surface of separation between cold easterly currents of polar origin, and warm westerly currents of equatorial origin. The cold air of polar origin is called "polar air," and the warm air of equatorial origin "equatorial air," while the surface of separation is known as the "polar front." The theory put forward by Bjerknes, the "polar front" theory, has not yet been fully developed. To begin with, the development of waves in an inclined surface of separation has not been treated with mathematical precision. The whole question of the exact processes involved in the production of cyclones at a polar front bristles with theoretical difficulties. The polar front is only inclined at a very small angle ($\frac{1}{2}°$ to $1°$) to the horizontal plane. Bjerknes regards the waves which form at the polar front as gravitational waves, and he suggests that the effect of the earth's rotation will be to increase the extent of the horizontal deviations, so that they become enormously greater (instead of much less) than the vertical displacements. The waves increase in amplitude, and a cyclone sometimes forms at the northern crest of a wave. This theory is strongly reminiscent of Emden's theory of sun spots (*Gaskugeln*, 1907). As put forward by Bjerknes it presents numerous gaps, and the argument is of a general character.

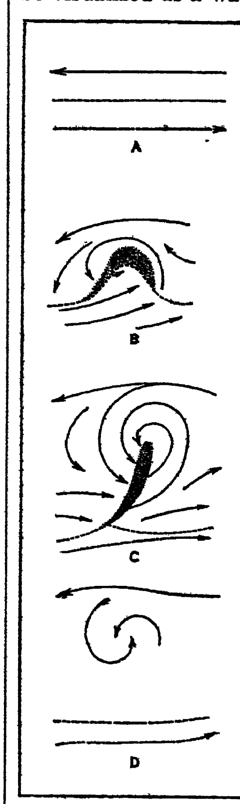


FIG. 6.—LIFE CYCLE OF CYCLONES

The process of formation of a cyclone according to this theory can be most readily explained by reference to the diagrams of figure 6, where in *a* the broken line represents a portion of the undisturbed polar front. The actual surface separating the warm and cold air is inclined to the horizontal at an angle of the order of $\frac{1}{2}°$, with the warm air above the cold. The first step is a bulge of the warm air into the cold air, as shown at *b*. This stage is marked by a fall of pressure at the tip of the tongue of warm air, and the bulge and the newly formed cyclone both travel with the warm current. This stage of the development is represented

in greater detail in figure 7, central portion, where the arrows represent the air currents, and the main rain areas are shaded. The association of rain with the ascent of air is clearly indicated in this diagram, there being an extensive area of precipitation in advance of the warm front. Heavy continuous rain does not occur in the warm sector. The lower diagram in figure 7 represents a vertical section from west to east across the warm sector.

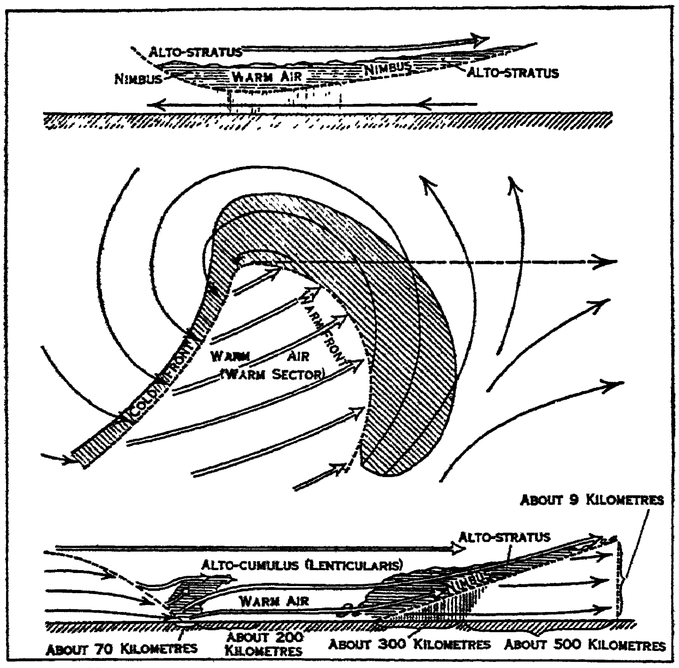


FIG. 7.—DIAGRAM OF IDEALIZED CYCLONE (YOUNG)

At the cold front the cold air pushes under the warm air, and this process is continued until the whole of the warm sector is lifted above the ground, as shown in figure 6c, and in the upper diagram in figure 7. The depression is then said to be occluded, and it subsequently diminishes steadily in intensity, and its motion dies away. Details of the association of weather with the polar front will be found in papers by J. Bjerknes and other Norwegian meteorologists in the *Geofysiske Publikationer,* Vols. i, ii, and iii, in papers by various English writers in the *Q.J.R. Met. Soc.* from 1923 onwards, and in a paper by J. Bjerknes, *Geophysical Memoirs,* No. 50.

A number of features of cyclones of middle latitudes can be more clearly realised by the study of fronts than has hitherto been possible. The Bjerknes cyclone starts its existence with a warm core, and ends with a cold core. Its cycle of growth is from asymmetry to symmetry, and only in the dying stage is the cyclone to be regarded as approximating to rotating fluid. The scheme of distribution of cloud and rain given by Bjerknes is in close agreement with the scheme of Abercromby which was previously accepted as the standard description of a cyclone, if we restrict our attention to the occluded cyclone, figure 6c. It is moreover undeniable that many of the cyclones which reach the British Isles from the Atlantic are occluded.

A very complete summary of the views of the Bergen (Norwegian) school, together with a detailed application of the Norwegian methods to a particular case of a polar front by Bergeron and Swoboda, in the *Proceedings of the Geophysical Institute* of Leipzig (vol. iii.) should be consulted.

A point of importance which is seldom mentioned in writings on these topics is that the cold front cannot be a true wedge with its point at the ground. The effect of friction at the ground, causing slowing down of the motion of air near the ground relative to the air at say 500 metres above the ground, is to cause the cold air to have a distinct nose raised above the ground. This has been confirmed by observations of temperature taken at different heights above the ground. Bjerknes has suggested that the polar front extends over very considerable distances, and may have a family of cyclones strung along its length. Each successive cyclone of a family passes further southward than its predecessor, and finally the family of 4 or 5 cyclones passes away, and a new family starts at a fresh polar front.

The practical application of the Norwegian ideas to the analysis of synoptic charts has led to very definite advances in forecasting weather, and though the theory which presents the cyclone as a wave in the polar front is very incomplete, the practical ideas developed by J. Bjerknes have helped to focus attention upon the physical consequences of the interaction of currents of air of different origin. It is beyond question that many cyclones do form at boundaries between cold and warm currents, and that they tend to follow the motion of the warm currents. Also the phenomena associated with the "occlusion" of cyclones are readily found on the weather map.

The Austrian View of the Origin of Cyclones.—Austrian writers, notably Exner (*Dynamische Meteorologie,* 2te Auflage, p. 337 *et seq.*), have regarded the development of cyclones at the surface of separation of warm and cold air as following a different course. In fig. 8 the cold air is shown shaded, the warm air unshaded. The first step is a deflection of the cold current southwards by one of the land masses of Greenland, Spitzbergen, Franz Josef Land, or Novaya Zembla, giving an outburst of cold air into the warm air, as shown in fig. 9 (a). The further development is shown in fig. 9 (b). The cold tongue C cuts off the direct supply of warm air into the region A, leading to the formation of a centre of low pressure there, with stream lines as shown in the diagram. The cold tongue is drawn along in the general direction of the warm air. Behind the cold tongue air is dammed up and forms an anticyclone.

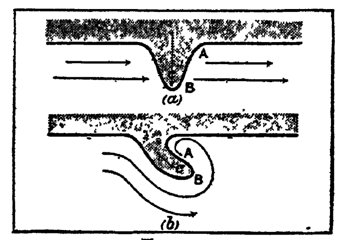


FIG. 8

Like the Norwegian scheme of construction of the cyclone, Exner's scheme attaches great importance to the phenomena of ascent and descent of cold air at fronts, but Exner does not regard the cyclone as of purely dynamical origin. Among recent important papers by Austrian writers on this and kindred subjects, reference should be made to papers by Exner in *Sitzungsber. Wiener Akad.* (from 1906 onwards), *Geografiska Annaler* (1920) and *Annalen Hydrog. u. Mat. Met.* (1919); by Ficker in the *Meteorologische Zeitschrift* (from 1910 onwards) and by A. Wegener in the same journal (1921). A paper by Ficker in *Met. Zeit.* (March, 1923) gives a bibliography of the more important papers up to that date.

The Amalgamation of Vortices.—In a series of papers (*Q.J.R. Met. Soc.,* vols. xlvii. and xlix.) Fujiwhara developed a theory of the origin of cyclones which he based upon observations of the behaviour of vortices in water. The usual hydrodynamical treatment of vortical motion in fluids leads to the conclusion that two vortices with the same sense of rotation should repel each other, while two vortices with opposite senses of rotation should approach each other. Fujiwhara's observations gave precisely the opposite result, that vortices rotating in the same sense attract each other and eventually amalgamate, and that vortices rotating in opposite senses should repel each other. Thus when a number of vortices having the same sense of rotation exist in proximity to one another, they tend to approach one another, and to amalgamate into one intense vortex. When a large vortex absorbs a smaller one, its intensity is increased. These results described in Fujiwhara's papers, are by no means new. Similar results are described by Mrs. Ayrton ("On a new method of driving off poisonous gases," *Proc. Roy. Soc. A.,* 1919), Ahlborn, (*Phys. Zeit.* xxiii.) and others.

The Travelling Anticyclone.—The anticyclone is to a certain extent the converse of the cyclone, in that it is a centre of high pressures and has a system of winds which blow round this centre in a clockwise sense relative to the earth. It is also commonly regarded as a region of descending air, but this is only true when the unit of time is the day or the week. The estimates which

have been made by Shaw of the rate of descent of air in anticyclones give velocities of the order of a few hundred metres per day.

No satisfactory theory of the origin of the travelling anticyclone has been evolved. Exner (*Dynamische Meteorologie* 2te. Aufl., p. 358) suggests that its origin may be due to the motion of currents of air from low latitudes which bring with them part of the stratosphere above them. Hanzlik (*Denkschriften Wiener Akad.*, 1908) investigated a number of anticyclones and classified them as "warm" and "cold." The cold anticyclone is shallow and does not extend to the stratosphere. Its motion is usually rapid. The warm anticyclone extends to higher levels, and its motion is slight. An anticyclone may frequently arrive over Europe as a cold anticyclone, but if it becomes stationary, then according to Hanzlik it may become warmer and more intense.

The line-squall, waterspout, and tornado are discussed in some detail by M. A. Giblett on "Line-Squalls," *Journal Roy. Aero. Soc.* 1927. Tropical cyclones (hurricanes) are described in any textbook (*e.g.*, Geddes' *Meteorology* or Hann's *Lehrbuch der Meteorologie*). Exhaustive studies of these phenomena are given by Mrs. E. V. Newnham in *Geophysical Memoir* No. 19, and by Cline in *Tropical Cyclones*. A fully illustrated article on "Tornadoes" by R. de C. Ward will be found in the *Quarterly Journal R. Met. Soc.*, 1917.

Elastic Oscillations of the Atmosphere.—Mathematical discussions of the elastic oscillations of the Atmosphere have been given by Rayleigh (*Collected Papers*, vol. iii. p. 335, and *Theory of Sound* § 333), and by Margules (*Sitzungsber. Wiener Akad.* ci part 2a, cii part 2a. An abstract of these papers was given by Trabert in *Met. Zeit.*, 1903).

At any station in the tropics a barograph trace shows two complete waves each day, maxima occurring approximately at 10 A.M. and 10 P.M., and the minima at 4 A.M. and 4 P.M. local time. The amplitudes of these waves are greatest at the equator, and diminish with increasing latitude. Beyond latitude 50°, this double wave becomes indistinct, and in latitudes above 70°, the nature of the phenomena changes. Near the poles the maxima of the pressure waves occur everywhere at approximately the same absolute time, between 10.30 and 13.30 Greenwich mean time (Simpson, "The Twelve-Hourly Barometer Oscillation," *Q.J.R. Met. Soc.*, 1918).

SOME PHYSICAL CONSIDERATIONS

Radiation in the Earth's Atmosphere.—The sun has an "effective" temperature of about 6,000° C and the position of maximum intensity in the band of wave lengths covered by the solar spectrum is at about 0·7 μ. Such radiation is only very slightly absorbed on its passage through the atmosphere, and so reaches the earth's surface with only a slight diminution of intensity by absorption, though with some loss by reflection from clouds. At the earth's surface, and particularly over the sea, some of the incoming beam of solar radiation is reflected upwards, while the remainder is absorbed. The radiation reflected back from clouds or the earth's surface passes outwards with very slight loss by absorption, and is therefore of no effect in heating the earth or its atmosphere. Aldrich (*Annals Astroph. Observatory* iv., App. 2, 1922) computes the fraction of radiation lost by reflection by clouds, the earth's surface, dust and other causes as ·43.

The earth in turn sends out radiation, whose wave-length is appropriate to its temperature. The maximum intensity of the terrestrial radiation is in the neighbourhood of 10 μ and such radiation is partly absorbed by the water vapour in the atmosphere, which also in turn sends out long wave radiation.

In any discussion of the effects of radiation upon an isolated element of air we must therefore take into account the radiation coming upward from the lower layers of the atmosphere, and the radiation coming downward from the upper layers of the atmosphere. Unfortunately these do not include all the possible sources of heat affecting the element of mass under consideration. As we have seen in the section *Dynamical Aspects*, one of the effects of turbulence is to produce a vertical flow of heat, which is upward or downward according as the lapse rate is greater or less than the adiabatic. In addition to this, there is a latitude transfer of heat. The equator being warmer than the poles, any motion of air across the circles of latitude carries warm air pole-ward or cold air equator-ward. Hence in considering the radiative effects over any particular zone, we must allow for the fact that it receives heat not only by direct radiation from the sun, but also by horizontal convection from other latitudes.

In computing the total amount of the incoming solar radiation, a deduction of 43% is made from the theoretical value, to allow for albedo or loss by reflection.

Variability of the Solar Constant.—The intensity of solar radiation falling in unit time on unit area of a surface placed perpendicular to the incoming beam, and at a height sufficiently great to be free from the scattering and absorption of the atmosphere, is called the *solar constant*. Its mean value is usually given as 1·93 gram calories per sq.cm. per minute, or 135 kw. per sq.dm. A long series of measurements at the Carnegie Institution's observatory on Mt. Wilson show it to vary between 1·90 and 1·98. Clayton in a discussion of solar activity and long period weather changes (*Smithsonian Misc. Coll.*, vol lxxviii., No. 4), shows that high values at Mt. Wilson are simultaneous with high values at Calama, Chile. This appears to establish definitely that the changes noted from time to time in the measurements of solar radiation are real changes in the amount of solar radiation. (See *Annals of the Astrophysical Observatory of the Smithsonian Institution.*)

Abbot has recently discovered a persistent period of 15¾ months in the variation of the solar constant, and there is evidence of a number of other shorter periods. It has been suggested by American writers that the variations of the solar constant are effective in varying terrestrial weather (H. H. Clayton, *World Weather*).

The Direct Effects of Incoming Solar Radiation.—The process of *convection* of heat does not become effective until the lapse rate has surpassed the adiabatic limit, but temperature at some distance above ground begins to rise before the lapse rate has reached the adiabatic limit. This phenomenon is probably due to the effect of direct radiation from the ground. The combined effects of radiation and turbulence have been discussed by Chapman (*Q.J.R. Met. Soc.*, 1925) and Brunt (*Proc. Roy. Soc.*, 1929, and 1930). Over land, the lapse rate near the ground may amount to several hundred times the dry adiabatic on sunny afternoons, while at night the cooling of the ground by radiation to clear skies builds up large inversions. The effect of night cooling on the formation of fog and mist has been discussed by G. I. Taylor (*Q.J.R. Met. Soc.*, 1917).

Over the oceans more incoming radiation is lost by direct reflection, some is used up in evaporation of water, and a considerable depth of water is necessary to absorb completely the remainder. Further the specific heat of water is about four times that of dry soil. Hence the temperature of the surface of the sea is far less variable than that of a land surface, and observations indicate that the diurnal range of temperature over the sea is of the order of 1°F. For the same reasons the seasonal variation of temperature is much less over the sea than over land, and so oceanic climates are more equable than land climates.

Efforts have been made to explain the existence of the stratosphere as a direct effect of balance of incoming and outgoing radiation. Reference should be made to the original memoirs of Gold (*Proc. Roy. Soc.*, 1909), Humphreys (*Astrophysical Journal*, 1909), Emden (*Sitzber. bayr. Akad. Wiss.*, 1913) and Milne (*Phil. Mag.*, 1922). Estimates of the amount of radiation leaving the earth in different latitudes have been given by Mugge (*Zeitschrift für Geophysik*, 1926) and Simpson (*Memoirs R. Met. Soc.*, 1928, 1929).

Mathematical discussion of the effects of radiation in the atmosphere is complicated by the presence of air and water vapour in varying proportions. The dry air is of little consequence in producing absorption or radiation, but as it shares with the water vapour the heat which the latter absorbs, its presence is equivalent to weighting the water vapour with an added specific heat.

The Ascent and Descent of Air.—While the lapse-rate remains on the average less than the dry adiabatic, but slightly greater than the saturated adiabatic, we can readily conceive

of any isolated mass of air which has become saturated and at a slightly higher temperature than its environment, being able to rise through its environment, since in the circumstances postulated its temperature would be at each successive level higher than that of its immediate environment. The converse process of the descent of air, however, is not readily understandable. This problem has not yet been satisfactorily solved, probably because the time scale of radiation effects has not been clearly laid down, and until this problem is solved it will not be possible to evolve a satisfactory explanation of the general circulation of the atmosphere. The direct effect of solar radiation is an ascent of air in the doldrums. The air which ascends flows away from the equator and it is of vital importance to determine at what stage in its flow poleward such air will be in a suitable condition to descend again to the surface of the earth.

The existence of ascending currents on a large scale is shown by the occurrence of rainfall, and it is thus possible to obtain some idea of the extent and intensity of such currents. Descending currents are usually less rapid, and in consequence their physical effects may be largely masked by the horizontal motions of the air. The outstanding feature of the distribution of temperature in the troposphere is its approximation to horizontal stratification, which is not a condition favourable to the descent of large masses of air from high levels to the ground. Moreover it appears probable that the conditions existing in the upper air do not show the same variability from place to place which characterises the surface layers.

The amount of energy which can be made available by vertical motion in particular cases can be evaluated by means of the tephigram (vide Shaw, *Manual of Meteorology*, Vols. i, iii). For an important discussion of the use of the wet bulb temperature in connection with the thermodynamics of vertical motion reference should be made to a paper by Normand (*Memoirs Indian Met. Dept.*, Vol. xxiii).

The Maintenance of the Atmospheric Engine.—It has been shown by Jeffreys (*Q.J.R. Met. Soc.*, 1926) and Brunt (*Phil. Mag.*, 1926) that if no external source of energy were effective the atmosphere would be brought to rest relative to the earth in about 10 days by friction. Brunt has shown that the energy destroyed by friction could be made good by the conversion of about 2 per cent of the energy of the incoming solar radiation into kinetic energy. This may in part be brought about by the ascent of heated air in the doldrums, followed by motion poleward and descent in latitude 35° North or South in consequence of cooling, but the physical processes involved in such a cycle are not clearly understood (see *Dictionary of Applied Physics*, vol. iii, article by N. Shaw). Further the general circulation of the atmosphere has been shown to be a very complex phenomenon, lacking symmetry about the earth's axis, so that no simple theory can be expected to explain it. It is now considered that the cyclones and anticyclones form an essential part of the general circulation, (*see* Jeffreys *Q.J.R. Met. Soc.*, 1926, 1927, and Exner *Dynamische Meteorologie*, 2nd edition, chap. ix). The distribution of temperature in the upper atmosphere, in particular the fact that the stratosphere is highest and coldest over the equator, is bound up with the general problem of the circulation of the atmosphere. For a discussion of some aspects of the stratospheric distribution see various papers by Simpson in the *Memoirs R. Met. Soc.*, 1928, 1929. For a discussion of the present position of theories of the general circulation of the atmosphere by E. W. Barlow see *Quarterly Journal R. Met. Soc.*, Jan. 1931; *see* also a paper by T. Bergeron in *Meteorologische Zeitschrift*, 1930. The work of Dobson and others on the distribution of Ozone (see *Proceedings of the Royal Society*, 1929, 1930) suggests a new line of attack upon some problems associated with the general circulation.

The Present Position of Meteorology as a Science.—The preceding pages give an outline of such parts of the Science of Meteorology as may be considered to be definitely accepted. In spite of the immense volume of literature on the subject, the amount of progress which has been made is still slight, and there remain many outstanding problems. Among these may be noted (1) various aspects of the distribution of temperature in the free atmosphere, (2) the nature of turbulence, (3) the physical causes underlying the formation of depressions and anticyclones and (4) the true nature and method of maintenance of the general circulation.

Under heading (1), at least four difficulties remain unsolved.—(a) The approximate constancy of the mean lapse-rate at all heights within the troposphere and in all latitudes. (b) The sudden nature of the change in lapse-rate at the tropopause. (c) The relative constancy of the lapse-rate within the stratosphere, and (d) The decrease of temperature within the stratosphere from equator to pole. With regard to (2) the defects of existing theories have been outlined on page 351. With regard to (3) and (4), which are perhaps only different aspects of the same problem, there is not available any satisfactory theory of the origin of the depression and anticyclone, and even the subtropical anticyclonic belts which form the most permanent feature of the earth's atmosphere have as yet not been adequately explained. Nor is it clear to what extent changes of pressure are to be ascribed to the effects of instability in the lower atmosphere, or to the effects of advection in the upper atmosphere. Until these problems have been solved at least in part, it is difficult to see how the practical application of the science of meteorology to the successful forecasting of weather can make any further progress.

BIBLIOGRAPHY.—For history of Meteorology. Napier Shaw, *Manual of Meteorology* (vol. i., 4 vols. 1926 etc.). For data of observation, H. H. Hildebrandsson and L. Teisserenc de Bort, *Les Bases de la Météorologie dynamique* (1898–1907); J. von Hann, *Handbook of Climatology* (trans. R. de Courcy Ward, 1903) and *Lehrbuch der Meteorologie* (3rd rev. ed., Leipzig, 1915); Napier Shaw, *Manual of Meteorology* (vol. ii.); A. F. Kendrew, *The Climates of the Continents* (2nd ed., 1927).

Methods of Computation: *The Computer's Handbook* (pub. by the Meteorological Office, 1921, etc.).

General Text-books. Cleveland Abbe, *Mechanics of the Earth's Atmosphere* (1862, etc.); A. Angot, *Traité de Météorologie* (1899, 2nd ed. rev. 1907); N. Shaw, *Forecasting Weather* (1911, 2nd ed. 1923), and *The Air and its Ways* (1923); V. F. K. Bjerknes, *Dynamic Meteorology and Hydrography* (1910–11); W. Georgii, *Wettervorhersage* (Dresden and Leipzig, 1914); F. Exner, *Dynamische Meteorologie* (1917 2nd edition 1925); W. J. Humphreys, *Physics of the Air* (1920 2nd edition 1929); A. E. McL. Geddes, *Meteorology* (1921); R. T. Glazebrook, *Dictionary of Applied Physics* (vol. iii.; 5 vols., 1922–23); R. Süring, *Leitfaden der Meteorologie* (Leipzig, 1927).

Introductory Textbooks. W. H. Pick, *A Short Course in Elementary Meteorology* (1921, 2nd ed. 1926); R. G. K. Lempfert, *Meteorology* (1920); D. Brunt, *Meteorology* (1928).

Periodicals. *See* also the *Quarterly Journal* and the *Memoirs* of the Royal Meteorological Society (London), the *Meteorologische Zeitschrift* (Berlin), the *Beiträge zur Physik der freien Atmosphäre* and *Veröffentlichungen des Geophysikalischen Instituts* (Leipzig); the *Geofysiske Publikationer* (Oslo); *The Monthly Weather Review* (Washington); the *Geophysical Memoirs* and the *Meteorological Magazine* published by the Meteorological Office, London; also *The Marine Observer* (1924). A bibliography of recent papers is published biennially by the Royal Meteorological Society. Bibliographies also appear in most issues of the *Monthly Weather Review* and the *Meteorologische Zeitschrift*. (D. Bru.)

METER, GAS: *see* GAS METER.

METER, WATER: *see* WATER METER.

METERS, ELECTRIC. These include induction-motor, mercury-motor and commutator meters, which register the revolutions of a disc or other armature caused to revolve, by the action of the current, at a speed proportional to the amperes or watts passing through the meter, and electrolytic meters in which the current or a shunted fraction of it passes through an electrolyte and decomposes it, the rate of decomposition being proportional to the current employed.

Induction-motor Type.—In the Ferranti alternating current watt-hour meter, a series coil of a few turns of thick wire carrying the main current is arranged below, and a shunt coil of many turns of fine wire is arranged above a horizontal rotary disc of aluminium. This disc is situated in the gap between the poles of a permanent magnet and the lower bearing of its vertical spindle is a sapphire carefully selected to reduce friction to a minimum. The magnetic fields due to the shunt and series windings produce a resultant rotating or shifting field which interacts with eddy

currents, induced in the disc so as to exert a driving torque proportional to the watts. A retarding torque is produced by the action of the permanent magnet also causing the speed of the disc to be proportional to the watts. A worm on the spindle drives the registering train; the registering dials are of the clock pattern, or of the cyclometer pattern.

To read the meter is a simple operation. In the clock pattern, starting from left to right, the figure last passed by the thousands pointer in its revolution is written down and the same procedure is followed for the hundreds, tens and units pointers in succession, the tenths registered on the small lower dial being read only when testing the meter. In the cyclometer pattern, the figures are written down just as they appear on the register. The cyclometer figure wheels are actuated by a falling weight; thus, the changing of the figure wheels does not throw any extra load on the meter.

Mercury-motor Meters.—In the Chamberlain and Hookham direct current ampere-hour meter, a copper disc is caused, by the action of the current, to rotate in a mercury chamber subject to the influence of a magnetic field due to a large permanent magnet. The vertical spindle of the disc, arranged to rotate with the minimum friction, is connected to the registering train with its series of clock dials. The peripheral wall of the mercury chamber is formed by a leather-lined metal band which is readily removable to permit inspection and refilling with mercury.

Commutator Meters.—Commutator meters have a wound armature connected in parallel with a shunt and arranged to rotate in the field of a permanent magnet.

Electrolytic Meters.—In the Reason syphon-tube meter, a solution of a mercury salt is hermetically sealed in a container, at the top of which are arranged a mercury anode and a cathode. During the operation of the meter, mercury is liberated at the cathode and collects in a syphon tube in the container; this tube, when full of mercury, discharges into the lower part of the container. Close to the right limb of the syphon tube is a vertical scale which registers the mercury level; in one form of the meter, this scale reads from 0 to 200 units. Below the scale is another which registers the level of the lower mercury column; this scale may read from 0 to 4,000 units. When reading the meter, both scales are read and the sum of the readings is taken. The Reason single-tube meter has one vertical mercury tube, which is read like a thermometer. In both forms, the mercury can be used repeatedly, the meters being re-set by tilting; the container is flexibly mounted to facilitate this operation.

In the Bastian electrolytic meter, acidulated water is decomposed by the action of the current, and the amount of water decomposed is read off on a vertical scale. (T. E. L.)

METHODISM, a term denoting the religious organizations which trace their origin to the evangelistic teaching of John Wesley. The name "Methodist" was given in derision to those Oxford students who in company with the Wesleys used to meet together for spiritual fellowship; and later on when John Wesley had organized his followers into "societies" the name was applied to them in the same spirit. It was however accepted by him, and in official documents he usually styles them "the people called Methodists." The fact that standards of Methodist doctrine are laid down as consisting of "Mr. Wesley's Notes on the New Testament and the 1st Series of his Sermons" (fifty-three in number), might seem to indicate a departure from existing systems, but it was not so. He fully accepted the recognized teaching of the Church of England, and publicly appealed to the Prayer Book and the Thirty-nine Articles in justification of the doctrines he preached. Methodism began in a revival of personal religion, and it professed to have but one aim, viz. "to spread Scriptural holiness over the land." Its doctrines were in no sense new. It was the zeal with which they were taught, the clear distinction which they drew between the profession of godliness and the enjoyment of its power—added to the emphasis they laid upon the immediate influence of the Holy Spirit on the consciousness of the Christian—which attracted attention, gave them distinction, and even aroused ridicule and opposition. Wesley and his helpers, finding the Anglican churches closed against them, took to preaching in the open air; and this method is still followed, more or less, in the aggressive evangelistic work of all the Methodist Churches. As followers rapidly increased they were compelled to hold their own Sunday services, and this naturally led them to appoint as preachers godly laymen possessing the gift of exhortation. These followed their ordinary avocations on week-days, but on Sundays preached to congregations in their own immediate neighbourhood, and hence were called *local preachers* as distinguished from *travelling preachers*. Some 13,000 congregations, chiefly in the villages, are dependent on local preachers. In the organization adopted to foster spiritual life the very characteristic "Class-meetings for Christian fellowship" take a prominent place. Membership in the church depends solely upon being enrolled in such a meeting for Christian fellowship, and accepting pastoral oversight.

The *Wesleyan Methodists* now represent the original body as founded by John Wesley in Great Britain and Ireland; but in America those who looked upon him as their founder adopted the episcopal mode of Church government after the War of Independence, and have since that time been known as *Episcopal Methodists* (*see* below). It should be noted that the *Welsh Calvinistic Methodists* are only slightly connected with the original body. They were indirectly the outcome of the evangelistic efforts of Howell Harris and Rowlands. Their work received the sympathy of Wesley and liberal financial help from the Countess of Huntingdon. For a time Whitefield was leader, and we find a reference to the "Whitefieldian and Wesleyan Methodists" in the Supplement to the *Gentleman's Magazine* for 1747, p. 619. The theological views of these teachers proved quite incompatible with the Arminianism of Wesley, and a definite breach between them and him took place in 1770. Other divisions have been formed at various times by secessions from the Wesleyan Methodists not on points of doctrine but on matters of church government. They are: Methodist New Connexion (founded 1797–1798); Bible Christians (1815); United Methodist Free Churches (about 1836); Primitive Methodists (founded 1807–1810); Independent Methodist Churches (about 1806); Wesleyan Reform Union (1850, reorganized 1859). The first three of these were joined in 1907 under the name of the United Methodist Church. *See* WESLEYAN METHODISTS, CALVINISTIC METHODISTS, PRIMITIVE METHODISTS, together with separate articles on the other bodies named above; and on the American branches, *see* below.

Missions.—The British Foreign Missionary Societies working under the direction of the three Methodist Conferences have a record of expansion and success. The Wesleyan Missionary Society has erected and equipped 12 colleges with 5,031 students, and also 36 high schools with 6,068 scholars, in addition to 16 theological and normal training institutions for native preachers. Important medical, agricultural and industrial hospitals and schools have also been established in West Africa, South India and China. These societies work in close co-operation with other branches of Christendom by adopting the apportionment of regions of missionary enterprise. They develop a missionary spirit among the native Christians and the creation of a native ministry.

Educational and Social.—The decline in the number of Sunday school teachers and scholars has given serious concern to the conferences. Efforts have therefore been made to increase the efficiency and the attractiveness of the Sunday schools, the work of which is not limited to Sunday, nor to school methods. The boy scouts, girl guides and life brigade movements, summer schools and Bible study circles supplement the work of the Sunday schools. The Wesley Guild and Christian Endeavour societies in British Methodism and the Epworth League in America are doing much to consolidate the work among young people.

In addition to a number of important educational institutions, the three British Methodist Churches have six theological colleges for training candidates for the ministry, which are being more and more brought into line with the curriculum of the various universities. In 1926 Oxford celebrated the bi-centenary of the election of John Wesley to a fellowship of Lincoln College, and, to honour the occasion, conferred the degree of Doctor of Divinity upon the Rev. John H. Ritson, the president of the mother conference, a scholar and graduate of Balliol College, and the first Oxford man elected to the chair of John Wesley.

Denominations	Ministers	Lay preachers	Church members and probationers	Sunday schools	Officers and teachers	Sunday scholars	Churches, etc.
Wesleyan Methodists:							
Great Britain	2,500	19,024	519,510	7,321	120,215	825,604	*8,600
Ireland	242	602	29,500	336	2,228	22,586	416
Foreign missions	747	11,149	287,759	2,981	10,741	168,660	5,311
French conference	26	63	1,757	25	85	693	55
South African conference	282	5,942	169,583	1,000	3,295	45,777	4,674
Primitive Methodists	1,087	13,456	220,806	3,971	54,866	394,050	4,554
United Methodist Church	713	4,735	153,857	2,068	37,777	242,836	2,216
Wesleyan Reform Union	26	504	10,178	203	2,412	24,085	215
Independent Methodist Churches	388	..	10,502	165	3,243	24,563	165
Australasian Methodist Church	1,136	8,036	166,101	3,511	30,916	203,431	3,752
New Zealand Methodist Church†	190	816	29,425	465	3,121	31,632	1,030
United States:							
Methodist Episcopal**	20,905	14,556	5,152,236	17,248	407,182	4,217,372	28,656
Methodist Episcopal, South	8,304	5,264	2,602,316	16,346	172,760	2,014,788	17,540
Methodist Protestant	1,134	377	188,878	1,988	17,495	180,071	2,257
African Methodist Episcopal (coloured)	7,000	6,330	608,029	7,200	29,996	320,000	7,500
African Methodist Episcopal Zion (coloured)	3,962	..	412,315	2,092	16,245	193,000	2,716
Coloured Methodist Episcopal	2,638	..	331,021	2,543	18,884	193,000	3,577
Free Methodist	1,200	..	40,251	1,280	10,150	68,945	1,260
Wesleyan Methodist	645	45	21,500	625	3,800	32,000	550
Primitive Methodist	80	75	11,905	102	1,524	14,781	102
Congregational Methodist	500	..	21,000	182	1,146	8,785	352
New Congregational Methodist	27	..	1,256	27	143	1,298	24
Union American Methodist Epis. (coloured)	205	105	18,812	67	321	2,531	267
African Union Methodist Protestant (coloured)	260	..	3,750	49	441	3,088	58
Reformed Zion Union Apostolic (coloured)	79	..	10,000	36	212	1,508	58
Reformed Methodist Union Epis. (coloured)	48	..	2,772	18	204	1,792	25
British Methodist Episcopal (coloured)	20	6	700	18	125	..	21
African Methodist Protestant	675	..	26,100	..	..	..	650
African American Methodist Episcopal	35	..	5,811	25	..	934	27
United Church of Canada	4,612	1,856	692,348	6,926	74,146	806,468	8,806
Japan Methodist Church	158	140	29,420	554	..	42,570	162
Totals	59,824	93,081	11,869,388	79,372	1,023,673	10,086,907	105,596

*Seating accommodation, 2,418,356.

†These figures include the Solomon Islands Mission with 64 lay preachers, 4,791 members, 41 Sunday schools, 1,384 scholars and 122 churches and preaching places.

**Methodism is also represented in several European countries by Conferences and Missions affiliated to the Methodist Episcopal Church of America, and their membership is included in the figures given above. The latest returns available are: Austria, 1,042 members; Bulgaria, 757; Denmark, 4,201; Finland, 2,254; France, 1,094; Germany (North), 23,200; Germany (South), 18,054; Hungary, 692; Italy, 3,860; Jugo-Slavia, 1,440; Norway, 7,567; Russia (and Baltic Mission), 3,545; Sweden, 16,475; Switzerland, 11,938.

Another department of British Methodism is its home missionary work in the villages and city centres. Wesleyan Methodism has its connectional and lay evangelists. Open air evangelistic services are regularly held, and in many places the theatres and public halls are utilised for extra services. New central halls take the place of down-town churches.

The British Methodist churches have been impressed with the economic and social results which have followed prohibition (*q.v.*) in the United States. Each of the sections has an active temperance and social welfare department. The three Churches have adopted a progressive temperance policy—first of local option, secondly, the complete extension of magisterial licensing authority to all political and social clubs, rich and poor alike; and, thirdly, the entire Sunday closing of all drinking bars.

The Methodist Brotherhood works in unison with the Dominion agents in London, who assist emigrants to the United States, Canada, Australia and South Africa, arrange their passages, and secure them employment. The Brotherhood embraces all Methodist churches, and it has met with success in bringing the emigrant into touch with Methodism overseas.

Methodist Union.—Methodist union transcends in importance all other movements in Methodism at the present time, and it is probably fraught with more momentous issues to the churches concerned than anything since the death of Wesley. A great impetus was given to this movement by the decennial gatherings of the Methodist Oecumenical Conference, which, instituted in 1881, meets alternately in London and America. It consists of delegates from all parts of the world, half of whom are ministers and half laymen. Each assembly has been followed by some decisive step forward along the path of union, and in all cases the ministry has loyally accepted the decisions of the majority. The results of union have far exceeded the anticipations of the churches, and there has been a great increase in membership and revenues.

In 1913, the Wesleyan Methodist Conference appointed a committee to collect information on the subject of union and to report to the next Conference. A final scheme of union was submitted to the yearly conferences of the three Churches in 1925 and was adopted by a very large majority.

BIBLIOGRAPHY.—N. Curnock, *Journal of John Wesley*, 8 vol. (1909–16); J. W. Laycock, *Methodist Heroes in the Great Haworth Round 1734–84* (1909); J. Robinson Gregory, *Students' History of Methodism*, 2 vol. (1911); *Oecumenical Methodist Conference Reports* (Toronto, 1911, London, 1921); G. Eayrs, *Letters of John Wesley* (1915); *British Methodism* (1920); J. S. Simon, *John Wesley and the Religious Societies* (1921); J. A. Sharp, *Catalogue of Wesleyana Belonging to the Wesleyan Methodist Conference* (1921); E. H. Sugden, *Wesley's Standard Sermons* (1921, etc.); J. Elsworth, rev. ed. of *Summary of Methodist Law and Discipline* (1924); rev. ed. of *Order and Form of Business in District Synods* (1925); J. S. Simon, *John Wesley and the Advance of Methodism* (1925). *See* also *Proceedings* and *Publications of Wesley Historical Society; Minutes of Conference* (annual).

(J. A. V.; R. W. Pe.; J. E.; X.)

General Statistics.—The general statistics of Methodism throughout the world are given in the table on p. 358, based on the latest returns obtainable.

METHODISM IN THE UNITED STATES

There are in the United States sixteen distinct Methodist denominations, all agreeing essentially in doctrine. John Wesley had been conducting his United Societies for more than twenty years before the movement took root in North America.

A.—Episcopal Methodist Churches.—Philip Embury (1729–1775), a Wesleyan local preacher, emigrated in 1760 from Limerick to New York. Robert Strawbridge (?–1781), a local preacher and native of Ireland, settled in Maryland. In 1766 Embury was stimulated by his relative, Mrs. Barbara Heck, to begin Methodist preaching, and a society was soon formed which grew rapidly. Five years later Francis Asbury was sent over, and was made assistant superintendent. Meanwhile Strawbridge had been preaching with success in Maryland and in Virginia. These "advance agents" of his spiritual propaganda brought with them Wesley's Arminian Theology. They brought also "the means of grace" on which Wesley placed the greatest stress; such as personal testimony in private and public, class and prayer meetings, watch-nights, love-feasts, the direct and fervent preaching of the Gospel and the singing of Wesleyan hymns, carried on by means of circuits and stations and exhorters. Wesley appointed Thomas Rankin (*c.* 1738–1810) superintendent of the entire work in America.

The first American Conference was held in 1773, and consisted of ten preachers, all of whom were born in England or Ireland. Asbury came to America to remain permanently; but Rankin, unable to identify himself with its people, to take the test oaths required in the Revolution, or to sympathize with the colonies, returned to England, as did all the English preachers except Asbury. By May 1776 there were 24 preachers and 4,921 members; but in the first year of the Revolution there was a loss of 7 preachers and nearly 1,000 members.

The preachers in the South determined upon administration of the sacraments, and a committee was chosen whose members ordained themselves and others. The Northern preachers opposed this step and for several years the Connexion was on the verge of disruption. An agreement was finally made to suspend the administration until Wesley's desires and judgment should be ascertained. He perceived that the society would disintegrate unless effective measures were speedily taken, and early in 1784 he ordained Thomas Coke (1747–1814), already in orders of the Church of England, as superintendent. Wesley sent Coke to America as his commissioner to establish, for the Methodist Society, a system of Church government, which should include the administration of Baptism and of the Lord's Supper. Wesley also appointed Thomas Coke and Francis Asbury "to be joint superintendents over our brethren in North America." Soon after Coke and his companions arrived they met Asbury and fifteen preachers, and a special conference was called, which opened on the 24th of December, 1784, in the suburbs of Baltimore, Maryland. This convention organized itself into a Methodist Episcopal Church, in which the liturgy sent by Wesley should be read, and the sacraments should be administered and deacons to be ordained by a presbytery using the episcopal form. Coke and Asbury were unanimously elected superintendents, Coke, aided by his clerical companions from England, ordaining Asbury as deacon and elder and formally consecrating him a general superintendent. This convention adopted the first Discipline of the Methodist Episcopal Church. It adopted the existing doctrinal standards, consisting chiefly of Wesley's Sermons and his Notes on the New Testament; also twenty-five of the Articles of Religion of the Church of England, modified so as to eradicate all trace of High Church ritualism, Anglican or Roman, and the distinctive doctrines of Calvinism. The Church thus established began its ecclesiastical career with 18,000 members, 104 travelling preachers, about the same number of local preachers, and more than 200 licensed exhorters. There were 60 chapels and 800 regular preaching places. Within five years the number of preachers swelled to 227, and the members to 45,949 (white) and 11,682 (coloured).

To bind the whole body the existing method required the concurrence of each Annual Conference with every proposition. This was inconvenient and occasioned much loss of time; therefore a General Conference was established to meet once in four years. The first was held in 1792, and therein arose a sharp conflict. James O'Kelly (1735–1826), a Presiding Elder in control of a large district, proposed that, when the list of appointments was read in the Conference, if any preacher was not pleased with his assignment he might appeal to the Conference. The motion being lost, O'Kelly and several other preachers seceded. As all "travelling preachers" were eligible, without election, to seats in General Conferences, widespread dissatisfaction prevailed among the distant Conferences. The era of the steamboat and the railway not having arrived, it was possible for two Annual Conferences, adjacent to the seat of the General Conference, to out-vote all others combined. This led to a demand for the substitution of a delegated General Conference, which was conceded by the Conference of 1808 to take effect four years later.

The slavery storm burst on the Conference in 1844. Bishop James Osgood Andrew (1794–1871), a native of the South, had, by inheritance and marriage, become a slaveholder. After debates of many days, he was requested "to desist from the exercise of the office of Bishop while this impediment remained." The Southern members declared that the infliction of such a stigma upon Bishop Andrew would make it impossible for them to maintain the influence of Methodism in the South, and a tentative plan of separation was adopted by the Conference by an almost unanimous vote. The result was that the Methodist Episcopal Church was bisected, and the members of the General Conference of 1848 represented 780 travelling preachers and 532,290 members fewer than it had numbered four years before. After the Civil War the increase in membership was noteworthy. The quadrennial Conference of 1868 represented 222,687 members more than its predecessor; of this gain 117,326 were in the Southern States. In 1872 lay representatives were admitted, the Constitution having been amended so as to make it legal. It was not, however, an equal representation. Not until 1900 were lay and clerical representation equalized. In 1864 the time limit of pastorates was lengthened to three years, and in 1888 to five years. This limit was taken off in 1900, and pastors can be reappointed at the will of the Bishop.

In 1900–1904 a general revision of the Constitution took place, and the words "lay members" were substituted for "laymen" in that part of the Constitution which deals with the eligibility of delegates to the General Conference, making possible the election of women. The General Conference has power to make rules and regulations for the Church, subject only to restrictions which protect the Standards of Doctrine, the General Rules, the disposition of the property of the Book Concern and its income, the income of the Chartered Fund, and the right of ministers to trial before a jury of their peers, an appeal, and similar rights of the laity. By a two-thirds vote of a General Conference, and two-thirds vote of the members of the Annual Conference, all of the members of the Lay Electoral Conferences, present and voting, what is said in these "Restrictive Rules" can be altered or repealed, except that which deals with the Articles of Religion and "the present existing and established Standards of Doctrine." In the Annual Conference the Bishop is the sole interpreter of law, subject to appeal to the General Conference. The district superintendent visits each charge several times annually. The Methodist

Episcopal Church in 1912 adopted the Episcopal area system with a flexible limit on the residence of a bishop in any one area.

The Methodist Episcopal Church South.—After the adjournment of the General Conference of 1844, the representatives of thirteen constituents resolved to determine what should be done to prevent Methodism in the South from being deprived of its influence over the whites and of the privilege, till then fully accorded, of preaching the Gospel and teaching its precepts to slaves. In 1845 a representative Convention was called; this body, with the approval and participation of Bishop Andrew, organized the Methodist Episcopal Church South. At its first General Conference, in 1846, the senior Bishop of the Methodist Episcopal Church, Joshua Soule (1781–1867), offered himself to the Church, which accepted him in his episcopal capacity. The Church thus founded began with 460,000 members, of which 2,972 were Indians, 124,961 coloured, and 1,519 travelling ministers. At the close of the war the Missionary Society of the Church was $60,000 in debt, the Publishing House practically in ruins, and of the more than 200,000 coloured members in 1860 there remained fewer than 50,000. The Conference of 1866 was held in New Orleans. Radical changes in polity were effected. The time limit on the continuation of pastorates was extended from two to four years. The most radical change was the introduction into the General Conference of a number of lay representatives equal to the number of clerical, and the admission into each Annual Conference of four lay delegates for each Presiding Elder's district.

The coloured people, with the consent of the Church, withdrew in 1870, and formed a new Church called the Coloured Methodist Episcopal Church. This church leads all branches of Episcopal Methodism with increases of over 60% in membership and over 100% church-school enrolment from 1910–25.

The titles to 175 educational institutions are held by the Church. The chief foreign missions are in China, Mexico, Brazil, Japan, Korea and China. Its mission in Japan and the mission of the Methodist Episcopal Church and the Methodist Church of Canada were united in 1907 as the Methodist Church of Japan.

The African Methodist Episcopal Church.—This body originated in 1816 in strained relations between the white and coloured Methodists of Philadelphia, Pennsylvania. It sustains Wilberforce University (of Wilberforce, Ohio) and other educational institutions, and has missions in Africa, South America, the West Indies and Hawaii. It is the largest Christian denomination consisting wholly of the Negro race.

The African Methodist Episcopal Zion Church.—Some of the coloured people in the city of New York, "feeling themselves oppressed by caste prejudice, and suffering the deprivation of Church privileges permitted to others," organized among themselves, in 1796, and in the year 1800 built a church and named it Zion. In this church the sexes are equally eligible to all positions. Its educational operations at first were failures, but gradually became successful. Its foreign missions were made a separate department in 1884.

The Coloured Methodist Episcopal Church.—In 1866 the General Conference of the Methodist Episcopal Church South authorized the bishops to organize its coloured members into an independent ecclesiastical body, if it should appear that they desired it. The bishops formed a number of Annual Conferences, consisting wholly of coloured preachers, and in 1870 these Conferences requested the appointment of five commissioners of the Caucasian part of the Church to meet five of their own number to create an independent Church. Two Bishops of the Methodist Episcopal Church South presided, and ordained to the Episcopacy two coloured elders, selected by the right coloured conferences. The coloured people by vote named the organization the Coloured Methodist Episcopal Church. The Union American Methodist Episcopal Church (coloured) agrees in doctrines and usages with other Methodist bodies, but maintains a separate corporate existence.

B.—Non-Episcopal Methodist Churches. The Methodist Protestant Church.—During the Methodist Episcopal General Conference of 1824, held in Baltimore, a Convention of "Reformers" met, and established a periodical entitled *The Mutual Rights of the Ministers and Members of the Methodist Episcopal Church* and made arrangements to organize Union Societies. Travelling and local ministers and laymen were expelled for schism and spreading incendiary publications. Prior to the Conference those expelled, and their sympathizers, formed themselves into a society named "Associate Methodist Reformers." These sent memorials to the General Conference of 1828, and issued addresses to the public. After a powerful and painful discussion, the appeals were rejected. The controversy centered upon lay representation, the episcopacy and the presiding eldership.

A General Convention was held on the 2nd of November 1830, a Constitution was adopted, and a new organization was established, styled the Methodist Protestant Church. Within eight years it had 50,000 members, the majority of whom were in the South and bordering states. The Methodist Protestant Church has a presbyterial form of government, the powers being in the Conference. There is no episcopal office or General Superintendent; each Annual Conference elects its own chairman. Its General Conference meets once in four years. Ministers and laymen equal in number are elected by the Annual Conferences, in a ratio of one delegate for 1,000 members. The General Conference of the Methodist Episcopal Church of 1908 sent delegates to the Conference of the Methodist Protestant Church, suggesting union, but formal negotiations have not been instituted.

The Wesleyan Methodist Connection or Church of America.—In the Methodist Episcopal Church slavery was always a cause of contention. In 1842 certain Methodist abolitionists conferred as to the wisdom of seceding. Among the leaders were Orange Scott (1800–1847), Jotham Horton and LeRoy Sunderland (1802–1885) and in a paper, which they had established, known as *The True Wesleyan,* they announced their withdrawal from the Church, and issued a call for a convention of all like-minded, which met on the 31st day of May 1843, at Utica, New York, and founded the Wesleyan Methodist Connection or Church of America numbering about 20,000 members within 18 months of its organization. As the Methodist Episcopal Church purged itself from slavery in 1844, and slavery itself was abolished in 1862, a large number of ministers and thousands of communicants, connected with the body, returned to the Methodist Episcopal Church. It had in 1926, 666 ministers, 675 churches, and 21,000 communicants. *The Congregational Methodists* originated in Georgia in 1852; but in polity they are not strictly Congregational. This Church has its membership chiefly in Southern states. *The Free Methodist Church* was organized in August 1860, and was the result of ten years of agitation. It was the purpose of the founders to conserve the usage and the spirit of primitive Methodism. The government of the Church is simple, in all but the Episcopacy and its adjuncts resembling that of the Church whence it sprang. The Free Methodist Church had in 1926 1,259 churches, and 34,751 communicants. The *Primitive Methodist Church,* as it exists in the United States, came from England.

The noteworthy changes in American Methodism since 1909 include (1) the steady growth of all its major branches; (2) movements toward the organic union of various units within the Methodist group and with other evangelical churches; and (3) educational advances resulting in liberalizing tendencies in theology, a higher appreciation of non-Christian religious groups with a consequent new approach to the problem of world evangelisation, the democratisation of Episcopal Methodist Churches and an increasing zeal for social justice, inter-racial understanding and the application of the teachings of Jesus to all human relationships and affairs, in politics and sociology as well as to purely personal conduct and belief.

The year 1925 saw the consummation of the Union of the Methodist, Presbyterian and Congregational Churches of Canada in the United Church of Canada. The Methodist Church, as the largest of the three denominational units, went into the United Church with 100% of its constituency, which at the time of the merger included 2,475 ministers, 1,946 lay preachers, 414,047 members, 451,636 church-school pupils, with 43,333 officers and teachers. In the United States a plan for the organic reunion of the Methodist Episcopal Church and the Methodist Episcopal

Church South failed (1925) by a narrow margin of the combined votes of lay and ministerial members of the southern church. The vote in the Methodist Episcopal Church at the same time was overwhelmingly in favour of the union. The vote of the Methodist Episcopal Church South referred the issue for reconsideration at the next session of the respective General Conferences of the two bodies.

The educational advances to which must be attributed certain tendencies already summarized include the following (1) an increase, commensurate with the growth in church membership, in the number, enrolment and financial support of secondary schools and colleges; (2) a rapid rise, especially in the United States, from the previous low average educational preparation and professional training of ministers, together with a corresponding advance in the curriculum standards for collegiate and theological institutions; (3) increasing attention to religious education through the church-school with the extension of the programme of religious education to include week-day instruction; (4) the widespread distribution and use of religious-educational literature in text-book and periodical form, the total regular circulation of which exceeds the membership of all Methodist Churches.

BIBLIOGRAPHY.—*See* Methodist Year Books; Disciplines, Proceedings of Conferences and General Oecumenical Conferences; Methodist periodical literature.

Also *see* Jesse Lee, *A Short History of the Methodists in the United States of America*, Baltimore (1810); Alexander McCaine, *History and Mystery of Methodist Episcopacy*, Baltimore (1829); Nathan Bangs, *A History of the Methodist Episcopal Church from its Origin in 1776 to the General Conference of 1840*, 4 vols., New York (1839–42); Francis Asbury, *Journal*, 3 vols., New York (1852); Thomas Ware, *Sketches of His Own Life and Travels*, New York (1839); Abel Stevens, *History of Methodism*, 3 vols., New York (1858); id. *History of Methodist Episcopal Church*, 4 vols., New York (1864); id. *The Centenary of American Methodism*, New York (1866); J. B. Wakeley, *Lost Chapters Recovered from the Early History of American Methodism*, New York (1858); Robert Paine, *Life and Times of William McKendree*, 2 vols., Nashville (1869); revised (1874); A. H. Redford, *History of the Organization of the Methodist Episcopal Church South*, Nashville (1871); Lucius C. Matlack, *Anti-Slavery Struggle and Triumph in the Methodist Episcopal Church*, New York (1881); Holland N. McCyeire, *A History of Methodism*, Nashville (1884); Stephen M. Merrill, *A Digest of Methodist Law*, New York, revised ed. (1888); Joel Martin, *The Wesleyan Manual, or History of Wesleyan Methodism*, Syracuse, N.Y. (1889); Daniel A. Payne, *History of the African Methodist Episcopal Church* (1891); John J. Tigert, *A Constitutional History of American Episcopal Methodism*, Nashville (1894); J. M. Buckley, *History of Methodism in the United States*, New York (1895); Daniel Dorchester, *Christianity in the United States*, New York (1895); J. W. Wood, *One Hundred Years of the African Methodist Episcopal Zion Church*, New York (1895); J. M. Reid, *Missions and Missionary Society of the Methodist Episcopal Church*, New York (1895); revised by J. T. Gracey; *History of Methodism in the United States* (1897); Edward J. Drinkhouse, *History of Methodist Reform*, 2 vols., Baltimore (1899); Henry B. Bascom, *Methodism and Slavery* (Nashville); Succock and Hutchinson, *The Story of Methodism*, New York (1925); and the *Discipline* and *Journals* of the various American Methodist Churches, and the Proceedings of the Centennial Methodist Conference (1884); of the First Ecumenical Conference (1881); of the second Ecumenical Conference (1891); and of the third Ecumenical Conference (1901); fourth Ecumenical Conference (1911); and the fifth Ecumenical Conference (1921). (X., F. J. McC.)

METHODIST NEW CONNEXION, a British Nonconformist Church, formed in 1797 by secession from the Wesleyan Methodists, and merged in 1907 into the United Methodist Church (*q.v.*). The secession resulted from a dispute regarding the position and rights of the laity. In its conferences ministers and laymen were of equal number, the laymen being chosen by the circuits and in some cases by representatives elected for life by conference. Otherwise the doctrines and order of the Connection were the same as those of the Wesleyans. At the time of the union with the Bible Christians and the United Methodist Free Church in 1907 the Methodist New Connexion had some 250 ministers and 45,000 members.

METHODIUS (*c.* 825–885), the apostle of the Slavs, was a native of Thessalonica, probably by nationality a Graecized Slav. His father's name was Leo, and his family was socially distinguished; Methodius himself had already attained high official rank in the government of Macedonia before he determined to become a monk. His younger brother Constantine (better known as Cyril, the name he adopted at Rome shortly before his death) was a friend of Photius, and had earned the surname "the Philosopher" in Constantinople before he withdrew to monastic life. Constantine about 860 had been sent by the emperor Michael III. to the Khazars, a Tatar people living north-east of the Black Sea, in response to their request for a Christian teacher, but had not remained long among them; after his return to within the limits of the empire, his brother and he worked among the Bulgarians of Thrace and Moesia, baptizing their king Bogoris in 861. About 863, at the invitation of Rastislav, king of "Great Moravia," who desired the Christianization of his subjects, but at the same time that they should be independent of the Germans, the two brothers went to his capital (its site is unknown), and, besides establishing a seminary for the education of priests, successfully occupied themselves in preaching in the vernacular and in diffusing their translations of Scripture lessons and liturgical offices. Some conflict with the German priests, who used the Latin liturgy, led to their visiting Pope Nicholas I., who had just been engaged in his still extant correspondence with the newly converted Bulgarian king; his death (in 867) occurred before their arrival, but they were kindly received by his successor Hadrian II. Constantine died in Rome (in 869), but Methodius, after satisfying the pope of his orthodoxy and obedience, went back to his labours in "Moravia" as archbishop of Syrmia (Sirmium) in Pannonia. His province appears to have been, roughly speaking, co-extensive with the basins of the Raab, Drave and Save, and thus to have included parts of what had previously belonged to the provinces of Salzburg and Passau. In 871 complaints on this account were made at Rome, nominally on behalf of the archbishop of Salzburg, but really in the interests of the German king and his Germanizing ally Swatopluk, Rastislav's successor; they were not, however, immediately successful. In 879, however, Methodius was again summoned to Rome by Pope John VIII., after having declined to give up the practice of celebrating mass in the Slavonic tongue; but the pope, contrary to all expectation, ultimately decided in favour of a Slavonic liturgy, and sent Methodius (880) back to his diocese with a suffragan bishop of Neitra, and with a letter of recommendation to Swatopluk. The closing years of the life of Methodius were embittered by continual ecclesiastical disputes, in the course of which he is said to have laid Swatopluk and his supporters under the ban, and the realm under interdict. Methodius is said to have died at Hardisch on the March, on April 6, 885. He was buried at Welehrad (probably Stuhlweissenburg).

The Greek Church commemorates St. Cyril on February 14 and St. Methodius on May 11; in the Roman Church both are commemorated on March 9. Their canonization (by Leo XIII. in 1881) is noteworthy, in view of the fact that Gregory VII. and several other popes condemned them as Arians. After the death of Methodius much of his work was undone; his successor Gosrad, a Slav, was expelled, with all the Slav priests, and the Latin language and liturgy supplanted the vernacular.

See Schafarik's *Slawische Alterthümer;* L. K. Götz, *Geschichte der Slavenapostel Konstantinus und Methodius* (Gotha, 1897); N. Bonwetsch, *Cyrill und Methodius, die Lehrer der Slaven* (Erlangen, 1885), and art. in Hauck-Herzog's *Realencyk. für prot. Theol.* iv. 384, where the literature is cited; G. F. Maclear, *Conversion of the Slavs* (London, 1879).

METHODOLOGY: *see* SCIENTIFIC METHOD.

METHUEN, a town of Essex county, Massachusetts, U.S.A., 10 m. N.E. of Lowell, on the Boston and Maine Railroad. The population was 15,189 in 1920 (34% foreign-born white, almost half of them from England) and was 21,069 in 1930 by the Federal census. It is a manufacturing centre, making cotton and woollen goods, hats and shoes. The factory product was valued at $11,973,260 in 1925. Methuen was set off from Haverhill and incorporated as a town in 1725. In 1917 it was chartered as a city, but the town form of government was resumed in 1921.

METHUSELAH, eighth in the list of ante-diluvians, Genesis v., is credited with the longest life, 969 years: he appears in the parallel list, Genesis iv., as Methushael. In each case he is the father of Lamech. Attempts—for which see the commentaries—

have been made to find etymologies for the name, and to equate it with a name in similar Babylonian lists, but all are precarious.

METHVEN, village, Perthshire, Scotland, $7\frac{3}{4}$ m. W. by N. of Perth by the L.M.S. railway. Pop. civ. parish (1931) 1,670. Only an aisle remains of the collegiate church founded in 1433 by Walter Stewart, earl of Atholl. One mile east of the village, Methven Castle, dating partly from 1680, occupies a fine situation in a park in which stands the Pepperwell oak, 18 ft. in circumference. At Dronach Haugh near the banks of the Almond, which bounds the parish on the N., the earl of Pembroke defeated Robert Bruce in 1306. At Lynedoch, his estate on the Almond, Thomas Graham, the Peninsular general, afterwards Lord Lynedoch, carried on many experiments in farming and stock-breeding. Trinity College occupies a beautiful position $4\frac{1}{2}$ m. north-west of Methven in Glenalmond, and is usually called by the latter name. It was the first public school on the English model in Scotland and was opened in 1847. At Tibbermore, or Tippermuir, about 3 m. south-east of Methven, Montrose won his first battle over the Covenanters in 1644.

METHYL ALCOHOL, in a more or less impure form known in commerce as wood spirit, being produced by the destructive distillation of wood. The name methyl from the Greek *μέθυ*, wine, *ὕλη*, wood, explains its origin. Discovered in 1661 by R. Boyle, it was studied in greater detail by Dumas and Peligot in 1831, and its synthesis by M. Berthelot from methane through methyl chloride followed in 1858. It is the simplest alcohol (*q.v.*) of the aliphatic series (*see* CHEMISTRY: *Organic*) with the formula CH_3OH; it is also known as methanol.

The older process of manufacture consists in distilling wood in iron retorts at about 500° C, when the aqueous distillate, containing methyl alcohol, acetic acid, acetone and methyl acetate, is neutralised with lime to fix the acetic acid and again distilled. Crude methyl alcohol thus obtained in the distillate can be purified by conversion into the calcium chloride methyl-alcoholate, $CaCl_2$, $4CH_3{\cdot}OH$, which is separated and again decomposed by redistilling with water. Purified methyl alcohol is dehydrated over caustic potash or lime. Further purification may be effected by converting methyl alcohol into one of its esters (acetate, oxalate or benzoate). Methyl alcohol is also obtained in the dry distillation of molasses.

Industrial Synthesis of Methanol.—A formidable rival to the wood distillation has arisen from the modern development of pressure chemistry (*q.v.*). The thermochemical equation $CO+2H_2 \rightleftarrows CH_3{\cdot}OH+27{,}200$ cal. shows that the synthesis of methyl alcohol from carbon monoxide and hydrogen will be favoured by increased pressure and also by diminishing temperature, providing that the reaction is facilitated by a suitable catalyst. These conditions have been realised by using a zinc oxide–chromic acid catalyst prepared by interaction between zinc oxide (3 mols.) and chromic acid (1 mol.) with subsequent reduction in hydrogen at 350° C. A mixture of one volume of carbon monoxide and two volumes of hydrogen when passed over the heated catalyst at 350–400° C under a pressure of 200 atmospheres gave a liquid product consisting mainly of methyl alcohol (up to 90%); the other ingredients are higher alcohols and water, the latter being formed during further condensation and also from the gradual reduction of the catalytic oxides. The catalytic chamber consists of a strong steel cylinder lined with copper, and the inlet and exit tubes consist chiefly of the latter metal. The organic product contains smaller amounts of the higher primary alcohols among which *n*-propyl alcohol and *iso*butyl alcohol, $(CH_3)_2CH{\cdot}CH_2{\cdot}OH$, have been identified (Morgan, Taylor and Hedley, *J. Soc. Chem. Ind.*, 1928). From these higher alcohols and water, methyl alcohol is readily separated by fractional distillation. When purified from traces of aldehydes by successive digestion with 2:4-dinitrophenyl-hydrazine and sodium and again rectified by distillation, it is obtained as a colourless, almost inodorous liquid, boiling at 66–67° C and having a specific gravity of 0·8142 at 0° C. It mixes in all proportions with water, ethyl alcohol or ether. Its chief industrial uses are as follows:—(1) starting material for formaldehyde, (2) denaturant for ethyl alcohol (wine spirit), (3) in varnish manufacture, (4) as a fuel, (5) as a chemical reagent in the fine chemical and synthetic colour industries.

The following derivatives have some industrial importance: *Methyl chloride,* CH_3Cl, a colourless gas boiling at −23° C, obtained by chlorinating methane, or preferably by passing hydrogen chloride into methyl alcohol in presence of zinc chloride. It is soluble in water and more so in alcohol. *Methyl bromide,* similarly prepared by the use of hydrogen bromide, is a volatile liquid boiling at 13° C (sp. gravity, 1·73). *Methyl iodide* boils at 43° C (sp. gravity 2·19). *Dimethyl sulphate,* prepared by adding chlorosulphonic acid or sulphur trioxide to methyl alcohol diluted with carbon tetrachloride, is a colourless oily liquid boiling at 187–188° C (sp. gravity 1·327). It is greatly used as a methylating agent in spite of its poisonous character. The inhalation of its vapours should be avoided. (G. T. M.)

METHYLATED SPIRIT: *see* ALCOHOL IN INDUSTRY.

METHYLENE BLUE, a "basic" dye of the thiazine class. (*See* DYES, SYNTHETIC.)

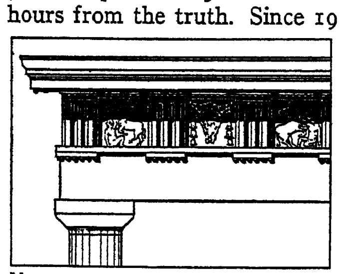
METHYL ORANGE: *see* AZO-COMPOUNDS.

METHYL VIOLET and the closely related crystal violet are "basic" dyestuffs belonging to the triphenylmethane or carbonium series. (*See* DYES, SYNTHETIC.)

METOCHITA, THEODORE [THEODOROS METOCHITES], a Byzantine author, man of learning and statesman, who flourished during the reign of Andronicus II. Palaeologus (1282–1328). After the deposition of his patron by Andronicus III., Metochita was deprived of his office of great logothete (chancellor) and sent into exile. He was soon recalled, but retired from political life to a convent, where he died in 1332. He was a man of very great learning, only surpassed by Photius and Michael Psellus.

Only a few of his numerous works have been preserved. The best known is *Ὑπομνηματισμοὶ καὶ σημειώσεις γνωμικαί*, *Miscellanea philosophica et historica* (ed. C. G. Müller and T. Kiessling, 1821), containing some 120 essays; for a list of them see Fabricius, *Bibliotheca graeca* (ed. Harles), x. 417; in these he chiefly made use of Synesius. Of his rhetorical pieces two have been published by C. N. Sathas in *Μεσαιωνικὴ βιβλιοθήκη* (1872), and two poems on religious subjects by M. Treu (1895). Metochita was also the author of works on philosophical and astronomical subjects.

METONIC CYCLE, in chronology, a period of 19 years during which there are 235 lunations, so called because discovered by Meton. Computation from modern data shows that 235 lunations are 6,939 days, 16·5 hours; and 19 solar years, 6,939 days, 14·5 hours. The relation between integral numbers of months and years expressed by Meton's rule therefore deviates only two hours from the truth. Since 19 Julian years make 6,939 days, 18 hours, the relation errs by only 1·5 hour when the Julian year is taken. Meton was an Athenian astronomer (fl. 432 B.C.).



METOPE. SCULPTURED SQUARE PANELS BETWEEN TRIGLYPHS, GREEK DORIC

METOPE, in architecture, the square portion of the Doric frieze, situated between the triglyphs (*q.v.*) or grooved blocks. In Greece the slab was often sculptured. (*See* ORDER.)

METRE: *see* VERSE and MEASURES AND WEIGHTS.

METRIC SYSTEM, that system of weights and measures of which the metre is the fundamental unit (adapted from Gr. *μέτρον*, measure). The theory of the system is that the metre is a $\frac{1}{10,000,000}$ part of a quadrant of the earth through Paris; the litre or unit of volume is a cube of $\frac{1}{10}$ metre side; the gramme or unit of weight is (nominally) $\frac{1}{1,000}$ of the weight of a litre of water at 4° C.

The idea of adopting scientific measurements had been suggested as early as the 17th century, particularly by the astronomer Jean Picard (1620–1682), who proposed to take as a unit the length of a pendulum beating one second at sea-level, at a latitude of 45°. These suggestions took practical shape by a decree of the National Assembly in 1790 appointing a committee to consider the suitability of adopting either the length of the seconds pendulum, a fraction of the length of the equator or a fraction of the quadrant of the terrestrial meridian. The com-

mittee decided in favour of the latter and a commission was appointed to measure the arc of the meridian between Dunkirk and Montjuich near Barcelona. Another commission was also appointed to draw up a system of weights and measures based on the length of the metre and to fix the nomenclature, which on the report of the commission was established in 1795. It was not until 1799 that the report on the length of the metre was made. This was followed by the law of the 10th of December 1799 fixing definitely the value of the metre and of the kilogramme, or weight of a litre of water, and the new system became compulsory in 1801. It was found necessary however to pass an act in 1837, forbidding as and from the 1st of January 1840, under severe penalties, the use of any other weights and measures than those established by the laws of 1795 and 1799. The metric system is now obligatory in Argentina, Austria, Hungary, Belgium, Brazil, Chile, France, Germany, Greece, Italy, Mexico, Netherlands, Norway, Peru, Portugal, Rumania, Yugoslavia, Spain, Sweden, Switzerland. Its use is legalized in Egypt, Britain, Japan, Russia, Turkey and the United States. In 1875 there was constituted at Paris the International Bureau of Weights and Measures, which is managed by an international committee. The object of the Bureau is to make and provide prototypes of the metre and kilogramme, for the various subscribing countries.

In England action has frequently been taken both by individuals and by associations of commercial men for the purpose of endeavouring to make the metric system compulsory. A Decimal Association was formed in 1854, but did not make very much headway. A bill was introduced into parliament in 1864 to make the metric system compulsory for certain purposes, but owing to government objections a permissive bill was substituted and subsequently became law as the Metric Act 1864. It was, however, repealed by the Weights and Measures Act 1878. In 1871 another bill was rejected in the Commons by five votes. In 1893 a representative delegation of business men pressed its adoption on the chancellor of the exchequer (Sir W. V. Harcourt), but he declined. But in 1897 a statute was passed, the Weights and Measures (Metric System) Act, which legalized the use in trade of the metric system, and abolished the penalty for having in one's possession a weight or measure of that system. (*See* also DECIMAL COINAGE and MEASURES AND WEIGHTS.)

METROCLES, a Greek philosopher of the Cynic school, was a contemporary of Crates, under whose persuasion he deserted the views of Theophrastus. His philosophical views, which were identical with those of Crates (*q.v.*), he expounded by precept and example with great success, and had among his pupils Menippus of Sinope. Having weighed the probable pains and pleasures of approaching old age, he decided that life offered nothing, and drowned himself. He is said to have written several works, which he afterwards burnt.

METRODORUS [of CHIOS], a member of the Atomistic school. A pupil probably of Democritus himself, he accepted the Democritean theory of atoms and void and the plurality of worlds, but held that the stars are formed from day to day by the moisture in the air under the heat of the sun. His radical scepticism is seen in the first sentence of his Περὶ φύσεως, quoted by Cicero in the *Academics* ii. 23 § 73. He says, "We know nothing, no, not even whether we know or not," and maintains that everything is to each person what it appears to him to be.

METROLOGY, a name for the science of pure measurement, is in practice restricted to mean measurement of the three fundamental quantities, mass, length and time, from which all other quantities, such as volume, density, velocity, acceleration, force and power, are derived. If "science is measurement" then without metrology there is no science. Even in its most direct application it covers a very wide field (*see* MENSURATION; SURVEYING; GEODESY; EARTH, FIGURE OF THE; MICROMETER; MEASURING INSTRUMENTS; TIME; CLOCKS; WEIGHTS AND MEASURES; WEIGHING MACHINES; METRIC SYSTEM). The question of the time standard, moreover, is particularly an astronomical one. There is no "absolute" standard; all measurement is relative.

Problems Involved.—The problem of metrology is twofold. First to provide and maintain unaltered the standards of reference by which other quantities are compared and measured; and secondly to provide means by which the comparisons may be made with accuracy sufficient for the particular purpose in view. The demands of science and industry at the present day require, for certain purposes, an extremely high degree of accuracy in these fundamental comparisons, so that what, at first sight, would appear to be a fairly simple problem becomes in fact one of great difficulty, involving the most expensive and elaborate apparatus. No measurement is ever absolutely correct. Some degree of experimental error is always necessarily present, and the approximate degrees of accuracy at present attainable in certain of the more fundamental operations in metrology, are as follows:—

Comparison of two platinum-iridium copies of the International Prototype Kilogramme: 1 part in 100,000,000.
Comparison of ordinary chemical weights: 1 part in 1,000,000.
Comparison of smaller masses by micro-balance: 1 part in 100,000,000.
Comparison of two yard or metre (line or end) standards: 1 part in 10,000,000.
Comparison of end standard with line standard: 1 part in 1,000,000.
Determination of volume and density for very special work: 1 part in 1,000,000.
Determination of volume and density, ordinary: 1 part in 10,000.
Calibration of set of end standards (not less than 1 in. in length): 1 part in 1,000,000.
Calibration of subdivisions of graduated yard or metal scale in terms of whole length: 0·000005 in. or 0·0001 millimetre.

STANDARDS OF LENGTH

The history of standards of length is one of varying ascendency of three principal competing types. A length may be defined by the distance, under certain specified conditions, either between the two end surfaces of a material standard bar, or between two suitable marks engraved upon it. Alternatively reference may be made to some "natural" standard. The standard yards of Henry VII. and Elizabeth preserved in the Standards Department of the Board of Trade, are end standards, incisions marking subdivisions of the yard being secondary only. The Elizabethan yard was superseded by one defined by the distance between two small dots on gold plugs inserted in it. When this bar was legalized in 1824, it was provided that in the event of loss it should be replaced by reference to a "natural" standard, the length of the pendulum beating seconds in the latitude of London.

It so happened that within a very short period this bar was in fact destroyed by the fire in the Houses of Parliament in 1834. The commission charged with its replacement found, however, that it was impossible to reproduce the seconds pendulum with so high an accuracy as the length of the bar itself could be reproduced by means of direct comparison with other bars which had previously been compared with the lost standard. The new standard yard, which is legal at the present day, was thus restored.

The metre was originally intended to be the 10,000,000th part of the earth's meridional quadrant. But it was soon found that not only was the determination of this natural standard an extremely laborious undertaking, but the accuracy attainable was less than that possible in the comparison of material standards, and the material Mètre des Archives, a platinum end standard, became the accepted standard of reference for the metric system until superseded in 1889 by the present International Prototype Metre, a platinum iridium line standard (*see* WEIGHTS AND MEASURES).

Wave Lengths as Natural Standard.—Some later developments, however, have appreciably changed the situation. In the first place the experiments of Michelson, followed by those of Fabry and Perot (*see* LIGHT) have finally established a natural standard (the wave length of the red line in the spectrum of cadmium) which is reproducible with accuracy at least as great as that attainable in the comparisons of material standards, which is definitely free from the suspicion of possible secular variation inevitably attaching to all material standards, and by means of which the material standards necessarily employed in everyday practice can be verified in any part of the world without the risk of accident or damage involved in the periodical transport of material national reference standards to and from the international central laboratory for comparison with the prototype. Secondly, such improvement has been effected during the last few years in the production of flat-ended standards that bars with accurately

parallel ends of the quality of optical mirrors are now available, whose lengths can be more directly determined by the method of optical interference than is the case with line standards, and which are also more accurately comparable with each other.

The International Committee on Weights and Measures, at its meeting in 1923, decided in principle on a wave-length standard subject to experiment in the various national laboratories. Such experiments are proceeding and within the next decade a very important result may be achieved.

Use of Material Standards.—There is evidence that the imperial standard yard has probably shortened by about 0·0002 inch since it was originally constructed in 1844, but has remained unchanged for the last 40 years. So far as is known, the international prototype metre has remained unchanged since its verification (1875–79). The evidence for this rests partly on subsequent recomparison with various national copies constructed in the same manner at the same time, and partly on two determinations, by different methods, at an interval of about 15 years, the first by Michelson and Benoit, and the second by Fabry and Perot, against the wave length of the red line of cadmium. These metre standards are all made of an alloy of 90% platinum and 10% iridium, regarded as the most satisfactory for ultimate standards. Its cost would be prohibitive for any other purpose.

Temperature Conditions.—All materials change in size to a greater or less degree with variation of temperature. It is therefore essential to specify exactly the temperature at which the material standard defines the unit of length, and further either to control the standard exactly to this temperature when making comparisons with it, or at least to ascertain its temperature exactly, and make allowance for its known expansion between that temperature and the standard temperature. The Imperial Standard Yard is correct at 62° F, the International Prototype Metre at 0° Centigrade. The numerical relationship between the two units has been twice accurately determined: in 1895 by Chaney and Benoit, with the result 1 metre = 39·370113 in.; and more recently (1922–25) at the National Physical Laboratory, with the result 1 metre = 39·370147 inches. The two results may be said to be in agreement within the experimental error of the various observations involved, and for all practical purposes the simple ratio 1 in. = 25·4 mm. (equivalent to 1 metre = 39·370079 in.) is exact.

The use of this ratio implies that the two objects being compared are both simultaneously at their common temperature of employment. For all everyday purposes of measurement, as for example in measuring a piece of work in an engineering workshop, it is unnecessary to bring the object to be measured to the standard temperature. If the work and the gauge with which it is being measured are made of materials having the same coefficient of expansion, and the former has been compared with the reference standard at the standard temperature, it is only necessary, when comparing the work with the gauge, to ensure that both are at the same temperature (not necessarily the standard temperature) to ensure that the work will be correctly measured.

Use of Invar.—For many purposes where very precise measurement is involved, it is of great advantage to have a material with a very small thermal expansion. Two such materials have been discovered. The first, known as "Invar," is a nickel-steel alloy, containing 36% of nickel, invented by Dr. Ch. Ed. Guillaume of the Bureau International (Sèvres). Different samples have coefficients ranging from about $1·5 \times 10^{-6}$ per 1° C, for large bars, down to zero, or even slightly negative values, for smaller bars, pendulum rods, drawn wire or rolled tape. These figures are to be compared with 11×10^{-6} per 1° C for steel, and 18×10^{-6} per 1° C for brass. Invar, unfortunately, has one very serious defect as a standard of length. It grows longer, rapidly at first and subsequently more slowly but continuously, so that after 20 years the length of a bar of invar will still be increasing at a rate of about 1 part in 2,000,000 per annum. More recently Dr. Guillaume has introduced a slightly different alloy, containing a percentage of chromium in addition to the nickel, which is described as "stable" invar. This alloy grows at an appreciably slower rate than ordinary invar, but still cannot be regarded as constant. Invar therefore is principally useful in a laboratory, in work where temporary constancy of length is the primary consideration, or in circumstances, as for example in the case of tapes and wires used for geodetic surveying, where the accurate ascertainment of temperature presents considerable difficulty. In these cases it is necessary to return the tapes or wires to the laboratory periodically for reverification. For the reasons indicated above, in everyday workshop measurements, gauges or scales should be made of material having a similar coefficient of expansion to the work to be measured, and invar therefore should not ordinarily be used for the construction of workshop standards.

Fused Silica and Natural Crystal Quartz.—The other material which has a very low coefficient of expansion is fused silica, which expands only $0·4 \times 10^{-6}$ per 1° Centigrade. A metre standard constructed of fused silica, in the form of a tube, with parallel plates fused in at the ends on the platinised surfaces of which the defining lines are ruled, has been made and kept under observation at the National Physical Laboratory since 1913. So far as can be detected, no change has occurred in its length. Such a standard is extremely fragile, and for this reason would hardly be adopted either as a fundamental reference standard or for everyday use, except in a metrological laboratory.

Reference should be made to the recent work of Perard, at the Bureau International, on end standards of natural crystal quartz. Such standards cannot, of course, be of the full length of the yard or metre. But they present several great advantages. Firstly, since the material is of great age and the molecules of which it is composed are arranged structurally in definite crystalline array, there seems little possibility of any secular change. Secondly, it lends itself to perfect optical finish of the defining end planes, which enables direct determination of length to be made in terms of light waves, with extremely high precision resulting in a proportional accuracy no less than is at present obtained in the comparison of yard or metre line standards, although the largest available specimens of crystal quartz, as well as the method of use, only enable such standards to be verified up to about 4 inches.

Line Standards; Mode of Comparison.—The comparison of two line standards is effected as follows: The bars are placed side by side, each on one of two parallel girders contained in a water bath, which is mounted on a carriage capable of being moved in a direction perpendicular to the length of the bars. The bars are constructed with their graduations on polished surfaces in the neutral plane of their cross section, and each is supported on two rollers spaced at such a distance apart that the distance between its graduation marks has a maximum value. Under these conditions any changes in the flexure of the bars due to slight errors in the positions of the supports can have no effect on the measured distances between the graduations. Two micrometer microscopes (*see* MICROMETER) are rigidly held in brackets supported in such a manner as to be unaffected by the motion of the carriage. Each girder has independent adjustments by means of which the lines on the bars can be brought into focus in the field of the microscopes. The water in the bath is stirred and the temperature read by means of accurately calibrated thermometers. Readings are taken by means of the microscopes alternately on the defining lines of each bar, and the mean of several independent readings is taken. The comparison is repeated with each of the bars turned end for end in turn in order to overcome any effect of asymmetry in the illumination of the graduation marks, and the bars are then interchanged on the two girders and the whole repeated once more, making eight complete sets of readings in all, from which the difference in length between the two bars is finally computed. In an important determination several bars (say six or eight) may be included, and each will be completely compared in the manner described above, against all the others, the best values for the differences between all the various bars being then computed from the individual observed differences by the method of least squares (*see* PROBABILITY), the residual errors serving to indicate the degree of accuracy which has been attained in the work.

Calibration.—The calibration of the subdivisions of a divided scale is done in a similar way, except that in this case the carriage of the comparator moves in the direction of the length of the bar. The microscopes are fixed successively at a series of suitable inter-

vals apart, for example, 1 dm., 2 dm., 3 dm., etc., and each principal interval of 1 dm., 2 dm., etc., is compared with every other interval of the same magnitude throughout the metre. By computation from the results so obtained the value of each decimetre is determined in relation to the whole length of the scale. In a similar manner each centimetre of one decimetre is compared with every centimetre of another decimetre, and as a result the value of each centimetre is found in relation to the whole of the other decimetre, and so in turn, in relation to the whole length of the metre. Millimetres are derived from centimetres in the same way, and so on. The complete calibration of a divided scale will be seen to be a very laborious process involving an enormous number of observations. The process is, however, simplified by the fact that the whole of the measurements are made on the one bar, so that, provided reasonable precautions are taken to ensure constancy of temperature, exact temperature measurements are not important.

The apparatus used to determine coefficients of expansion is similar to the transverse comparator, but has two independent water baths mounted on the carriage. One of these, containing a bar preferably of invar, is kept at a constant temperature, while the other, containing the bar under examination, is brought successively to a series of suitable temperatures. The two bars are compared at each temperature of the second, and so the variations of its length with temperature are determined.

A number of machines of different types, and varying sensitivity, are available for comparing end standards by contact measurement, or, if the end faces are of sufficiently perfect finish, they may be directly compared by the method of optical interference. In the latter case the two bars are brought in turn between two semi-silvered optically flat glass surfaces, and the number of wave lengths in the small spaces at either end between the measuring surface of the bar, and the semi-silvered surfaces of the optical flats are determined by direct measurement of the angular diameters of the interference rings formed by monochromatic light. This enables the fraction of a wave length to be determined with exactness, and if several different wave lengths are used in turn, whose mutual ratios are known, the whole number of waves is easily determined by deduction, as only a particular set of corresponding whole numbers will give fractions agreeing in every case with the series actually observed.

In the mechanical contact type of measuring machine the bar is measured between two opposed anvils, one of which may either be fixed, or may be movable by means of a micrometer screw, while the other is capable of a small movement operating some form of sensitive indicator. The two bars to be compared are inserted in turn between the anvils, and if the whole difference between them is sufficiently small the movement of the indicator over a calibrated scale may suffice to determine it. If the difference is greater, the indicator must be brought to a fixed mark by an adjustment of the moving anvil, the difference in length being then ascertained by the difference in reading of the micrometer wheel.

Mode of Calibration of End Standards.—The calibration of a set of subdivisional end standards is effected by taking them together in pairs of nominally equal added lengths, and comparing their sums, in the manner just described. In the last 20 years there have been developed, first by the firm of C. E. Johansson, Sweden, and later at the National Physical Laboratory, England, and by Hoke in America, methods of producing short flat-ended gauges of such perfection that any two of them if put together will adhere firmly to each other by "wringing." The process of wringing appears to depend essentially on the presence of a very minute trace of liquid (grease or moisture) between the surfaces of the gauges. This wringing film is extremely thin, and the bond between the two surfaces appears to be formed by short chains of liquid molecules, only two or three molecules long, attached at either end to the molecules of the solid surfaces.

These gauges are usually made in series, *e.g.*, 1 in., 0·9 in., 0·8 in. . . . 0·1 inch. Suppose we wish to calibrate such a series, of which the 1 in. is supposed to be already known as the result of some previous calibration. For convenience we will assume that we have available a duplicate set of pieces, which we denote by 0·1′ in., 0·2′ in. . . . 0·9′ inch. To determine, for example, the value of the 0·7 in. gauge, we wring up in turn all the various nominally equal combinations indicated below, and compare them in a suitable measuring machine, the small observed differences being indicated by

$$\begin{aligned}
0{\cdot}7 &= 0{\cdot}7'+\alpha_0\\
0{\cdot}7+0{\cdot}1 &= 0{\cdot}8+\alpha_1\\
0{\cdot}7+0{\cdot}2 &= 0{\cdot}9+\alpha_2\\
0{\cdot}7+0{\cdot}3 &= 1{\cdot}0+\alpha_3\\
0{\cdot}7+0{\cdot}4 &= 1{\cdot}0+0{\cdot}1+\alpha_4\\
0{\cdot}7+0{\cdot}5 &= 1{\cdot}0+0{\cdot}2+\alpha_5\\
0{\cdot}7+0{\cdot}6 &= 1{\cdot}0+0{\cdot}3+\alpha_6\\
0{\cdot}7+0{\cdot}7' &= 1{\cdot}0+0{\cdot}4+\alpha_7\\
0{\cdot}7+0{\cdot}8 &= 1{\cdot}0+0{\cdot}5+\alpha_8\\
0{\cdot}7+0{\cdot}9 &= 1{\cdot}0+0{\cdot}6+\alpha_9
\end{aligned}$$

Adding up all these equations we see that the sums of the second columns on either side cancel out, and we get

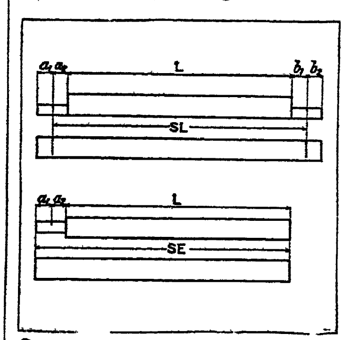
$$10\times 0{\cdot}7 = 7\times 1{\cdot}0+\sum_0^9 \alpha$$

$$\text{or}\qquad 0{\cdot}7=\tfrac{7}{10}\times 1{\cdot}0+\tfrac{1}{10}\sum_0^9 \alpha$$

The size of each of the other pieces may be determined in a precisely similar manner.

It may be noted that in the determination of sizes in this manner, the length of each gauge is automatically associated with the thickness of one wringing film, which, for clearness in conception, may be regarded as representing half a film thickness on either end surface, so that when two gauges are wrung together a whole film is established between them. As the gauges are normally used in this manner, this result is logically what is required. The wringing films, moreover, are in any case exceedingly thin. When initially formed, their thickness depends to some extent on the viscosity of the liquid of which they are composed, but if a sufficient length of time is allowed to elapse they tend to thin down to a limiting thickness, less than 0·000001 in. for all liquids.

There is one more fundamental operation which, whatever may be the nature of the ultimate standard adopted, will always be required in its practical application to everyday requirements, and that is the determination of the length of an end standard in terms of the corresponding line standard, or vice versa. This is a matter of considerable difficulty, and several methods have been employed for the purpose. Probably the best method is that introduced by Mr. H. L. P. Jolly, formerly of the National Physical Laboratory, and now of the Ordnance Survey Department, Southampton. It involves the use of an intermediate end standard, and of two special parallel-faced end blocks, which can be wrung on to the ends of this standard.



COMPARISON OF LINE AND END STANDARDS

Each of the end blocks carries graduation marks as shown on its polished upper surface. The composite bar is compared in the ordinary way in a comparator, with the standard line bar. Each of the end blocks is turned round in turn, and re-wrung on the end of the bar, and the comparison repeated. We thus obtain the four results:—

$$\begin{aligned}
L+a_2+b_1&=S_L+\beta_1\\
L+a_1+b_1&=S_L+\beta_2\\
L+a_1+b_2&=S_L+\beta_3\\
L+a_2+b_2&=S_L+\beta_4
\end{aligned}$$

or, adding and dividing by 2

$$2L+a_1+a_2+b_1+b_2 = 2S_L+\tfrac{1}{2}\{\beta_1+\beta_2+\beta_3+\beta_4\}$$

Each of the end blocks is then removed in turn and the other wrung centrally on the end of the bar, the new combinations being compared in a measuring machine with the standard end bar, with the results

$$L+a_1+a_2=S_E+\gamma_1$$
$$L+b_1+b_2=S_E+\gamma_2$$

or adding

$$2L+a_1+a_2+b_1+b_2=2S_E+\gamma_1+\gamma_2$$

From this equation, and the one previously found, we obtain the result

$$2S_L+\tfrac{1}{2}(\beta_1+\beta_2+\beta_3+\beta_4)=2S_E+\gamma_1+\gamma_2$$

which gives us the desired value of the line standard S_L in terms of the end standard S_E or vice versa.

To complete our survey of the fundamental operations involved in length measurement, reference must be made finally and very briefly to the process of verifying longer measures, such as are used in surveying. In the first place a long bar, graduated in multiples of the standard length unit, is required. This is compared, yard by yard, or metre by metre, with the standard line bar, in a large comparator. This bar in turn is compared either with suitable reference marks engraved on metal studs let into a mural base at intervals corresponding to the length of the bar, or else directly with the divisions of a graduated tape. The tapes or wires after verification, either directly, or by comparison with the mural base, are used to determine base lines in the field, by comparison with temporary bench marks set up at intervals apart roughly equal to the length of the tape.

STANDARDS OF MASS

No attempt has so far been made to define a unit of mass by means of any natural standard, though a standard of this kind, *e.g.*, a definite multiple, say, of the atomic mass of helium, would not be inconceivable. Prior to the discovery of the radioactive elements mass was regarded as the essentially constant attribute of matter, and there was no reason to anticipate any change in a material standard of mass except by actual damage due to abrasion, oxidation, hygroscopic absorption or other similar causes. And there still remains a reasonable choice of materials, which, given due care in preservation and handling, may be expected with considerable confidence to exhibit constancy of mass.

Platinum and Platinum-iridium.—Our predecessors, ignorant of radioactive processes, were fortunate in the choice of platinum and platinum-iridium (10% iridium) as the materials of construction for the ultimate reference standards of mass, the Imperial Standard Pound, and the International Prototype Kilogramme, respectively. The degree of consistency (within 1 part in 10^8) with which recomparisons of various national copies of the kilogramme, made after the lapse of many years, have in general repeated the original determinations, speaks convincingly, not only as to the suitability of the standards themselves, but as to the perfection of the balances used in the comparisons. The relation between the two units, according to the best ascertained determination, is 1 kg. = 2·2046223 pounds. This value has received legal sanction in Great Britain.

Crystal Quartz.—Another material presenting a high degree of constancy of mass is crystal quartz. This, however, has the disadvantage of having a comparatively low density. It also suffers from hygroscopicity, and requires careful handling to ensure the elimination of any effects due to surface electrical charges caused by cleaning.

Buoyancy Corrections.—In the comparison of two standard masses in air, allowance must be made for the upward buoyant effect due to the volumes of air which they respectively displace. The less the density of the mass, the greater will be the buoyancy correction. The accuracy attained in the intercomparison of a series of platinum-iridium standards is no doubt attributable to a considerable degree to the fact that they all have comparatively high, and very closely equal, densities, so that the net buoyancy corrections are very small, and a comparatively rough determination of the air density consequently suffices to give the correction with negligible error. In comparing a number of masses differing appreciably in density, *e.g.*, platinum, quartz and brass, the accurate determination of the buoyancy correction presents much greater difficulty, and several attempts have been made to overcome it by actually conducting the weighing *in vacuo*. This involves enclosing the whole balance in an air-tight case, and manipulating the weights entirely by mechanical means from outside, without opening the case. Leakage at the glands where the operating spindles enter the case has, however, so far proved an almost insuperable obstacle to successful weighing *in vacuo*. Everyday weighings for commercial purposes are of course necessarily conducted in air, but the differences in buoyancy between the weights used, and the goods weighed, are negligible for this purpose. It is necessary, however, to provide a basis for the periodical reverification by inspectors of weights and measures of traders' weights, which may be of iron, brass or other materials. For this purpose a "commercial" standard is employed. This standard is of brass (of density 8·143) adjusted to agree *in vacuo* with the Imperial Standard Pound of platinum. Inspectors' standards are also of brass, and all verifications of these standards, and thus indirectly of traders' weights, are made by comparison, *in air*, with the commercial brass pound.

Use of the Balance.—Even when weighings are not conducted *in vacuo* the construction and manipulation of a balance for the accurate comparison of primary standards of mass are distinctly elaborate. It is necessary for the greatest care to be taken to preserve constancy of temperature, in order to maintain a steady zero reading of the balance. For this reason the room containing the balance must be thermostatically controlled, and the observer either works entirely from outside the room, or, if he enters it, must remain at a distance from the balance, all the manipulation of the weights being effected from outside the balance case by mechanical control operated by means of long rods, and the movement of the balance beam being observed either through a telescope, or by the movement across a scale of a spot of light reflected by a small mirror attached to the beam.

Consecutive Weighings.—To eliminate any effect due to slight inequality in the lengths of the two arms of the balance, at the same time to minimise the effect of any small residual drift of zero due to a gradual change in temperature conditions and to obtain a determination of the sensitivity of the balance at the time of weighing, consecutive weighings should be made to the following order:—

Left-hand pan	*Right-hand pan*	*Mean Reading*
$A+x$	B	p_1
A	$B+x$	p_2
B	$A+x$	p_3
$B+x$	A	p_4
$B+x$	A	p_5
B	$A+x$	p_6
A	$B+x$	p_7
$A+x$	B	p_8

Here A and B are the two masses being compared, and x a small known weight which serves to determine the sensitivity. Each mass is weighed an equal number of times on each pan of the balance, and the mean time of all the weighings of each mass on each pan is the same, so that the effect of any steady temperature drift is eliminated. In weighing, the balance is not brought to rest, but the pointer, or spot of light, is observed while swinging, and the extreme positions of several successive swings to right and left are noted. From these the mean readings or rest points corresponding to each arrangement of weights on the scale pans are calculated. If, for example, four successive readings are q_1, q_2, q_3, q_4, then, allowing for the effect of the gradual reduction in the amplitude of the swing, due to damping, the corresponding rest point, p, is $\frac{1}{8}(q_1+3q_2+3q_3+q_4)$.

If p be the rest point when two *equal* masses of value nominally equal to A and B are on the pans, then we have

$$A-B+x=k(p_1-p) \qquad B-A+x=k(p_5-p)$$
$$A-B-x=k(p_2-p) \qquad B-A-x=k(p_6-p)$$
$$B-A-x=k(p_3-p) \qquad A-B-x=k(p_7-p)$$
$$B-A+x=k(p_4-p) \qquad A-B+x=k(p_8-p)$$

whence

$$8(A-B)=k(p_1+p_2-p_3-p_4-p_5-p_6+p_7+p_8)$$
and
$$8\ x\ =k(p_1-p_2-p_3+p_4+p_5-p_6-p_7+p_8),$$
so that
$$A-B=x\frac{p_1+p_2-p_3-p_4-p_5-p_6+p_7+p_8}{p_1-p_2-p_3+p_4+p_5-p_6-p_7+p_8}$$

Usually of course several masses will be compared each with each in turn, and the best values for the differences between them finally computed by the method of least squares from all the observed differences obtained in the above manner.

The construction of the balance must be such as to ensure that after each successive arrestment of the beam and pans, the knife edges are brought into exactly the same relationship with the planes, and to secure this it is necessary to support the pans by means of a series of crossed knife edges below each terminal knife edge on the beam. If the weighings are not conducted *in vacuo*, the air density must be calculated for each weighing from observations of temperature, pressure and hygroscopic state of the air, and each observed reading corrected for air buoyancy, allowing for the effect of temperature on the volumes of the weights.

The volumes, and hence the densities, of the weights are determined by weighing them, first in air, and then immersed in distilled water, against other weights always in air. The density of the air must be calculated as usual from its temperature, barometric pressure and humidity, and that of the distilled water is known from its temperature. The difference between the two weighings, due allowance being made for the air buoyancy corrections on all the weights involved, is equal to the difference in weight between the quantities of water and air at the observed densities of each, which would fill a volume equal to that of the weight being examined. If for any reason it is considered objectionable to immerse a standard weight in water, it is possible to determine its volume, though somewhat less accurately, by means of a volumenometer, which is an apparatus for observing the change of pressure of the air enclosed within a given space, when a definite change is made in its volume, firstly when it is filled with air alone, and secondly when the weight is enclosed within it.

The calibration of a set of fractional or multiple weights in terms of the original unit can be effected by weighing together in groups of nominally equal sum by a process precisely analogous to that described above for a set of fractional end standards.

Ordinary brass weights usually exhibit a certain variability of mass, which is probably attributable to variations of surface condition depending on the degree of humidity of the surrounding atmosphere. Care should, of course, be taken to see that the metal of which weights are made is free from porosity, and weights intended for precision work should be made solid, without screwed-in tops covering holes containing adjusting material. The surfaces of high class weights are frequently electroplated with gold or platinum, with the object of minimising the effects of oxidation and hygroscopic action on the surface. Of the two, platinising is the preferable process, but weights coated with either gold or platinum have been found to exhibit instability to a certain degree, though usually less than in the case of unplated weights. The success of gilding or platinising depends upon the care exercised to obtain a firm and hard deposit.

To minimise the effects of temperature upon the action of a balance, a beam of invar may be used. But it must be remembered that invar is to a certain extent magnetic, and if results of high precision are required, care must be taken with such a beam as to ensure that it is completely screened from any possible magnetic influence. The balance should preferably be entirely enclosed within a sheet iron case.

For weighing very small quantities, and in particular for comparing the densities of small quantities of gases, micro-balances constructed entirely of fused quartz have been used. Such balances have been made both with knife edges, and preferably, with the beam torsionally supported on a thin horizontal quartz fibre at right angles to its length, and the pans supported from its ends by means of other fibres fused directly to it. The weighings are usually made by arranging a small bulb or similar contrivance at one end of the beam, counter-balanced by solid quartz at the other end. The two ends of the beam are therefore differently affected by the buoyancy of the air, and weighings are made by adjusting the pressure of the air in the balance case until the buoyancy just restores the beam to balance. The air pressure is read by means of a suitable manometer, and serves to measure the weight of the object under examination. With such balances loads as small as $\frac{1}{10}$ gramme have been weighed to an accuracy of 1 part in 10^8.

STANDARDS OF CAPACITY

Theoretically, the unit of capacity should be the same as the unit of volume—that is, the volume of a cube each of whose sides is equal to the unit of length. In practice, however, it is extremely difficult to construct such a cube with accuracy, and still more difficult to measure the internal volumes of vessels of different shapes in terms of the unit of length. Practical necessity has therefore ordained the use of a unit of capacity based on the unit of mass, rather than on the unit of length.

In the metric system the kilogramme was originally intended to be the mass of one cubic decimetre of pure distilled water when at its temperature of maximum density (4° Centigrade). Although great care was taken in the construction of the original kilogramme from this definition, and the result attained was closer than might have been anticipated in view of the difficulty of the problem, it has been found by very careful experiment that the litre, which is now defined as the volume occupied by 1 kilogramme of water at 4° C, actually equals 1·000028 cubic decimetres. The gallon is somewhat similarly defined as the volume occupied by 10 lb. of pure distilled water at 62° F when weighed in air at a barometric pressure of 30 in. of mercury, against brass weights. As the weighing has to be made in air, and the density of the brass weights is not prescribed by the Act (Weights and Measures Act 1878) there is a certain ambiguity about this definition. On reasonable assumptions it has been calculated that 1 gallon = 4·5459631 litres.

It will be noted that in the case of the litre the definition refers to the kilogramme *mass*—that is to say, the weighings are to be reduced to vacuum, by applying a suitable correction for the difference of the air buoyancy on the distilled water and on the weights used for weighing it. This entirely eliminates the difficulty mentioned as regards the exact definition of the gallon. Much confusion of thought has, however, arisen from the preference of some chemists for the use of the so-called "Mohr's litre," which is defined, on the same lines as the gallon, as the volume occupied by 1 kg. of distilled water, when weighed in air, against brass weights, at a temperature which has never been explicitly laid down. Roughly, a Mohr's litre equals 1·002 true litres. It is very unfortunate that the term litre should have been appropriated to a unit so vaguely defined and which differs from the true litre by an amount that, although small, is too great to be negligible. For most purposes the difference between the millilitre and the cubic centimetre can safely be neglected.

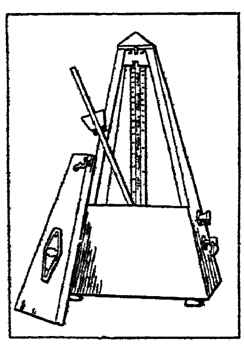
Commercial and Scientific Purposes.—For *commercial purposes* the gallon and the litre are both represented by material standards of capacity, constructed as nearly as possible in accordance with their respective definitions. These standards are in the form of cylindrical metal vessels with flat brims, and are filled exactly to their brims by the aid of flat glass "strikes." Comparisons with other vessels are made by transfer, the vessel under comparison being first filled and emptied to compensate for the amount of water left behind in the standard when the latter is emptied into the vessel being tested.

For *scientific apparatus*, such as flasks, burettes, pipettes, etc., where higher accuracy is needed, it is found necessary as a rule to base the verification directly on the original definition by actually weighing the quantity of pure distilled water contained in, or delivered from, the vessel, making due allowance for the temperature of the water at the time of weighing and for the buoyancy of the surrounding air. In the case of vessels, such as burettes and pipettes, which are intended to deliver, and not to contain, definite quantities of liquid, it must be remembered that after delivery the walls are left wet to an extent which depends not only on the rate at which delivery is effected and the time

allowed for subsequent drainage but also on the viscosity and surface tension of the liquid being measured. The rate of delivery is of more importance than the drainage time, and provided it is sufficiently slow the quantity of liquid delivered will be reasonably constant. Suitable delivery times and error allowances are scheduled in a pamphlet on testing volumetric glassware issued by the National Physical Laboratory.

Bibliography.—The literature of metrology is somewhat scattered. The best collected account will be found in a series of articles contained in the *Dictionary of Applied Physics* (1922–23) (and in particular vol. 3 thereof), edited by Sir R. T. Glazebrook, K.C.B., F.R.S., and published by Macmillan, London. Many detailed references are given in these articles. For full descriptions of the more fundamental operations the various volumes of the *Travaux et Mémoires du Bureau International des Poids et Mesures* (Paris, Gautier-Villars) should be consulted. In addition, consult the annual reports of the Standards Department, Board of Trade (H.M. Stationery Office, London); Miller, *Phil. Trans.*, 146 (1856), on the construction of the new standard pound; Airy, *Phil. Trans.*, pt. 3, p. 17 (1857), on the construction of the new standard yard; Kaye, "A Silica Standard of Length," *Proc. Roy. Soc.*, A85 (1911); Michelson, *Light Waves and Their Uses* (Chicago University Press); C. E. Guillaume et Benoit, *La Mesure rapide des Bases géodésiques* (1908); and Guillaume, *Les Applications des Aciers au Nickel* (Paris, 1904); and *Proc. Phys. Soc.*, 32, 374; Sears, *Precise Length Measurements*, Cantor Lectures, Royal Society of Arts (1923). (J. E. S.)

METRONOME, an instrument for denoting the speed at which a musical composition is to be performed. Its invention is generally ascribed to Johann Nepomuk Maelzel, a native of Ratisbon (1772–1838), but erroneously, since its actual inventor was a Dutch musician named Winkler. It consists of a pendulum swung on a pivot; below the pivot is a fixed weight, and above it is a sliding weight that regulates the velocity of the oscillations by the greater or less distance from the pivot to which it is adjusted. In its simplest form the metronome is put in motion by hand and allowed to go on swinging to and fro of its own momentum till it comes to rest. It has a scale of numbers marked on the pendulum, and the upper part of the sliding weight is placed under that number which is to indicate the quickness of a stated note, as M.M. (Maelzel's Metronome) 𝅗𝅥 = 60, or ♩ = 72, or ♪ = 108, or the like. The number 60 implies a second of time for each single oscillation of the pendulum—numbers lower than this denoting slower, and higher numbers quicker beats. A more complicated metronome is actuated by clock-work, makes a ticking sound at each beat, and continues its action till the works run down; while a still more intricate machine has also a bell which is struck at the first of any number of beats.



BY COURTESY OF CARL FISCHER
METRONOME WITH FRONT OFF TO SHOW PENDULUM

METROPOLIS, a city of southern Illinois, U.S.A., on the Ohio river and Federal highway 45; the county seat of Massac county. It is served by the Burlington Route, the Illinois Central, the Nashville, Chattanooga and St. Louis and the Paducah and Illinois railways, and (for freight) by river steamers. Pop. (1920) 5,055 (84% native white, 15% negro); local estimate at 7,000 in 1928. It has numerous and diversified manufacturing industries, with an annual output valued at $3,500,000. The city was founded about 1837 and incorporated in 1871.

METROPOLIS, a mother-city (Gr. μήτηρ, mother, πόλις, city), and so the name of the parent state from which colonies were founded in ancient Greece (*see* Greece: *History, Ancient*). The word was used in post-classical Latin for the chief city of a province, the seat of government, and ecclesiastically for the see of a metropolitan bishop (*see* Metropolitan). It is thus used now for the capital of a country, which contains the various official buildings of the administrative departments, the houses of parliament, etc. In the case of London, the term "metropolitan" is sometimes applied to the whole area including the "City of London," *e.g.*, "Metropolitan Asylums Board"; and sometimes, as in "Metropolitan Police," excludes the City, which has its own police force (*see* London).

METROPOLITAN, in the Christian Church, the title of a bishop who has the oversight over bishops of subordinate sees. In the Western Church the metropolitan is practically the same as the archbishop (*q.v.*); in the Eastern Church he ranks above the archbishop, but below the patriarch (*q.v.*).

METSU, GABRIEL (1630–1667), Dutch painter, was the son of Jacob Metsu, a painter of Leyden, by his third wife Jacomina Garnyers. According to Houbraken, Metsu was taught by Gerard Dow. He was registered among the first members of the painters' corporation at Leyden; and he was still a member in 1649. In 1650 or soon after he settled at Amsterdam. One of his earliest pictures is the "Lazarus" at the Strasbourg museum, painted under the influence of Jan Steen. Under the influence of Rembrandt he produced the "Woman taken in Adultery" (1635), now in the Louvre. To the same period belong the "Departure of Hagar," formerly in the Thoré collection, and the "Widow's Mite" at the Schwerin gallery. But sacred art was ill suited to his temper, and he turned to other subjects for which he was better fitted. That at one time he was deeply impressed by the vivacity and bold technique of Frans Hals can be gathered from Lord Lonsdale's picture of "Women at a Fishmonger's Shop." Metsu depicted with surprising success the low life of the market and tavern, contrasted, with wonderful versatility, by incidents of high life and the drawing-room. In no instance do the artistic lessons of Rembrandt appear to have been lost upon him. The same principles of light and shade which had marked his schoolwork in the "Woman taken in Adultery" were applied to subjects of quite a different kind. A group in a drawing-room, a series of groups in the market-place, or a single figure in the gloom of a tavern or parlour, was treated with the utmost felicity.

Metsu married in 1658, and became a citizen of Amsterdam in 1659. One of the best pictures of his manhood is the admirable "Market-place of Amsterdam," at the Louvre. Equally fine are the "Sportsman" (1661) and the "Music Lovers" at The Hague, and the "Game-Dealer's Shop" at Dresden, with the painter's signature and 1662. Among the five examples of the painter at the Wallace collection, including "The Tabby Cat," "The Sleeping Sportsman" is an admirable example. Among his finest representations of home life are the "Repast" at the Hermitage in St. Petersburg (Leningrad); the "Mother nursing her Sick Child" of the Steengracht gallery at The Hague. Metsu died at Amsterdam in 1667, and was buried on Oct. 24 of that year.

See Hofstede de Groot, *Catalogue of Dutch Painters* (1907).

METTERNICH-WINNEBURG, CLEMENS WENZEL LOTHAR, Prince (1773–1859), Austrian statesman and diplomatist, was born at Coblenz, May 15, 1773. His father, Count Franz Georg Karl von Metternich-Winneburg zu Beilstein (d. 1818), was a diplomatist who had passed from the service of the archbishop-elector of Trier to that of the court of Vienna; his mother was Countess Maria Beatrix Aloisia von Kagenegg. At the time of Clemens Metternich's birth, and for some time subsequently, his father was Austrian ambassador to the courts of the three Rhenish electors, and the boy was thus from the first brought up under the influence of the tone and ideas which flourished in the small German courts that lay within the sphere of influence of the France of the *ancien régime*. In 1788 he went to the university of Strasbourg, but the outbreak of the French Revolution caused him to leave after two years.

Metternich was a witness of the excesses of the mob in Strasbourg, and he ascribed his life-long hatred of political innovation to these early experiences. In 1790, by way of striking contrast, he was deputed by the Catholic bench of the Westphalian college of counts to act as their master of the ceremonies at the coronation of the Emperor Leopold II. at Frankfurt, a function which he again performed at the coronation of Francis II. in 1792. The intervening time he spent at Mainz, attending the university and frequenting the court of the archbishop-elector, where his impressions of the Revolution were strengthened by his intercourse with the French *émigrés* who had made it their centre. The outbreak of the revolutionary war drove him from Mainz, and he went to Brussels, where he found employment in the chancery of his father, at that time Austrian minister to the Government of

the Netherlands. Here, in Aug. 1794, he issued his first publication, a pamphlet in which he denounced the "shallow pates" of the old diplomacy and argued that the only way to combat the French revolutionary armies was by a *levée en masse* of the population on the frontier of France—singular views for the statesman who was destined to be the last great representative of the old diplomacy.

After a long stay in England, where he made the acquaintance of the prince of Wales (afterwards George IV.), Metternich went to Vienna; and on Sept. 27, 1795 he married at Austerlitz the Countess Eleonore von Kaunitz, a grand-daughter of the Austrian chancellor of that name. This alliance not only brought him great estates in Austria, but introduced him into the most exalted circles of Viennese society. Here he was well qualified to hold his own by reason of his handsome presence, the exquisite courtesy of his address and a certain reputation for gallantry. In Dec. 1797 he was chosen by the Westphalian counts as their representative at the Congress of Rastadt, where he remained till 1799. In Jan. 1801 he was appointed Austrian envoy to the elector of Saxony, and he then came into touch with many Russian and Polish families of importance. In Nov. 1803 his serious diplomatic career began with his appointment as ambassador at Berlin. His diplomacy here was not very successful although Prussia ultimately (1805) signed a treaty with Austria and Russia; but he had made himself personally so agreeable to the French envoy that after his appointment as ambassador to Petersburg, Napoleon requested that he might be sent to Paris, where he took up his residence as ambassador in Aug. 1806. His influence in European politics grew rapidly henceforward. At first he ingratiated himself everywhere at the French court and in society, notably with Talleyrand and Caroline Murat, Napoleon's sister. In 1809, however, war broke out between France and Austria, as Metternich had personally urged in his court. He was arrested as a reprisal for the action of the Austrian Government in interning two members of the French embassy in Hungary, and in June, on Napoleon's capture of Vienna, he was conducted there under military guard.

In July he was exchanged at Komárom for the French diplomatists, and was present with Emperor Francis at the battle of Wagram. On July 8, he succeeded to Stadion's place, and became minister of State on Aug. 4. He was absent at the peace conference at Altenburg when the emperor signed the Treaty of Schönbrunn on Oct. 14, 1809, and thus had nothing to do with this document, although on Oct. 8 he had been appointed minister of foreign affairs, a post he held for 40 years.

The position of Austria, reduced as she was by the Treaty of Schönbrunn to the level of a second-rate power, was one of great difficulty and danger, and of this Metternich was fully conscious. Up to this time, his policy had not been wholly free from emotional impulse; but henceforward it was nothing but calculation, caution and a mechanical balancing of chances. His first ambition was to gain time, and to separate Napoleon from the tsar. The power which seemed to him best worth courting was Austria's late enemy, although he was determined not to lose his freedom of action by any too great concessions. Napoleon's request for the hand of the Archduchess Marie Louise, whether due to Metternich's initiative or not, fitted his plans admirably. He accompanied the archduchess to Paris on March 13, 1810. The definite concessions which he established for Austria were, indeed, small; Napoleon declared that anything further must depend on Austria's attitude in the Franco-Russian War which he now stated to be inevitable. Yet Metternich had restored Austria's freedom to move. He hurried back to Vienna on Oct. 10, just in time to stop the strong pro-Russian party at the Austrian court from compromising this liberty by concluding an alliance with Russia, and to win over the emperor for his policy of armed abstention. With the approach of the Franco-Russian War, this policy became increasingly difficult to maintain in its entirety; but although Metternich concluded an alliance with Napoleon on March 14, 1813, promising him military assistance in return for considerable concessions which France was now obliged to offer, he at once informed Russia that Austria's troops would only act on the defensive, and held out a prospect of a renewal of the old alliance of the conservative powers. When Napoleon suffered by catastrophe in Russia, Metternich extricated Austria from her alliance, alleging that it had been abrogated by Napoleon's own act; reverted to neutrality; and had soon manoeuvred his country into the position of arbiter of Europe. Napoleon's signature of the armistice of Pleiswitz gave Austria time to complete her armaments. When Metternich visited Napoleon at Dresden on June 26, he still posed as the impartial "mediator," assuring the emperor "on his honour as a German count" that Austria was still free of "engagements." Yet he already had in his pocket the draft of the second treaty of Reichenbach (which was not, indeed, signed till the following day), whereby Austria contracted with Russia and Prussia to put 150,000 men in the field, and not to make peace without the consent of her allies, should Napoleon reject the ultimatum which was to be put to him. Metternich's object was, in fact, only to gain an extension of the armistice, till Austria was ready to take the offensive. As for the terms offered to Napoleon, his acceptance of them need not hamper the plans of the allies, while his rejection of them would be a blow to his waning popularity in France.

In the war that followed, although Metternich signed a fresh treaty with Russia at Töplitz (Sept. 9), committing Austria more closely to the policy of the allies, he was chiefly anxious to ensure that the balance did not swing too far, nor strengthen overmuch either Russia or Prussia. The course of events forced him, against his wishes, to agree to the restoration of the Bourbons, but in other respects the Treaty of Chaumont (March 1, 1814) was a real triumph for him, since it laid down that at the final settlement Germany was to be reconstituted as a confederation of sovereign States, and also did much to temper the fear of a Russian dictatorship by consecrating the principle of that concerted action of the Great Powers, in affairs of international interest, which after Napoleon's fall governed the European system.

On April 10, Metternich arrived at Paris, ten days after its occupation by the allies. He was now at the height of his reputation; on Oct. 20, 1813, two days after Leipzig, he had been created an hereditary prince of the Austrian Empire; he now received from the Emperor Francis a unique honour: the right to quarter the arms of the house of Austria-Lorraine with those of Metternich. At the same time (April 21) the countship of Daruvar was bestowed upon him. On May 30, Metternich set his signature to the Treaty of Paris, and immediately afterwards accompanied the Emperor Alexander and King Frederick William on a visit to England. On July 18, he was back in Vienna, where the great congress was to meet in the autumn. The dignity of a Hungarian magnate was bestowed upon him.

At the congress Metternich's charm of manner and great social gifts gave him much personal influence; the ease and versatility with which he handled intricate diplomatic questions, too, excited admiration; at the same time he was blamed for his leaning to intrigue and *finesse* and for a certain calculated disingenuousness which led to an open breach with the Emperor Alexander.

Whatever the real wisdom of the decisions, he reached a settlement in Germany and Italy precisely in accordance with his wishes and emerged from the congress, of which he had been unquestionably the greatest figure, wholly content with his work. He was destined to spend most of the remainder of his life in an attempt to stabilize and make permanent the situation which he had so largely helped to create. The key-note of his policy henceforward was his attempt to use the European concert as an instrument for ensuring the "stability" of Europe by suppressing any "revolutionary" movements. Both Austria's multinational character, and her central position in Europe caused him to follow a policy that was essentially European. *"C'est que depuis longtemps l'Europe a pris pour moi la valeur d'une patrie,"* he said to the Duke of Wellington in 1824; and to his wife he wrote: "I have become a species of moral power in Germany, and perhaps even in Europe." In part this was due, no doubt, to personal vanity, but he had also arranged his system so that it must feel the shock of any disturbance even in the remote parts

of Europe, much more in Germany, Italy or Austria itself. So in his system of diplomacy by congress, Metternich, everywhere the central figure, busied himself in repressing liberty, whether in Germany, Spain or Italy. At first his dominance was unquestioned, especially after he had finally won the Tsar Alexander over to his side; it was weakened first by the ascension to office of Canning in England, and still further by the revival of the Eastern Question (*q.v.*) in the shape of the Greek revolution, which left Austria isolated in the Near East. The revolutions of 1830 seemed to threaten Metternich's system, yet gave it, at least, a temporary new lease of life. The Berlin convention of Oct. 15, 1833, which reaffirmed the divine right of intervention was a fresh triumph for Metternich's diplomacy, yet it was his last conspicuous intervention in the general affairs of Europe. Although he himself hardly realized it, his system had already passed away.

In domestic affairs Metternich was not, indeed, the whole-hearted reactionary for which he was often taken. He was too intelligent not to see the abuses inherent in the Austrian governmental system, and would gladly have remedied some of them. The real author of the incredibly reactionary and aggressive *régime* in Austria in the opening half of the 19th century was the Emperor Francis I. Metternich declared himself more than once, and possibly believed himself to be a liberal. But in any case, he lacked the moral courage to urge the reforms which he felt to be necessary, and he certainly misjudged the forces of his time. His mind was essentially 18th century, and he thought in terms of the State not the nation. He saw that nationalism was fatal to Austria's position in Germany, Italy and at home, and for this reason struggled against it; but he totally miscalculated its real strength, and so the work of his later years, and even at the Congress of Vienna, failed completely to secure the stability which he preached. Although for many years chancellor of Austria, he was not, indeed, primarily interested in internal policy, not mainly responsible for it, and probably could not have reformed it greatly. After the death of Francis I. he was, in any case, too old to change. He was too experienced not to realize the sickness of the State, but he was content to veil it from himself and to attempt to veil it from others. The world was not deceived; but it was not until the Vienna mob, in 1848, was thundering at the door of his cabinet that Metternich himself realized the truth to which he had tried to blind himself. With his fall his system also fell; and his flight from Vienna was the signal for the revolutions of 1848.

The resignation of Prince Metternich, handed in on March 13, 1848, was accepted by the emperor on the 18th, and the prince and his family at once left for England. Here he lived in great retirement, at Brighton and London, until Oct. 1849, when he went to Brussels. In May 1851 he went to his estate of Johannesberg; in September he returned to Vienna. The events of 1848 had not shaken his self-complacency; they seemed to him rather to confirm the soundness of his own political principles. He died on June 11, 1859.

Probably no statesman has, in his own day, been more beslavered with praise and bespattered with abuse than Metternich. By one side he was reverenced as the infallible oracle of diplomatic inspiration, by the other he was loathed and despised as the very incarnation of the spirit of obscurantism and oppression. The victories of democracy brought the latter view into fashion, and to the liberal historians of the latter part of the 19th century the name of Metternich was synonymous with that of a system in which they could recognize nothing but a senseless opposition.

The later reaction against this view found its fullest expression in the work of Srbik (*see* below); but Srbik's own estimate has been questioned. Of the "technique" of diplomacy Metternich was a master. His despatches are models of diplomatic style. They, are, indeed, sententious, over-elaborate and excessively lengthy, yet their phrase-making was often the result of astute calculation.

In private life Metternich was a kind, if not always faithful, husband and a good father, devoted to his children, of whom he had the misfortune to lose several before his death. He was three times married. His second wife, Baroness Antonie von Leykam, Countess von Beilstein, died in 1829; his third wife, Melanie, Countess Zichy-Ferraris, died on March 3, 1854. Of his sons three survived him: Richard Clemens Lothar (1829–95), his son by his second marriage, who was Austrian ambassador in Paris from 1859 to 1871; Prince Paul (1834–1906) and Prince Lothar (1837–1904), his sons by his third marriage. His grandson Prince Clemens (b. 1869), son of Prince Paul, married in 1905 Isabella de Silva Carvajal, daughter of the marquis de Santa Cruz.

Bibliography.—A vast mass of unpublished material for the life of Prince Metternich exists in public and private archives; to some of those in the F.O. Records references are given in the bibliography to chap. 1. of vol. x. of the *Cambridge Mod. Hist.* Of published documents the most important are in the collection *Aus Metternichs nachgelassenen Papieren* (1880–84), edited by his son, Prince Richard Metternich. There is a complete French translation issued contemporaneously, and an English version, of which only five volumes (down to 1835) have been published, under the title *Memoirs, etc.* (London, 1880–82). These *Memoirs,* especially the autobiographical parts, must be read with considerable reserve; even the official letters and documents, which are their most valuable contents, have been to a certain extent "edited." Fedor von Demelitsch's *Fürst Metternich und seine auswärtige Politik,* vol. i., to 1812 (Munich, 1898), is an elaborate and useful analysis of Metternich's foreign policy, based on a large mass of unpublished archives. A very full modern biography is that by H. von Srbik, *Metternich, der Staatsmann und der Mensch* (Vienna, 1925).

METZ, a town of France, capital of the department of Moselle, on the Moselle, 99 m. N.W. of Strasbourg by rail, and on the through route from Paris to Mainz and Frankfort. Pop. (1926), 63,125.

History.—Metz, the Roman *Divodurum,* was the chief town of the Mediomatrici, and was also called by the Romans Mediomatrica; Metz is a contracted form. Caesar describes it as one of the oldest and most important towns in Gaul. The Romans, recognizing its strategical importance, fortified it, and supplied it with water by an imposing aqueduct, the remains of which still exist. Under the Roman emperors Metz was connected by military roads with Toul, Langres, Lyons, Strasbourg, Verdun, Reims and Trier. Christianity was introduced in the 3rd century. In the middle of the 5th century the town was plundered by the Huns under Attila; later it came into possession of the Franks, and was made the capital of Austrasia. On the partition of the Carolingian realms in 843 Metz fell to the share of the emperor Lothair I. as the capital of Lorraine. Its bishops, whose creation reaches back to the 4th century, now began to be very powerful. Metz became a free imperial town in the 13th century, and soon became prosperous. Having adopted the reformed doctrines in 1552 and 1553, it fell into the hands of the French and was defended against Charles V. by Francis duke of Guise. It now sank to the level of a French provincial town, and its population dwindled from 60,000 to about 22,000. At the peace of Westphalia in 1648 Metz, with Toul and Verdun, was formally ceded to France. It was taken by the Germans in 1870 and ceded to them in 1871. It was retroceded to France after the World War.

Buildings, Industries, etc.—The general appearance of the town is quaint and irregular, but there are several handsome modern streets. The Moselle, which is here joined by the Seille, flows through it in several arms, and is crossed by 14 bridges. Of the ten city gates the most interesting are the Porte des Allemands on the east, a castellated structure built in 1445, and the Porte Serpenoise, flanked by turrets belonging to the old ramparts, on the south. The cathedral, 13th to 16th centuries, with huge pointed windows, slender columns and numerous flying buttresses, belongs to the period of the decadence of the Gothic style. St. Vincent, 13th and 14th century Gothic, has a Renaissance façade, and St. Eucaire, 12th–15th century restored, has a pilgrimage chapel. The public library contains an extensive collection of works relating to the history of Lorraine. Metz is the seat of a bishopric, of a prefect, of the VI. military region and the XXXV. army corps, of tribunals of first instance and of commerce, of a board of trade-arbitrators and of a chamber of commerce. The chief industries are the manufacture of shoes and metal-goods and the preserving of fruits and vegetables. There is a national tobacco factory. Trade is in wine, grain, cattle and garden produce.

As a fortress, Metz has always been of the highest importance,

and throughout history down to 1870 it had never succumbed to an enemy, thus earning for itself the name of La pucelle. The original town walls were replaced by ramparts in 1550, and the citadel was built a few years later. By 1674 the works had been reconstructed by Vauban. Under Napoleon III. the fortress was strengthened by a circle of detached forts, which, after 1870, were modified and completed by the Germans, who treated the fortress as the pivot of operations against France.

BATTLES AROUND METZ, IN THE FRANCO-GERMAN WAR, 1870

Colombey–Borny (August 14).—The French army under Marshal Bazaine was in and about Metz. The German I. and II. Armies, on the march from the Saar, were heading for the Moselle between Metz and Pont-à-Mousson, and on the morning of Aug. 14 the German I. Army (I., VII. and VIII. Corps, under General v. Steinmetz) lay on and east of the French, with outposts well to the front, watching the French camps east of Metz, which were little more than 1m. to the front. Steinmetz had received from headquarters overnight instructions that on Aug. 14 the I. Army would maintain the positions occupied during the 13th, and merely passed on these orders to his corps commanders. In Metz, meanwhile, Bazaine had decided to retreat. The II. Corps (Frossard) and VI. (Canrobert) began to retire about midday, the III. (Leboeuf), IV. (Ladmirault) and Imperial Guard (Bourbaki) were to follow. These preparations being observed, the German outposts got under arms. Goltz, in command of the VII. Corps determined at 3 P.M. to advance to the ridge between Colombey and Borny (which was still occupied by French outposts), in order to clear up the situation. The ridge was easily captured, but the sound of the firing at once set all the neighbouring troops in motion, and fortunately so, for the French had immediately retaliated on Goltz. Between 4 and 6 P.M. there was continuous heavy fighting on the front from Borny to Mey, held by Leboeuf's corps, as both sides brought fresh troops into the field, and the troops engaged rapidly slipped from all superior control. Shortly before 6:30 Ladmirault's corps came up, endangering the right flank of the Prussian I. Corps (General v. Manteuffel). Meanwhile Steinmetz had been sending peremptory orders to the battlefield to stop the battle, but neither of the corps commanders was able to enforce them. Fortunately for the Prussians, Bazaine had issued similar orders to his subordinates, who, having their men better in hand, were able to obey; and as night began to close in the French broke off the action and retired under the guns of the Metz forts, convinced that at last they had "broken the spell" of German success. In this action the Germans brought only 30,500 on to the battlefield out of more than 100,000 which could have been engaged before darkness. Bazaine actually deployed 50,700 to oppose them. He might, however, had he been so minded, have struck with his whole army—nearly three times this force, and, judging from the course events actually took, we can have little doubt as to the result of such a blow. The losses on either side were in killed and wounded—French 3,600, Germans 4,800.

The Battle of Vionville—Mars-la-Tour (August 16).—On the following day (15th) the German II. Army approached the Moselle above and below Pont-à-Mousson, with a view to overtaking and heading off Bazaine in his presumed retreat to the Meuse (*see* FRANCO-GERMAN WAR). So far, however, from being ahead of the Germans on the road to Verdun, the French were actually, late in the afternoon of Aug. 15, bivouacked on the plateau of Rezonville, and there their outposts were placed, not where they could see the surrounding country, but at the regulation distances of 600 to 1,000 paces from the bivouacs. At daybreak on the 16th, no Prussians being reported in sight by the outposts, the troops began nonchalantly to prepare for the resumption of the march. On the Prussian side, Alvensleben's Corps (III.) shortly after daybreak was moving north-westward from the Moselle in two columns, on Vionville and Mars-la-Tour, Alvensleben himself riding in advance. The 6th cavalry division was ordered to precede the right column and scout towards Rezonville. No one was aware of the dangerous proximity of the French army.

About 9 A.M. the 5th cavalry division, with two horse artillery batteries (flank guard of the X. Corps from Thiancourt), and accompanied by Caprivi (chief of staff, X. Corps, and afterwards chancellor of the German Empire), were trotting up the western slopes of the ridge which runs between Tronville and Vionville. Reaching its summit they suddenly found themselves in face of at least 40,000 encamped French troops. The temptation proved too great for the artillery, who promptly fired into the midst of the nearest camp. This gave the alarm and Frossard's II. Corps at once stood to arms and advanced, encountering the Prussian 6th cavalry division, which promptly bore away to cover. Meanwhile Alvensleben himself had seen the surprise of the French camps. The sound of the heavy firing coming from the eastward convinced him of what had been gradually dawning on him—that with barely 30,000 men he was in the presence of the whole French army.

In a few moments his decision was taken. Calling on the X. Corps, away to the south-westward, for support, he determined to screen his own weakness by a vigorous attack. By universal consent this is approved as the boldest resolution arrived at by an independent commander throughout the war. His 5th infantry division had already encountered the advancing French as it came out of the defile leading from Gorze up to Rezonville. Now the 6th infantry division, at this moment between Puxieux and Tronville, was ordered to wheel in to their right and attack. Under the onset of this division the French began to retire eastward. Bazaine had meanwhile arrived on the scene, and ordering forward fresh troops to relieve (not to reinforce) those already engaged, he rode forward to watch the operations—and narrowly escaped capture.

After an ill-advised French cavalry charge had been shattered by the Prussian infantry volleys, for about two hours there was a lull in the fighting, which the Prussians utilized on their right in bringing up reinforcements through the Bois des Ognons. On their left, however, no fresh troops were as yet available, and on being informed, about 2:30 P.M., that French cavalry seemed to be about to charge the exhausted 6th division, Alvensleben ordered Bredow's cavalry brigade to charge, and if necessary to sacrifice itself, to save the infantry. Bredow's command (six squadrons of the 16th Ulans and 7th Cuirassiers) moved off in line of squadron columns and ascended the gentle incline which still hid them from their enemy. Arrived at the summit, Bredow sounded "line to the front" but the men, no longer to be restrained, dashed forward, before the line could be completed, almost due east against long lines of infantry and artillery which they now saw for the first time about 1,200 yards in front of them.

This distance was covered at the fullest extended speed of the horses, and reaching the infantry they swept over them "like hounds over a fence"—in the words of an eyewitness. So sudden had been their onset that very few were hit until the infantry had been passed; then the latter, recovering from the shock, turned and fired into the cavalry from behind, whilst a whole fresh division of French horsemen charged them in flank. After a desperate melée of some minutes, the survivors, breaking their way a second time through the French infantry, eventually reached the shelter of their own lines, having lost rather more than half their numbers, but having saved the situation momentarily.

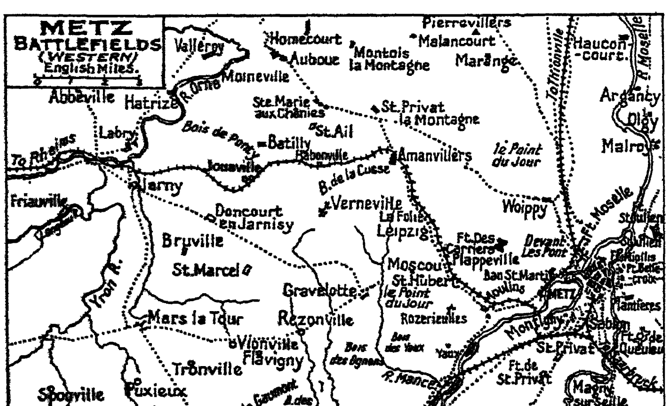
Meanwhile, unknown to Alvensleben, a fresh storm was brewing on his left, where Ladmirault's Corps had arrived from St. Privat—on his own initiative, not Bazaine's intention—and reached a position north of the Tronville copses whence his guns could fire into the left rear of the long line of Prussian guns on the heights above Vionville and Flavigny. Their fire threw the latter into serious confusion and he had decided to attack with his nearest division (de Cissey) in the direction of the steeple of Vionville, when the sudden apparition of a closed mass of Prussian troops detaching itself from the low dust-cloud of a slow-moving infantry column, and forming to the south of Mars-la-Tour, arrested his attention. Unanimously he and his staff agreed that this fresh enemy could only be the advanced guard of a large Prussian force, and delay occurred while the situation was investigated. Actually this body consisted only of the 38th brigade (Wedell), forming part of the X. Corps. In equal ignorance of the situation it moved diagonally across the front of Cissey's division, which, catching sight of them, opened a devastating fire

upon their left flank, and then charged, rolling up their line. The 1st Guard Dragoons, however, rode down the pursuers and by their self-sacrifice relieved the remnants of the infantry.

This was the scene which for the moment held the attention of Prince Frederick Charles when at length he reached the battlefield from Pont-à-Mousson. All along the rest of the line the Prussians were still holding their own, and on the extreme right fresh troops from the IX. Corps were streaming up through the woods against the French left wing. But on the left there was every sign of incipient disaster, and to avert this only the cavalry were at hand. Sending, therefore, hasty orders to the 5th and 6th cavalry divisions to concentrate to the west of Mars-la-Tour, the prince ordered them from there to sweep round on the right rear of the French army. The same idea had, however, occurred to Ladmirault, and he had called on the two nearest French cavalry divisions to put it into execution, and as the Prussians began to reach the plateau west of Mars-la-Tour and the Yron brook from the south, the French were deploying across it some two thousand yards to the north.

Then followed a duel—the one great cavalry duel of the war—between upwards of two thousand horsemen a side. But it was delivered by both sides in a series of regimental charges, and was singularly indecisive. For about half an hour great crowds of riders, hidden by dense clouds of dust, drifted aimlessly about the plain, till at length the charge of a single squadron delivered on the outer French flank, brought the whole mass into motion northeastward, and, both sides sounding the rally, the engagement gradually ceased. It was now about 7 P.M. and night was coming on. Seeing the dust-clouds drifting away northward, and noting the lethargy which seemed to have settled over the whole French line, Prince Frederick Charles decided to assert his own independent will to conquer by a final assault along his whole front. Guns, cavalry, infantry, everything that could still stand were to take part in it. But the troops soon lost direction in the smoke dusk and became involved in the direst confusion; and exhaustion put an end to the Prussian advance.

Thus closed the hardest fought battle of the Franco-German War. From 9 A.M. to 3 P.M. only 23,700 rifles, 8,100 sabres and 126 guns had been brought into action by the Germans against 59,100 rifles, 6,700 sabres, and 300 guns on the French side, and



even at the close of the day the former had only deployed 47,100 rifles, 8,300 sabres and 222 guns against 83,000 rifles, 8,000 sabres and 432 guns including 24 mitrailleuses. The chief characteristic of the day's fighting was the terrible effectiveness of the Prussian artillery, which was handled in masses and not, as on the French side, by batteries. The latter arriving singly on the field, were quickly reduced to silence. Deprived of their support, the gallant counter-attacks of the French infantry were repeatedly shattered, after rolling back the opposing infantry. As for the cavalry, on both sides, although they several times intervened to avert a menace, they proved altogether incapable of affecting the decision.

Gravelotte-St. Privat (August 18).—The position on to which the French army fell back from the field of Vionville is formed by a ridge some six miles long running from Rozerieulles almost due north to Roncourt, and connected with the general plateau between the Meuse and Moselle by a gentle saddle running from Amanvillers west towards Doncourt. North of this saddle the slopes are passable by troops of all arms in close order. To the south the rivulet of the Mance forms a formidable obstacle. Scrub and woods with dense undergrowth line both its banks, and, except by the great chaussée from Metz to Verdun, access to the French side becomes impossible to troops in ordered bodies. It does not appear that the position had been systematically examined or apportioned to the several corps. The army merely swung backwards, pivoting on its left wing. No lines of march were assigned to the several units, consequently the confusion became great; and, arriving late, many of them had so little idea of the general situation that they actually placed outposts to the north and east, whilst the whole enemy army lay south and west.

Fortunately for the French the Germans were too exhausted by the battle of the 16th to attempt to interfere with these movements. At daybreak on the 18th the royal headquarters (which now for the first time arrived at the front) still had no certain knowledge as to whether the French main army was in retreat, or in a position for a fight. Hence the orders issued overnight on the presumption that the main force of the French was retreating to the north and west were allowed to stand, and the whole II. Army (Prince Frederick Charles) moved off in échelon from left to right, the I. Army under Steinmetz, being left in observation of the troops visible on their front and of the garrison of Metz itself. And it had only the VII. Corps immediately available if the enemy counter-attacked. But Steinmetz had not ordered, nor had Zastrow, the corps commander, undertaken any preparations to meet an emergency. About 10 A.M. the corps of the II. Army had reached the following positions: VIII. Corps, Rezonville; IX. near St. Marcel; Guard approaching Doncourt; XII. towards Jarny; the III. and X. still in their bivouacs preparing to move. The cavalry of the Saxons had established the fact that the French had not retreated northward, but though scouts from the Guard had already seen the enemy on the heights of St. Privat, this information had not yet reached headquarters, nor had it been transmitted to the IX. Corps, which it most closely concerned.

Shortly after 10 A.M. Moltke, still under the impression that the French right extended no farther than La Folie (2m. north of the Metz road), determined to attack with the IX. and VIII. Corps whilst the Guard executed a turning movement via Habonville against the French right. The IX. Corps was to engage, but not to push its attack home until the Guard could co-operate. The XII. Corps was left to its own devices, but fortunately the crown prince of Saxony, who commanded it, had ridden forward and, seeing the French force towards Roncourt, had issued orders which in the event proved decisive. In pursuance of his instructions Manstein, commanding the IX. Corps, set his two divisions in motion towards La Folie and the Bois de la Cusse, and advanced to reconnoitre the French position. Suddenly coming in sight of the camp of a whole French corps (the 4th), he decided to execute an artillery surprise on a grand scale. At noon, just as the French infantry were falling in for midday roll-call, sufficient guns were in position, and suddenly opened fire. But the effect was disappointing. The French infantry ran to their arms, and moved forward to attack, while their artillery also took up the challenge, and from the heights near St. Privat the 6th Corps, whose presence was unsuspected by the Prussians, joined in. The batteries on the extreme Prussian left were saved by the timely arrival of companies of Hessian infantry. An obstinate fight ensued.

Prince Frederick Charles now brought forward the 2nd division of the Guard to the Hessians' assistance, while the 1st division attacked Ste. Marie. Meantime the crown prince of Saxony (XII. Corps), with a better view than his superior, was already aware that the French position extended to Roncourt at least, and had despatched a whole division down the valley of the Orne to outflank them. No news of this movement, however, appears to have reached Prince Frederick Charles. The Prussians rushed Ste. Marie, but became disordered, and more than an hour passed

before the troops could be re-organized. With the Hessians and the IX. Corps the action still dragged; the 3rd brigade of the Guard had become involved in the fight, and notwithstanding the arrival of the corps artillery of the III. Corps the situation was still critical.

About 4:30 P.M. the prince therefore had to consider how long it would take to obtain a decision. To postpone it till the morrow seemed undesirable; to achieve it before nightfall was only possible at the cost of immediate effort. He therefore decided to assault St. Privat with all the Guards available, and called up the III., X. and Saxons to assist them. The 4th brigade of the Guards now received their orders to attack Jérusalem (a hamlet a little south of St. Privat), and the 1st division was ordered to assault St. Privat itself. Pape, commanding the division, after pointing out his lack of artillery support transmitted the order. The deployment of his 2nd brigade was hindered first by the gardens of Ste. Marie and then by the overlapping of the 4th brigade, so that it had to wheel half-left in mass before it could gain room to deploy. Almost as the commands were given, the French suddenly opened an overwhelming long-range fire and their bullets swept like hail through the crowded mass of the German troops. Nevertheless the wheel was effected, the fresh direction taken, the troops extended for attack, and then the whole brigade dashed towards their objective. Meanwhile the 1st brigade had moved round the north of the village and carried out its extension without serious hindrance. The whole line then raced forward to reach the effective range of their very inferior weapons, which were about equal at 200yd. to the French rifle at 600. But the losses of the 2nd brigade, particularly in officers, had been too heavy, and the rush died out.

It was now about 6 P.M. and a long pause ensued, while the 220 guns, which by degrees had unlimbered behind them, brought these villages under fire. About 7P.M. the Saxon turning-movement took effect; their infantry from the Orne valley attacked Roncourt from the north, and about 7:15 the village was carried. With the III. and X. Corps now coming up, Prince Frederick Charles, although still unaware of the capture of Roncourt, decided to call on the whole of his force to attack. He was in the act of issuing his orders when a psychological wave swept through the fighting-line, and the men rose and rushed the village at the point of the bayonet. It was now about eight o'clock, and the light was failing.

The confusion in and around St. Privat, where troops from four corps were all intermingled, became so extreme that no further infantry-advance could be attempted; so under cover of a fierce artillery duel the remnants of the unfortunate French 6th Corps drifted away towards Metz down the many ravines leading into the river valley. The "annihilation" of the Guard at St. Privat has become historic. Yet, heavy as were the losses of the 1st Guard division they were not excessive compared to those previously endured—roughly one-third of their effectives had fallen. But the legend cannot be justified when the facts are compared with the slaughter of the Seven Years' War, of Napoleon's battles, the Crimea, and the American Civil War.

In the southern sector of the battlefield, where an entirely independent engagement had been raging all the afternoon; when Manstein's guns had opened fire opposite Amanvillers, Goeben's VIII. Corps and Zastrow's VII. Corps had promptly moved "to the sound of the guns," and his support. Both corps took as their primary objective the farms of St. Hubert and Point du Jour, standing just above the defile made by the Verdun-Metz road where it climbs out of the Mance ravine towards the French position. About 3:30 P.M. St. Hubert was carried and Steinmetz, believing the main French position to have been pierced, ordered the 4th cavalry division to cross the ravine by the *chaussée* and pursue. Simultaneously Zastrow had ordered his corps artillery to advance and Goeben, also, pushed up reserves.

All these columns converged upon the defile and a hopeless entanglement ensued. Here, exposed to all the random bullets and shells of the French, a panic ensued, thousands of men breaking away and flying in wildest confusion through Gravelotte towards the west. Hardly had they melted away when the French made a most brilliant counter-attack from their main position between the farms of Leipzig and Moscow. This was stopped almost entirely by the Prussian artillery fire; but the news of its coming sent another wave of panic through the mass, many thousands bolting right upon the front of their own batteries, thus masking their fire at the most critical moment, and something like a crisis in the battle arose. Fortunately the II. Corps was now rapidly approaching (about 6 P.M.) and the king, against Moltke's advice, now ordered Steinmetz to attack again with all his forces. Darkness and a third panic delayed the preliminary movements, but at length the II. Corps, together with all of the VII. that could be collected, moved down into the valley. Just as the leading German troops were approaching St. Hubert the French again began to fire, their bullets plunging down among the fresh arrivals, who knowing nothing of what had taken place about St. Hubert (where the remnant of their own infantry were still offering a desperate resistance) opened fire into the backs of their own men, and a fourth panic began which soon spread to the stragglers crowding the Mance ravine. Fortunately, by the superb gallantry of some of the company officers and men, the new arrivals were induced to recognise their mistake, and by degrees about 10 P.M. the whole of the II. Corps succeeded in reaching the plateau between St. Hubert and Point du Jour, where the débris of VII. and VIII. Corps had gathered. But in the darkness and confusion no forward movement against the French (only 400yd. to their front) could be initiated, therefore the whole mass passed the night where they stood until daylight disclosed the French retreat.

Meanwhile the king, Moltke and Bismarck, had ridden back behind Gravelotte where they passed two hours of intense anxiety. From the flash of the rifles it was clear that the French main position was still intact, and as every body of troops within thirty-six hours' call had been engaged there seemed little prospect of renewing the struggle next morning. No news too had come from Prince Frederick Charles. About midnight tidings of the capture of St. Privat arrived, and all anxiety ended.

The Investment of Metz (Aug. 19–Oct. 14).—During the night following the battle of Gravelotte the French army withdrew within the line of the forts round Metz. The 6th Corps only was severely shaken, the 4th (the best of the whole army), though it had fought hard twice within forty-eight hours, losing nearly 30% of its strength, was still well in hand, and the 3rd, 2nd and Imperial Guard were almost intact. After a fresh issue of ammunition and food they would have been capable of an attempt to thrust aside the I. German Corps, the only one in their direct path, and then fight their way across the communications of the II. and III. German Armies until they regained touch with the French railways to the south-west about Troyes. And although the latter army would have been a difficult obstacle, the chance of success was fair.

Bazaine, however, withdrew entirely under cover of the forts, and set about the reorganisation of his troops in the most leisurely manner. The Metz forts, though insufficiently armed and some incomplete, were nevertheless too formidable for any field army to attempt without the aid of a powerful siege train, which for the moment was not available. Hence the Germans decided from the first to reduce the place by hunger, calculating that with the extra 150,000 men thrown back upon the fortress, its food supplies could not last very long. On the morning of the 19th the German army was far too exhausted for further efforts. In the course of the afternoon the royal headquarters, creating a new army under the crown prince of Saxony for field operations towards the Meuse, assigned the remainder of the II. Army, and the whole of the I. Army to Prince Frederick Charles as commander-in-chief of the army of investment. Steinmetz was shortly afterwards relieved of his command and returned to Germany. This brought the strength of his command to eight corps, numbering some 220,000 men; an enormous mass to feed.

For the moment the chief care of the Prince was to guard against an attempt of the French army to break out to the westward. The encircling positions were fortified with a light outpost line, behind which was drawn a main position on which every art of the engineer was expended. The water-supply of the town was promptly interrupted, but the river water was quite drinkable.

Meanwhile the French in Metz had been diligently at work. There was no real deficiency of ammunition and stores in the fortress, and provisions for forty days were reported in hand. Bazaine issued orders for a break out to the northward by the right bank of the river, but at the last moment he wavered. Calling a council of war on the heights of Fort St. Julien, he asked the opinion of his subordinates, who were unanimously against the proposed sortie, principally because the artillery "had only ammunition enough for a *single* battle!" Besides, the Germans had long since become aware of the movement in progress, and all chance of surprise was past. It was also raining very heavily. Accordingly the scheme was abandoned. On August 29 Bazaine, receiving word of Macmahon's move to his relief, determined to renew the attempt.

At this moment (Aug. 31) the positions of Manteuffel's command (I. Corps and 3rd Landwehr division) were most dangerously extended, and a surprise at daybreak might have had far-reaching results. But the habit of excessive bugling and band-playing betrayed the French design even before daybreak. This time he adhered to his decision, but the concentration was not complete until 1:30 P.M., and not till 4 P.M. did the attack open (battle of Servigny or Noisseville); his opportunity had been allowed to slip, and though his first onset overwhelmed the German outposts, their main line held good, and masses of guns unlimbering over a front of some 4m. rendered all further attempts to break the German cordon abortive. Next morning the fighting was renewed, but the whole French army was disheartened. It was obvious that what they had failed to do by surprise was hopeless now that twenty-four hours had been given in which the Germans could make counter-preparations. Therefore about noon a general retirement under the guns of the forts took place, and the last serious hope of the French army had vanished. Some 120,000 men with 528 guns had been engaged against 60,000 Germans with 222 guns, and had been beaten off with a loss of 3,500 men. The Germans had lost about 3,000.

The investment now resumed its regular course, and as time wore on the conditions in Metz and the surrounding camps became deplorable. Towards the close of September rations had to be reduced, and the troops began slaughtering the cavalry horses for food. Probably to cheer the men by a semblance of activity Bazaine attempted a large sortie on Oct. 1 in the direction of Ladorchamps, and fighting continued into the 2nd, but without prospect of success, and the profound depression following on defeat sent up the sick list rapidly. One other sortie towards Noisseville followed on the 7th, but it was beaten off with the utmost ease by the investing troops, who were well fed and cared for. By this time even the gun-teams had followed the cavalry horses to the slaughter-house, so that the French as an army had ceased to exist. On the recognition of this fact negotiations for capitulation were begun on Oct. 13, and on the 14th the Army of the Rhine surrendered. Had it held out even forty-eight hours longer events before Paris and Orleans might have taken a different turn. The investment of Metz had lasted 54 days, and the death-roll of the civil population had risen to 3,587 against 1,200 in the corresponding period of a normal year. The army itself had only lost from sickness 2,600 men.

MEUDON, a town of northern France, in the department of Seine-et-Oise, 6 m. E. of Versailles by rail and about 2½ m. S.W. of Paris. Pop. (1926) 17,537. The remains of a castle (17th century) burned during the siege of Paris in 1871 have since been adapted as an observatory. In the 16th century the cardinal, Charles of Lorraine, built at Meudon a magnificent château destroyed in 1803.

MEULEN, ADAM FRANS VAN DER (1632–1690), Flemish painter, born in Brussels. He was a pupil of the battle painter Peter Snayers, and was called to Paris about 1666 by Colbert, at the instance of Le Brun, to fill the post of battle painter to Louis XIV. His paintings during the campaigns of Flanders (1667) so delighted Louis that from that date Van der Meulen was ordered to accompany him in all his expeditions. In 1673 he was received into the French Academy, attained the grade of councillor in 1681, and died full of honours in Paris in 1690. He is best represented by the series of 20 paintings, executed for Louis XIV., now in the Louvre.

MEUNIER, CONSTANTIN (1831–1905), Belgian painter and sculptor, was born at Etterbeek, Brussels, on April 12, 1831, and was a pupil at the academy there. His first exhibit was a plaster sketch, "The Garland," at the Brussels Salon in 1851. Soon afterwards, on the advice of the painter, Charles de Croux, he gave up sculpture for painting. Influenced by Millet, he began to absorb socialistic ideas, and chose most of his subjects from the life and surroundings of miners and factory workers. About 1880 he was commissioned to illustrate those parts of Camille Lemonnier's description of Belgium in *Le Tour du Monde* which referred to mines and factories. After a visit to Spain in 1882, where he painted "The Tobacco Factory at Seville" (Brussels gallery), he was appointed professor at the Louvain Academy of Fine Arts, and in 1885 returned to statuary, producing, among other works, "The Puddler," "The Hammerer" (1886), "The Mower" (1891), "The Glebe" (1892), and the "Puddler at the Furnace" (1893); and "The Horse at the Pond." He collaborated with Charles van Stappen in 1893, in the scheme for the decoration of the Botanic garden at Brussels. The "Monument to Labour," an unfinished work for the Brussels gallery, comprises four stone bas-reliefs, "Industry," "The Mine," "Harvest" and the "Harbour"; four bronze statues, "The Sower," "The Smith," "The Miner" and "The Ancestor"; and a bronze group, "Maternity." Meunier died at Brussels on April 4, 1905.

See Lemonnier, *Constantin Meunier* (1904); K. Scheffler, "Constantin Meunier," in Muther's *Die Kunst* (1908).

MEURICE, PAUL (1818–1905), French dramatist, was born in Paris on Feb. 7, 1818. In 1848 he became the editor of the *Evénement,* founded by Victor Hugo, and in 1869 he was one of the promotors of the *Rappel,* a journal on similar lines. He was the literary executor of Victor Hugo, and edited his works (1880–85). In collaboration with Auguste Vacquerie and Théophile Gautier, he produced *Falstaff* (1842), a play in imitation of Shakespeare, and in 1843 an imitation of the *Antigone;* and with Alexandre Dumas a *Hamlet* (1847). He also wrote *Benvenuto Cellini* (1852), *Schamyl* (1854), *Struensée* (1893), and a dramatic version of *Les Misérables* (1878). He died on Dec. 12, 1905.

MEURSIUS (JOHANNES VAN MEURS) (1579–1639), Dutch classical scholar and antiquary, was born at Loosduinen, near The Hague. At the age of 16 he produced a commentary on the *Cassandra* of Lycophron. Political disturbances caused him to leave Leyden, where he was professor of Greek, for Sorö in Denmark, where he died on Sept. 20, 1639. Many of his classical editions and treatises are printed in Gronovius's *Thesaurus Antiquitatum.* Scaliger called him "pedant" and "ignoramus," which he hardly deserves.

Complete edition of his works by J. Lami (1741–63). *See* Van der Aa's *Biographisch Woordenboek der Nederlanden* (1869), and J. E. Sandys *Hist. of Class. Scholarship* (1908), ii. 311. O. 1138

MEURTHE-ET-MOSELLE, a department of north-eastern France, formed in 1871 out of those parts of the old departments of Meurthe and Moselle which continued French. Before 1790 it belonged to Lorraine, or to one or other of the bishoprics of Toul, Metz and Verdun. Pop. (1926) 552,087. Area 2,036 sq. miles. It is bounded east by Lorraine, north by Belgium and the grand-duchy of Luxemburg, west by the department of Meuse, and south by that of Vosges. The department is formed of the basins of Meurthe and Moselle near Nancy, but not of the part of the Moselle basin focussing on Metz, for the department was reconstituted after that city had been taken by the Germans in 1871. It extends northwards to the frontier of Luxemburg along the scarp of the Côtes de Moselle (Oolite), including the Haute Plaine de la Voëvre within its borders. The department is hilly and rises to 2,041 ft. in the south-east near the Vosges. Summers are hot and winters severe. The mean annual temperature is between 48° and 49°. The annual rainfall averages between 28 and 32 in. The chief crops are cereals and potatoes, clover, mangel-wurzels, tobacco, hops and beetroot. The vine is cultivated; the best vintages are in the Toul district. Fruit trees include pear, apple, walnut, cherry and plum. Oak and wych-elm are most frequent in

woods in the west, beech and fir in the Vosges. The French school of forestry has its seat at Nancy. Horse-rearing is important. The salt-workings (chiefly between Nancy and St. Nicolas), and the iron-mines (round Nancy and Longwy) of Meurthe-et-Moselle are very important. Industries include manufacture of boots and shoes, straw and felt hats, pottery, tanning and brewing, cotton and wool spinning, and the manufacture of cotton goods, hosiery, embroidery, chemicals, soap, crystal, mirrors, glass, army clothing and paper. The Eastern railway from Paris to Strasbourg goes through Nancy. The main waterway is the canal between the Marne and the Rhine, communicating with the Moselle, which is navigable from Frouard downwards, and with the Eastern canal, which unites the Meuse and the Moselle with the Saône and the Rhone. The department constitutes the diocese of Nancy, under the archbishop of Besançon, has its court of appeal at Nancy, and forms a part of the district of the VI. (Metz) and the XX. (Nancy) army corps, and of the académie (educational division) of Nancy. There are three arrondissements (Nancy, Briey and Lunéville), with 29 cantons and 600 communes. The principal towns are Nancy, the capital, Lunéville, Toul, Longwy, Pont-à-Mousson and St. Nicolas.

MEUSE, a department of France, formed out of a part of Lorraine and Champagne. Pop. (1926) 218,131. Area, 2,408 sq. miles. It is bounded north by Belgium and the department of Ardennes, east by that of Meurthe-et-Moselle, south by those of Vosges and Haute-Marne, and west by those of Marne and Ardennes.

Oolitic rocks outcrop over most of the surface, and the department has the impervious lower Cretaceous clays beyond its western border and the Lias beyond its eastern one. The Meuse river crosses it from south-south-east to north-north-west, beneath a limestone scarp on the west (1,388 ft. in the south-west), and a ridge rises rapidly on the east (Côte de Meuse) to the high plain of the Woëvre. To the northern part of the western scarp the name of Argonne is given. The east of the Woëvre drains to the Moselle via the Orne and the Made, the valleys of which thus give access to the Meuse from the north-east; this gave St. Mihiel and Verdun very special significance in the World War. West of Verdun the hills of the Argonne diminish rapidly in height northwards. Most of the department save the north-west is over the 600 ft. level.

Its winters are less severe than those of the Vosges, but it is not so temperate as the Seine region. The average annual rainfall is about 30 inches. The chief crops are wheat, oats, rye, barley, clover, potatoes and mangel-wurzels. The vine is grown to some extent, notably at Bar. The forests, occupying more than a quarter of the area, are mainly of oak, and are rich in game, as are the rivers in fish. Baskets are made in the Argonne. Mineral wealth includes good freestone (Euville, Lérouville). It has iron and steel works, wire-works, and manufactories of files, hardware and edge tools. Ligny-en-Barrois manufactures scientific instruments. There are cotton-spinning, wool-weaving, and hemp, flax and jute factories, sawmills, carriage works, leather manufactures, glassworks, paper-mills, distilleries and flour-mills. The department is served by the Eastern railway, the principal lines being that from Paris to Strasbourg through Bar-le-Duc and Commercy, that from Paris to Metz through Verdun, and the branch line of the Meuse valley. The chief waterways are the canal connecting the Marne with the Rhine and the Eastern canal along the Meuse valley; together they are 145 m. long.

The department forms the diocese of Verdun under the archbishop of Besançon; it has its court of appeal and académie (educational division) at Nancy, and forms part of the district of the VI. army corps (Metz). There are 3 arrondissements—Bar-le-Duc, Commercy and Verdun—28 cantons and 586 communes. The principal places in the department are Bar-le-Duc, the capital, Commercy, Verdun and St. Mihiel.

MEUSE (Flem. *Maes*, Du. *Maas*), a river, 560 m. long, rising at Pouilly, 15 m. north of Langres, France, and flowing northward across the zone of Upper Jurassic rocks which are largely calcareous and give a steep-sided valley of some depth. On this section are the war-scarred S. Mihiel and Verdun, the latter where a line of relatively low land going from the Moselle to the Paris basin crosses the line of the Meuse valley. After passing Mézières the river crosses the lower Palaeozoic rocks of the Ardennes in a narrow valley, entering Belgium north of Givet to proceed to Namur. Here it is joined by the Sambre (left) and, now known as the Maas, turns eastward along the Belgium coalfield to Liège where it again turns north to pass Maastricht, forms the frontier for some distance and enters Holland below Maeseyck. After passing Roermond and Venloo it flows into the Waal channel of the Rhine and near Gorinchem it divides into two branches, the northern flowing due west to join the Lek (Rhine) above Rotterdam and the southern turning south passes along the canalized channel of the New Merwede and enters the Hollandsch Diep. It is also canalized between Liége and Visé and below Maastricht.

MEUSE-ARGONNE OPERATION. On Sept. 2, 1918, ten days before the St. Mihiel Battle in the World War, and during the concentration of troops therefor, an agreement was reached that the American I. army should attack on the Meuse-Argonne front immediately after the completion of the St. Mihiel operation. Marshal Foch had proposed the assignment of American divisions to the French II. and IV. armies, but as the American commander-in-chief, Gen. Pershing, adhered to his purpose of employing the main part of the American troops as an integral army unit.

This American operation, supported on the west by the French IV. Army, was strategically associated with the British-French St. Quentin-Cambrai attack and the combined Allied Ypres attack. The conception underlying these simultaneous offensives was to force such dispersion of the enemy reserves as to weaken his defence generally, or compel such concentration at vital points as would jeopardize other parts of his line. The vital portion of the German front was astride the Meuse river because, here, his main supply artery (Carignan-Sedan-Mézières), traversing the difficult Ardennes forest, was closest to the battle line. Withdrawals were accepted on all fronts except the Meuse-Argonne.

While the ultimate objective of the Meuse-Argonne operation was the severance of the German lines of supply, the immediate purpose was the reduction of the fortified area embraced by the Meuse river—Argonne forest and Hindenburg position extending from Brieulles through Romagne to Grandpré. The French high command hardly expected even this result before winter. The region was ideal for defence, commanded on the east by the Côtes de Meuse and west by the Argonne Forest and dominated in the centre by the heights of Montfaucon, Vauquois, Romagne, Bourgogne and Barricourt. With four successive positions, linked together by numerous interlocking strong points and machine gun emplacements, the defence was continuous for the whole area. Four years of occupation had created a zone 22 km. in depth of defensive strength unsurpassed on the western front. A possibility of ending the war in 1918 and full confidence in the fighting qualities of his troops, prompted the American commander-in-chief to risk his partially trained army in this difficult operation. In two weeks, this army was to reduce the St. Mihiel salient, change to a front about 100 km. distant and attack the fortified Meuse-Argonne zone, a task without parallel in the World War.

On Sept. 22, 1918, the American I. Army, Gen. Pershing commanding, took over the entire front from the Moselle river via Verdun to include Argonne Forest at La Harazée. The command embraced the XVII. French Corps and three French divisions north of Verdun. Maintaining a defensive attitude on the new St. Mihiel front with two army corps, the II. and IV., and eight divisions, and an aggressive defence about Verdun with one army corps and three divisions, all available units were assembled for the decisive attack west of the Meuse river by Sept. 25, 1918. The forces consisted of three army corps, the I., V. and III., 15 divisions (9 in front line and 6 in reserve), nearly 2,800 cannon, over 800 aeroplanes, about 180 tanks and necessary munitions, supplies and hospitals, some of the artillery, aviation, tanks and services coming from the French. This concentration, increasing to over 1,000,000 men in October, was accomplished by night movements over limited communications during and immediately after the St. Mihiel battle in less than three weeks. American feints and ruses

east of the Meuse and Moselle rivers led the Germans to expect an extension of the St. Mihiel operation so that the attack was almost a complete surprise. At this time the Germans had in line, Gen. Von Gallwitz's Detachment C, 10 Divisions at St. Mihiel front: Gen. Von der Marwitz's V. Army, eight Divisions, astride the Meuse river, and part of the Crown Prince's III. Army, three Divisions, astride the Aire river and the Argonne Forest.

After three hours of violent artillery preparation, the American I. army advanced at 5:30 A.M. on Sept. 26, between the Meuse river and the Argonne Forest inclusive with Montfaucon-Romagne-Buzancy as the axis of attack. During the first two days a steady advance was made except at Montfaucon, which the German stubbornly held until the second day and thus gained time for the arrival of reserves. By the 28th, the German had been driven back 11 km., when his reinforcements of eight divisions and considerable artillery and aviation launched strong counter-attacks which maintained intact his main Hindenburg position. Cross and flanking fire from the Côtes de Meuse and the Argonne Forest, coupled with severe fighting during the inclement weather after the 27th, inflicted heavy losses necessitating the relief of three American divisions which were experiencing their first battle. While all except a few heavy guns had passed "no man's" land by the 27th, supply and evacuation were difficult through the deep shell-battered zone over the four partially destroyed roads available. The attack of the French IV. Army in the Champagne made such slight progress that the American commander-in-chief granted Marshal Foch's request for two of his needed divisions as reinforcements to that army, desiring its early advance to assist in "pinching out" the Argonne Forest.

Having driven a salient into the centre of the enemy's defensive zone, the Americans with the three fresh divisions proceeded on Oct. 4 to outflank the Argonne Forest and Côtes de Meuse north of Verdun. After the 1st division had captured Fleville, the I. Corps, crossing the Aire river on the night of Oct. 6–7, assaulted the Argonne heights about Cornay. Severe fighting drove the Germans from the forest into Grandpré by the 10th. The French IV. Army on the west then advanced to the line of the Aisne river. In the attack against the Côtes de Meuse on Oct. 8, the enemy lost several important observation and artillery stations and over 3,000 prisoners.

With the danger of flanking fire reduced by these operations, the Americans in the centre again assaulted the vital Romagne heights which commanded the approaches to the Hindenburg line. By Oct. 16, Côte Dame Marie had been captured and the last organized defensive position in this vital area penetrated. By the end of October, the whole army had gained a footing in this position and the penetration at Grandpré and in the centre at Romagne heights had been complete. In the meanwhile, the French IV. Army made several unsuccessful attempts to cross the Aisne river west of the Bois de Bourgogne.

These American successes confirmed the judgment of the American commander-in-chief in declining Marshal Foch's proposal to limit the American I. Army to the Meuse valley and to create a new army (French-American) under French command to operate on both flanks of the Argonne. The American fighting had been incessant, day and night, the weather trying and replacements scarce. Artillery, tanks and transportation were inadequate and gas ammunition extremely short. However, the fortitude, resourcefulness and leadership of this newly organized army insured success. In a month's combat it had advanced 21 km., reducing four German positions and capturing over 18,000 prisoners, 370 cannon, 1,000 machine guns, and had forced the Germans to employ 31 divisions, including their last reserves. The strain on the German was calamitous and his morale was reaching the breaking point. The critical aspect of the situation was depicted by Gen. Von der Marwitz's declaration to his command about this time: . . . "The heaviest part of the task will thus fall on the V. Army . . . and the safety of the Fatherland will be in its hands. It is on the firm resistance of the Verdun front that depends the fate of a great part of the Western Front, perhaps even of our nation. . . ." Hindenburg in his memoirs added: "It was plain that this situation could not last. . . . Moreover the pressure which the American masses were putting upon our sensitive points in the region of the Meuse was too strong."

Preparing for an easterly advance the American commander-in-chief created a second army, placing Lt.-Gen. Hunter Liggett in command of I. Army on Oct. 16, and Lt.-Gen. Robert L. Bullard over the II. Army on the St. Mihiel front, himself retaining personal direction of this army group. While the I. Army continued its advance north and east, the II. Army was in readiness to move toward Briey.

For the first time the I. Army was able to prepare for its next general attack under normal conditions. Practically all its auxiliaries were now manned by Americans, and a new front with its manifold installations and services did not have to be created. Experience had welded the Army into an effective team with decisive striking power. Concentrating artillery and its aerial bombing in support of its V. Corps (centre), the I. Army, on Nov. 1, 1918, broke through the German defences to the north-east of Buzancy, the 2nd Division advancing nearly 9 km. The Germans were demoralized. On Nov. 2, the I. Corps on the left of the army pursued the enemy beyond Boult-aux-Bois clearing a passage of the Aisne River for the French IV. Army, while the centre and right carried the heights of Barricourt. By a night advance on Nov. 2–3 the approaches to Beaumont were cleared and the German Army between the Meuse and Bar Rivers was in full retreat. The following day the advance continued to the line of the Meuse capturing the heights commanding Sedan during the night of Nov. 6–7. With the German supply line (Carignan–Sedan) under heavy artillery fire by Nov. 3, the III. Corps (right) by a brilliant operation forced a crossing of the Meuse south of Dun-sur-Meuse and in conjunction with troops east of the Meuse cleared the northern slopes of the Côtes de Meuse by Nov. 7. Pursuant to Marshal Foch's instructions of Nov. 9 the advance continued to positions commanding the Chiers river, east of Stenay. Only the Armistice saved the German V. Army from complete destruction. American tactics and the American commander-in-chief's firm adherence to open warfare-training, the value of the rifle and bayonet and the possibilities of the offensive were justified by the brilliant successes in these operations.

With the capture of Côte Dame Marie on Oct. 16, the American I. Army penetrated defences covering the vital German supply lines and jeopardized a successful retreat of the German Army in the northern part of the western front. The Germans employed over one fourth of their divisional strength to meet the American attack, *i.e.*, 47 Divisions west and 15 Divisions east of the Meuse river. The American I. Army employed 31 Divisions (24 American and 7 French) on the whole front with a total ration strength in Oct. of 1,031,000. The Americans captured 26,000 prisoners, 847 cannon, 3,000 machine guns and large quantities of material and suffered 117,000 killed and wounded. (J. J. P.)

MEUSE LINE, the chain of French forts which prior to the World War were intended to close the passage of the Meuse between Verdun and Toul. The total length of the line was 31m., and the *forts d'arrêt* were disposed along the right bank. Between Toul and Épinal the frontier districts were designedly left open, and at Épinal the Moselle Line (*q.v.*) began. These lines formed part of the defensive scheme adopted by France in 1873–75.

MEW, CHARLOTTE (1870–1928), English poet. Her work appeared at first in various periodicals, but in 1917 a collection of 17 poems was issued by the Poetry Bookshop. An enlarged volume appeared under the title of *The Farmer's Bride* in 1920, and there are perhaps 20 more in existence. She was extremely critical of her own work, and the very small proportion of it which she allowed to be published is of a high quality. She died on March 24, 1928. For some time before her death she had been in receipt of a Civil List pension granted by the prime minister.

MEWS, PETER (1619–1706), English royalist and divine, was born at Caundle Purse, Dorset, on March 25, 1619, and was educated at the Merchant Taylors' school, and at St. John's college, Oxford, of which he was scholar and fellow. When the Civil War broke out in 1642 he joined the Royalist army. He was taken prisoner at Naseby; but was released, and in 1648 sought refuge in Holland. He became friendly with Charles I.'s secretary, Sir

Edward Nicholas, and made two journeys to Scotland in the king's service in 1653. Before this Mews had been ordained. Regaining his fellowship at Oxford after the Restoration, he received many preferments. In 1667, when at Breda arranging peace between England and Holland, he was chosen president of St. John's college, Oxford, in succession to his father-in-law, Dr. Richard Baylie, and afterwards became vice-chancellor of the university and dean of Rochester. Appointed bishop of Bath and Wells in 1672, Mews resigned his presidency in 1673, and in 1684 was elected bishop of Winchester, a position which he filled until his death on Nov. 9, 1706. Mews lent his carriage horses to pull the cannon at a critical moment during the battle of Sedgemoor. He was, however, in sympathy with the seven bishops, and as visitor of Magdalen college, Oxford, he supported the fellows in their resistance to James II. He took the oaths to William and Mary in 1689.

See S. H. Cassan, *Lives of the Bishops of Winchester* (1827); and the *Nicholas Papers*, ed. G. F. Warner (1886–97).

MEXBOROUGH, an urban district in the West Riding of Yorkshire, England, 11 m. N.E. of Sheffield, on the L.N.E. railway. Pop. (1931), 15,856. Situated on the river Don, which affords water communication with the Humber. The castle hill is crowned with some fine earth works of uncertain date. The large industrial population is mainly employed in glass, pottery and iron works and in the neighbouring stone quarries.

MEXICO, a Federal republic of North America, though belonging partly to Central America, in the geographical sense, and extending from the United States southward to Guatemala and British Honduras. Its northern boundary-line follows the Río Grande del Norte (Río Bravo) from its mouth northwestward to lat. 31° 47′ N., thence on that parallel westwards for 100 m., thence south to lat. 31° 20′ N., thence due west to the 111th meridian, thence in a straight line, nearly west-north-west, to a point on the Colorado river 20 m. below the mouth of the Gila river, thence northward to the mouth of the Gila, and thence nearly due west along the old line between upper and lower California, to a point on the Pacific coast one marine league south of the southernmost point of San Diego bay, this line having a total of 1,810 miles. The boundary-line with Guatemala and British Honduras is even more arbitrary, beginning at the mouth of the Suchiate river, on the Pacific coast, and following that stream to its source, thence determined by the peaks of Tacaná, Buenavista and Ixbul, from there following a parallel to the Chixoy river, which is really the Upper Usumacinta, to a point on the Usumacinta itself about 16 miles S. of Tenosique (Tabasco), thence due east to the San Pedro Mártir river, thence north to lat. 17° 40′ N., which it follows eastward to the border between British Honduras and Guatemala, thence north to the Hondo river which it skirts to Chetumal bay. The length of this border line is not known accurately.

Physical Geography.—Nowhere does the official boundary between Mexico and neighbouring countries coincide with any real barrier between different regions, nor is it a line of demarcation between different tongues, since the Spanish language is still the natural vernacular of thousands of people north of the American border. Mexico is essentially a region of transition through which one passes gradually from North America into Central America.

Mexico consists largely of an elevated plateau, open in the direction of the United States, limited on its two maritime sides by a double chain of mountains, themselves a continuation of American ranges, which meet one another at La Junta, south-east of Puebla. To this plateau must be added a fringe of lowlands extending on both sides between the mountains and the sea; a high region in the south-east which forms part of the Central American plateau; and two peninsulas, one, that of Lower California, which is evidently a continuation of the American coast range, and the other one, Yucatán, made almost entirely of a low calcareous plain.

Heilprin has shown that the great plateau of Mexico is what remains of a folded region, partly eroded, and covered with deposits of volcanic and detritic origin, and that the chains that are left are undoubtedly the continuation of the American Basin ranges deflected towards the south-east. Remains of transverse chains are to be seen in the isolated ridges and peaks, rising above the level of the table-land, and, in some cases, forming well-defined basins. Two such depressions are particularly conspicuous, the Bolsón de Mapimí, in which the resemblance to the American Basin ranges is quite evident, and the Valley of Mexico, formerly provided with large bodies of water, now replaced by small lakes and marshy lagoons.

The Mexican high plateau has a general elevation of about 8,000 ft. in the States of Mexico and Puebla. Its southward slope is abrupt, while the one to the north is gradual, being about 4½ ft. to the mile, as shown by the elevation at Ciudad Juárez, opposite El Paso, which is only 3,600 feet. In a general way the plateau slopes from south to north and from west to east.

Mountains.—The marginal ranges limiting the high tableland on both sides have been called by the Spaniards Sierra Madre Occidental and Sierra Madre Oriental, but such names are more picturesque than scientific and may easily be a cause of confusion since there are other sierras madres, not only in South America, but in Mexico itself. Anyway, such names can only be considered as having a general signification, and Mexicans give a different one to the various ranges forming the sierras madres.

The northern part of the Sierra Madre Occidental consists of several parallel ranges, the most eastern of which are the Sierra Tarahumare and the Sierra de Durango, while the most western are the Sierra del Nazareno, the Sierra Yaquí and the Sierra Fuerte, all of them converging to form the Sierra del Nayarit. The total length of the former ranges is 900 miles. The altitude of this part of the Sierra Madre Occidental rises constantly from north to south, as shown by the height of the culminating peaks, the Álamos, in the north, 5,874 ft.; the Frailecitos, in the centre, 6,840 ft.; and the Cerro del Pimal, in the Sierra del Nayarit, 11,319 feet. At about 20° of latitude, corresponding to the geographical position of the Nevado de Colima, 14,363 ft., and of the Volcán de Colima, 12,750 ft., the great chain again divides, the western part, or Sierra Madre del Sur, following the shore more or less closely as far as the isthmus of Tehuantepec, and the eastern branch crossing the plateau in a south by east direction.

The Sierra Madre Oriental is narrower and lower, except in its southern part. It rises southwest of Tampico, reaching high altitudes along the western frontier of Veracruz with the Cofre de Perote, or Naucampátepetl, 13,419 ft., and the magnificent snow-capped cone of Orizaba, or Citlaltepetl, 18,209 feet.

Crossing the highest part of the Mexican plateau is a broken and chaotic series of ranges, uniting the two *sierras madres,* part of which is sometimes called Cordillera de Anáhuac, where rise the *Malinche*, or Malintzin, 14,636 ft., the gigantic snow-clad cone of the Popocatepetl, 17,888 ft., the Ixtaccihuatl, 17,323 ft., and further west, the Nevado de Toluca, 15,168 feet.

The Sierra Madre del Sur, or Sierra de Oaxaca, of which the only high peak is the Zempoáltepetl (meaning 20 peaks), 11,139 ft., decreases in height from north to south until it reaches the low-lying isthmus of Tehuantepec, the lowest altitude (*portillo*) of which is 787 ft. (Böse), and the highest point, reached by the trans-isthmian railway, 852 feet. After this interruption the chain, now known as Cordillera de Chiapas, or de Soconusco, is seen to rise again, its summits reaching 7,872 ft., with the cone Soconusco, and 14,000 ft. with the Tacaná.

The great peninsula of Lower California, the "fleshless arm of Mexico" (*el brazo descarnado de México*), as the Mexicans call it, is a rugged region, evidently the continuation of the coast range of the United States, the Gulf of California corresponding to the San Joaquín-Sacramento valley. Its frame is made of four successive chains with an especially noticeable break in the middle, where the extinct volcanic group of Tres Virgenes is found. The highest recorded peak is the Calamahue, or Santa Catalina, 10,122 feet. These coastal ranges can be linked with the Sierra Madre del Sur, through the Tres Marías isles and Cape Corrientes, on the mainland (Gabb, Aguilera, Ordóñez, Suess).

Volcanoes and Earthquakes.—Starting almost at the border between the United States and Mexico, we find the beginning of a chain of volcanoes that is practically unbroken until it reaches

the southern end of South America. The Piñacate, of Sonora, 1,656 ft., is the only one, north of the Lerma river, that shows any activity, but south of that river we find the Ceboruco, 7,100 ft., which was still active in 1875, and the Colima volcanic group, of which the Fuego, 14,200 ft., has had frequent eruptions, the latest being the one of 1909. East of Colima rise the Tancítaro, 12,000 ft., and the famous Jorullo, 4,262 ft., whose first eruption took place in 1759; while north-east of this group we find the Nevado de Toluca or Xinantecatl, 15,000 ft., now quiescent, but whose former eruptions must have been formidable. South-east of the Nevado de Toluca is the Popocatepetl, 17,888 ft., not entirely extinct, whose crater is 500 ft. deep and 2½ m. in circumference, the craterless (although of volcanic origin) Ixtaccihuatl, 17,323 ft., the above mentioned Malinche, Cofre de Perote, and, finally, the Orizaba, the highest of all, 18,209 ft., probably the most perfect and beautiful of all volcanoes, and comparable to the Peruvian Misti and the Japanese Fuji. South-east of Veracruz is an isolated volcanic group of which the Tuxtla, 4,900 ft., had a terrific eruption in 1793 but is now quiescent. On the Pacific coast the Soconusco, 7,872 ft., smokes occasionally and, right on the border itself, the Tacaná, 14,000 ft., is still active.

Earthquakes, of which there were terrific ones in 1474, according to Aztec traditions, are particularly frequent in the Pacific region of Mexico, especially from San Blas to the Guatemalan border, the town of Chilpancingo being generally the spot most affected. In 1909 it was reduced to a mass of ruins, while Acapulco was almost as badly treated, partly on account of a tidal wave that followed the shock. The city of Tehuantepec is another place that has been frequently shaken. The Gulf region is rarely affected.

Coastal Region.—The low land, or *tierra caliente* region, which lies between the sierras and the coast, consists of sandy and marshy deposits near the sea, but some sections of the coastal lands, where débris from neighbouring mountains have accumulated, may reach an altitude as great as 3,000 feet, while on the Pacific coast mountain spurs may extend down to the littoral (Cape Corrientes, Cerro del León). In Tabasco and in south-west Campeche the low lands cover a much vaster extension and are made of the alluvial deposits of the Usumacinta and Grijalva net of rivers. The Yucatán peninsula, north of the Petén lagoon, is formed entirely of a white limestone of very low altitude, the geological age of which is quite recent (Sapper, Heilprin, Engerrand).

The difference between the aspect of the Atlantic (Gulf of Mexico) coast and that of the Pacific is as great in Mexico as it is in the United States. The former, 1,080 m. long, is generally low and sandy, and shows no bay of commercial importance except the shallow Tamiahua lagoon, the relatively deep Laguna del Carmen (the only one that has a natural harbour owing to the protection afforded by the islands of Carmen and Puerto Real), and those on the eastern coast of Yucatán, of which almost no use is made because the region itself is still undeveloped. The general lack of secondary articulations, characteristic of the Gulf coast, and the fact that all the rivers which have their mouths there are obstructed by sand-bars, explain why the good ports on the Gulf of Mexico are artificial; and it must also be remembered that this coast is by far the most important in respect to international communications. The leading ports are Tampico and Veracruz; the former, which is a river port, has been considerably improved by the building of breakwaters or jetties, while the latter is almost entirely man-made. Puerto México (Coatzacoalcos), on the river of the same name—a port whose future on account of its situation could hardly be doubted—has been improved in the same way as Tampico. Large boats can go as far up the river as Minatitlán, 26 m. from the coast. Progreso, the henequén (Sisal hemp) port, has taken the place of old Sisal, but can accommodate small vessels only and is losing depth on account of the slow rising of that part of Yucatán. Tuxpan, notwithstanding its growing importance in connection with the oil business, has not been much improved. Frontera, in spite of its favourable location at the entrance of a large river, is almost useless on account of a bar, while Campeche, at the head of a small, artificial harbour, is almost entirely silted.

The Pacific coast, 2,860 m. long, rugged and much better articulated, has excellent bays, one of which, that of Acapulco, is truly magnificent, though they are all cut off from the interior by the rough and abrupt ranges of the Sierra Madre Occidental. The only important ports are those connected with the interior by railway; viz., Guaymas, Topolobampo, Mazatlán, San Blas, Manzanillo and Salina Cruz. Lower California has some excellent natural bays, such as those of Ensenada de Todos Santos, La Magdalena, on the Pacific coast, and Santa Inés and La Paz on the Gulf of California.

There are no islands of great importance belonging to Mexico. El Carmen, with the port of the same name, on the Gulf of Mexico, Isla Mujeres and Cozumel on the east coast of Yucatán, are the only ones worthy of mention on the Atlantic coast, and the Tres Marías in the Pacific near San Blas, are used as a penal colony.

Rivers.—One would hardly expect that a country consisting mostly of a high denuded plateau and enjoying but a scanty rainfall would be provided with important rivers. It was, in fact, on that account that Mexico found it necessary to develop an efficient net of railways. On the Gulf side, where rivers are all obstructed with bars, we find first the Río Grande del Norte or Río Bravo, a river that is much more American than Mexican if we take into consideration the official boundary and the fact that its 1,800 m. of length is mainly in American territory. Ending in a small delta it has lost all the commercial importance it formerly possessed. Its leading branch on the Mexican side is the Conchos. Further south the Soto la Marina river hardly deserves mention because of the undeveloped region it traverses. The Pánuco river is one of the relatively important streams of Mexico owing to its numerous branches and to the fact that its mouth, thanks to a system of jetties, has been much improved, in order to facilitate the considerable commerce of Tampico. It now drains the lakes of the Valley of Mexico. The Papaloapam, whose head waters are in the mountains of Oaxaca, and the San Juan, which flows through one of the richest regions of the *tierra caliente*, finally unite in the lagoon of Alvarado. The Coatzacoalcos, in the isthmus region, owes its importance to the works that have been constructed to improve its entrance, as a means of improving in turn the port of Puerto México (Coatzacoalcos). It is navigable as far as Minatitlán, where there is a large oil refinery.

The Grijalva and the Usumacinta unite in a common delta but nothing has been done to prevent the forming of a bar and, as a result, the port of Frontera has not developed as much as one might have expected bearing in mind the splendid region the two rivers and their many branches pass through. The Grijalva, called Chiapas in its upper course, rises in the State of Chiapas and is navigable for 90 m., its total length being 350 miles. The Usumacinta, which rises in the Altos region of Guatemala, and is navigable as far as Tenosique, is a powerful river of majestic aspect, gathering in the waters of two important branches, one of which, the Río de la Pasión, has its headwaters in British Honduras. Its total length is said to be 330 miles. The Yucatán peninsula has no superficial streams, the whole country being made of a porous limestone through which the rain penetrates and forms subterranean rivers opening either into the coastal lagoon or into the Gulf itself, sometimes at quite a distance from the littoral. As a consequence, all the important villages are near some of the holes, or natural wells, called *cenotes* or rather *tzonotes*, through which one can reach the subterranean water, sometimes at a depth of as much as 400 feet. However, the south-eastern part of the peninsula, the geological constitution of which is somewhat different, has a relatively important river whose source lies in Petén and whose sluggish course has been chosen as the border between Mexico and British Honduras.

On the Pacific coast rivers are, with two exceptions, even less important on account of the narrower coast. The Río de las Balsas, or Mexcala, which rises in the southern part of the plateau (State of Tláxcala) might be termed a torrent during part of its course, then it runs some distance underground, after which it comes to the surface to cross a relatively large extension of *tierra*

PHOTOGRAPHS, (1, 2, 4-11) HUGO BREHME, (3) THOMAS LEE

MEXICAN SCENES IN CITY AND COUNTRY

1. View of the Merced Market in the Native Ghetto of Mexico City
2. Palm forests near the Tamasopo, in the state of San Luis Potosí
3. The *chinampas,* or floating gardens of Lake Xochimilco, south of Mexico City. The gardens were originally planted on mats of interlaced twigs covered with dirt, and were rowed out on the lake
4. A banana grove in Atoyac, Veracruz
5. Mount Popocatepetl in eruption. The volcano has a height of 17,888 ft., and is one of the highest peaks in the republic of Mexico
6. Part of the court and stairway of the Palacio del Conde de Santiago. This palace, which dates from the years following the Conquest, is among the oldest buildings of the Colonial period in Mexico City
7. El Palacio Nacional, the national palace of Mexico City. Many government offices are housed in this building which occupies a large city block. Its façade extends along the east side of the Plaza Mayor
8. A native home of tropical Mexico. The straw thatched roof is characteristic of this part of the country
9. View overlooking Guanajuato City, capital of the state of Guanajuato. The city is situated in a narrow mountain gorge high above the great plateau and is one of the oldest places in Mexico
10. The ancient Spanish aqueduct of Los Remedios
11. Tamasopo river near Veracruz

caliente, and finally ends in a broad estuary at about the 18th parallel. The Lerma, Río Bravo, Río Grande or Santiago, also begins on the plateau, near the Nevado de Toluca, from which it reaches Lake Chapala, then leaves it and forms a fall 50 ft. high and 430 ft. wide at Juanacatlán not far from Guadalajara, after which it runs through deep canyons till it reaches the Pacific ocean, north of San Blas. Other rivers are the Mezquital, the Fuerte, Yaquí and Sonora.

Lakes.—Mexico has no great lakes, the Chapala being the largest, with a length of 80 m. and a width of 35. In Michoacán are, among others, the superb little lakes of Pátzcuaro and Cuitzeo, but the most interesting of all the Mexican lakes, on account of their historical meaning, are those of the Valley of Mexico, Xalco, Xochimilco, Zumpango, Xaltocán, S. Cristóbal and Texcoco, the latter being the only one whose level is lower (by 4 to 6 ft.) than that of the City of Mexico, and whose shallow waters are brackish. All these lakes are evidently the remains of a former body of water of much greater area. The Xochimilco, whose waters are no more than a few inches deep, would have been transformed into a salty plain years ago, had it not been for its constant reception of the overflow from the higher lakes. For centuries the City of Mexico was again and again flooded during the rainy season by its dangerous neighbours until a system of drainage was established through which the excess of water is sent to a branch of the Pánuco river, together with the sewage of the capital. Lacustrine depressions of great interest are found in other parts of the country, such as the Guzmán and the Sta. María, in the State of Chihuahua, the lagoons of the Bolsón de Mapimí, the Tlahualila lagoon which receives the Nazas river (370 m.) and the Laguna del Muerto, fed by the Río Aguanaval during that part of the year when it reaches that body of water. In the Yucatán peninsula the brackish lagoon of Chichankhanab is a fine example of a greatly varying body of water.

Geology.—The dominant topographic feature in Mexico, as we have seen, is its high plateau, which is made of Cretaceous formations and of detritic and volcanic rocks, the latter being by far the most important. The lowlands on both sides are largely made of recent beds, while folded Cretaceous and Tertiary layers, interspersed with eruptive formations, make the bulk of the region south of the isthmus of Tehuantepec. Yucatán is an immense slab of limestone of recent age. Strangely enough, nowhere in Mexico, with perhaps the exception of the Carboniferous of Chiapas, do we find Primary formations of clearly established age. Some of the oldest eruptive rocks must be of Precambrian and Paleozoic ages, but, so far, it has been impossible to classify them with certainty—this being true even of the so-called gneiss of Oaxaca. The Silurian, Devonian and Carboniferous of Sonora, Chihuahua, and other northern States, are termed doubtful by the best authorities. Mesozoic formations other than Cretaceous are represented in Mexico but the extension covered by them is not considerable. Black schists, greyish clays and greenish sandstones containing ammonites belonging to the *Sirenites, Protrachyceras, Clionites* and *Anatomites* genera, together with pelecypods, such as *Palaeoneilo* and *Aviculidae*, have been found by Burckhardt near Zacatecas and are of Triassic age. The Jurassic, well studied by the same geologist, is represented in northern Mexico, in the states of Veracruz, Zacatecas and San Luis Potosí, showing sometimes an interesting mixture of Russian and Mediterranean species (Sierra de Mazapíl, Zacatecas). The Upper Oolitic of Cerro de Titania (Tlaxiaco) contains an essentially neritic fauna with *Gryphaea* and *Exogyra*, quite similar to the more northerly Jurassic of the Malone mountains (Texas).

The Cretaceous, for knowledge of which we are indebted to Felix, Lenk, Aguilera and especially Böse, is enormously developed in Mexico, the lower one being found little folded near the American border, while it is deeply folded towards the centre of the country. In the Tlaxiaco and Tehuacán regions it shows Mediterranean and Texan affinities. The Middle Cretaceous of the type found in Texas extends as far south-west as the State of Michoacán, but it is also represented in the States of Mexico, Hidalgo, Morelos and Querétaro. The Upper Cretaceous, the lower formations of which are so finely developed in Texas, has not been discovered in Mexico, but the Campanian exists in Central Mexico, while beds of the Laramie type are known in Nuevo León. The Cenozoic era is represented by extensive deposits in the two low coastal regions, especially in the States of Tabasco, Chiapas, Campeche and Yucatán, but there is no doubt that many eruptive rocks and detritic formations of the high table-land are of that age. The Nummulitic is known in Chiapas; the Oligocene in Veracruz and Chiapas, while Miocene faunas have been found in the isthmus by Böse and in Chiapas by Urbina and Engerrand. The Pliocene and the Pleistocene are hard to distinguish, especially on the high plateau. We know enough, however, to be able to state that faunas of mastodons, horses, camelidae and glyptodons lived in Mexico at the end of Tertiary times. Most of the Yucatán peninsula is made of Pliocene and Pleistocene formations. No proof has been found as yet of the existence of man in Mexico before the Holocene.

Volcanic activity must have begun some time during the Cretaceous or at the beginning of the Tertiary era. Many geologists think that the high plateau is a folded region on which enormous quantities of eruptive rocks accumulated, in the first instance andesitic lava; later, after valleys had been cut through it, new eruptions have originated the formation of thick layers of rhyolites and dacites; and, still further, one more period of volcanic activity resulted in the formation of basaltic tables found above all the other rocks.

Climate.—Two causes contribute to make the climate of Mexico among the most varied on earth: one, the great longitudinal extension of the country, which stretches through 17 parallels of latitude, with the tropic of Cancer crossing it about midway, and the other, the fact that the larger part of the country consists of a very high plateau. In order to give an accurate account of the climate of Mexico, we have to resort to the old division into three (even four) vertical zones, *tierra caliente, tierra templada* and *tierra fría*, which, although applicable to other countries, such as Guatemala and Colombia, finds its best possible application in Mexico.

The *tierra caliente* rises from sea-level to an altitude of about 3,280 ft. and includes the coastal zone, 30 to 40 m. wide, the Yucatán peninsula, all of Tabasco, part of Chiapas, the isthmus of Tehuantepec and a relatively small part of Oaxaca, its mean temperature ranging from 77 to 82° F, rarely falling to less than 60°, but reaching 105°, 110° and even higher on many points of the Pacific coast, especially Guaymas (max. 119° F), Mazatlán, Manzanillo and Acapulco though on the Atlantic coast, even in Yucatán, regular breezes make the heat somewhat less oppressive. The maxima, observed anywhere in Mexico, are not higher, however, than those recorded in some parts of Texas and Arizona.

The *tierra templada*, or subtropical zone, rises to an elevation of from 5,500 to 6,000 ft. and comprises "the greatest portion of Coahuila, Nuevo León, San Luis Potosí, nearly half of Tamaulipas, a small part of Veracruz, nearly the whole of Chiapas and Oaxaca, and a large portion of Guerrero, Jalisco, Sinaloa and Sonora." Its mean annual temperature is 75° F and it has justly been called the best of the three zones, even to Europeans, on account of its lacking the anaemiating influences that are found at higher altitudes. Orizaba and Jalapa, in the State of Veracruz, are typical stations.

The so-called *tierra fría*, which ranges from about 5,500 to 9,000 ft., is made of all the higher parts of the plateau, and its average temperature is about 63° F. At such altitudes there is never any real heat, nor are winters cold, although a slight frost during the night is a frequent occurrence. Once in ten years a few snow flakes may be seen falling on the City of Mexico; but during the winter there is a great difference in temperature in the same house between the rooms exposed to the sun and the others less favourably situated, and foreigners find it impossible to stay in the latter without artificial heat. Its climate may be compared to that of Tuscany, but the maxima of heat and cold that can be observed in Florence are never experienced on the Mexican high plateau. In Mexico City the coldest months are December and January while the warmest are April and May.

Some climatologists consider a fourth zone, the *tierra helada,* or frozen land. It is found above the third one and is made of all the mountains and peaks above the high plateau. The term is exaggerated when applied to its lower parts where forests are found and where cereals are cultivated, but it is evident that at a very high altitude polar conditions are encountered. Such zones are, of course, uninhabited except in rare cases, the ranch of Tlamecas on the Popocatepetl, the altitude of which is 12,500 ft. and which is inhabited the whole year round, being one of them. The succession of climates represented by these different zones can be experienced in a few hours by going on the train from Veracruz to Mexico City. Where the plateau is cut by deep valleys, one can admire the marvelous spectacle offered by the three zones in succession with their wheat-fields, maize, coffee trees, light green patches of sugar-cane and finally the banana tree in its finest development.

Rainfall.—As has been mentioned in another part of this article, the annual rainfall is very heavy in the *tierra caliente,* south of the tropic of Cancer, while near the border on the west side, there is almost none. In certain parts of southern Campeche, in Tabasco and in Veracruz the annual rainfall reaches 80, 90 and even 100 in. (Huatusco district). In most of Mexico it is the absence or the presence of the rain that marks the changing seasons. As is the case with many countries of South America, Mexico has only two such seasons, the dry and the rainy. These seasons come at slightly different times according to latitude and altitude. In Mexico City the former which, despite the fact that it is called summer, is characterized by colder weather, during a few months, begins in October and ends in June. The latter corresponds to the rest of the year. Each season shows some short changes for a few days, on regular dates, in connection with astronomical phenomena. The annual rainfall for the whole republic is 59 in.; it is less than 25 in. in the Valley of Mexico.

Flora.—The immense diversity that Mexico offers in environment and climate is the natural explanation of its remarkable variety in plant life, from the desert flora of the north to the luxuriant tropical one. Although three leading divisions would be expected, corresponding to the different climatic areas, it is more accurate to adopt four—one for the plateau and the arid coastal zones, another for the *tierra templada* and the *tierra fria,* a third for the *tierra helada* and the fourth for the humid *tierra caliente.* No fixed limit can be set, however, between one flora and another, since local conditions, determined by a varying amount of sun radiation, wind and humidity, may bring about deviations from the general rule.

The arid regions, especially the desert zones of the north, have their peculiar vegetation, such as yucca trees, hundreds of species of cacti, and many types of agave and mesquite bushes. A few drops of rain change the whole aspect of the country for some days, the whole desert being almost suddenly covered with flowers of the most brilliant colors. Among the cacti the most interesting, perhaps, are the gigantic *pitahaya,* which bears excellent fruits, the strange *órganos* (*Cactus hexagonus*) and the commoner varieties, yielding the ever present *tuna* whose alternate green, yellow and red colours correspond to the successive seasons. Less numerous but economically more important are the agaves, of which the *Agave americana,* from which the *pulque* is extracted, is the most popular, while other varieties give different types of *mescal.* Some plants of the *Agave americana* are said to yield 2,000 pounds of sap in six months. Most vegetable fibres used in Mexico come from some kind of agave, the *ixtle* fibre being produced by *Agave uninvitata,* while the *Agave rigida* var. *elongata* yields the famous *henequén* or Sisal hemp. This particularly valuable variety of agave is grown in the Yucatán peninsula and in the State of Tamaulipas only.

On the central and southern parts of the high plateau, or *tierra fria,* where there is a greater degree of humidity, relatively abundant trees are found on the slopes of the mountains, cereals of Eurasian origin can be cultivated, and all kinds of fruit trees may be grown, together with the local maize. It is hard to say where the exact limit between the *tierra fria* and the *tierra helada* may be determined because the deforestation of the high plateau has allowed the pine trees of the higher altitudes to invade relatively warmer regions. In ascending the slopes of the mountains, one finds an intermediate zone where different varieties of oaks (*Quercus crassifolia, Q. reticulata,* etc.) are found, together with a pine tree of high altitude (*Pinus oocarpa*), the ocote pine, long and short leaved pines and the *oyamel* (*Abies religiosa*).

TAPPING A ZAPOTE CHICO TREE FOR CHICLE, THE BASIS OF CHEWING GUM

On the slopes of the mountains around the Valley of Mexico forests can be seen of the superb *ahuehuete* (*Taxodium distichum*). The extreme upward limit of trees seems to be between 12,500 and 13,500 ft., but juniper bushes occur as high as 14,000 ft.; above that, only grasses are found until one reaches the lower limit of the snow field. The same thing may be said of the limit between the *tierra fría* flora and that of the *tierra templada.* It is only gradually that one passes from the former to the latter and it is only in the presence of the banana, coffee and orange trees that one can feel sure of having reached a lower level. For a long stage the ocote pine and many varieties of oaks are found together, especially on the eastern slopes, with the addition of magnolias, acacias, myrtles, mimosas and bamboos. There are still cacti when the level is reached where the first palm trees appear, but it is only when the latter is found in abundance that one is in the real *tierra caliente.*

The vegetation of the *tierra caliente* is of such variety as to bewilder the stranger. Trees of hundreds of species, themselves half-buried among palms and ferns of all kinds, form the frame on which hang closely interwoven curtains of lianes and epiphytes, while saprophytic and parasitic plants of infinite diversity are found at the foot and on the trunks of the trees, or on the decaying vegetable matter that litters the soil of the forests. To open a way through such an entangled mass, even with a *machete,* is a slow and painful process, more especially, perhaps, because of the oppressive semi-darkness that surrounds the explorer. In the forests of Chiapas are found more than 50 species of cabinet-wood, including the ebony, the mahogany, the rosewood and the Spanish cedar. Other valuable trees of the *tierra caliente* are the log-wood (*Hematoxylon campechianum*), the dividivi tree (*Caesalpinia coriaria*), the *zapote chico* (*Achras sapota*), exploited in Campeche and Chiapas for chicle, as well as rubber trees. There are not less than 17 oil-bearing plants in Mexico and a much larger number of medicinal ones, yielding jalap, arnotto, ginger, licorice, sarsaparilla, ipecac and various gums.

Among the many plants of economic value that America has given to the world, several might with some right claim Mexico as their country of origin. It is perhaps true of the cacao tree, of the maize, probably derived through mutation from the teosinte (*Euchloena mexicana*), or from a hybrid of the teosinte and of some cultivated grass of the sorghum tribe (*Andropogonae*), of the tomato and also of the *aguacate,* or alligator pear. Most of these plants bear either Aztec names or those of Aztec origin. Moreover, many plants of economic value, the origin of which is to be found in the Old World, have encountered conditions favourable to their acclimatization in Mexico; such is the case of the citrus and practically all the temperate fruits and vegetables of Europe. Mexico has 50 varieties of beans, several dozens of green and red pepper; and it grows the potato, sweet potato, yam, sugar-cane, cotton, indigo, coffee, vanilla and banana.

Fauna.—Since Pliocene times—that is to say, since the two Americas were united—the two faunas have merged, and the

Mexican fauna of to-day is made of animals of South and North America, with predominance of the latter. The high plateau attracted the North American fauna (Sonorian fauna: wolf, coyote, buffalo, bear, beaver, etc.) while the low lands, on both sides, and to the South, forced the South American fauna (jaguar, puma, five species of monkeys, etc.) toward and into the United States. Besides the above-mentioned, the Mexican fauna includes the *ocelotl,* a typical Aztec name, the lynx, badger, otter, raccoon, tapir, two species of peccary, the skunk, several species of opossum, the sloth, two species of ant-bears, the armadillo, at least three species of deer, the Mexican big horn (still found in Chihuahua and Lower California), the fur-bearing seal and many different kinds of small rodents. Bats are numerous, among them the dangerous vampire, which makes it so difficult to keep horses in some parts of Chiapas and Campeche.

Mexican birds are extremely numerous, and comprise many beautiful species, while a few (notably the *zenzontle* or mocking-bird) are songsters, the latter being identified with the cold and temperate zones. In the warm zone, on the other hand, as well as in the temperate, are found many varieties of parrots, parrakeets and macaws besides toucans, spoon-bills, boat-bills, ducks, pelicans, cormorants, sandpipers, curlews, grackles, ever-abundant chachalacas (*Ortalina polycephala*), wood peckers, jays, cuckoos, turkeys, partridges, quail and doves (sometimes seen in immense bevies), buzzards, especially the black zopilote which is protected by the Mexican laws as the scavenger of the country, and many humming-birds (*chupaflor, chupamiel*). The gorgeous *quetzal* (*Trogon resplendens*) has almost disappeared from Mexico and is now rarely found even in Guatemala where its love of freedom has made it the emblem of the country. The turkey is the only important domestic animal of Mexican (and American) origin that was added to the European farm-yard.

Reptiles of all denominations can be found anywhere in Mexico. All tropical rivers and lagoons abound in alligators, while the sea gives abode to enormous turtles and the swamps to tortoises and iguanas. One species of iguana, the black one, is largely arboreal. Lizards of many varieties are found everywhere; snakes are equally abundant, some, like the *palanca* (*fer de lance* of Martinique), the *naoyaca* and 13 out of the 15 species of American rattlesnakes being much dreaded. Many interesting varieties of amphibians are also to be found, as, for example, the remarkable tree-climbing frogs and toads and the famous axolotl.

Notwithstanding the great abundance of marine fishes of many varieties which may be had for the effort, there is no real fishing industry in Mexico. Some of the coast lagoons, for example Río Lagartos, in Yucatán, have enormous quantities of fish on which feast numerous alligators and flamingoes.

In the tropical parts of Mexico man's greatest and most dangerous enemies are the insects, especially the many varieties of *garrapatas,* or ticks, *niguas* or chigoe (*Oestrus humanus*), *jején* or gnat, mosquitoes and fleas, the first of these having in some instances wiped out cattle and horses from certain districts. Numerous species of ants are also found, the most famous being the leaf-cutting variety. The most destructive type of insect, however, is the so-called white ant or termite.

Population.—A comparison of the results of the census of 1921 (including some data extending it to 1924) with those of the 1900 census, as well as the density per square mile in each State and in the whole republic, is afforded by the table in next column, showing the distribution by States.

States	Area in square miles	Population 1900	Population 1921	Density per square mile 1921
Aguascalientes .	2,499	102,416	107,581	43·06
Campeche .	19,672	86,542	70,087	3·57
Chiapas . . .	18,307	360,799	422,683	23·10
Chihuahua . .	94,830	327,784	401,622	4·24
Coahuila . . .	58,067	296,938	394,341	6·80
Colima . . .	2,010	65,115	91,749	45·65
Durango . . .	47,692	370,294	338,511	7·10
Guanajuato . .	11,808	1,061,724	860,364	72·87
Guerrero . . .	24,888	479,205	531,565	21·36
Hidalgo . . .	8,064	605,051	627,991	77·88
Jalisco . . .	31,152	1,153,891	1,191,957	37·94
México . .	8,263	934,463	879,846	106·49
Michoacán . .	23,199	935,808	935,654	40·33
Morelos . . .	1,917	160,115	103,519	54·00
Nayarit . . .	10,445	150,098	157,093	15·04
Nuevo León . .	25,136	327,937	336,412	13·38
Oaxaca . . .	36,374	948,633	949,978	26·12
Puebla . . .	13,126	1,021,133	1,023,428	77·96
Querétaro . . .	4,433	232,349	220,231	49·68
San Luis Potosí .	24,418	575,432	445,681	18·26
Sinaloa . .	22,588	296,701	341,265	15·11
Sonora . . .	70,483	221,682	275,127	3·91
Tabasco . . .	9,783	159,834	178,389	18·24
Tamaulipas . .	30,735	218,948	287,957	9·38
Tláxcala . . .	1,555	172,315	178,570	114·84
Veracruz . . .	27,759	981,030	1,165,104	41·98
Yucatán . . .	14,867	309,652	358,221	24·10
Zacatecas . . .	28,125	462,190	379,329	13·48
Distrito Federal .	572	541,516	906,063	15·85
Baja California .	55,619	47,624	62,831	1·14
Quintana Roo . .	19,357		10,966	0·57
Republic . . .	751,743	13,607,219	14,234,799	18·9

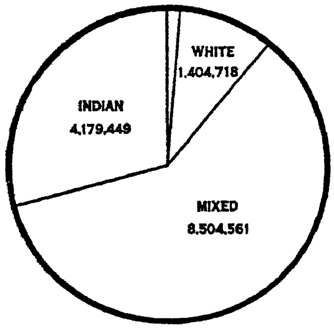
The most important cities of the Republic are Mexico City, 633,000 inhabitants, Guadalajara, 119,468, Puebla, 96,121, Monterrey, 85,000, San Luis Potosí, 85,000, Tampico 80,000 (estimated), León, 80,000 (estimated) and Veracruz, 48,633. The number of foreigners residing in Mexico is relatively small, their proportion to the total population being only 1·41%, more than half of whom are of Spanish tongue. According to the last census the Spaniards, 26,675, are the most numerous and then come Americans, 21,740, Guatemalans 17,473, Chinese, 14,813, about 3,500 Germans, 3,500 French, 3,500 English and 3,000 Italians. Most foreigners live in the large cities, Mexico City having 12,063 Spaniards, 2,382 Americans, 1,652 French, 1,223 Germans, 803 Cubans and 610 English. Most Guatemalans are of the peon class and live in the frontier State of Chiapas. There is a considerable emigration of Mexicans, chiefly unskilled labourers, to the United States, although this is shown by the Mexican official statistics in an indirect way only, 2,392 Mexicans being given as residing in foreign countries, of whom 1,753 are in the United States; on the other hand 83,376 are said to live abroad, without specification of the country of their residence, which is evidently the United States. The total figures for emigration and immigration, between 1911 and 1923, are 752,338 for the former and 1,041,975 for the latter, but they are somewhat open to question and could hardly, therefore, lead to any kind of conclusion.

MEXICAN PEON

Of the Mexican population, the mixed element, partly Indian, partly white, seems to be numerically in the lead, its proportion having passed from 22%, according to the 1810 census, to 40% (1900) and 43% (1921); but the value of such figures must not be put too high. The Indian element has fallen from 62% to 38%, while the white has changed little, mounting from 18% to 19%. Any other racial element is entirely negligible in Mexico. Economic conditions in the republic are not favourable to the settling of large numbers of white workmen or farmers, while the Indian element, being the most ignorant (death rate of Indian children at least 50%) and the least adaptable, has little chance of displacing the more modern and more active mestizo.

Non-Spanish Europeans rarely reached Mexico, since there was a law against their settling there, with a temporary exception for the Portuguese. However, it is known that some Flemish, French and Italians lived in Mexico during colonial times, two or three of whom even played an important rôle, but they had hispanified their names and were supposed to have come from the peninsula. Only men migrated, and, as they were young and intended to stay, they invariably married local women, while the converse could not, of course, take place. The modern half-breed

is therefore a product of this type of crossing. During the colonial régime the name *mexicano* was applied to the Indian only, the creole, or mestizo, being called *americano*. The white man, even when born in Mexico, was always called *español,* though another name *gachupín* (he who wears shoes) was also applied by the other inhabitants. It is easy to understand, on account of the conditions explained above, that few of those *españoles* were of pure white blood, and that the 70,000 who were supposed to be in Mexico in 1811 were simply individuals whose complexions approximated to whiteness.



FIGURES FROM THE STATESMAN'S YEAR BOOK, 1927

COMPOSITION OF THE POPULATION OF MEXICO IN 1921

The small section between Indian and White includes 101,958 "foreigners" and 44,113 not classified

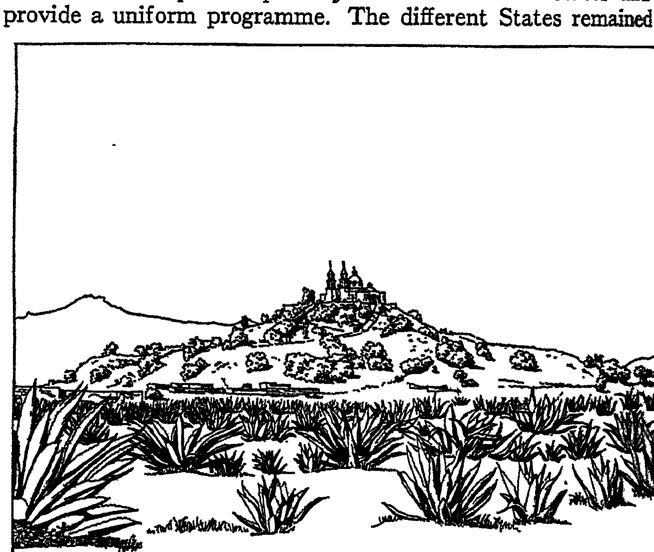
Indians were, from the beginning, classified on the basis of their speech. According to Orozco y Berra there are 192 languages and dialects in Mexico, besides 62 that have become extinct since the conquest. Francisco Belmar reduced this number to a much smaller figure, while, according to Cyrus Thomas and John R. Swanton, whose work is the most recent on the subject, the modern Mexicans speak 59 tongues divided into 20 families. The leading family, by far, is the Nahuatlan, of which the Aztec or Mexican, is a dialect. The latter is spoken by about 650,000 individuals, which means about one-fourth of the Mexican population of Indian tongue, and it is found in the States of Sonora, Chihuahua, Durango, Sinaloa, Zacatecas, part of San Luis Potosí, Nayarit, Jalisco, Guerrero, Morelos, part of México, Puebla, Vera Cruz, Tabasco, Chiapas and extends into Central America as far as Chiriquí. The second group in importance is that of the Maya, spoken by at least 400,000 individuals, if we include the Huastecos in the group, it covers part of Veracruz, Tamaulipas and San Luis Potosí (Huastecas), most of Tabasco and Chiapas and all of Yucatán and Quintana Roo, besides the larger part of Guatemala, British Honduras and a small part of Spanish Honduras. The *Zapotecan,* found in Oaxaca and parts of the neighbouring States, is the language of some 350,000 Indians; while the Otomian, which one hears in the States of San Luis Potosí, Guanajuato, Querétaro, Hidalgo and México, is spoken by about the same number. Other important tongues are the Totonacan, of Veracruz (75,000), and the Tarascan of Michoacán and surrounding States (40,000).

Some dialects are now spoken by only a few individuals and the number of the extinct tongues is constantly increasing. According to R. Bonaparte, more than one-half of Mexico is entirely Hispanified, while the States of Nayarit, Guerrero, Oaxaca, Chiapas, Campeche and Yucatán are still largely Indian, if we take into consideration the use of aboriginal languages. Five of these linguistic groups of Mexican Indians had civilizations of their own at the time of the conquest. One may still find abundant remains of these, such as more or less well-preserved monuments of all kinds. The Mayas reached the highest degree of culture, not only in Mexico, but in America; while the Aztecs, who built up a militaristic empire, came next, to be followed by the Zapotecs, the Tarascos and the Totonacs. In physical characteristics the Mexican Indians differ a great deal, though they all have, with the only exception of the wavy-haired Huauchinangos of Puebla, black, coarse and stiff hair.

Political Organization.—According to the new Mexican constitution, promulgated on Feb. 5, 1917, Mexico is a federated republic of 28 States, each with a considerable degree of home rule, having its own governor, a legislature and judiciary, elected by popular vote. Besides the States, there are two territories and one Federal District, the administration of which is in the hands of the central Government. The States are generally subdivided into *distritos* or *partidos,* and these into *municipios,* but some have adopted special divisions with other names. The State of Nuevo León has *municipios* only. The Federal legislative power is vested in a Congress, consisting of a Chamber of Deputies, elected for two years, on the basis of one for each 60,000 inhabitants, or fraction of more than 20,000, and of a Senate of 58 members, two for each State and the Federal District, half of which number must be renewed every other year. The president is elected for four years (six years, 1928) and is not eligible for immediate re-election. He appoints a cabinet composed of seven secretaries. He must be a Mexican by birth, as well as son of a Mexican by birth, and he shall not have taken part, directly or indirectly, in any military uprising, riot or *coup*. Each State has but one representative body which is called Cámara de Diputados.

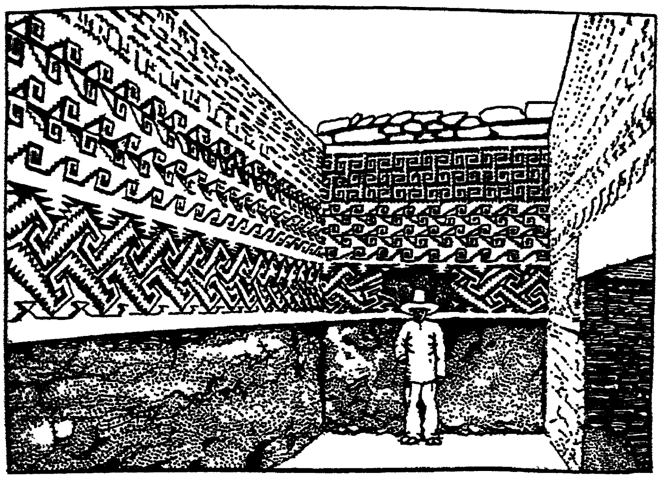
The new Constitution contains a large number of provisions touching education, religion and the exploitation of the mineral resources of the country—matters that will be treated elsewhere. There are some laws protecting workmen against undue exploitation; for example, no man can be forced to work more than eight hours in daytime or seven at night; he may claim a share in the profits of his employer and he has the right to strike. The number of clerks, or officers, employed by the Federal Government was 38,212 in 1924, instead of 32,693 in 1923. Public expenses have been, however, reduced a great deal, largely through a diminution of military expenditure, as shown by the total amount paid for salaries to Government employees and soldiers, which in 1918, 1922 and 1926, respectively, was $137,889,386, $199,730,670 and $154,734,772 Mexican pesos. (The peso is worth about 50 U.S. cents.) The judicial power is exercised by district and circuit courts, and a Supreme Court composed of 11 judges elected for life.

Educational System.—Education is supposed to have been compulsory since 1867 but in spite of efforts to enforce the law, only a small percentage of children have attended schools until recent years. In 1892 and 1896 laws were enacted which vested in the Government the direct control of education in the territories and Federal District, and established a High Board of Education to supervise primary education in the States and to provide a uniform programme. The different States remained in charge of secondary and higher education. Much more attention has been given to the school system in recent years, and progress is evident everywhere. Education is free and compulsory from 6 to 16 years of age and is under Federal control, each State appropriating for schools as much as it deems proper or possible and the Federal Government adding subventions when necessary. Considerable attention is also given to vocational instruction, especially in agriculture, and much further development along this line may be expected in the future. According to the new Constitution, no religious corporation, or minister of any religious creed,


ANCIENT PYRAMID AT CHOLULA, A RELIC OF TOLTEC CIVILIZATION

Constructed of sun-dried bricks and earth, this pyramid is the largest of its kind in the world, being 177 feet high and covering an area of 45 acres. Its summit, now surmounted with a chapel dedicated to the Holy Virgin, was at the time of the Spanish conquest crowned with an imposing temple to the god Quetzalcoatl

shall establish or direct schools of primary education. The total number of public primary schools in Mexico was 9,299 in 1924 and the total number of children who attended them was given as 727,227—actually only one-fourth of the children of school age in the country. On the average it may be said that there is one for every 300 registered children. Of these schools 8,388 were partly supported by the Federal Government. Besides these



SIDE HALL IN THE TEMPLE RUINS OF MITLA, SOUTHERN MEXICO
The five clusters of buildings at Oaxaca, known as Mitla, are believed to have been a centre of Zapotecan culture until a short time before the Spanish conquest

schools there are 460 public schools for workmen, 46 kindergartens and 1,822 private primary schools. The total number of teachers in 1925 was 18,499, of which 4,104 had graduated from some normal school.

There are two universities in the republic, at Mérida, Yucatán, and Mexico City, respectively, the latter having been founded in 1553 and reorganized in 1910. The University of Mexico City holds a summer session that is attracting a large number of American students every year. Several scientific institutions, some attaining world reputation, are located in the capital, such as the National observatory (Tacubaya), the Geological Institute, the National Museum of Archaeology, Ethnology and History and the School of Mines. To these must be added the National Conservatory of Music, the School of Aviation, the Military academy (Chapultepec) and a number of other establishments doing research along many lines of human knowledge. The Escuela Preparatoria can be compared to the best European secondary schools. In Mexico City one also finds the headquarters of the leading learned societies, the best known ones being the Society of Geography and Statistics, the Antonio Alzate Scientific Society, the Academy of Medicine, the Academy of Law and Jurisprudence, the Mexican Geological Society and the Society of Natural History. The National library has 400,000 volumes.

Religion.—The number of Protestants in the Republic, most of whom are not Mexicans, is so small that the Catholic is practically the only church. Mexico has been Catholic since the Conquest, although many Indians have still a very pagan conception of Christianity. The church is administered by three archbishops and 23 suffragan bishops. The first official bishopric, which was that of the capital, was created in 1530 and was occupied by the famous Fray Juan de Zumárraga. Fifteen years later it was elevated to the rank of archbishopric and in 1863 it was divided into the three archdioceses of México, Guadalajara and Michoacán. In the 19th century the church grew immensely wealthy until in 1859 it owned practically one-third of the republic. Juárez, the great Indian president, inspired the laws of La Reforma, which nationalized its property, deprived it of State support and forbade it any participation in political affairs. The Constitution of 1917 and the interpretation given it by President Calles further restricted the power of the church. Places of public worship must be at all times under governmental supervision. The church can not own property, and priests, who must all be Mexican-born, may not participate in politics. There are several Protestant missions in Mexico, but their growth has been slow.

Finance.—The Mexican monetary unit is the gold peso, and coins are made of 2·5, 5, 10, 20 and 50 pesos, respectively. Gold or silver the peso is theoretically worth 50 (American) cents, although the silver standard varies slightly in accordance with the market value of that metal. The amount of gold coined by the Government in 1923 totalled $15,644,619. Of the 34 chartered banks existing in Mexico in 1908, 29 had the right of issuing bank-notes, the total value of which amounted to $97,787,878 at that time. Since the Constitution of 1917 was promulgated banks have no longer been allowed to issue notes, this right being reserved to one "State Bank" (*Banco Unico*) and they have accordingly become only institutions of discount and deposit. In 1925 the Banco de México was founded by the Government and in 1926 the Banco de Crédito Agrícola. The exchange value of the old notes varied (1926) between $2\frac{1}{2}$ and $22\frac{1}{2}$ cents of peso ($1\frac{1}{4}$ to $11\frac{1}{4}$ cents of dollar) per nominal peso, according to the metallic reserves of the bank that had issued them. As a demonstration of the confidence of the Mexican people in their Government, the fact may be mentioned that deposits in the banks passed from $45,951,487 (pesos) in 1925 to $134,672,271 in 1926. The assets of all the Mexican banks were said to be $738,386,696.

In 1923 Federal revenues amounted to $256,259,123, while in 1925 they rose to $309,306,011. State revenues passed from $53,155,299 to $64,849,218, and municipal from $47,281,836 to $46,037,877. Taxes per capita amounted to $21.36 in 1926 (Great Britain $177.55). The following figures show the variations in revenues and expenditures for a certain number of years:

Year	Revenues	Expenditures
1906–07	$114,286,122	$ 85,076,641
1908–09	98,775,511	92,967,393
1910–11	111,142,402	100,913,924
1923	237,876,206	246,837,134
1926*	315,000,000	305,000,000
1927*	334,000,000	327,000,000

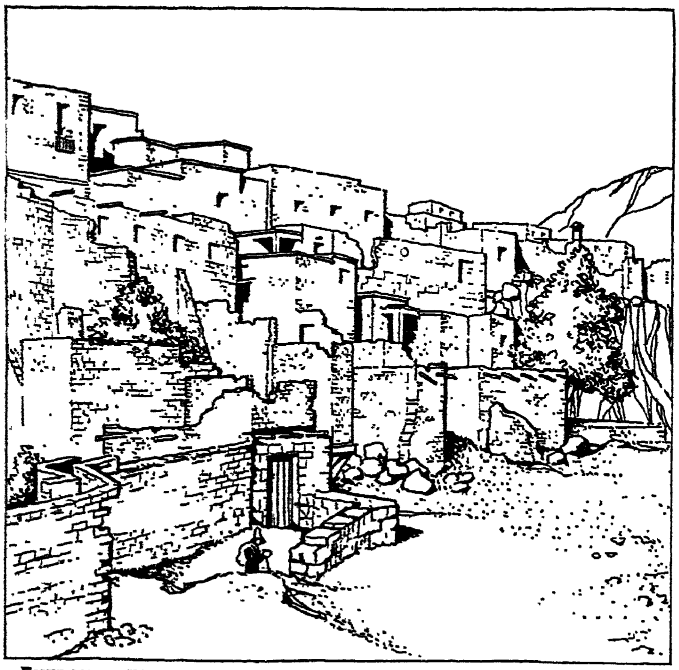
*Estimated.

The total Mexican external debt amounted to $500,000,000 plus $200,000,000 for interest in arrears in 1922. According to an agreement, signed on June 16, 1922, by Adolfo de la Huerta and the International Committee of Bankers, a payment of $15,000,000 was made on Dec. 8, 1923, for the year 1923, but owing to a revolutionary outbreak no other payment was made. In 1925 the Lamont-Pani Agreement was signed which excluded the National Railways from Mexico's external debt.

Defence.—The revolution has thoroughly changed the defensive organization of the country. Military education (including defensive exercises) is compulsory for all citizens. Besides this emergency force there is a regular army, nominally numbering 50,000 men and commanded by officers, who in many cases have received their military training at the Escuela Militar de Aspirantes (Military academy) located in the Chapultepec castle. Five gunboats and a few smaller vessels protect the long coast and there is a naval academy at Veracruz. There is also an aviation school at Mexico City.

Mineral Wealth.—Mexico is one of the richest countries in the world, if not the richest, in metals of many different kinds. From 1521 to 1922 Mexico yielded 155,000 metric tons of silver of a total value of $3,000,000,000. This was then two-thirds of the world's production and the output is still (1927) one-third. The total American capital invested in Mexican mines amounts to $500,000,000. It is highly probable that if Mexico ever drops to a low rank among the petroleum-producing nations, it will still be one of the leading ones in mining. Metals make two-thirds of the Mexican export trade. There are more than 75,000 property-titles, covering a mining territory of 520,000 hectares and 80,000 men are engaged in the mining and ore-smelting industries. Gold is especially abundant in Lower California, Chihuahua, Durango, Michoacán, Puebla, Sinaloa and Sonora, the total production having varied between 20 and 24 tons between 1919 and

1926, one-third of which was exported and the rest coined in the capital. Silver is mined in Guanajuato, Zacatecas, San Luis Potosí, etc., and gold is frequently found with it. The annual production of silver is generally between 2,500 and 3,000 tons, of which six-sevenths are exported while the rest is left to be coined in Mexico. Lead is next in importance and is found in the States of Hidalgo, Oaxaca, Querétaro, Jalisco, Puebla, etc.,



ENTRANCE TO GUANAJUATO, CENTRE OF SILVER MINING INDUSTRY
Guanajuato, founded in 1554, is composed of many hillside mining hamlets grouped about the central town. The silver deposits are among the richest in Mexico

its output having passed from 5,703 tons in 1915 to 60,513 in 1921, 110,455 in 1922, 164,140 in 1924 and 171,767 in 1925. Copper, mined in Michoacán, México, Guerrero, Lower California, Sonora, etc., yielded 205 tons in 1915, 70,223 in 1918, 26,978 in 1922, 49,112 in 1924 and 51,336 in 1925. Zinc mines gave 5,806 tons in 1915, 45,000 in 1917, 6,142 in 1922, 18,937 in 1924, 45,770 in 1925 and 106,367 in 1926, the great variations in the amount of the output being due to political conditions of the country. Other mining products of importance are graphite, arsenic, mercury, antimony, tin, tungsten and molybdenum. Mexico has very little anthracite but much low-grade coal in the northern part of the country, the supply of which is estimated at 300,000,000 tons, the annual output varying between 739,980 tons in 1921 and 1,335,780 in 1925. The value of the metals mined during the first semester of 1924 is given in the following table, in Mexican pesos:

Metals	Production	Exportation
Silver	$59,628,586	$45,075,031
Lead	28,602,451	28,602,451
Gold	16,756,506	5,587,622
Copper	14,363,124	14,363,124
Zinc	1,967,425	1,967,425
Arsenic	415,886	415,886
Graphite	388,487	388,487
Mercury	57,364	57,364
Antimony	25,969	25,969
Tin	9,977	9,977
Molybdenum	9,369	9,369

Iron is found everywhere in Mexico, the Cerro del Mercado, in Durango, being assumed to be entirely made of that metal (500,000,000 tons). The total value of the iron smelted by the Compañía Fundidora de Fierro y Acero de Monterrey and others is estimated at $11,433,038 in 1925 against $8,273,236 in 1921.

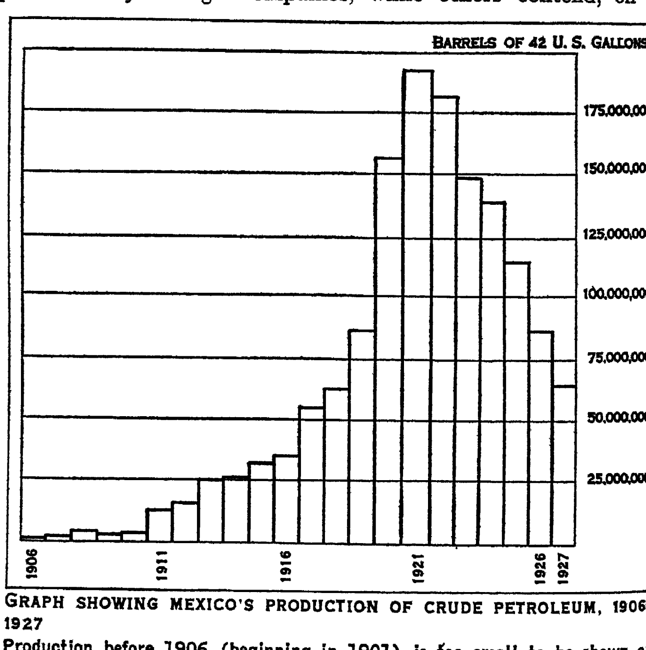
More than anything else, the production of petroleum in Mexico has called the world's attention to that country. Despite the spectacular aspect of that production and although a small part only of the country has been explored by the oil geologists, there are indications that no other oil-fields of importance may be found outside of the Gulf coast regions. Mexican oil is produced in considerable quantities in the State of Veracruz, in those portions of Tamaulipas and San Luis Potosí which are near Tampico and, in small quantities, in some regions of Tabasco and Chiapas. Much of it is heavy oil, suitable for fuel, but some of the lighter variety is found in Tabasco (Macuspana) and in the Isthmus of Tehuantepec. The following figures give, in Mexican pesos, the amount of foreign and Mexican capital invested in the Mexican oil-fields: United States, $614,487,263; Great Britain, $356,776,199; Netherlands, $75,758,960; Mexico, $11,582,405; other countries, $6,943,253; total, $1,065,548,110.

The history of the oil production in Mexico has been most remarkable, not only with regard to the annual output, but also on account of the enormous and prolonged yield of certain wells. Annual Mexican oil production is as follows:—

Year	Number of barrels	Value
1901	10,345	..
1911	12,553,798	..
1921	193,398,587	$365,873,625
1923	149,585,856	285,920,299
1924	139,878,294	232,084,563
1925	115,515,700	299,268,632
1926	90,421,973	225,122,242
1927	64,200,000	..

The total production from 1901 to 1927 was 1,400,927,297 bbl. valued at $2,469,924,580.

The striking decrease in production, noticeable in recent years —a phenomenon which brought Mexico down from second to fourth place among oil-producing countries (thus following the United States, Russia and Venezuela)—is by some associated with disturbed political conditions which have discouraged exploitation by foreign companies, while others contend, on the other hand, that the richest fields are, to all appearance, becoming exhausted. Many wells in the Tepetate pool and in the Pánuco field were affected by salt water in 1919 and 1920. At all events the average production of the new wells is much smaller—a fact easily proved by comparing the average daily production of 10 bbl. for the wells drilled between 1923–26 to that of 40 bbl. corresponding to the wells drilled between 1920–1922. The output of the Naranjos field in 1920, 90,000,000 barrels, is the largest in the history of the World.



GRAPH SHOWING MEXICO'S PRODUCTION OF CRUDE PETROLEUM, 1906–1927
Production before 1906 (beginning in 1901) is too small to be shown on this scale. Total for the 5 years 1901–05 was 502,000 barrels. Total from 1901 through 1928 was 1,465,127,000 barrels, 9.3% of the world production

Agriculture.—The proportion of Mexican land that can be

cultivated under present conditions, according to modern methods, is relatively small. On the high plateau nothing can be done without expensive irrigation; for the best soil elements have been washed down in a few valleys where fertility is remarkable. At least one-fifth of Mexico is unfit for agriculture. At present, indeed, no more than 30,000,000 ac. are under cultivation, 20,000,000 of which require irrigation. Outside the plateau there are only grazing lands and forested areas, all of which would require vast expenditure of capital if they were to be adapted to agricultural purposes. Moreover, in many parts of the country, the lack of adequate transportation is a serious drawback. However, in recent years, a great effort has been made in order to improve conditions. Important irrigation works, whose total cost will be 60,000,000 pesos have been begun in different parts of the Republic, and the sum of 22,000,000 pesos is being spent in building modern highways.

According to a law enacted in 1923 every Mexican citizen, over 18 years of age, is entitled to a plot of land of no more than 25 ha. of irrigable land, or a maximum of 100 ha. of dry land, or up to 500 ha. of grazing land; but the sale of such a plot to a foreigner or to a Mexican owning as much is prohibited. A serious effort is being made to teach modern methods to the Mexican farmer and there is no doubt that, assuming a state of domestic peace, the output of Mexican agriculture, which is not very large now, could be considerably increased. As a proof of the interest shown in agricultural work by the people of Mexico let the fact be mentioned that in 1925 farm implements to the value of $4,178,000 were bought in the United States, as against $843,742 in 1909. In 1925 the increase in the cultivated area was 47·66% for cotton, 876·60% for alfalfa, 258% for rice, 70% for potatoes, 159% for bananas, 88% for wheat, 26% for Indian corn and 1848% for oranges. Indian corn is one of the most important agricultural products of Mexico, though the crop is still inadequate as some has to be imported year after year. Production in metric tons for the leading crops is given in the following table:—

Crop	1910	1921	1923	1925
Indian corn	2,059,242	1,550,000	2,573,682	..
Beans	176,069	71,034	118,685	..
Sugar cane	2,200,794	2,185,365	2,769,960	3,879,626
Wheat	258,177	138,508	371,684	..
Sisal hemp	113,088	115,684	123,184	267,916
Coffee	35,789	34,424	39,986	48,206
Bananas	36,510	..	86,318	160,344
Tobacco	14,396	8,000	11,035	10,497
Cotton	..	31,938	38,025	47,070
Rice	..	29,776	31,963	106,601
Cacao	..	8,646	2,024	4,249
Oranges	..	..	11,435	210,456

The Laguna district (Coahuila, Durango) used to be the leading cotton-producing area, but since 1922 Lower California has outranked it. The value of the cotton crop for 1923 was $57,791,064. Yucatán produces seven-eighths of the Sisal hemp of the world; the value of the 1925 crop was more than $47,000,000. Indian corn is grown everywhere in Mexico and the value of the crop is generally around $200,000,000. Veracruz is the leading State in sugar production, its output being more than double that of Sinaloa, the next ranking State.

The total value of the lumber, including precious woods, from the forests in 1925 was about $1,800,000. The chicle production passed from 2,110 tons in 1921 to 4,412 tons in 1925, the market value of the latter being $7,895,516.

Manufactures.—Considering the possibilities of the country, especially its abundance of raw materials, its water power, and cheap labour, Mexico is far from being industrially developed. Nevertheless a large proportion of the needs of the country can already be met by existing local manufactures. Some of these wares, such as pottery, some forms of tobacco, saddles, candles, soap, chocolate and others, are still fashioned as they were before the Conquest or in the first years of the Spanish occupation. Others such as zarapes, rebozos, glass and shoes, are made according to more or less modern methods. For other categories of articles the mode of manufacture is quite up-to-date, as for example, cigars, cigarettes, sugar, beer, broadcloth, cassimeres, blankets, underwear, hosiery, percales, calicoes, matches, explosives, paper, furniture, metallurgical products, etc.

Besides the iron and steel works (at Monterey) and the tobacco factories, the cotton mills may be considered among the most important agencies of production. In 1923 there were 109 of these with a working personnel of 39,629 and provided with 29,668 looms, having 802,363 spindles; altogether they consumed 23,343,701 kilos of cotton yielding 28,567,596 kilos of products sold for $97,562,594. In 1925 the figures were 130 mills, 43,199 workmen, 30,800 looms, 831,524 spindles, 40,996,834 kilos of cotton consumed and 33,576,583 kilos of products worth $108,395,604.

Commerce.—According to official Government statistics foreign trade in pesos was as follows for the years 1921–25:—

	Imports	Exports
1921	$493,161,741	$756,823,697
1922	308,499,612	643,549,695
1923	315,108,526	568,471,114
1924	321,371,605	614,712,515
1925	390,996,172	682,484,832
1926	381,263,640	691,769,739

The increase in 1926, compared with the figures for the prerevolutionary years is about 115·65%, although, of course, the decreased purchasing power of the peso has to be considered. The leading articles of exportation, as might be expected, were minerals such as oil, silver, gold, copper, zinc; the vegetable ones, sisal hemp, coffee, rubber, chicle, cabinet woods, tobacco, sugar, cattle and hides. Imports consist largely of manufactured articles, such as machinery and tools, textiles, cotton, grain, automobiles, drugs, furniture, coal, etc. Trade with the United States was as follows in millions of pesos:—

	1922	1923	1924	1925
United States Imports	197	235	232·2	274·5
United States Exports	517	471	493·5	516·9

With Great Britain it was:—

	1922	1923	1924	1925
Imports	23·8	21·5	22·5	30·7
Exports	49·7	34·8	34·6	44·6

Germany, France and Spain following in order of importance. Although the commercial balance seems to be in favour of Mexico, it must not be forgotten that most of the companies, exploiting Mexican wealth, are foreign and that their profits are of relatively small advantage to the republic. Here are some comparative data, in pesos, on the exportation of Mexican products for the years 1921 and 1925:—

	1921	1925
Sugar	$ 9,116	$ 1,687,410
Cattle	411,344	996,185
Chicle	4,200,861	7,895,516
Cotton	5,982,846	8,868,289
Coffee	10,206,843	24,428,722
Beans	102,936	2,379,937
Fresh fruits	496,350	3,147,120
Chick-pea*	80,245	3,405,131
Sisal hemp	29,392,833	31,406,528
Ixtle	1,197,983	6,406,845
Fresh vegetables	1,166,384	13,703,048

*Exported to Spain.

The importance still attached to alimentary products brought from foreign countries is an evident proof that agriculture is not yet sufficiently developed in Mexico. For the year 1925 Mexico paid $5,379,333 for Indian corn, $5,261,008 for wheat, $3,621,827 for flour, $4,571,084 for preserves of all kinds, $2,224,015 for eggs, etc. It was also necessary to import lumber to the value of about $9,000,000; but the bulk of the imports, as said above, is made of manufactured products. In 1923 Mexico bought 9,363 automo-

biles, worth $7,801,822, in 1924, 9,124, worth $11,892,131 and in 1925, 23,501, worth $25,935,032.

Communications and Transportation.—In 1925 Mexico had 20,972 m. of railways (19,719 in 1910)—the second highest mileage in Latin America, though still very inadequate to the needs of a country of so few navigable rivers. The development of the Mexican railways is due almost entirely to the statesmanship of Porfirio Diaz. The first railroad, built in 1854, was the line connecting Mexico City with its suburb, Guadalupe. In 1909 most lines were put under direct Federal control under the name of National Railways of Mexico (National, Inter-oceanic, Inter-national, Veracruz-Pacific, Central and some others, totalling about 14,000 m.). Other lines are the Northern Mexico, Kansas City-Mexico & Orient, United Railways of Yucatán, etc. Freight carried by the different lines, with returns, amounted to:

	Metric tons	Returns
1923	6,719,236	$103,206,704
1924	6,664,855	117,864,842
1925	7,291,893	121,567,600

The total revenues derived from these lines was $118,429,234 in 1923, as against $150,622,239 in 1922. More railways are necessary, the Yucatán peninsula, among other regions, being without railway connection with the rest of the country. Modern tramway lines are found in all the important cities. The tramways of Mexico City carried 48,553,048 passengers in 1924 and earned $5,247,397.

Airmail service between San Antonio, Dallas, Laredo and Fort Worth, Texas, in the United States, and cities in the interior of Mexico was inaugurated Oct. 1, 1928.

At the end of 1925 there were 53,554 automobiles in Mexico. Telegraph and telephone lines, under Federal control, totalled 55,394 m. of wire in 1921, while the State-owned and private lines added 20,706 m. of wire to the former. 5,698,026 telegrams went over the lines in 1924. There are 24 radio-telegraphic stations in the republic, through which 250,392 communications were sent in 1924. Mexico City has 24,500 telephones and there are 50,360 in the whole country.

Bibliography.—Alexander von Humboldt, *Voyage aux régions équinoxiales du nouveau continent* (1809); A. García Cubas, *Cuadro geográfico de los Estados Unidos Mexicanos* (Mexico, 1889); E. von Hesse Wartegg, *Mexico, Land und Leute* (Vienna 1890); Elisée Reclus, *The Earth and its Inhabitants*, vol. xvii. (1891); Berghaus, *Physikalischer Atlas* (Gotha, 1892); E. Seler, *Mexico und Guatemala* (1896); Roland Bonaparte and others, *Le Mexique au début du XXe siècle* (1898); F. Starr, *Indians of Southern Mexico* (Chicago 1899); R. de Zayas Enriquez, *Los Estados Unidos Mexicanos* (Mexico 1899); Carl Lumholtz, *Unknown Mexico* (1902); Justo Sierra and others, *Mexico; its Social Evolution* (Mexico 1904); J. G. Aguilera, "Aperçu sur la géologie du Mexique pour servir d'explication à la carte géologique de l'Amérique du Nord," *Compte-Rendu du Congrès géologique international* (Xe session, 1906); R. de Zayas Enríquez, *El Estado de Yucatán* (New York, 1908); Auguste Genin, *Notes sur le Mexique* (Mexico 1908–10); T. Philip Terry, *Mexico* (Guide) (Boston 1909); R. F. Martin, *Mexico in the 20th Century* (1907); H. Gadow, *Travels in Southern Mexico* (1908); R. Aguilar y Santillán, *Bibliografía geológica y minera de la República Mexicana* (1908); G. Buschan, *Illustrierte Völkerkunde*, vol. iii. (Stuttgart, 1922); Max. Sorre, *Mexique et Amérique Centrale* (Paris, 1928); *see* also official publications on Mexican statistics. (G. C. E.)

COLONIAL PERIOD. 1519–1821

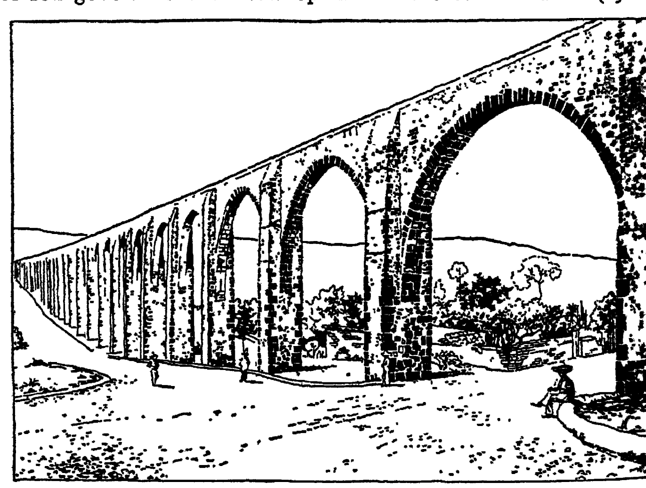
For ancient Mexico before the Spanish Conquest *see* the articles Central America, *Archaeology, Ethnology;* and North America, *Anthropology*.

The overthrow of the Aztec empire by a Spanish force under Hernando Cortés between 1519 and 1521, the execution of the last Aztec emperor, Cuauhtemoc, and the rapid extension of the Spanish conquest from Mexico City as a base, introduced the colonial period of Mexican history. Beginning in 1523 and continuing until the forced resignation of the last viceroy in 1821, New Spain was administered by royal governors until Dec. 1528; by *audiencias* from 1528 to 1535; and by viceroys and *audiencias* after 1535. In all, 61 individuals were appointed viceroys of New Spain, one of whom served a second term. Because of either the death or disability of a viceroy, the *audiencia* at Mexico City assumed administrative powers on 14 different occasions.

New Spain: Extent.—New Spain was one of the four viceroyalties comprising the over-seas possessions of the Crown of Spain known as the Kingdom of the Indies. As modified soon after its establishment in 1535, the viceroyalty of New Spain included and stretched northward from Central America above present Panama. It also included the Spanish West Indies, Venezuela for a number of years, and the Philippines from 1565 to 1584. The north-eastern boundary of New Spain, by a treaty with England in 1670, was fixed just south of Charlestown, S.C.; at the same time its most northern occupied outpost was Taos, New Mexico. Later, New Spain was delimited in the east by the English occupation of Georgia, and, further west, between 1699 and 1763, by the French occupation of Louisiana. New Spain expanded greatly when Western Louisiana was ceded in 1763 by France to Spain, who held it until its retrocession to France in 1800. On the other hand New Spain suffered territorial loss in the east when Spain ceded Florida to England in 1763. Twenty years later Spain acquired West Florida and regained East Florida from England; both provinces were acquired by the United States between 1810 and 1819. In the west, California was occupied between 1769 and 1776.

New Spain was delimited on the north in 1776 when the provinces from Texas to California were erected into a military and political jurisdiction known as the *Comandancia General de las Provincias Internas,* administered by a commandant general. Many changes in organization were subsequently made.

Government and Organization.—The chief administrative subdivisions of the viceroyalty of New Spain at the close of the 18th century were the captaincies-general of Guatemala and Havana. The former included all of the present Mexican State of Chiapas and all of Central America north of Panama; the latter included the Spanish West Indies, Louisiana and Florida. Over the captains-general the viceroy exercised only general supervisory and administrative authority. The viceroyalty proper and the captaincies-general were sub-divided for local administrative purposes into provinces. They were administered by governors, who were appointed by the king and were responsible to him through either the viceroy or the captains-general. The only institution of self-government in New Spain was the town council (*ayuntamiento,* or *cabildo*), composed of municipal judges (*alcaldes ordinarios*) and councilmen (*regidores*).



ONE OF THE AQUEDUCTS CONSTRUCTED IN MEXICO BY THE EARLY SPANIARDS AND STILL IN A STATE OF GOOD PRESERVATION

Aside from its administrative organization, New Spain was divided into four judicial districts, at the head of each of which was an *audiencia.* Such a body functioned primarily as a court of appeals, but it also exercised extensive administrative powers. The seats of the *audiencias* were Mexico City, Guatemala, Santo Domingo (moved to Puerto Príncipe, Cuba, after 1793) and Guadalajara. At Mexico City the *audiencia* served as a viceregal council, although the viceroy was not obliged to follow its advice. The viceroy could preside over the judicial sessions of the audi-

encia but did not have a vote in judicial matters. Similar relations existed between the *audiencia* and the captains-general at Guatemala. The *audiencia* of Santo Domingo exercised administrative authority over all of the Spanish West Indies until 1784, when it lost that authority over the captaincy-general of Havana; it continued to exercise administrative authority over the rest of the Spanish West Indies until 1793, at which time France came into possession of the entire island of Española (Haiti). This *audiencia* also exercised administrative authority over Venezuela for many years. The judicial authority of the *audiencia* of Santo Domingo extended over all of the Spanish West Indies, Florida, Louisiana after 1763, and Venezuela until 1786. The *audiencia* of Guadalajara, in addition to exercising judicial jurisdiction over western and north-western New Spain, including the *Provincias Internas* after 1776, exercised administrative authority in the province of Nueva Galicia.

On the military side the viceroy of New Spain was captain-general of the entire viceroyalty. In practice, however, he exercised merely supervisory military authority in the captaincies-general of Guatemala and Havana. In the *audiencia* districts of Mexico and Guadalajara he exercised direct military authority. The powers of the subordinate or local captain-general were exercised by some provincial governors. At first the viceroy was in charge of the fiscal administration of New Spain. In 1786, however, a separate fiscal administration, dependent upon the viceroy, was introduced with the establishment of the intendancy system. Under this system the viceroyalty proper was divided into twelve intendancies and three provinces. Each intendant was ruled by a governor-intendant, who assisted in the collection of revenues and, in addition, was charged with certain administrative, judicial and military authority in his intendancy.

The Church and the People.—The regular and secular clergy, particularly the former, supplemented the work of the conquerors. The Franciscans were the first regulars to enter New Spain with papal sanction, three of them arriving in May 1522. The members of this order were noted for their charitable work among the Indians and for their missionary work on the northern frontier from Florida to California. Regulars of many other orders followed the Franciscans to New Spain, notably the Augustinians, the Dominicans and the Jesuits. The last-named were transferred in 1572 from Florida to western New Spain where they were actively engaged until 1767 in missionary and educational work and in advancing and holding the frontier. Each of the orders had its own organization, the principal unit of which was the province, which was administered by a provincial. The various orders in 1805 were maintaining 254 convents in New Spain proper. Secular organization began with the nominal creation of the bishopric of Yucatán in 1519; actually it began with the creation of the bishopric of Tlaxcala in 1526. Juan de Zumárraga arrived as first bishop of Mexico City in 1528; in 1547 Mexico City became the seat of an archbishopric. In 1805 there were in present Mexico one archbishop, eight bishops and 1,703 parishes. The Council of the Indies, a joint body of clergy and laity, exercised sovereign authority. Through special concessions of the papacy the king of Spain became virtually the administrative head of the colonial church. As such, the Crown appointed to all ecclesiastical holdings, supervised the conduct of the clergy, and controlled ecclesiastical revenues. The liberal policy of the Crown was such that the church became immensely wealthy and early attained preponderant power and influence. Alamán states that its wealth in 1821 included not less than one-half of the real property and capital of the country. Its power may be judged from the petition of the city council of Mexico to Philip IV. in 1644 to stop the foundation of religious houses, to suspend ordinations because there were more than 6,000 unemployed clerics and to suppress feast days because there were at least two each week. To assist the church a tribunal of the Inquisition was established in Mexico in 1571. By the Crown the church was delegated almost exclusive control over education, but this it was unable to diffuse widely, though Humboldt said that in certain respects Mexico surpassed England. According to authoritative estimates, out of a population of about 6,000,000 at the beginning of Mexican independence, only 30,000 were literate. On the other hand the church established a number of higher institutions of learning, the underlying aims of which were to equip young men of the upper classes for the priesthood and the practice of law. The most noted of these institutions was the Royal and Pontifical University of Mexico which was inaugurated in 1553. The Church also had charge of charitable institutions, as hospitals and orphanages.

Three distinct races were represented in New Spain—the European, the Indian and the negro. The most important of these races was the European, with Spaniards overwhelmingly predominating. They were divided into two classes—gachupines, or European-born Spaniards, and creoles, or American-born Spaniards. For the gachupines were reserved most of the political, commercial and social preferments. The total number of Europeans in New Spain in 1800 probably was about 885,000, of which number approximately 15,000 were gachupines. The native race remained the most numerous. In 1800, in New Spain proper, the Indians probably numbered 3,000,000, or approximately 50% of the total population. Negroes were early brought to New Spain to work as slaves on the coastal agricultural lands. Prior to 1575 they probably outnumbered the whites, but by 1821 they had largely been absorbed or else had bought their freedom and had disappeared. Few Spanish women came to America at first, and at the close of the colonial period they probably did not total more than one-tenth of the European-born Spaniards. As a result, there were many classes of mixed blood, the most important being the mestizo (Indian and European); the sambos (negro and Indian), and the mulattoes (negro and white). The number of persons of mixed race in 1800 was approximately 2,000,000. A few Chinese and Malays were settled on the Pacific coast.

On the theory that the Indians were its wards, the Crown felt obliged to protect, convert and civilize them, and justified in utilizing their labour. The chief means by which it was hoped to attain these ends was the *encomienda* system. Allotments (*repartimientos*) were made to conquerors, to whom the Indians living thereon were given in trust (*encomienda*). Such a grantee (*encomendero*) was obligated to protect his Indians and to provide missionaries and teachers for them; he was also empowered to exact tribute of them. Not all Indians were given in *encomienda*, those living on royal lands being under overseers, appointed by the king, known as *corregidores* and *alcaldes mayores*. These officials after 1786 were replaced by assistants of the governors-intendant known as sub-delegates. While the theory of the *encomienda* system was benevolent, it resulted, in practice, in the abject enslavement of many of the natives. The system was introduced in New Spain by Cortés. Steps looking toward its correction and final abolition were taken in 1542 but it was not finally abolished until the 18th century. It should be recorded that the first church council in Mexico protested against the abuse of power over the Indians. This was an early subject of difference between church and State.

Expansion of the State.—The most continuous development in New Spain—one of dramatic interest and international importance alike—was the northward advance of the frontier of settlement. For the first decade after the capture of Mexico City, the Spaniards, except for the founding of Pánuco (Tampico) in 1522, confined their activities to the regions south and west of the capital. The creation of royal provinces in Central America between 1525 and 1527 cut off opportunities for expansion there. The heroic age of exploration followed, being ushered in by the journey of Cabeza de Vaca from the Florida and Texas coasts to the Gulf of California between 1528 and 1536. Soon afterward the Coronado and De Soto expeditions made known northern Mexico and the southern half of the present United States; the Cabrillo-Ferrelo expedition coasted as far north as Oregon; and the Villalobos expedition from New Spain to the Philippines gave Spain title to those islands.

For nearly two decades following the founding of Culiacán, Sinaloa, in 1531, the frontier of settlement in New Spain extended in an irregular semi-circle, with the base resting on Guadalajara and Mexico City, from Culiacán, on the Gulf of California, to Pánuco, on the Gulf of Mexico. Led by wealthy miners and

cattle barons and by humble missionaries, the northernmost outposts in both the east and the west by 1590 advanced still farther north, while the arc of the circle, in large measure, was filled in. In that year the frontier stretched from Cerralvo, on the lower Rio Grande, by way of Saltillo and San Bartolomé, to San Felipe at the mouth of the Sinaloa river. Meanwhile, Florida had been permanently settled in 1565 by a large expedition from Spain under Menéndez de Avilés. The purpose was to hold Florida against the French Huguenots who had attempted to colonize it. In 1598 the frontier of New Spain proper moved across 600 m. of desert north of the line of 1590 and halted in the upper valley of the Rio Grande The objects were to make New Mexico a base from which to anticipate other nations in the discovery of a supposed strait (North-west Passage) and to exploit the sedentary Pueblo Indians. New Mexico was thus permanently occupied save for the period of the Pueblo Rebellion (1680–92).

Spanish advances in the later 17th and 18th centuries were occasioned almost altogether by the fear of foreign aggression. The short-lived French settlement in Texas under La Salle (1684–87), although it failed, prompted Spain to occupy temporarily east Texas (1690–93); English aggressions westward from South Carolina prompted Spain to found Pensacola, Fla., in 1698. The founding and expansion of French Louisiana, beginning in 1699, made necessary the permanent occupation of Texas in 1716, title to which France never disputed with Spain after 1722. The boundary between French Louisiana and Spanish Texas came to be regarded as the Arroyo Hondo, midway between Los Adaes, the capital of Texas, and Nachitoches, the westernmost French outpost on the Red river, E. of Los Adaes. In north-western New Spain between 1591 and 1767 the Jesuits were chiefly responsible for the advance of the frontier from the line of settlement of 1590 into southern Arizona, and, beginning in 1697, into Lower California. The most noteworthy advances of the Spanish frontier were made after 1763. Western Louisiana having been acquired from France, it was necessary for the Spaniards to advance to the Mississippi and hold at that stream the Anglo-Americans all the way from New Orleans to and beyond St. Louis. From the acquisition of the Floridas by treaty in 1783, until the retrocession of Louisiana to France in 1800 the frontier of settlement of Spain in America extended from St. Augustine, Florida, to New Orleans, thence north to St. Louis, and thence west, by way of Santa Fe, to San Francisco.

The leading events of the colonial period in New Spain proper can be given only in bare outline here. The first two viceroys, Mendoza and Velasco, are extremely important because by them the course of viceregal administration in New Spain was definitely marked out. Mendoza's administration (1535–50), was made notable by his encouragement of exploration, an attempt to suppress the *encomienda* system, the Mixton Indian uprising, the definite incentive to northward expansion through the development of mining north of the line of settlement of 1531, and by a violent epidemic among the natives. Viceroy Velasco ranks high as a humanitarian and an expansionist. By freeing 150,000 male Indian slaves and a large number of women and children, he earned the titles of "Liberator" and "Father of his Country."

The inordinate vanity of Martín Cortés, son of the Conqueror, and the fear of the *encomenderos* that they would lose their rights, culminated in an abortive and disastrous attempt in 1566 to set up Cortés as king—the only separatist movement prior to the 19th century. In the latter half of the 16th century Hawkins, Drake, Cavendish, and other Protestant freebooters, inspired by hatred of Catholicism and patriotic motives alike, engaged in lucrative smuggling of goods into Spanish America and in even more lucrative preying upon Spanish commerce and coast towns. The establishment of regular galleon service between Acapulco and Manila after 1571 made possible the development of an extensive commerce between Spain and the Far East across New Spain. This and the establishment of extensive woollen and cotton factories in the latter part of the 16th century redounded greatly to the material advantage of New Spain.

The regular and secular clergy had early come into conflict, particularly over the tithes and the control of the Indians. The conflict reached a crisis and merged into one between church and State during the viceregal administration of the Marqués de Gelves, 1621–24. This energetic reformer favoured the appointment of regulars to deal with the natives, and in so doing came into conflict with Archbishop Serna of Mexico, who placed the city under an interdict, excommunicated the viceroy, and constrained him to hide from a mob.

During the reign of Viceroy Albuquerque (1702–11), which coincided with the war of the Spanish Succession, his chief concern was the defence of the coasts from British attacks and the fighting of pirates. By the Treaty of Utrecht (1713) England secured commercial privileges which proved in practice to be an entering wedge for much illicit commerce. Friction that resulted therefrom finally culminated in a commercial war which soon merged into the war of Austrian Succession. During the latter war the raids of Admiral Anson in the Pacific struck a hard blow at the commerce between New Spain and the Philippines. Spain entered the Seven Years' War in 1761, only to lose Havana and Manila to the British. Florida was given to England in exchange for them at the close of the war. During the war of the American Revolution, Spain declared war against England (1779) but declined to make an alliance with the American Colonies. Of considerable aid to the colonists as early as 1776 was the anti-English policy pursued by Don Bernardo Gálvez, Spanish governor at New Orleans. After Spain entered the war he directed offensive operations against the British in the territory north of the Ohio river and personally waged successful campaigns against the British in West and East Florida, thereby obtaining them for Spain at the close of the war.

Viceroy Casafuerte's reign (1722–34) was made notable by the publication of the *Gaceta de México*—published intermittently at first—and the *Mercurio de México*. A formidable negro rebellion in Veracruz and a terrible epidemic among the natives were notable events of 1735 and 1736. Viceroy Ahumada (1755–60) is noted for his many administrative reforms. A few years later, a special royal visitor, clothed with supreme power, José de Gálvez, instituted many important administrative, economic, commercial and fiscal reforms. Not the least result of these was an increase from $6,000,000 to $20,000,000 in the annual royal revenues from New Spain—an accomplishment that was effected without increasing taxes. It was at Gálvez's suggestion that the *Comandancia General de las Provincias Internas* and the system of intendancies were established. One of the notable events of the later 18th century was the expulsion of the Jesuits from New Spain, as from all of the Spanish Dominions, in 1767, under orders of Charles III.—these being carried out in New Spain by Gálvez on the night of June 26. The Jesuits were arrested *en masse*, their property, which some authorities have estimated as high as 10,000,000 pesos, was sequestrated, and they were expelled, their place in the north-west being taken by the Franciscans. The second Count of Revilla Gigedo (1789–94), of all the viceroys of that century, ranks as the greatest reformer, statesman and promoter of industry and commerce.

The Independence of Mexico.—The European situation between the outbreak of the French Revolution in 1789 and the wave of liberalism that swept over the Mediterranean States in 1820 profoundly influenced the movement for the independence of New Spain. At the same time the introduction of the revolutionary doctrines of "liberty, equality and fraternity" spread to Latin America and inspired hope among the creoles, who were ambitious to enjoy commercial, political and social preferments on an equal footing with the gachupines.

The greatest impetus to the independentist movement came when Napoleon deposed the rightful king of Spain in 1808 and placed his own brother Joseph upon the throne. At once a small, politically ambitious minority in New Spain, acting on the theory that with the deposition of Ferdinand VII. sovereignty had reverted to the people, demanded a share in the government of the viceroyalty. For selfish reasons the viceroy, Iturrigaray, lent a willing ear to these suggestions and proposed the convocation of a national congress. Thoroughly alarmed at such suggestions and fearful that they would lose to the creoles some of their privileges

through severance from Spain, the gachupines deposed Iturrigaray and took over the Government. Thus intrenched in power they easily suppressed an abortive separatist movement initiated by the creoles in Michoacán in 1809. When the viceroy, Venegas, arrived in Sept. 1810, the hold of privileged autocracy on New Spain never appeared stronger.

While the jealous gachupines and the ambitious creoles thus quarrelled in New Spain over the question of the extension of privileges a great socio-economic upheaval of the masses developed under the leadership of Father Miguel Hidalgo y Costilla, a member of the lower clergy who had been profoundly influenced by the doctrines of the French Revolution. This movement had as its object the extension of human rights and privileges to the great mass of Indians and mestizos whose claim to such privileges was equally revolutionary to creoles, gachupines and the higher clergy. At the outset the uprising, which assumed the character of a race war under the patronage of the Virgin of Guadalupe, was led by Hidalgo and Allende, a captain of cavalry. Their greatest success was the capture of the wealthy city of Guanajuato, after which they threatened the capital. But the revolutionists were decisively defeated at Calderón in 1811 and soon afterward the leaders were executed. Another liberal member of the lower clergy, Morelos, continued the movement. Although he met with serious reverses in the terrible siege of Cuautla in 1812 he rallied the south to his cause and in 1813 was able to convoke a congress which issued a declaration of independence and drafted a republican Constitution. Morelos was captured and executed at Mexico City in 1815. Thereupon, the revolutionary movement disintegrated into guerrilla warfare. The tide had already begun to turn when in 1820 the liberal Spanish Constitution of 1812 was proclaimed after a military uprising in Spain. Its promulgation in Mexico caused the high clergy and the gachupines to fear that a liberal Government in Spain would force upon them toleration and the loss of privileges, disestablishment and disendowment, all of which they had successfully opposed, first, in the period from 1808–10, when the ambitious creoles had demanded reforms, and second, in the period since 1810, when the social upheaval of the masses had largely caused the creoles and the gachupines temporarily to forget their differences. Accordingly the clerical and gachupine opponents of liberalism resolved upon the absolute separation from the Spanish monarchy as the only means of preserving their position.

The first move of the conservatives was the selection of a suitable military leader in the person of Agustín de Iturbide, a creole ex-officer in the Spanish army. He easily induced the unsuspecting viceroy to send him into the field against the rebels. His real purpose, however, in case he could not defeat Guerrero, was to win him over to the separatist movement. This was finally accomplished when, without informing the viceroy, Iturbide signed with Guerrero on Feb. 24, 1821, the Plan de Iguala—a crude *pronunciamiento* which laid down as the bases of the new State the continuation of the Roman Catholic Church as the established church of Mexico, the establishment of an independent limited monarchy, and the equality of rights for Spaniards and native-born Mexicans. Thus the Plan de Iguala was, in theory, a compromise, but one which was destined to bid successfully for the support of the various classes in New Spain. In the interest of the proposed plan, Iturbide first sought the co-operation of the viceroy, Apodaca, who refused, but was powerless to stem the flood of spontaneous support given the plan. When Juan O'Donojú, the last viceroy, arrived in July he was unable to get beyond Veracruz, and, accordingly, recognized the independence of Mexico in the Treaty of Córdoba. Iturbide triumphantly entered Mexico City on Sept. 27, 1821. The following day a provisional governing Junta, named by Iturbide, signed the "Act of Independence of the Mexican Empire," and appointed a regency of five, with Iturbide as its president. These acts marked the beginning of the national period of Mexican history.

INDEPENDENT MEXICO

Mexico has had a turbulent existence since independence. In 1823 the monarchy was repudiated in favour of a republic. From 1823 until 1860 a bitter contest was waged between adherents of federalism and centralism. A Federal republic was definitely established in 1857 but federalism was on the defensive for ten more years, first, in a three-year civil war and, second, during the period of the French intervention and the empire of Maximilian. Since 1867 there has been no organized opposition to federalism in Mexico, but during nearly one-half of that period the Díaz dictatorship prevailed in the guise of Federal institutions. Indecision concerning the form of government was accompanied by political instability. Between 1821 and the rise of Díaz in 1876, there were two regencies, two emperors, several dictators, and enough presidents and acting or provisional executives to make no fewer than 74 governments. Furthermore, the last 100 years have witnessed approximately that number of revolutions. Most of these, however, have been political or personal in character. In fact, since 1810 there have been only three general upheavals in Mexico, each of which has been socio-economic in character and more or less beneficent in its results. The first, begun in 1810 by Hidalgo, substituted the creoles for the gachupines and resulted in greater power and wealth for the church, which in 1807 had been debarred from inheriting real estate. The second, begun in 1854, disendowed and disestablished the church, but worked to the advantage of the great landowners The third, begun in 1910 and continuing down to the present time, was directed chiefly against the landed aristocracy and is strongly nationalistic.

The Mexican empire was of short duration. In the first Mexican Constituent Congress, which met on Feb. 24, 1822, the republicans were in the majority and between them and Iturbide a conflict soon developed. This was terminated on May 18 by a military *pronunciamiento* in favour of Iturbide, and by his extra-legal election as emperor by a minority in Congress. Iturbide was crowned on July 21, 1822, but fresh conflicts broke out between him and the Congress which were only terminated by his forcible dissolution of that body. This arbitrary procedure reacted in favour of a republican armed movement, initiated by Santa Anna. Finally, convinced of the hopelessness of his position, Iturbide abdicated on March 19, 1823. The Congress deported him to Italy, and granted him a pension. He returned with political ambitions the following year, and on landing (having been previously outlawed) was arrested and executed (July 15, 1824). The Congress, left in absolute control after the abdication of Iturbide, created a provisional executive triumvirate; announced (June 12) the adoption of the federal form of government; and issued a decree (June 23) convoking a new Constituent Congress. This body drafted a Federal Constitution which was promulgated Oct. 4, 1824, and Guadalupe Victoria was inaugurated as first president.

The First Federalist Régime, 1824–34.—Confronted by manifold difficulties, the Federalists were able to remain in power and to retain the federal form of government for only one decade after 1824. At the outset, Centralist and Federalist organizations as such disappeared, their places being taken by two Masonic organizations. The Conservatives, Monarchists and Centralists affiliated with lodges of Scottish-Rite Masons (*Escoceses*), and the Liberals, Republicans and Federalists, encouraged by the American minister Poinsett, organized rival lodges of York-Rite Masons (*Yorkinos*). Through boisterous professions of fraternal and political creeds members of the rival lodges kept the country profoundly agitated. An attempt at revolt by Vice President Bravo, the grand master of the Escoceses, was suppressed. The thoroughly discredited and demoralized Escoceses thereupon refrained from naming a presidential candidate in 1828 and instead threw their support to Gómez Pedraza, the Liberal contender for the presidency with Vicente Guerrero, the grand master of the Yorkinos. Gómez Pedraza was declared elected but as a result of an appeal to arms Guerrero was inaugurated for the second presidential term beginning April 1, 1829. Shortly afterward Spain made a final attempt to reconquer Mexico, but the invaders were repelled at Tampico by Santa Anna (Sept. 1829). During the invasion, Vice President Anastasio Bustamante seized the opportunity to declare against President Guerrero and was joined by the bulk of the army. Guerrero was deposed, after having served as president less than nine months, and finally retired to Acapulco, where

he was treacherously seized, tried and executed (Jan. to Feb. 1831). The next year Santa Anna headed a successful revolution against Bustamante in behalf of Gómez Pedraza, thereby enabling him to serve the last three months of the term for which he had been elected in 1828. In the deferred elections, held early in 1833, Santa Anna and Gómez Farías were elected president and vice president, respectively, for the term beginning April 1 of that year. During the greater part of the next 13 months Gómez Farías, serving as acting president, was responsible for many liberal changes, including the laicization of education, the relaxation of monastic vows, the discontinuance by the State of the collection of tithes, and the right of the State to appoint church officers. The Liberals were Whigs rather than Populists. Their dominant desire was to seize the privileges of the Conservatives, in the control of government, the ownership of land and the profits of foreign trade, which had been a Government monopoly. They were little concerned about the welfare of the masses. The liberal measures aroused the opposition of the Clericals and Conservatives, and Santa Anna, taking advantage of the situation to act as their defender, assumed the presidency on April 24, 1834. The following month, as virtual dictator, he dissolved Congress and the State legislatures, and substituted creatures of his own for the governors of the States and mayors. By such action he undid the liberal reforms of Gómez Farías and reduced to a nullity the federal system of which he had been the chief original defender.

The Conservatives and Clericals who thus came into power indirectly with Santa Anna retained control until 1846 under a centralized form of government. A new Congress discarded federalism (Oct. 3, 1835) and framed a centralist Constitution (Dec. 30, 1836), known as the *Siete Leyes* or Seven Laws. By it the States were converted into departments, ruled by governors appointed by the central authority, and popular representation was considerably reduced. Anastasio Bustamante became the first Centralist president. When he failed to satisfy questionable damage claims of French nationals in Mexico a French fleet in 1838 blockaded the coast, bombarded the fortress of San Juan de Ulua, and temporarily occupied Veracruz. This gave Santa Anna the longed-for opportunity to pose as the country's defender which, in turn, reawakened his political ambitions. Full opportunity to realize them, however, was deferred until 1841, when he joined a successful revolution against Bustamante. The Plan of Tacubaya (Sept. 28, 1841), put forward by the revolutionists, abolished all but the judicial provisions of the *Siete Leyes*, conferred upon Santa Anna power of reorganizing the administration, and provided for a new constituent assembly. When it met in June, 1842, the Federalists were in the majority, much to Santa Anna's chagrin. Accordingly he retired, leaving the reins to Nicolás Bravo. He dissolved the Federalist assembly and convened a hand-picked one which adopted an ultra-centralist Constitution (June 12, 1843). Santa Anna was inaugurated first president under it on Jan. 2, 1844, but because of his mal-administration, extravagance and profligacy, was overthrown before the end of the year and exiled. José Joaquín Herrera, who succeeded him (Dec. 1844), was a constructive statesman and adopted conciliatory foreign and internal policies but was overthrown (Jan. 1846) by Ultra-Centralists, Monarchists and anti-Americans led by Gen. Mariano Paredes. Seven months later, in order to solidify public opinion during the war with the United States the Federalist Constitution of 1824 was restored (Aug. 5, 1846). Recalled from his exile to oppose the foreign invaders, Santa Anna was elected president (Dec. 1846) under the Constitution which he had repudiated.

The substitution of a central for a federal form of government was the occasion for uprisings in various parts of Mexico, all of which were finally suppressed except that in Texas, which had been settled principally by colonists from the United States in consequence of contracts granted to immigration agents (*empresarios*) to introduce colonists. The first such contract was granted to Moses Austin, in 1821, and was carried out by his son Stephen. Because of the incompatibility of Mexican and American settlers in Texas and their mutual distrust, Texas gradually drifted toward inevitable rebellion. Various specific grievances developed after 1826 that widened the breach, but the pretext for the rebellion of the Texans was the centralization policy inaugurated by Santa Anna in 1835, culminating in the abolishment by the Mexican Congress of the federal form of government. A provisional revolutionary government, which professed to be acting in defence of the Constitution of 1824, functioned in Texas from Nov. 3, 1835, until March 1, 1836; on the following day the unqualified declaration of Texan independence was issued. Santa Anna attempted to reduce Texas, showing great severity, but was eventually defeated and captured by Houston at the battle of San Jacinto. There he signed an agreement pledging himself to work for the recognition of Texan independence upon his return to Mexico. The Mexican Government, however, repudiated Santa Anna, and a nominal state of war continued between Mexico and Texas, whose independence was recognized by the United States, Belgium, the Netherlands, France and England (1837–41).

War with United States, 1846–48.—The Texas question was chiefly responsible for war between the United States and Mexico. Texas had applied for admission into the American Union in 1836 but annexation was delayed by those in the United States who were opposed to acquiring more slave territory. Fearful of British and French influence in Texas, however, the U.S. Congress early in 1845 adopted a resolution providing for annexation. Texas agreed, and on Dec. 29, 1845, was formally admitted to the Union. The Mexican minister withdrew from Washington following the adoption of the annexation resolution and the U.S. minister was recalled from Mexico. Nevertheless, President Polk was conciliatory, and late in 1845 sent Slidell to Mexico to attempt to settle all differences between the two countries—the chief ones arising from the disputed Texas boundary and the unsettled damage claims of U.S. citizens against Mexico—and also to purchase, if possible, California and New Mexico. Slidell's mission might have been successful, in part, but for the triumph of the war party in Mexico under Paredes. It was not until President Polk was informed that Mexico desired war, that he ordered American troops into the disputed region between the Nueces and the Rio Grande rivers. Hostilities inevitably followed and a state of war with Mexico was declared by the U.S. in May 1846.

The original plans of the U.S. general staff called for (1) an invasion by Gen. Taylor of northern Mexico, which it was hoped would overawe the Mexicans and induce them to come to terms; (2) the military occupation by Gen. Kearny of the territory from New Mexico to California, which was to be held as an indemnity; and (3) the blockade of both coasts of Mexico by the United States fleet. The two last-named plans materialized fully; in addition, Gen. Doniphan led a side expedition from Santa Fe, New Mexico, to Chihuahua and Monterrey. Gen. Taylor's campaign, however, won all military engagements but failed of its object. The Mexicans, instead of submitting as the American army advanced, put up a vigorous defence, and at Buena Vista, on Feb. 22 and 23, 1847, Santa Anna opposed the Americans in the best-fought engagement of the war and the last one in the north. When the spirit of the Mexicans was revealed, a campaign from Veracruz to Mexico City under Gen. Scott was decided upon. Veracruz was captured after a three-weeks' siege (March 7 to 29, 1847), Santa Anna was decisively defeated at Cerro Gordo (April 18) and Gen. Scott, with greatly superior forces fought his way into the Valley of Mexico, and entered Mexico City Sept. 13, 1847. Peace was formally re-established with the Treaty of Guadalupe Hidalgo, concluded on Feb. 2, 1848. By it the Rio Grande was fixed as the southern boundary of Texas and the territory north of an irregular line extending from El Paso, by way of the Gila river to the Pacific ocean, was ceded to the United States; in return the United States paid Mexico $15,000,000 and assumed all claims of her citizens against Mexico.

Second Federalist Régime, 1846–53.—The Federalists, responsible for the conduct of the war against the United States, remained in power six more years after Santa Anna had been defeated and left the country. President Herrera (1848–51) attempted to reorganize the Government, restore order and establish credit. This programme was realized only in part, due to military and political disorders. However, when Arista succeeded Herrera, Mexico witnessed for the first time the peaceful transfer

of executive authority from a constitutional president to his constitutionally elected successor. The experiment was not to be repeated soon, for Arista, cognizant of his general unpopularity, gave way (Jan. 1853) before a movement promoted by Clericals and Conservatives, who favoured the convocation of a constituent assembly. After an interregnum (Jan.–March 1853) a group of militarists succeeded in effecting the recall of Santa Anna. Installed as president on April 20, 1853, he surrounded himself with Conservatives. On Dec. 16, disregarding all restraints, he declared himself dictator, with the title of "most serene highness." A few days later the sale of Mesilla valley (present Arizona, south of the Gila river) to the United States was negotiated, but the purchase money was soon dissipated. Santa Anna's zero hour, however, had already arrived. While Federalist and Centralist office seekers and doctrinaries wrestled for control after 1824, the mestizo and Indian masses, in social and economic degradation and misery, were either ignored or used as pawns. In practice, haughty creoles had merely usurped the places of haughtier gachupines. The church owned in 1854 a great part of all urban property, controlled or owned much of the rural property, had an annual income greater than that of the National Government, and acted as unofficial banker for the people. The gaze of the land-hungry masses fell upon this great domain. Therefore, the recall of the faithless Santa Anna by the Conservatives, his seizure of dictatorial power, and his alienation of the national domain, were but pretexts and not fundamental causes for the revolution of Ayutla, which swept him into perpetual political exile, and provided a liberal Constitution. This revolution was initiated by the mestizo revolutionary patriot, Juan Álvarez, and was formally proclaimed on March 1, 1854. It was soon joined by a future galaxy of heroes, including Comonfort, Juárez and Díaz, and as it spread Santa Anna left the country in Aug. 1855. On Oct. 4, Álvarez was installed as provisional president. He soon resigned and was succeeded by Comonfort, who served as provisional president.

The presidencies of Álvarez and Comonfort were signalized by the promulgation of two laws and the adoption of the Constitution of 1857. The enactment (Nov. 23, 1855) of the first law was secured by Juárez, the Zapotec Indian minister of justice in Álvarez's cabinet, from whom it takes its name (Ley Juárez). By limiting the jurisdiction of ecclesiastical and military courts to offences of the clergy and military, the law for the first time provided for the legal equality of all citizens. Feeling that religion was being attacked, the Clericals opposed the law. Equally noteworthy was the Ley Lerdo (June 25, 1856), so called from its author, Miguel Lerdo de Tejada, minister of finance in Comonfort's cabinet. This law prohibited religious and civil corporations from acquiring or owning rural or urban property not used for the specific object of the corporation, and obliged corporations then owning such property to sell the same to the tenants or usufructuaries on reasonable fixed terms, for the benefit, however, of the owners. In practice neither law accomplished its full object. Nevertheless, they were both incorporated substantially in the new Federal Constitution (promulgated Feb. 12, and effective Sept. 16, 1857) along with other clauses recognizing the natural and inalienable rights of man and providing for religious toleration and agrarian reform—all of which made the new Constitution appear extremely liberal in comparison with that of 1824. The Liberals, however, were still working for the interests of the middle class, rather than of the masses.

As the Constitution of 1857 went into effect, opposition increased. Comonfort was installed as constitutional president on Dec. 1, but within less than three weeks, vainly hoping to reconcile the two hostile political groups, accepted the Plan de Tacubaya (Dec. 17, 1857), which repudiated the new Constitution. He was promptly made dictator by the Conservatives, who took steps to draft a new Constitution under his auspices. Having used Comonfort, the Conservatives soon deposed and exiled him (Jan. 21, 1858) and named as his successor a thorough Conservative, Zuloaga. For the next three years Mexico was the prey of civil war between two rival Governments—the Constitutionalists at Veracruz under Juárez, who, as chief justice of the Supreme Court had succeeded Comonfort, and the Conservatives at the capital. The latter were better organized and early inflicted serious defeats upon the Constitutionalists. Juárez won a great moral victory, however, when he was recognized by the United States (April, 1859); this allowed him to draw supplies of arms and volunteers thence. In July 1859, Juárez published decrees suppressing the religious orders, nationalizing ecclesiastical real property (of the estimated value of more than $125,000,000, exclusive of churches, monasteries, schools, hospitals, libraries and art treasures), establishing civil marriage and registration, transferring the cemeteries to civil control—in short, disestablishing and disendowing the church. In 1859, each of the rival governments made transactions that were humiliating to Mexican sovereignty or provocative of future trouble; they can only be explained by the desperate straits of each party. In return for promised aid, the Conservative president, Miramón, approved a treaty with Spain, which recognized unjust claims of Spanish nationals against Mexico. The same year Miramón, pressed for funds, made a transaction with Jecker, a Swiss banker settled in Mexico, whereby he was to lend Miramón $15,000,000 on such terms that the latter was liable for $16,800,000. Bonds to that amount were issued to Jecker who went into bankruptcy after he had delivered to Miramón only $1,470,000. Soon, however, he bribed French officials to press, in behalf of his French creditors, for the settlement of the bonds at their face value. Also Juárez, in the hope of securing a loan, and desirous of forestalling threatened European intervention, concluded with the United States a treaty which gave the latter, in virtual derogation of Mexican sovereignty, rights of transit by diverse routes across México, and unusual guarantees for U.S. nationals residing there. This treaty was not ratified by the U.S. Senate. Until 1860 the Constitutionalists were on the defensive. In March of that year, however, the U.S. Government gave Juárez, on the ground that his Government was *de jure,* both moral and material aid, and thereby frustrated the plans of the Conservatives to attack Veracruz. Henceforth, they were on the defensive. During the war both sides levied forced contributions on much foreign property, the Conservatives being the worst offenders. The United States withdrew recognition from their Government in 1858; the following year outrages on British subjects caused the British minister to break off diplomatic relations. Finally, on Nov. 17, 1860, Miramón, under the plea of necessity, seized $660,000 which had been left under seal at the British legation. Dec. 22 his forces were routed by the Juarist Gen. Ortega and his Government overthrown.

European Intervention, 1861.—Juárez entered Mexico City on Jan. 11, 1861, and at once took under consideration Mexico's internal problems. The Spanish minister, the papal legate and members of the episcopate were expelled. In return for British recognition Juárez acknowledged as valid British claims—including a new loan—totalling nearly $70,000,000. Steps were taken to enforce the decrees of 1859 disestablishing and disendowing the church. The financial difficulties, however, seemed insuperable. Mexico's acknowledged indebtedness to Europe alone exceeded $82,000,000. In addition there were the indefensible Jecker claims which the French Government now backed up. Juárez, however, would recognize as valid only the cash actually received by Miramón from Jecker. Finally, the Congress decreed (July 17, 1861) the suspension for two years of interest payments on the external national debt. This was the occasion for the French minister to ask for his passports and for the British minister to suspend diplomatic intercourse with the Juárez Government. These events fitted in with the ulterior designs of Napoleon III., who was influenced by his Spanish wife, by the great landowners and by the exiled Mexican Clericals to interest himself in the cause of centralized monarchy and the church; in addition, he was ambitious for political and commercial reasons to establish French hegemony in Spanish America. Finally a convention between Great Britain, France and Spain for joint intervention in Mexico was signed in London on Oct. 30, 1861. Juárez succeeded in negotiating a separate arrangement of the British claims but this was rejected by the Mexican Congress; the assistance of the United States with a small loan, Mexican territory being demanded as security, was also rejected. In mid-December

Veracruz was occupied by Spanish troops; the French fleet and troops arrived soon after, with instructions to seize and hold the Gulf ports until claims were satisfied by collection of duties; Great Britain sent ships, and landed 700 marines. In view of the unhealthiness of Veracruz, the convention of Soledad was concluded with the Mexican Government; it permitted the foreign troops to advance inland to more healthful sites pending a claims conference in April, and incidentally recognized the Juárez Government. But as the French harboured leaders of the Mexican Conservatives, pressed the Jecker claims and showed an unauthorized disposition to interfere in Mexican domestic politics, Great Britain and Spain withdrew their forces in April 1862. More troops were sent from France. Their advance was checked by Zaragoza and Díaz at Puebla on May 5 (Battle of Cinco de Mayo); and in Sept. 30,000 more French troops arrived under Gen. Forey. Wintering at Orizaba, they recommenced their advance (Feb. 17, 1863), reduced Puebla, and on June 7 entered Mexico City which had been abandoned by the Juárez Government. A provisional government of Mexican Conservatives, nominated by the French minister Saligny, adopted monarchy, offered the crown, at Napoleon's instance, to Maximilian of Austria, brother of Emperor Francis Joseph, and, in case of his refusal, left its disposal to Napoleon III.

Maximilian Emperor.—Maximilian, after being endorsed in a nominal Mexican plebiscite, renounced his Hapsburg rights of succession and accepted the Mexican crown. He reached Mexico City on June 12, 1864, where he found the greater part of the country already occupied by the French and reactionary troops, the Juárez Government finally being obliged to transfer to Paso del Norte on the Rio Grande. But the empire was unstable from the beginning and gradually Maximilian came to realize that he was little more than a pawn of a political faction sustained by foreign troops. Maximilian had liberal ideals and his efforts to conciliate the republican opposition and to form a coalition cabinet of Liberals and Monarchists, together with his refusal to restore the church property that had been nationalized by Juárez, cost him the support of his original backers; and, when pressed for funds, he could obtain loans only on the most disadvantageous terms. Nevertheless, Maximilian's troops met with some notable successes. In the south Díaz was driven from Oaxaca in Feb. 1865 and in the north the condition of the Juarists became desperate. But no matter how hard pressed, Juárez was unyielding and the Republicans, defeated in open battle, resorted to guerrilla war. In desperation, Maximilian issued a decree on Oct. 3, 1865, which authorized the court-martial and summary execution of any rebel and the fining and imprisonment of anyone aiding the rebel cause. This decree was later made the basis for convicting Maximilian of murder and thus prepared his own fate.

Maximilian's rule was short but primarily for reasons disassociated with Mexican internal affairs. In view of the Monroe Doctrine, the realization of Napoleon's dream and Maximilian's tenure alike depended on the triumph of the Southern Confederacy. With the Union triumphant in 1865, the Secretary of State, Seward delivered an ultimatum to Napoleon that wrung from him early in 1866 a promise to withdraw his soldiers from Mexico. Other factors contributed to influence Napoleon to yield: the anticipated commercial returns from the Mexican venture had not materialized and the French tax-payers loudly protested against its cost; at the same time Bismarck's aggressions against Austria caused Napoleon to desire to have his troops at home. In desperation Maximilian vainly attempted to placate estranged Clericals; then his wife, Charlotte of Belgium undertook to dissuade Napoleon from withdrawing his support. Finding Napoleon obdurate and the pope, to whom she appealed, unable to aid her, she became permanently insane, dying in 1927. With the last of the French troops withdrawn early in 1867, Maximilian's downfall was hastened. Díaz pushed north to Mexico City while the forces of Juárez besieged Maximilian in Querétaro. There, betrayed as he was attempting to flee, Maximilian was captured (May 15, 1867). He was court-martialled and executed on June 19, 1867.

Juárez President.—The downfall of Maximilian made possible the definite establishment of a republican and federal form of government in Mexico; notwithstanding, political stability was longer deferred. Juárez was re-elected in 1867, but his proposal for an extra-legal amending of the Constitution met with popular disapproval; and his reduction of the army aroused discontent among the soldiery. A crop of revolutions followed, but after a partial restoration of order, a general amnesty was decreed (Oct. 13, 1870). A claims convention was signed with the United States (July 4, 1868) and friendly relations were resumed with some European nations. When Juárez stood for re-election in 1871, he was accused of seeking to make himself dictator, and when, after an indecisive election, Congress declared him president, one of the defeated candidates, Díaz, appealed to arms. His revolution was unpopular and had been virtually suppressed when the sudden death of Juárez removed its chief *raison d'être* (July 18, 1872). Sebastián Lerdo de Tejada, as president *ad interim*, granted general amnesty and called a special presidential election, in which he overwhelmingly defeated Díaz. During his administration, commendable progress in suppressing banditry was made, the Veracruz-Mexico railroad was opened, the Juárez measures disendowing the church and separating it from the State were incorporated in the Constitution, and diplomatic relations were renewed with France and Spain. Trouble developed in 1876 when the Lerdists laid plans to control the elections of that year. Díaz again appealed to arms, declaring in the Plan de Palo Blanco for the sanctity of the Constitution and the principle of no re-election. Lerdo was declared re-elected, but was overthrown by Díaz, after a campaign of dramatic incidents that culminated in the battle of Tecoac (Nov. 16, 1876), and was forced into exile together with the dissenting president of the Supreme Court, Iglesias. After a short provisional term, Díaz was installed as president on May 5, 1877. The following year the Constitution was amended so as to prevent the re-election of executives.

Díaz President.—Except for the term of González (1880–84), Díaz was president until 1911. He thus violated one of the fundamental bases of the Plan of Palo Blanco, but not without first having the Constitution conveniently amended. With Díaz a new era was unconsciously ushered in. In addition to political instability, economic progress had been slow. The number of rural holdings had only increased since 1810 from 14,382 to 19,500; there were only 430 m. of railroad in the country; financial conditions were deplorable. Social conditions had not been greatly changed. Eighty-five per cent of the population of 10,000,000 were Indian and Indian-like people. Only 350,000 children were in the public schools and fully 75% of the population was illiterate.

In marked contrast to the political instability of the past, the history of Mexico from 1876 to 1910 was almost void of politico-military strife. Díaz's policy was to keep down disorder; to centralize authority in his own hands; to foster railway development and economic progress—in large measure by attractive concessions to foreign capital; to develop native manufactures by protective tariffs; to introduce new industries; to promote forestry; to improve education—principally in urban centres; and, above all, to place the national credit on a sound basis. By 1910 most of these aims had been realized. Summary extra-legal executions of malefactors and political conspirators—notably a group of alleged conspirators in 1879—and the policing of the country by a unique and efficient rural gendarmerie contributed to the disappearance of the old revolutions. Also several formidable uprisings of Indians—as the Mayas in Yucatán and the Yaquis in Sonora—were suppressed with great severity. Centralization was effected by Díaz assuming the right to nominate either directly or indirectly, for all Federal, State and municipal offices; by his influence upon bills while being drafted and considered in Congress; and by the deference to his wishes of the members of the Supreme Court in all cases affecting the Government or political matters. Railroad mileage increased to more than 15,000 m. by 1910. Textile factories in 1910 numbered 135 and employed 33,000 hands. Mexico's foreign trade in 1910, totalling more than 450,000,000 pesos, was nearly ten times that of 1873; the modern harbour of Veracruz was finished in 1902; nearly a billion dollars of gold were mined between 1870 and 1909; in 1910 Mexico ranked second in the production of copper; the oil industry at the close of Díaz's

administration was a growing industry. The number of children in the public schools by 1906 had increased to 615,134, and, for the year 1910, in addition to State support, the Federal Government appropriated 7,000,000 pesos or 6¾% of its total budget, for education. In the realm of public finance notable progress was made. Foreign obligations were adjusted and refunded; the tariff was made protectionist; the monetary standard was changed from silver to gold; the hated tax on sales (*alcabala*) was abolished; the budget was balanced, reserves created and new loans effected.

Finally, Díaz, through his conduct of foreign relations, had raised Mexico to a proud position among the nations. In 1877 only six and in 1910 no fewer than 42 foreign Governments had representatives in Mexico. Early relations between Díaz and the United States were strained, due to the temporary refusal of the United States to accord recognition and to border disturbances. These differences were satisfactorily adjusted and after 1888 disputes with the United States were transient. A crisis with Guatemala over the boundary was averted in 1895. The same year, in the difficulty between the United States and England over the Venezuelan boundary, Díaz expressed strong adherence to the Monroe Doctrine in principle, and suggested that its maintenance should be undertaken by all American Powers. In 1906 and 1907 Díaz co-operated with President Roosevelt in mediating successfully between Central American belligerents and took part in the establishment of the Central American Court of Justice. The second Pan American Congress met in Mexico City in 1901.

Successful and beneficent as had been some of the policies of Díaz, others had been reactionary and prejudicial to the best interests of the country. Particularly disastrous in their effect were the land policies of Díaz. A presidential decree in 1890 expropriated and allotted in severalty the theretofore inalienable tillable lands of the villages known as *ejidos*—or communal lands which had long constituted the principal means of independent support of the majority of the sedentary Mexican Indians. The reactionary land law of 1894 legalized the squandering within a few years of a vast national domain. The combined effect of the above-cited decree and law was highly favourable to the landed aristocracy and unfortunate to the masses. By 1910 a total of 96·9% of the rural heads of families owned no real property. Of that in the possession of the other 3·1% was owned by fewer than 1,000 powerful landholders whose estates varied in size up to 6,000,000 acres. Furthermore, approximately 10,000,000 Indians (probably three-fifths of the population), in addition to losing their communal lands, had become serfs. In short, the condition of the masses in 1910 was even more deplorable than it had ever been. Under such conditions Mexico's third great socio-economic upheaval was inevitable and at hand. Other errors of Díaz may be briefly described. Rural education was almost completely ignored. The reform laws were not observed. The church made a partial economic and political recovery, living a precarious existence by executive clemency. Foreign concessionaires were so favoured that national resentment was deeply stirred. An historic principle that had been followed continuously during the colonial and national periods down to 1884 was reversed and by the mining laws of that year, 1892, and 1909, surface owners were given the right, without governmental approval, to exploit subsoil deposits which formerly had belonged first to the king and later to the nation. Finally, the Díaz Government had become a closed political corporation, although there were many who were qualified for participation in governmental affairs.

Revolution of 1910.—Political discontent finally culminated in armed rebellion, and this, in turn, was the occasion for a general upheaval. Díaz's announcement in 1908 that he would welcome opposition in the next campaign was the inspiration of Francisco I. Madero to initiate a political crusade in which he condemned presidential succession and demanded effective suffrage. Madero was nominated by the anti-re-electionists, but was arrested for sedition in June 1910. Escaping to Texas he issued a plan which, in addition to his original proposals for political reforms, included a demand for agrarian reforms. The incorporation of this plank caught the ear of the downtrodden masses who promptly gave Madero their support upon his return to Mexico. Henceforth the aims of the revolution were chiefly socio-economic and not political in character. Díaz attempted to suppress the revolution by force, but failing resorted to promises and belated reforms. These likewise were futile, and he resigned on May 25, 1911, and soon left Mexico forever.

After a short provisional presidency, Madero was inaugurated as constitutional president on Nov. 6, 1911. His administration was characterized by weakness and blunders. When he made concessions to the old Díaz party he lost the support of those who had rebelled to secure political reforms; when he did nothing to achieve agrarian reforms, he aroused the active antagonism of the masses. Rebellions flared up, resulting in chaotic conditions by 1912. President Taft prohibited the shipment of arms to Madero's opponents and advised Americans to leave Mexico.

A Conservative counter-revolution, headed by Victoriano Huerta, met with success in Feb. 1913. The forced resignations of President Madero and Vice President Suárez on Feb. 19, enabled Huerta to seize executive power through constitutional forms. Three days later Madero and Suárez were executed. Huerta, however, faced insuperable obstacles. President Wilson refused to recognize him because of his usurpation of authority and because of holding him responsible for the political executions. From within he was opposed by the disappointed masses, led by Carranza, Villa and Zapata, who had joined the revolution to obtain social and agrarian reforms. They were aided indirectly by the troubles of Huerta with the United States. At Tampico an affront to an American naval officer prompted an official demand that the United States flag be saluted. Huerta's refusal was followed by the American seizure of Veracruz (April 21, 1914). Huerta had already been embarrassed by the mission of John Lind, who had been sent to Mexico by President Wilson to induce him to assent to his own elimination, and the seizure of Veracruz led to the severance of diplomatic relations with the United States. Argentina, Brazil and Chile proffered their good offices, which were accepted, but the Niagara Falls Conference that followed failed to agree on a provisional president. Huerta was finally forced to resign on July 14, 1914.

Carranza President.—Between the revolutionary leaders who co-operated to overthrow Huerta, a dreary and sanguinary civil war developed which produced a flock of presidential pretenders and further delayed much-needed agrarian reforms. These came finally in a provisional decree issued by Carranza on Jan 6, 1915. It provided, where practicable, for the restitution to villages of *ejidos* illegally alienated in the past and for the expropriation of lands necessary to endow with *ejidos* other villages in need of them. The effect of this, the first constructive act of the revolution, was the crystallization of revolutionary sentiment in support of Carranza which, in turn, won for him the recognition of the United States and eight associated Latin-American republics as *de facto* president of Mexico. This success piqued Villa, who, in a deliberate attempt to involve Carranza in international difficulties, perpetrated the massacre of 18 American miners at Santa Isabel (Jan. 10, 1916) and the raid on Columbus, New Mexico (March 9), in which 17 Americans were killed. The Pershing punitive expedition of 12,000 troops immediately but ineffectually pursued Villa far into northern Mexico, much to the embarrassment of Carranza. The American expedition was finally withdrawn (Feb. 5, 1917) but not before it had been attacked by Carranza's forces, at which time several Americans were killed and a score captured (June 21, 1916). Meanwhile, the success of Carranza made possible the crystallization of other revolutionary aims less urgent than those relating to agrarian reforms. Accordingly, when a constituent assembly at Querétaro drafted a new Constitution early in 1917, it not only incorporated substantially the Carranza provisional decree of 1915, but made provision for the realization of the less urgent revolutionary aims, namely, the return to the national ownership of subsoil deposits, the limitation of the acquisition of agricultural property by foreigners, and the effecting of reforms similar in principle to the reform laws of Juárez and Lerdo de Tejada.

Carranza's administration as first president under the new Constitution was disappointing. Little was realized in the way of

effective agrarian reforms. Decrees, charged with being confiscatory in character, by which Carranza sought to enforce the constitutional provisions relating to the national ownership of subsoil deposits in which foreigners were interested, involved him in diplomatic controversies with foreign powers. In the United States intervention was loudly demanded, danger of which was augmented prior to the close of the World War by Carranza's anti-American and pro-German attitude. Finally, through threats of curtailing production, the petroleum companies forced Carranza (Jan. 1920) to suspend his objectionable decrees, but without prejudice to the final adjudication of the dispute. During 1919 Carranza's hold on the country weakened. Rebel activities were wide-spread, corruption prevailed in the army and banditry was general. This situation, together with the non-enforcement of the Constitution and the avowed intention of Carranza, in conformity with his pledge, to impose a civilian, I. Bonillas, as his successor in the presidency, inspired an armed rebellion that was soon dominated by the so-called Sonora triumvirate, composed of De la Huerta, Obregón and Calles. The rebel movement got under way in Sonora early in April 1920 and on May 8 Obregón entered Mexico City on the heels of the fleeing Carranza who was assassinated 13 days later. Following De la Huerta's provisional presidency, Obregón was installed Dec. 1, 1920.

Administration of Obregón, 1920–24.—The many aims of the revolution began effectively to be realized during Obregón's administration. The prompt application of the agrarian laws enabled the Government to re-establish peace throughout the country. Supreme Court decisions upholding some of the contentions of the petroleum companies stimulated their activities and in 1921 production reached the record-breaking total of 193,397,587 barrels. Efforts to refund the Mexican debt which were begun in 1921 were successful in June 1922. Mexico assumed full obligation for the $500,000,000 principal of the debt, the $200,000,000 of defaulted interest, and certain internal debts, and agreed to resume service on the debt, beginning Jan. 1, 1923. The debt agreement was temporarily suspended on July 1, 1924. Education was encouraged among the rural classes, largely Indians, for whom 960 schools were built, many of them large, conspicuous buildings. One of the outstanding events of 1923 was the expulsion of the papal delegate, Mgr. Filippi, whose permission to conduct open air religious exercises, granted by the State authorities of Guanajuato, was not recognized by the Federal Government. The Vatican and Catholic organizations in general protested against this action. An exciting presidential campaign followed late in 1923 and when Obregón threw his support to Calles, De la Huerta and his followers rebelled. Their initial successes menaced the Government and Obregón took the field and conducted a campaign on three fronts. Material and moral aid from the U.S. enabled Obregón to triumph, after which Calles was elected president and inaugurated on Dec. 1, 1924.

The agrarian and petroleum policies of the Obregón Government were responsible for strained relations with the United States. Secretary of State Hughes, who was interested in the general problem of protecting American property rights in Mexico, first endeavoured to negotiate with Obregón a treaty of amity and commerce that would adequately guarantee such protection. Failing in this, Charles B. Warren and John B. Payne, as members of a joint commission, were sent to Mexico with instructions to secure the restoration or proper reparation for the taking of lands owned by Americans, to obtain satisfactory assurances against confiscation of subsoil interests owned by Americans prior to the promulgation of the Constitution on May 1, 1917, and to negotiate appropriate claims conventions. Hughes wished also to raise the question of religious liberty in Mexico; this issue was dropped, by the wish of Mexico, as a purely domestic concern. The joint commission (in session from May 14 to Aug. 15, 1923) reached satisfactory understandings on the most important questions at issue. Under certain conditions American owners of lands expropriated by the Mexican Government for *ejidos* for villages were obligated to accept 20 year 5% bonds for a maximum of 1755 hectares and a just value, paid in cash, for any excess taken. At the same time the Mexican Government recognized the unqualified right of owners who were U.S. citizens, and had suffered losses or damage because of acts resulting in injustice in carrying out the agrarian policy of the Mexican Government, to have recourse to a general claims commission. On the theory that the mining laws of the Díaz régime, through the reversal of an historic principle, had in reality conferred a gift of the subsoil on surface owners, and on the argument that under Napoleonic and Mexican law a gift was not a gift until the donee had performed some positive act indicative of his intention to accept the gift, the Mexican Government recognized the right to the subsoil of all surface owners who, before May 1, 1917, had performed some positive act indicating their intention to exploit the deposits beneath their surface lands. It refused, however, to do more than grant preferential rights to the oil in the subsoil to surface owners who before May 1, 1917, had not performed the afore-described positive act. Nevertheless, because the U.S. Government refused to admit the above distinction, the Mexican Government recognized the former's right "to make any reservation of or in behalf of its citizens." On the basis of the above understandings, as mutually approved by Presidents Obregón and Coolidge, the Obregón Government was recognized by that of the United States on Aug. 31, 1923. A special claims commission whose report was signed on Sept. 10, provided for the adjudication of all claims against Mexico of citizens of the United States suffered "through revolutionary acts" between Nov. 20, 1910, and May 31, 1920 A general claims convention signed on Sept. 8, provided for the adjudication of all other claims of the citizens of either country that originated between July 4, 1868, and the date of the termination of the commission. Obregón had the support of the Agrarians.

President Calles, who was a strong supporter of the programme of 1917, came into power pledged to maintain order, to practice economy, and to promote the economic and social welfare of the Mexican people. He was supported by the Labour Party. A heavy hand was promptly laid on trouble makers, but the programme of economic and social development was impeded by the deplorable financial condition of the Government and by its inability to obtain a loan. Accordingly, President Calles adopted a drastic policy of retrenchment, and in less than eight months an actual saving of over 60,000,000 pesos had been effected. In Oct. 1925 the debt agreement of 1922 was modified to Mexico's advantage—chiefly by the separation of the debt of the national railways, which were returned to private ownership, from the national debt—and arrangements were made for the resumption of interest payments beginning Jan. 1, 1926. Toward labour, which had steadily grown more aggressive and radical, President Calles adopted a firm attitude. The railway service was federalized, thereby reducing the likelihood of strikes, and in the spring of 1925 presidential action prevented a national sympathetic strike called by the Tampico Federation of Labour Unions. Upon the recommendation of President Calles the Mexican Congress, in Dec. 1925, passed the alien land and petroleum laws. The first was an enabling act designed to put into operation the theretofore unfulfilled constitutional provisions relating to the limitation of the acquisition by foreigners of agricultural land in Mexico; the second law was designed to put into operation by legislative action, as opposed to presidential decrees, the constitutional provisions relating to the national ownership of subsoil deposits. Early in Jan. 1926, just as a spirited diplomatic controversy with the United States concerning these laws reached an apparent crisis, the Mexican Catholic episcopate took a positive stand against the theretofore almost wholly unenforced religious and educational provisions of the Constitution and thus precipitated a conflict between church and State. An apostolic letter of Pope Pius XI. (Feb. 2, 1926) which voiced sympathy for the Mexican clergy because of the "wicked . . . regulations and laws . . . against the Catholic citizens of Mexico," intensified the uncompromising attitude of both the Government and the episcopate. The conflict reached a crisis on July 31, at which time the clergy, in preference to submitting to an executive decree designed to enforce the religious and educational provisions of the Constitution, which they regarded as imposing impossible conditions for the practice of their ministry, withdrew from the churches, and thus suspended reli-

gious exercises requiring the services of priests. The Government maintained its position. Churches, as well as all other church property, which had been nationalized, were taken in charge by Government agents, but the churches in most cases were kept open for individual worship. The Government expressed a willingness to transfer the custody of the churches to the clergy if they agreed to recognize the law. Opposition to the law resulted in several outbreaks, which were suppressed. In addition, many members of the episcopate were deported (since April 1927) on the ground that they had encouraged the Catholic uprisings.

Despite international and internal troubles the Calles Government made notable progress in developing irrigation projects, in building roads and in promoting education, particularly among the rural classes. In 1926 a total of 46,000,000 pesos was spent on education. This sum was equivalent to 8½% of the Federal budget plus about 40% of the total budgets of all the States. A politico-military rebellion late in 1927, headed by two presidential candidates, Generals Gómez and Serrano, was suppressed with rigour.

The alien land and petroleum laws were vigorously protested against by the U.S. Government, chiefly because of their alleged retroactive and confiscatory character. The controversy apparently reached a crisis with the official promulgation of both laws early in 1926. The diplomatic exchanges yielded no agreements but the tension was relieved in March. At that time, Secretary of State Kellogg, in answer to various questions concerning the proposed application of specific provisions of the alien land law, received apparently satisfactory replies from the Mexican Government; at the same time Kellogg apparently indicated a willingness to be content with the petroleum law provided American owners who had performed an above-described positive act before May 1, 1917, were confirmed in their rights to the subsoil. The second phase of the diplomatic controversy was opened by Kellogg on July 31, 1926. Vigorous complaints against specific provisions of both land and petroleum laws were made and when the Mexican replies showed that the two Governments differed fundamentally on all specific points raised by Kellogg, the United States in a virtual ultimatum (Oct. 30) warned Mexico not to deprive American owners in Mexico of any of their property rights. The Mexican Government countered by requesting that violations of recognized principles of international law be indicated. Since then neither law has been the subject of public diplomatic representations. The petroleum law in theory went into effect on Jan. 1, and the alien land law on Jan. 21, 1927. The latter, apparently, was quite generally accepted by aliens in Mexico. Articles 14 and 15 of the petroleum law, which were among those vigorously protested against by Kellogg, required owners of the surface who acquired their titles prior to May 1, 1917, to exchange them for "confirmatory concessions," good for 50 years, and, under certain conditions, renewable. Property of owners not complying with the law before Jan. 1, 1927, was to revert to the Mexican nation. On the latter date, however, the Mexican Government made no move to take over such property, and, instead, merely cancelled drilling permits of non-conforming companies on the ground that they had not complied with articles 14 and 15. This made possible a test of the constitutionality of the two articles, and a decision of the Mexican Supreme Court (Nov. 17, 1927) declared that they were unconstitutional. The decision was at once accepted by the Mexican Government and before adjournment in December the Mexican Congress re-enacted the petroleum law with the two controverted articles amended so as to conform with the Supreme Court decision. Authorized executive regulations governing the new law promptly met with the approval of the United States Government when they were issued on March 27, 1928. Thus two, but only two, of the various provisions of the law that are objectionable to the American interests upheld by Kellogg have been eliminated by the Supreme Court decision. Relations between the United States and Mexico have shown marked improvement since the arrival (Oct. 1927) of Dwight W. Morrow as United States Ambassador to Mexico. The mainsprings of his diplomacy have been respect for Mexican sovereignty and personal contacts designed to show interest in and respect for the Mexican people and their Government.

On July 17, 1928, President-elect Obregón was assassinated by a fanatic, José de León Toral. At the special session of the Mexican Congress, on Sept. 1, President Calles declared that he would not again seek election. The Congress elected Emilio Portes Gil, secretary of the interior, provisional president, who took office on Dec. 1, 1928.

On Mar. 3, 1929 a concerted revolutionary *coup d' état* broke out in Vera Cruz and in the northern States, engineered by military and civil leaders, professing themselves loyal to the memory of Obregon but not in sympathy with Calles or Portes Gil. Calles was immediately appointed Secretary of War and took control of operations. Within a week the revolt in Vera Cruz collapsed and, the rebel power was broken at the battles of Jimenez and La Reforma. Pascual Ortiz Rubio was elected President of Mexico in Nov. 1929; he visited the United States in December, and, returning to Mexico, was inaugurated on February 5, 1930.

Bibliography.—For English readers the standard work is still H. H. Bancroft, *History of Mexico, 1516–1887* (San Francisco, 1883–88), and supplementary histories. The best one-volume history of Mexico in English is H. I. Priestley, *The Mexican Nation, A History* (New York, 1923). Standard Mexican authorities are: Lucas Alamán, *Historia de Méjico* (Mexico, 1849–52) I. Álvarez, *Estudios sobre la historia general de México* . . . (Zacatecas, 1875–77); V. Riva Palacio, ed., *México á través de los siglos* (Barcelona, 1888–89); N. de Zamacois, *Historia de Méjico desde sus tiempos mas remotos* . . . (Mexico, 1876–82). Important documents relating to the Colonial period, the struggle for independence and the French intervention are found in *Documentos inéditos ó muy raros para la historia de México* . . . (Mexico, 1905–11), published under the editorship of Genaro García and Carlos Pereyra. A large and informative illustrated work, edited by Justo Sierra, sumptuously produced but inadequately translated, is *Mexico, its Social Evolution* (Barcelona, 1900–04). For colonial institutions and administration *see* G. Desdevises du Desert, *L'Espagne de l'Ancien Régime: les Institutions* (Paris, 1899); Juan de Solórzano y Pereyra, *Politica Indiana* (Madrid, 1629–39, 1776); L. S. Fisher, *Viceregal Administration in the Spanish-American Colonies* (Berkeley, 1926); and Alexander von Humboldt, *Essai politique sur le royaume de la Nouvelle Espagne* (Paris, 1811; English trans., New York, 1811).

H. G. Ward's *Mexico* (London, 1829) is excellent for the history and description of Mexico during the first decade after independence. For Mexico just before the war with the United States, *see* Mme. Calderón de la Barca, *Life in Mexico* (Boston, 1843); and W. Thompson, *Recollections of Mexico* (New York, 1847). For the war with the United States the standard authority is J. H. Smith, *The War with Mexico* (New York, 1919). A valuable study of the liberal movement during its early stages is W. H. Callcott, *Church and State in Mexico, 1822–1857* (Durham, 1926). For Maximilian, the Bluebooks on Mexican affairs contained in *Accounts and Papers* (presented to parliament), vol. lxv. (1862) and vol. lxiv. (1863) are valuable; E. de Kératry, *La Créance Jecker; l'empereur Maximilien son élévation et sa chute* (Eng. trans. by Venables); *La Contre-guérilla française au Mexique*, are especially noteworthy; Prince Felix Salm-Salm's *Diary* gives valuable information as to Maximilian's decline and fall. Also J. F. Domenech, *L'Empire mexicain* (Mexico, 1866), and *Le Mexique tel qu'il est* (Paris, 1867); Daran, *El General Miguel Miramón* (Rome, 1886). For a recent scholarly study *see* J. Musser, *The Establishment of Maximilian's Empire in Mexico* (Menasha, 1918). *See* also F. Bulnes, *El verdadero Juárez* (Mexico, 1904) and G. García, *Juárez; refutación . . . a Bulnes* (Mexico, 1904). For an impartial and well-written account of the Díaz régime *see* D. Hannay, *Díaz* (New York, 1917).

For the background of the socio-economic upheaval that began in 1910 *see* H. Phipps, *Some Aspects of the Agrarian Question in Mexico* (Austin, 1925); G. M. McBride, *The Land Systems of Mexico* (New York, 1923); A. Molina Enríquez, *Los grandes problemas nacionales* (Mexico, 1909); F. González Roa, *Las cuestiones fundamentales de actualidad en Mexico* (Mexico, 1927). For events in Mexico since 1910 the following works are useful: H. Baerlein, *Mexico, the Land of Unrest* (Philadelphia, 1913); M. Márques Sterling, *Los últimos dias del Presidente Madero* (Havana, 1917); E. L. Bell, *The Political Shame of Mexico* (New York, 1914); L. Gutiérrez de Lara and E. Pinchón, *The Mexican People; their Struggle for Freedom* (Garden City, 1914); E. O'Shaughnessy, *A Diplomat's Wife in Mexico* (New York, 1916); E. D. Trowbridge, *Mexico To-day and To-morrow* (New York, 1919); S. G. Inman, *Intervention in Mexico* (New York, 1919); G. H. Blakeslee, ed., *Mexico and the Caribbean* (New York, 1920); Wallace Thompson, *The People of Mexico* (New York, 1921); C. L. Jones, *Mexico and its Reconstruction* (New York, 1921); C. Beals, *Mexico—an Interpretation* (New York, 1923); E. A. Ross, *The Social Revolution in Mexico* (New York, 1923); M. Sáenz and H. I. Priestley, *Some Mexican Problems* (Chicago, 1926).

For the early Constitutions of the republic *see* I. A. Montiel y Duarte, *Derecho público mexicano* . . . (Mexico, 1871–82). A study of the Constitution of 1857 by B. Moses is in the *Annals of the Ameri-*

can Academy of Political Science II., i. (1891). An English translation of the Constitution of 1917 by H. N. Branch, published in parallel columns with that of 1857, is in a supplement to the *Annals* of the same academy, published in Philadelphia (May, 1917). For diplomatic relations between Mexico and the United States *see* W. R. Manning, *Early Diplomatic Relations between the United States and Mexico* (Baltimore, 1916); G. L. Rives, *The United States and Mexico, 1821–1848* (New York, 1926); J. F. Rippy, *The United States and Mexico* (New York, 1926); C. W. Hackett, *The Mexican Revolution and the United States, 1910–1926* (Boston, 1926; World Peace Foundation Pamphlet, vol. ix., no. 5); W. Lippman, "Vested Rights and Nationalism in Latin America," *Foreign Affairs* (New York, April 1927); J. P. Bullington, "Problems of International Law in the Mexican Constitution of 1917," *American Journal of International Law* (Oct. 1927) and "The Land and Petroleum Laws of Mexico," (*ibid.*, Jan. 1928); Ernest Gruening, *Mexico and Its Heritage* (1928). (C. W. H.)

MEXICO, a central plateau State of the Republic of Mexico. Pop. (1921) 884,617, largely Indian. Area, 8,262 sq. miles. Enclosed within its boundaries, except on the south, is the Federal District and capital city of Mexico with an area of 572·5 sq. m., which is not included in that of the State. The State is divided into two unequal parts by the Sierra de Ajusco and Montes de las Cruces, which form a wooded ridge across it from east to west, with a general elevation of about 10,000 ft. above sea-level, or about 2,500 above the plateau level.

A considerable part of the northern section of the State consists of the Valley of Mexico, a nearly circular flat-floored basin, once the bed of a great lake but now covered with swamps, sodden meadows and small lakes. The surrounding country drains into this depression, but an artificial outlet has been created by the opening of the Tequixquiac tunnel. Beyond its margin the plateau drains west to the Pacific through the Lerma, and north-east to the Gulf through the San Juan and Pánuco. South of the Sierra de Ajusco the country is roughly mountainous and drains to the Pacific through tributaries of the Balsas. Within the depression of the north are the lakes of Zumpango, San Cristóbal, Xaltocán, Chalco, Xochimilco and Texcoco, the last-named three lying partly or wholly in the Federal District. Texcoco has the lowest level and its water is brackish and undrinkable, though that of the streams flowing into it and of the other lakes is fresh. Lake Xochimilco is celebrated for its "floating gardens" or *chinampas* (*see* MEXICO, FEDERAL DISTRICT OF). The principal industries of the State are mining and agriculture. The principal agricultural products are cereals, sugar, *maguey* (from which "pulque" is made), coffee and fruit. In recent years the mining of gold and silver has taken high rank, particularly in the district of El Oro in the western part of the State. Stock-raising has also had a profitable development, owing to the proximity of the national capital. The manufacturing industries are important; among the manufactures are cotton and woollen fabrics, flour, dairy products, glass-ware, pottery, bricks, wines and spirits. The making of "pulque" is one of the chief industries of the State, and the product is sent in large quantities to the national capital. The State is traversed by the Central, National, Mexican International and Interoceanic railways, and by short lines from the national capital to neighbouring towns. The capital is Toluca, and other important towns are El Oro de Hidalgo (pop. 14,804 in 1921); Amecameca de Juárez (pop. 6,974 in 1921); Zumpango (pop. 5,405 in 1921), 30 m. N. of the national capital; and Tenango del Valle (5,824 in 1921), 15 m. S.E. of Toluca.

MEXICO, FEDERAL DISTRICT OF, a territory set apart for the independent and exclusive use of the Mexican Federal Government, occupying the south-eastern part of the Valley of Mexico, and taken from and lying within the State of Mexico, which forms its boundaries on all sides except the south where it touches the State of Morelos. Pop. (1921) 906,063, largely Indian; area, 572·5 sq. miles. The district is very irregular in outline, its greatest length (north-west to south-east) being 30 m., and its greatest breadth 25 miles. It is divided into 13 municipalities, México, Guadalupe-Hidalgo, Atzcapotzalco, Tacuba, Tacubaya, Mixcoac, Cuajimalpa, San Angel, Coyoacán, Tlálpam, Xochimilco, Milpa Alta, Ixtapalapa, General Anaya and Ixtalco; the first of these comprises the national capital and its immediate suburbs, and the other 12 the unequal divisions of the district with a considerable number of towns and villages. Indians and half-breeds form more than one-half of the rural population being engaged in agriculture, gardening, manufacturing and trade. The government of the district is exercised by the national executive in accordance with the organic law of 1903, though some measure of popular government is vested in municipal councils (*ayuntamientos*) elected by popular vote for terms of four years. The administrative officers, who are appointed by the national executive, consist of a governor of the Federal District, the director-general of public works and the president of the superior board of health. The governor represents the national Government, and has special charge of the fire and police departments, prisons, imposition of penalties for violation of ordinances, public diversions and festivities, civil registry, street traffic, inspection of weights and measures, and the sale of intoxicating liquors. The director-general of public works has special charge of the water supply, streets and roads, parks, monuments, public lighting, drainage, street cleaning, public buildings not under Federal control, cemeteries, slaughter-houses and markets, building operations and all municipal or communal property. The president of the superior board of health has charge of all sanitary works, general sanitary inspection, the sanitary administration of markets, slaughter-houses and cemeteries, and the introduction of meats from other localities. The government of the district is copied, in part, from that of the District of Columbia in the United States, but its citizens are not disfranchised.

The principal towns of the district are merely suburbs of the capital. Within the municipal limits of Mexico City are Chapultepec, Santa Anita and the hot springs of El Peñón, which are popular suburban resorts easily reached by the ordinary urban tramway service. Chapultepec (Grasshopper Hill) is an isolated rock nearly 200 ft. high surrounded by a beautiful park and surmounted by a fortified structure called the "Castle," containing the summer residence of the president. A finely graded road leads to the summit. The park contains a grove of old cypress trees (*Taxodium distichum*, called "ahuehuetes" by the natives), one of which is 45 ft. in circumference and nearly 200 ft. high. The hill is nearly 3 m. south-west of the centre of the city and once commanded one of its principal causeway approaches. It was assaulted and captured by the American forces under Gen. Winfield Scott on Sept. 13, 1847, after a stubborn resistance. A monument to the cadets of the military school who died in this battle stands in the park. The castle, which was planned by the viceroys, was built and decorated by the Emperor Maximilian, who planned for it the drive known as the Paseo de la Reforma. Guadalupe or Guadalupe-Hidalgo (pop. 11,473 in 1921), 2½ m. north by east from the plaza of Mexico City, near the shore of Lake Texcoco, is chiefly known for its shrine to Our Lady of Guadalupe, who is said to have appeared there to the Indian Juan Diego in 1531. The shrine stands on the principal plaza and is visited by many thousands of pilgrims during the year, whose pious contributions have so enriched the church that its sacred vessels, altar-rails, candelabra and other accessories are estimated to contain 50 tons of silver. The treaty of peace between Mexico and the United States was signed here Feb. 2, 1848. Tacubaya (pop. 54,775 in 1921), about 5 m. west-south-west of the plaza, is noted for its old residences and beautiful gardens. The National Astronomical observatory occupies a modern edifice. At Popotla, now well within the city of Mexico, is an aged tree under which, according to tradition, Cortés sat and wept after his terrible retreat from the Aztec capital on the *noche triste*. Farther south, on the lowest slopes of the mountain range are San Angel, Coyoacán and Tlálpam, favourite country residences of the richer citizens. Xochimilco (field of flowers) (pop. 8,936 in 1921), on the west shore of the lake of that name and 10 m. south by east of the city, is an Indian town dating long before the discovery of America.

MEXICO, a city of Missouri, U.S.A., 110 m. N.W. of Saint Louis; the county seat of Audrain county. It is on Federal highway 54, and is served by the Burlington Route, the Chicago and Alton and the Wabash railways. Pop. 6,013 in 1920 (15% negroes); 8,290, 1930 by Federal census. It is in the blue-grass region of the State, which produces especially horses and mules, grain, hay, cattle and hogs. The city has large deposits of high-

grade fire-clay. It manufactures shoes, flour, fire-brick and stove-linings; and is the seat of Hardin college for girls (Baptist, 1873).

MEXICO, GULF OF, a mediterranean gulf almost surrounded by the coasts of the United States and Mexico, and forming the northern division of the extension westward of the west Atlantic trench (*see* ATLANTIC OCEAN). Its southern boundary is defined by the partly submerged ridge which extends eastwards from the peninsula of Yucatán, and on which the island of Cuba is situated; to the east it communicates directly with the Atlantic by the Strait of Florida. On the western side of Yucatán a southerly embayment is formed by the Gulf of Campeachy. The U. S. coast closely follows the parallel of 30° N., while the parallel of 20° N. cuts across the Gulf of Campeachy; the greatest length—Veracruz to Florida—is 1,120m., and greatest width—Galveston to Campeachy—680 miles. The total area is approximately 716,000sq. miles.

The deepest part of the Gulf of Mexico, the so-called Sigsbee deep, lies below the line of 2,000 fathoms, between 23° and 25½° N., and 84½° to 95° W. It is widest to the west, where the breadth is about 120m., and narrows to 25m. at its greatest depth (2,119 fathoms) between 86° and 88° W., widening again to some 80m. farther eastward. The continental shelf is for the most part narrow; its breadth is 6m. at Cape Florida, 120m. along the west coast of Florida, 10m. at the southern pass of the Mississippi, 130m. near the boundary of Texas and Louisiana, and 15m. off Veracruz. The shores are low, sandy, and marshy, the coast-line being frequently doubled by lagoons. There are no islands except the "Keys" of Florida and Yucatán, and Cuba.

The tides in the Gulf of Mexico are of comparatively small range (springs rarely exceed 4ft. and neaps 2½ft.), but a remarkable feature is the exaggeration of the diurnal inequality to such an extent as almost to extinguish the semi-diurnal tide in the inner parts of the gulf, giving high and low water only once daily. The mean level of the water in the Gulf of Mexico was formerly given as about 40in. above that of mean sea-level at New York, but later reports on precise levellings from New York to Biloxi through St. Louis describe it vaguely as "somewhat higher." The current movement in the Gulf of Mexico consists of a rotational movement in the direction of the hands of a watch, the branch of the equatorial current which enters the Caribbean sea passing into the gulf by the Strait of Yucatán and issuing from it by the Strait of Florida as the Gulf Stream.

From March to September the prevailing winds are the north-east trades; these undergo considerable modification on account of the configuration of the surrounding land, and the rains which accompany them are interrupted by spells of calm thick weather, and rarely by northerly winds known as *Nortes del hueso colorado* and *Chocolateros*. In the colder dry season, from October to April, the climatic situation is dominated by the relatively high temperature of the surface of the gulf, causing a cyclonic inflow of air which is associated with the strong northerly winds or "northers" prevailing on the western side, more particularly along the Mexican coast. The northers sometimes blow with terrific force and are at times accompanied by rain. The form and position of the Gulf of Mexico exercise a profound influence on the climate of the United States. (H. N. D.)

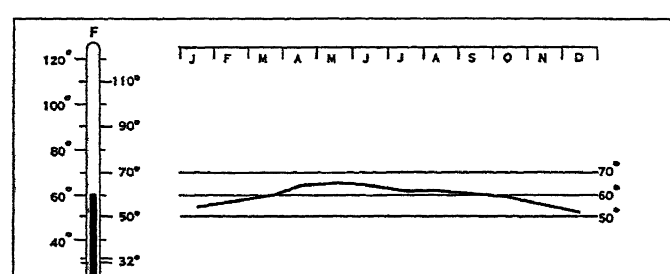
MEXICO CITY, capital and metropolis of the Republic of Mexico, and chief town of the Federal District, near the southern margin of the great central plateau of Mexico, in lat. 19° 25′ 45″ N., long. 99° 7′ W. It is about 200 m. in a direct line W. by N. of Veracruz, its nearest port on the Gulf of Mexico, with which it is connected by two railway lines, one of which is 264 m. long; and about 181 m. in a direct line N.N.E. of Acapulco, its nearest port on the Pacific, with which it is connected partly by rail and partly by a motor road. The city had a population of 615,367 at the census of 1921 (271,956 males and 343,411 females), of whom 23,668 were foreign-born; estimate for 1924, 880,000. The majority of the inhabitants is composed of Indians and mestizos, from whom come the factory workers, labourers, servants, porters and other wage-earners. The foreign population includes many capitalists and industrial managers, who are doing much to develop the country, the large American colony being concentrated in a fine modern residential district in the south-west.

The city stands on a small plain occupying the south-western part of a large lacustrine depression known as the Valley of Mexico (*El Valle de México*), about 3 m. from the western shore of Lake Texcoco, whose waters once covered a considerable part of the ground now occupied by the city. The valley, including the drainage basin of Lake Zumpango, has an area of 2,219 sq.m. (1,627 sq.m. without that basin). The elevation of the city above sea-level is 7,415 ft., only a few feet above the level of Lake Texcoco. The general elevation of the valley is about 7,500 ft., that of Lake Zumpango being 7,493 ft., and of Lake Chalco 7,480 feet. The rim of the valley is formed by spurs of the cordillera on all sides—the Sierra de Guadalupe (650 to 750 ft. above the city) on the north, the Sierra Nevada, with its snow-clad peaks of Popocatépetl and Ixtaccíhuatl farther away to the south-east, the Sierra de Ajusco, and the Montes de las Cruces bordering the depression on the south and west. Earthquake shocks are of frequent occurrence, but the city rarely suffers any material damage. The great earthquake shocks of July 30 and 31, 1909, however, caused considerable damage in the city, and a few lives were lost.

Lake Texcoco is a shallow body of brackish water, with area of about 11½ sq.m., and is fed by a number of small streams from the neighbouring mountains, and by the overflow of the other lakes. Its shores are swampy and desolate and show considerable belts of saline incrustations with the fall of its level. The Aztecs settled there because of the security afforded by its islands and shallow waters.

The Chalco and Xochimilco lakes, 8 or 9 m. to the southward, which are separated by a narrow ridge of land, are connected with the lower part of the city by an artificial canal called "La Viga," 16 m. long and 30 ft. wide, which serves as an outlet for the overflow of those lakes and as a waterway for the natives, who bring in flowers and vegetables for sale. Lake Xochimilco, celebrated for its *chinampas* or "floating gardens" (*see* MEXICO, FEDERAL DISTRICT OF), is supplied largely by fresh-water springs opening within the lake itself. Lake Chalco is greatly reduced in size by railway fillings and irrigation works.

Climate and Health.—The climate of the city is temperate, dry and healthy. The temperature ranges from a minimum of



WEATHER GRAPH OF MEXICO CITY. THE THERMOMETER INDICATES THE ANNUAL MEAN TEMPERATURE. THE CURVE SHOWS THE MONTHLY MEAN TEMPERATURE, AND THE COLUMN, THE NORMAL MONTHLY PRECIPITATION

about 35° F in winter, to a maximum of 79° in summer. The nights are always cool, and there is a marked difference between sun and shade. The year is divided into a wet and dry season, the former from April to September, the latter from October to March. The rainfall, however, is light, about 20 to 25 in., but, with the assistance of irrigation, it serves to sustain a considerable degree of cultivation in the neighbourhood of the city. The health of the city, unfortunately, does not correspond with its favourable climatic conditions. The death-rate has been notoriously high, though the completion of the valley drainage works in

1900, supplemented by underground sewers in the better parts of the city, by a more adequate water supply, and by better sanitation, have improved matters. The annual death-rate per 1,000 was 54 for the Federal district in the year 1901, 50 in 1902, 48 in 1903, 46 in 1904, and 56 in 1905; the increase for the last-mentioned year being due to an epidemic of typhus fever. During the year 1915 a disastrous epidemic of typhoid fever, that caused an appalling number of deaths, developed in the city, due to the neglect of public services brought about by the revolutionary disturbances, and within the next few years frequent recurrences of influenza raised the death-rate. The mortality during 1924 reached 57·40 per 1,000.

Streets and Plazas.—The city is laid out with almost unbroken regularity, and is compactly built. The newer and better residential sections are on the south-western side; the poorer districts are on the eastern side, nearer the swampy shores of Lake Texcoco. As the name of a street changes with almost every block, according to the old Spanish custom, a list of street names is sometimes mistakenly accepted as the number of continuous thoroughfares in the city, so that it has been said that Mexico has 600 to 900 streets and alleys.

Several new residential suburbs have been created by cutting up adjacent estates (*haciendas*) into building lots; many new modern streets have been cut, and old dirty squares have been transformed into neat flower-decked plazas. In 1923 the area of the city was about 15 sq.m., divided into eight sections (*cuarteles* or *demarcaciones*), and sub-divided into about 1,000 squares. There are over 200 m. of tramways, and tram service, furnished by an English company and managed by English and Canadians, is efficient. Outside the Indian districts of the eastern and southern outskirts the streets are paved with asphalt or stone, lighted with electricity and gas, and served with a good street railway service. The political and commercial centre of the city is the *Plaza Mayor*, or *Plaza de la Constitución*, on which face the cathedral, national palace, and municipal palace. Grouped about the *Plaza de Santo Domingo* are the old convent and church of Santo Domingo, the court of the Inquisition, now occupied by the School of Medicine, the offices of the *Departamento de Comunicaciones*, and the old custom-house (*aduana*). Close by are the old church of the Jesuits and the school of mechanic arts (*artes y oficios*) with its large and well-equipped shops. Among other well-known *plazas* are: Loreto, on which faces the great enclosed market of the city; Guardiola, in the midst of handsome private residences; San Fernando, with its statue of Vincente Guerrero; and Morelos, with its marble statue of the national hero of that name. The *Paseo de la Reforma*, the finest avenue of the city, is a broad boulevard extending from the *Avenida Juárez* south-west to Chapultepec, a distance of nearly 3 miles. At intervals are circular spaces, called *glorietas*, with statues (the famous bronze equestrian statue of Charles IV., the magnificent Independence column and the monuments to Columbus, Cuauhtemoc, the last of the Aztec emperors, and Juárez). Other notable avenues are Bucareli and Juárez, and the *Avenida de la Viga*, which skirts the canal of that name. The principal business street runs westward from the *Plaza Mayor* toward the *Alameda*, and is known as the *Avenida de Francisco I. Madero*, for five squares, and as *Avenida Juárez*, along the south side of the *Alameda* to its junction with the *Paseo*. The *Alameda*, or public garden, ½ m. W. of the *Plaza Mayor*, covers an area of 40 ac., and occupies the site of the old Indian market and place of execution, where occurred the first auto-da-fé in 1574.

Noteworthy Buildings.—The great cathedral stands on or near the site of the Aztec temple (*teocalli*) destroyed by Cortés in 1521. The foundations were laid in 1573 and the church was finished about 1811. Standing close beside the cathedral is the highly ornamented façade of a smaller church, called *El Sagrario Metropolitano*. The city has about 60 church edifices, including *La Profesa, Loreto, Santa Teresa, Santo Domingo* and *San Hipólito*. At the time of the secularization of Church properties there were about 120 religious edifices in the city—churches, convents, monasteries, etc., many of which were turned over to secular uses. The national palace, also on the *Plaza Mayor*, has a frontage of 675 ft. on the east of the *Plaza*, and covers a square of 47,840 sq.yd., or nearly 10 acres. It contains the executive offices of the Government, the Senate chamber, the general archives, national museum, observatory and meteorological bureau. The palace occupies the site of the residence of Montezuma, which was destroyed by the Spaniards, and that of Hernando Cortés, which was also destroyed in 1692. It has three entrances on the *Plaza*, and over its main gateway hangs the "liberty bell" of Mexico, first rung by the humble parish priest, Hidalgo, on the night of Sept. 16, 1810, to call the people of Dolores to arms, and now rung at midnight on each recurring anniversary by the president himself. The national museum, which occupies the east side of the national palace, is rich in Mexican antiquities, among which are the famous "calendar stone," supposed to be of Toltec origin, and the "sacrificial stone" found in the ruins of the great *teocalli* destroyed by Cortéz. Near the cathedral is the *monte de piedad*, or Government pawnshop, endowed in 1775 by Pedro Romero de Terreros (*conde de Regla*) with £75,000, and at one time carrying on a regular banking business, including the issue of bank-notes. The national library, which has upwards of 225,000 volumes, occupies the old St. Augustine church.

Other notable buildings are the general postoffice, begun in 1902 and finished in 1907; the Minería, occupied by the schools of mining and engineering; the military school, occupying a part of the Castle of Chapultepec; the Iturbide palace, now occupied as a hotel; the Chamber of Deputies; the Palace of Justice; the old mint, dating from 1537; the penitentiary, completed in 1900; the Panteón, with its bronze monuments to the most celebrated Mexicans; the general hospital; the Jockey Club on Plaza Guardiola, now an American restaurant; the National university and new school edifices of modern design. The magnificent National Theatre, begun in 1900, has been partially completed, 12,000,000 pesos having been spent on it up to 1922.

Types of Construction.—The old Spanish edifices were very solidly constructed of stone, and private residences were provided with iron gates and window guards strong enough to withstand an ordinary assault. Private houses were also provided with flat roofs (*azoteas*) and battlements, which gave them great defensive strength, as well as a cool, secluded retreat for their inmates in the evening. The old Moorish style of building about an open court, or *patio*, still prevails. The better residences of the old style were commonly of two storeys—the ground-floor being occupied by shops, offices, stables and servants' quarters, the living rooms of the family being on the second floor. The modern constructions, such as those of the *Colonia Juárez* and other new residential districts are more attractive.

Drainage and Water Supply.—Mexico was formerly one of the worst drained large cities of the New World, its subsoil being permanently saturated and its artificial drainage being through open ditches into the San Lázaro canal, which nominally discharged into Lake Texcoco. The difference in level between the city and the lake being less than 6 ft. and the lake having no natural outlet typhoid fever became a common epidemic in its lower and poorer sections. In 1629 the streets of the city were covered to a depth of 3 ft. and remained flooded until 1634. The earliest effort to correct this evil was by the Dutch engineer, Maartens (Span., Martínez), who planned a deep cutting through Nochistongo hill, north of the city, to carry the overflow of Lake Zumpango to the river Tula, a tributary of the Pánuco. The cutting was 13 m. long and is known as the Tajo de Nochistongo. It was begun in 1607 but was not completed until 1789, and then it was found that the city was still subject to partial inundations, although an enormous sum of money and 70,000 lives of Indian labourers had been expended upon it. During the year 1856 President Ignacio Comonfort invited tenders for drainage works conditional on the use of waste waters for irrigation purposes, and the plan executed consists of a canal and tunnel 43 m. long, starting from the east side and 4¼ ft. below the mean level of the city, and running north to Zumpango and thence eastward into a tunnel over 6 m. long, which discharges into a small tributary of the Pánuco river, near the village of Tequixquiac. The greatest depth of the tunnel is 308 ft. The works were completed in 1900.

For the water supply the Aztecs used the main causeway through their city as a dam to separate the fresh water from the hills from the brackish water of Texcoco, and also obtained drinking water from a spring at the base of Chapultepec. The Spaniards added three other springs to the supply and constructed two long aqueducts to bring water into the city. Three other sources were added during the 19th century, and in 1899–1900 steps were taken to secure a further supply from the Río Hondo. Besides these there are 11 public and 1,375 private artesian wells in the city. All these sources are estimated to yield about 220 to 230 litres per head per day.

Educational Institutions.—Considerable attention has always been given to education in Mexico, but in colonial times it was limited in scope, and confined to the dominant classes. The old University of Mexico, with its faculties of theology, law and medicine (founded 1551 and inaugurated 1553), ceased to exist in 1865 and was succeeded by schools of engineering, law and medicine, which have been signally successful. The university, however, was reopened in 1910. A summer school, in connection with it, was established in 1922, designed especially to attract foreign students for the study of Spanish. The Government also maintains schools of agriculture, commerce, fine arts, music, pharmacy, technology and an admirable high school, besides a large number of primary and secondary schools, for which modern school buildings have been erected. Normal and industrial schools for both sexes are maintained, the latter (*artes y oficios*) performing a very important service for the poorer classes.

By the Constitution of 1917 elementary education was made free, compulsory to the age of 15 and secular, but pending the provision of enough secular schools many of the old schools under religious auspices continued to function. There are several good daily papers published in Mexico City. The World War increased the interest of Mexicans in reading, and as a result a number of new periodicals, of a superior quality, were established in the city, which had the first printing press in the New World and the first regularly issued newspaper.

Industries.—Through lack of water-power and cheap fuel, Mexico has never been rated as a manufacturing city. However, the development of electric power, and the possibility of transmitting it for long distances, have worked a noteworthy change in this respect, and a large number of industries have been added in recent years. The largest of the electric-power plants is on the Necaxa and Tenango rivers, in the State of Puebla, 92 m. from the city, which furnishes 40,000 h.p. for industrial and lighting purposes. Another plant is in the suburb of San Lázaro, the current being distributed by over 100 m. of underground mains in the city, and many miles of overhead wires in its outskirts and suburbs. Other plants are at San Ildefonso, 12 m. distant, and on the Churubusco river, 16 miles.

Manufacturing, still relatively unimportant, was represented in 1925 by some 215 establishments, with an annual output valued at 10,000,000 pesos, and employing about 10,000 workers, most of whom were Indians and half-breeds (*mestizos*). Foundries and iron-working shops add much to the prosperity of modern Mexico City. There are also large cotton mills and cigar and cigarette factories. In the suburbs, oils, chemicals, cigarettes and bricks are made at Tacuba; cotton textiles at Contreras, San Angel and Tlálpam; paper and boots at Tacubaya, and bricks at Mixcoac and Coyoacán. A little farther away are the woollen mills of San Ildefonso, the paper-mills of San Rafael, and important works for the manufacture of railway rolling stock.

Railway Communications.—The railway connections include direct communication with one port on the Gulf coast and with two on the Pacific, and indirect communication with two on the Gulf. The Mexican and Inter-oceanic lines connect with Veracruz, the Mexican Central with Manzanillo, via Guadalajara and Colima, and the Veracruz and Pacific (from Córdoba) with the Tehuantepec line and the port of Salina Cruz. The last-mentioned line also gives indirect connection with the port of Coatzacoalcos, and the Mexican Central, via San Luis Potosí, with Tampico. A southern extension of the Mexican Central, via Cuernavaca, has reached the Balsas river and will be extended to Acapulco, once the chief Pacific port of Mexico and the dépôt for the rich Philippine trade. A Mexican extension of the (American) Southern Pacific has been completed from Nogales to Guadalajara, which gives the national capital direct communication with the thriving ports of Mazatlán and Guaymas. In addition to these, the Mexican Central and Mexican National, now consolidated, give communication with the northern capitals and the United States, and the Mexican Southern runs southward, via Puebla, to the city of Oaxaca. These railways, with the shorter lines radiating from the city, connect it with nearly all the State capitals and principal ports.

HISTORY

The Aztecs.—Mexico City dates, traditionally, from the year 1325 or 1327, when the Aztecs settled on an island in Lake Texcoco. The Aztec name of the city was Tenochtitlán, derived either from Tenoch, one of their priests and leaders, or from *tenuch*, the Indian name for the "nopal," which is associated with its foundation. The modern name is derived from Mexitli, one of the names of the Aztec god of war, Huitzilopochtli, which name was later on applied also to the Aztecs themselves. The island settlement which was practically a lake-village built on islets—some of them undoubtedly artificial—grew rapidly with the increasing power and civilization of its inhabitants, who had the remains of an earlier civilization to assist in their development. About the middle of the 15th century their mud-and-rush dwellings were partly replaced by stone structures, grouped around the central enclosure of the great *teocalli* and bordering the causeways leading to the mainland. The town had reached its highest development when the Spaniards appeared in 1519, when it is said to have had, including suburban towns, a total of 60,000 dwellings, representing about 300,000 inhabitants.

Allowance should be made for the habit of exaggeration among the Spanish adventurers of that time, and also for the diplomacy of Cortés in magnifying his exploits to win the favour of his king. The truth is, without doubt, that the dwellings of the lower classes were still built of reeds and mud, and covered the greater part of the city's area, otherwise it is impossible to understand how a mere handful of Spanish soldiers, without tools and explosives, could so easily have levelled it to the ground. After its almost total destruction in Nov. 1521, Cortés employed some 400,000 natives in rebuilding the city on its former site. Since then the lake has decreased greatly in extent, its area being reduced to $11\frac{1}{2}$ sq.m. and its shore-line being more than 3 m. distant from the city it once surrounded. During Spanish rule the only break in the ordinary course of events was the revolt of 1692, which resulted in the destruction of the municipal buildings. The city was not much disturbed by the struggle for independence.

In the war between Mexico and the United States Mexico City was the chief point of attack. The American army, under Gen. Winfield Scott, arrived at Ayotla, 16 m. S.E. of the city on Aug. 10, 1847, moved around the capital on the south side to avoid its heavy fortifications, crossed the difficult terrain of the Pedregal, a field of broken lava, and succeeded in capturing point after point of the city's outlying defences (including the hill of Chapultepec), thus forcing the surrender of the Mexicans on Sept. 13. The city was then occupied by the American army and held until the signing of the Treaty of Guadalupe-Hidalgo, May 1848.

The French intervention of 1861 led to a second occupation by a foreign Power—a French military force under Gen. Forey taking possession in June 1863. Maximilian, archduke of Austria, was crowned emperor of Mexico in the cathedral in June 1864, and held possession of the capital until June 21, 1867, when it was captured by Gen. Porfirio Díaz.

During the revolutionary movements beginning in 1910, Mexico City was taken and re-taken many times, never, however, suffering serious damage. On Sept. 29, 1927, a long distance telephone between Mexico City and Washington, D.C., was inaugurated, the event being celebrated by an exchange of greetings between the chief executives of the two nations. The total length of the Washington–Mexico City circuit is 3,357 miles.

For further description *see* H. H. Bancroft, *History of Mexico* (San Francisco, 1883); R. S. Barrett, *Standard Guide to the City of Mexico*

and Vicinity (Mexico, 1900); T. A. Janvier, *The Mexican Guide* (5th ed., New York, 1890); D. Charnay, *Ancient Cities of the New World* (Eng. ver., New York, 1887); and the *Plano de la ciudad de México,* in the *Diccionario enciclopédico hispano-americano,* xii. 740 (Barcelona, 1893).

MEYER, CONRAD FERDINAND, one of the greatest of Swiss poets and novelists, was born at Zürich on Oct. 11, 1825, and died on Nov. 28, 1896, at Kilchberg (near Zürich), where he had settled in 1875. In his youth he studied law and pursued historical researches in Italy; but he began his career as author comparatively late in life. As compared with Gottfried Keller (*q.v.*), for example, Meyer is more of the cosmopolitan and patrician and less of the democrat. His style is singularly pure and polished, and he appeals strongly to readers of culture. His poems include *Balladen* (1867), *Romanzen und Bilder* (1870), *Huttens letzte Tage* (1871), and *Engelberg* (1873)—the last two powerful narrative poems. His *Gedichte* have been published in at least 20 editions. Of his novels, in which he shows a preference for Renaissance subjects, the most popular are *Jürg Jenatsch* (1876; 312th ed., 1924) and *Der Heilige* (1880; 198th ed., 1924). The latter was translated into English by M. von Wendheim, as *Thomas à Becket, the Saint* (1885). *Die Versuchung des Pescara* (1887) was translated by Mrs. C. Bell (1890). His charming short stories were collected in 1885 (206th ed., 1924).

BIBLIOGRAPHY.—Lives of Meyer have been written by A. Reitler (1885); A. Frey (1900); R. d'Harcourt (1913); M. Nussberger (1919); H. Maync (1925). *See* also L. Frey, *C. F. Meyer's Gedichte und Novellen* (1892); K. E. Franzos, *K. F. Meyer* (1899); B. Meyer, *C. F. Meyer* (1903); A. Bettelheim, *Louise von François und Conrad Ferdinand Meyer* (1905); A. Langmesser, *C. F. Meyer* (1905) and *Conrad Ferdinand Meyer und Julius Rodenberg* (1918); E. Korrodi, *C. F. Meyer; Studien* (1912); W. Brecht, *C. F. Meyer und das Kunstwerk seiner Gedichtsammlung* (1918); E. Brock, *Die Landschaft in C. F. Meyer's Novellen und Gedichten* (1926).

MEYER, EDUARD (1855–1930), German historian, was born at Hamburg on Jan. 25, 1855. He was educated at Bonn and Leipzig, where in 1879 he qualified in ancient history. He afterwards became professor of ancient history at Breslau (1885), Halle (1889) and Berlin (1902). Meyer realized the great importance of folklore, historical monuments and numismatics as aids to the study of ancient history, and the value of his original methods in treating the subject was recognized by the universities of Oxford, St. Andrews and Freiburg from which he received honorary degrees. Meyer's principal works are: *Geschichte des alten Aegyptens* (1887); *Forschungen zur alten Geschichte* (1892–99); *Wirtschaftliche Entwicklung des Altertums* (1895); *Die Entstehung des Judentums* (1896); *Zur Theorie und Methodik der Geschichte* (1902); *Geschichte des Altertums* (3rd. ed. 1909); *Caesars Monarchie und das Principat des Pompeius* (2nd ed. 1919); *Preussen und Athen* (1919); *Ursprung und Anfänge des Christentums* (3 vol., 1921–23). Meyer died August 31, 1930.

MEYER, HEINRICH AUGUST WILHELM (1800–1873), German Protestant divine, born at Gotha on Jan. 10, 1800, spent most of his life at Hanover where he held a pastoral charge and eventually became superintendent. He died there on June 21, 1873. He prepared, with other scholars, the well-known *Kritischexegetischer Kommentar Zum Neuen Testament* (16 vols., 1832–59), since re-edited by later scholars. Meyer's commentary was published in English in Clark's series (20 vols., 1873–82).

MEYER, JULIUS LOTHAR (1830–1895), German chemist, was born on Aug. 19, 1830, at Varel in Oldenburg. He studied medicine at Zürich and Würzburg, and then turned to physiological chemistry at Heidelberg and finally to mathematical physics at Königsberg. After holding various positions as a lecturer he became, in 1876, professor of chemistry at Tübingen, where he died on April 11, 1895. His earliest work was on the chemistry of the blood, but his name is best known for the share he had in the development of the periodic classification of the elements (*see* PERIODIC LAW). He noted, as did J. A. R. Newlands independently in England, that if they are arranged in the order of their atomic weights they fall into groups in which similar chemical and physical properties are repeated at periodic intervals; and in particular he showed that if the atomic weights are plotted as ordinates and the atomic volumes as abscissae, the curve obtained presents a series of maxima and minima, the most electro-positive elements appearing at the peaks of the curve in the order of their atomic weights. His book on *Die modernen Theorien der Chemie,* which was first published in Breslau in 1864 and later translated into English, contains a discussion of relations between the atomic weights and the properties of the elements. In 1882 he received from the Royal Society the Davy medal in recognition of his work on the Periodic Law.

See *Berichte d. Deutsch. Chem. Gess.* vol. 28. p. 1103 and *Journal of the Chem. Soc.* (1896) p. 1403.

MEYER [MARIE], PAUL HYACINTHE (1840–), French philologist, was born in Paris on Jan. 17, 1840. He was educated at the Ecole des Chartes, and in 1863 was attached to the manuscript department of the Bibliothèque Nationale. In 1876 he became professor of the languages and literatures of southern Europe at the Collège de France. In 1882 he was made director of the Ecole des Chartes, and in 1883 became a member of the Academy of Inscriptions. He was one of the founders of the *Revue Critique,* and a founder and the chief contributor to *Romania* (1872). Paul Meyer began with the study of old Provençal literature, but also ranks as a great modern authority on the French language. He edited many old French texts for the *Société des anciens textes français,* and independently.

MEYER, VICTOR (1848–1897), German chemist, was born at Berlin on Sept. 8, 1848. He studied at Heidelberg under R. W. Bunsen, H. F. M. Kopp, G. R. Kirchoff and H. L. F. Helmholtz (*qq.v.*); he also worked under Baeyer (*q.v.*) in Berlin. In 1870 he was appointed extraordinary professor at Stuttgart polytechnic, and in 1872 succeeded J Wislicenus (*q.v.*) at Zürich. In 1885 he obtained the chair of chemistry at Göttingen, and in 1889 he succeeded Bunsen at Heidelberg. He was awarded the Davy medal in 1891. Meyer proved to be not only a great investigator but also a stimulating teacher, with a wonderful command of language. He suffered from ill health and committed suicide on Aug. 8, 1897.

Meyer's first papers dealt with the composition of camphor, chloral hydrate and the structure of benzene (*q.v.*). In 1872 he discovered the aliphatic nitro-compounds (*q.v.*), and this led him on to the study of nitroso-compounds and nitrols. In 1882 he discovered the oximes (*q.v.*) and showed that they can exist in stereo-isomeric forms; he also investigated the chemistry of these compounds very thoroughly. In 1871 he devised a method for determining vapour densities (*see* CHEMISTRY: *Physical*), and this led him on to a series of pyro-chemical studies, in which the vapour densities of inorganic substances were determined at fairly high temperatures. The results of this work, with his brother, Carl Meyer, were collected in *Pyrochemische Untersuchungen* (1885). In the course of a lecture demonstration he made an observation which led him to the discovery of thiophene (*q.v.*) in 1883; he studied the substance and determined its structure; the results are published in *Die Thiophengruppe* (1888).

See C. Meyer, "Victor Meyer" in *Ber. d. deutsch chem. Ges.* (1908); B. Horowitz, "Victor Meyer His Life and Work," *Jnl. Franklin Inst.* (1916); T. E. Thorpe's *Essays in Historical Chemistry* (3rd ed., 1911).

MEYERBEER, GIACOMO (1791–1863), German composer, first known as Jakob Meyer Beer, was born at Berlin Sept. 6, 1791[1] His father, Herz Beer, was a banker; his mother, Amalie (*née* Wulf), was a woman of high intellectual culture; and two of his brothers distinguished themselves in astronomy and literature. He studied the pianoforte, first under Lauska, and afterwards under Lauska's master, Clementi. When seven years old he played Mozart's Concerto in D Minor in public, and at nine he was pronounced the best pianist in Berlin. For composition he was placed under Zelter, and then under Bernard Weber, director of the Berlin opera, by whom he was introduced to the Abbé Vogler. Vogler received him into his house at Darmstadt, where he formed an intimate friendship with Weber. In 1812 the grand duke appointed Meyerbeer court composer. His first opera, *Jeptha's Gelübde,* failed lamentably at Darmstadt in 1811 and his second, *Wirth und Gast* (*Alimelek*), at Vienna in 1814. Bitter disappointment over these failures drove him to Italy.

[1]Or, according to some accounts, 1794.

At Venice he was captivated by Rossini, and produced a succession of seven Italian operas—*Romilda e Costanza, Semiramide riconosciuta, Eduardo e Cristina, Emma di Resburgo, Margherita d'Anjou, L'Esule di Granata* and *Il Crociato in Egitto*—which all achieved a success as brilliant as it was unexpected. Against this act of treason to German art Weber protested, and an invitation to Paris in 1826 led him to review his position dispassionately. For several years he produced nothing in public; but, in concert with Scribe, he planned his first French opera, *Robert le Diable* (Grand Opéra, 1831). It was the first grand romantic opera, with situations more theatrically effective than any that had been attempted either by Cherubini or Rossini, and with ballet music such as had never yet been heard, even in Paris.

His next opera, *Les Huguenots*, was first performed in 1836. In gorgeous colouring, rhetorical force, consistency of dramatic treatment, and careful accentuation of individual types, it is at least the equal of *Robert le Diable.* Meyerbeer then spent many years in the preparation of his next greatest works—*L'Africaine* and *Le Prophète.* The libretti of both these operas were furnished by Scribe; and both were subjected to countless changes.

Meanwhile Meyerbeer accepted the appointment of kapellmeister to the king of Prussia, and spent some years at Berlin, where he produced *Ein Feldlager in Schlesien,* a German opera, in which Jenny Lind made her first appearance in Prussia. Here also he composed, in 1846, the overture to his brother Michael's drama, *Struensee.* But his chief care at this period was bestowed upon the worthy presentation of the works of others: Weber's *Euryanthe,* and *Rienzi* and *Der fliegende Holländer,* the first two operas of Richard Wagner, who, then in poverty and exile, would, but for him, have found it impossible to obtain a hearing in Berlin. With Jenny Lind as prima donna and Meyerbeer as conductor, the opera flourished brilliantly in the Prussian capital.

Meyerbeer produced *Le Prophète* at Paris in 1849. In 1854 he brought out *L'Étoile du nord* at the Opéra Comique, and in 1859 *Le Pardon de Ploërmel* (*Dinorah*). His last great work, *L'Africaine,* was in active preparation at the Académie when, on April 23, 1863, he was seized with a sudden illness, and died on May 2.

See lives and studies by J. Weber (1898), J. Dauriac (1913), Hermann Abert (1918) and Julius Kapp (1920).

MEYERHOLD, VSEVOLOD EMILIEVICH (1873–), Russian theatrical producer, was born in Moscow and from 1898–1905 was well known as one of the most distinguished actors of the Moscow Art theatre. He then began to produce plays, adopting a new convention in opposition to the "true-to-life" ideas of Stanislavsky, in which the actor and the stage setting presented a complete harmony. After the Revolution he carried these methods to. an extreme, using no curtain and a bare stage with purely formal scenery. He managed the Revolutionary theatre, Moscow, and also acquired a theatre of his own, and in both produced political propaganda plays. His views are set forth in his book, *The Theatre* (St. Petersburg, 1913).

MEYNELL, ALICE (1849–1922), British poet. By her marriage in 1877 Alice Thompson became Alice Meynell. She had the fortune to find herself in that mid-Victorian era which still held freshly to its heritage from Keats and Shelley, from Wordsworth and Coleridge. It felt its heart torn by the griefs of the Brontës, stirred by their glories, and almost clung to the hand of Elizabeth Browning. Eagerly awaiting every recurring sign of Tennyson's fertility, it yet respected the long pause of Patmore; and took for its own the volumes of Dante and Christina Rossetti, warm from the press. With these two women of song, Elizabeth and Christina, Alice Meynell's name is associated.

Mistress Anne Killigrew had been told by Dryden, "thy father was transfused into thy blood." That girls alike with boys, inherit from fathers as from mothers, was the theme of a verse where Alice Meynell, after the desolations of the World War, gave the comforting signal:—

> The crippled world! Come, then,
> Fathers of women with your honour in trust.
> Approve, accept, know them daughters of men,
> Now that your sons are dust.

Her own father, having left Cambridge and unsuccessfully contested two costly elections for parliament as a free trader, became very much a citizen of the world. After his marriage with Christiana Jane Weller, a beautiful and accomplished girl to whom her adoring friend Charles Dickens fitly introduced him, he made his home much in Italy, devoting himself to the liberal learning of the two daughters: Elizabeth, the elder, afterwards Lady Butler, famous as a war painter; and Alice, who early began to put her rhymed thoughts shyly upon paper.

The volume of *Preludes* was issued (for the girl what an association) by Tennyson's then publisher, Henry S. King, on the word of his "reader"—later his successor—C. Kegan Paul, who, not trusting his own judgment all the way, read some of them aloud to George Eliot, receiving her deciding approbation. The critics were mostly silent; and even those who praised hesitated. But the volume made its own quiet way, Ruskin in all ways first in his soaring praises: "The last verse of that perfectly heavenly 'Letter of a Girl to her own Old Age,' the whole of 'San Lorenzo's Mother' and the end of the 'Sonnet to a Daisy,' are the finest things I have yet seen or felt in modern verse." Rossetti, too, spread the news of the young poet's advent, reciting "Renouncement" by heart to his friends, and saying that it was "one of the three finest sonnets ever written by women." Browning, having read a brief quotation buried in a halting press appreciation, "conceived the desire to read the rest for myself," and found its beauty "even beyond what the indifference of the reviewer should have prepared me for." The volume brought her many a friend—and more. For the reviewer in *The Pall Mall Gazette*—a paper to which she was later to be a conspicuous contributor—quoted the sonnet "My Heart shall be thy Garden," and found for it a reader whom it reached revealingly. A consequent introduction to the sonneteer by a common friend was followed by a marriage that fulfilled for him Crashaw's "heaven-on-earth" for 45 years.

On Mrs. Wilfred Meynell, as she then (1877) became, fell a long silence as a poet. The muse does not ordinarily leave cards on the happily and busily married; the domesticities and the "sweet sense of providing" are not the fashioners of those "sweetest songs" that breed from "saddest thoughts." Eight children were born, one of whom died in infancy: a grief that put into poetry the dread reminder that the giver of life is also the giver of death: "and she who slays is she who bears, who bears." A like sensitiveness to life's cruelties put her, for all her reticence, on political platforms, and marched her in multitudinous processions, in favour of the granting of votes to women and the opening of long closed professional doors. Compassion was the companion of all her walks abroad, for the over-burdened man and animal; for the beggar-woman to whom she cried with her gift, in Portuguese fashion, "Have patience, little saint"; for the underfed in London slums which she at one time sedulously visited; and for the beast in the shambles, in shame for whose martyrdom she refused to eat meat until, after persuasion, she sought by more impersonal methods to further laggard reforms.

Her married life matured her vigilance as a mistress of prose. In W. E. Henley of *The Scots Observer* and *The National Observer,* she encountered an editor who heartened her by his boisterous welcomes: "That woman's taking her place at the steering wheel" was one of his recorded acclaims. Later, in *The Pall Mall Gazette* of Harry Cust's editorship, she was accorded a weekly column which left her a large range in the choice of subjects. George Meredith, reading here her "princely journalism," sought with her an acquaintance that soon became a "dearest friendship." In a magazine—those were still the days of the magazines—he spoke of her words as having the "living tremor in them," just as he had before said that Carinthia's had the "throb beneath them." Of her essays, he wrote: "The surprise coming on us from their combined grace of manner and sanity of thought is like one's dream of what the recognition of a new truth would be. They leave a sense of stilled singing on the mind they fill. The writing is limpid in its depths."

Coventry Patmore, too, her yet warmer admirer, published, when Tennyson died, his unavailing plea for her succession to the laureateship. Her close friendship for such seniors coincided

with that for her contemporaries, and for her juniors, chief among whom was Francis Thompson, who addressed to her his exquisite sequence of poems *Love in Dian's Lap*, of which, Patmore said, Beatrice or Laura might have been proud. Of the homage paid to her, another chosen friend, J. L. Garvin, has well said: "Alice Meynell was in herself a person of her age, sure, as I think, of perpetual remembrance, even if half a dozen of her shining contemporaries had not competed in vain to spoil her with praise. It was what no one could do: recognition only made her humble." And these contemporary praises notwithstanding, G. K. Chesterton predicts: "She was deservedly famous; but I will venture to prophesy that her fullest fame is yet to come. The whole modern world must immeasurably enlarge itself before it comes near the measure of her mind." She died in London on Nov. 27, 1922.

Alice Meynell's *Preludes* (1875), long out of print, re-appeared in a volume of *Poems* (1893) including new ones; and these, together with yet later verses separately issued as *A Father of Women* (1917) and *Last Poems* (1923), are all assembled in the complete volume of *Poems* (1923) now in circulation. Of her prose, several small volumes of essays in the '90s—*The Rhythm of Life* (1893), *The Colour of Life* (1896) and *The Spirit of Place* (1899)—were followed by *Ceres' Runaway* (1909), by *Hearts of Controversy* (1917), by *The Second Person Singular* (1921) and finally by the standard volume of selected *Essays* (1914)—the selection being her own. Other books were *John Ruskin* (1900), *The Children of the Old Masters* (1903), *Mary, the Mother of Jesus* (1912) and *London Impressions* (1898). Two anthologies give her choice among poems—*The Flower of the Mind* (1897) and *The School of Poetry* (1923), the first including Notes and the second Commentaries. She prefaced editions of *The Sonnets from the Portuguese* and Christina Rossetti's *Poems* (1910), as well as a decade of volumes "The Red Letter Library"; she introduced in 1903 a volume of reproductions of Sargent's Portraits; and she made for English readers a Selection from the Poems of J. B. Tabb (1906). (W. Me.)

See Viola Meynell, *Alice Meynell* (1929).

MEYRIFAB, a small semi-nomad tribe of Semitic stock, on the east bank of the Nile near Berber who never marry slaves.

MÉZIÈRES, PHILIPPE DE (*c.* 1327–1405), French soldier and author, was born at the château of Mézières in Picardy. He belonged to the poorer nobility, and served under Lucchino Visconti in Lombardy, and subsequently under Andrew, king of Naples, who was assassinated in September 1345. He then set out for the East in the French army. After the battle of Smyrna in 1346 he was made a knight, and went to Jerusalem. He planned a new order of knighthood, the first sketch of which was drawn up by him in his *Nova religio passionis* (1367–1368; revised and enlarged in 1386 and 1396). From Jerusalem he went in 1347 to Cyprus to the court of Hugo IV., where he met the king's son, Peter of Lusignan, then count of Tripoli; but he soon left Cyprus, and had resumed soldiering when the accession of Peter to the thrones of Cyprus and Jerusalem (Nov. 1358) induced Mézières to return to the island, probably in 1360, when he became chancellor. He came under the influence of the pious legate Peter Thomas (d. 1366), whose friend and biographer he was to be, and Thomas, who became patriarch of Constantinople in 1364, was one of the chief promoters of the crusade of 1365. In June 1366 Mézières was delegated to Venice, to Avignon and to the princes of western Europe, to obtain help for Cyprus against the Saracens. His efforts were in vain; even Pope Urban V. advised peace with the sultan. Mézières remained for some time at Avignon, seeking recruits for his order, and writing his *Vita S. Petri Thomasii* (Antwerp, 1659), which is invaluable for the history of the Alexandrian expedition. The *Prefacio* and *Epistola*, which form the first draft of his work on the projected order of the Passion, were written at this time.

Mézières returned to Cyprus in 1368, but was still at Venice when Peter was assassinated at Nicosia at the beginning of 1369, and he remained there until 1372, when he went to the court of the new pope Gregory XI. at Avignon. In 1373 he was in Paris, and he was thenceforward one of the trusted counsellors of Charles V. He was tutor to the future Charles VI., but after the death of Charles V. he was compelled to retire. He lived thenceforward in the convent of the Celestines in Paris, but continued to exert an influence on public affairs. To this period of his life belong most of his writings. Two devotional treatises belong to 1386–1387. In 1389 he wrote his *Songe du vieil pélerin*, an elaborate allegorical voyage in which he described the customs of Europe and the near East, and advocated peace with England and the pursuit of the Crusade. His *Oratio tragedica*, largely autobiographical, was written with similar aims. Mézières died in Paris on May 29, 1405.

See A. Molinier, *Manuel de bibliographie historique* vol. iv. (1904); and especially the researches of N. Jorga, published in the *Bibliothèque de l'école des hautes études* vol. 110 (Paris, 1896); and the same writer's *Philippe de Mézières, et la croisade au xiv. siècle* (1896). Jorga gives a list of his works and of the mss. in which they are preserved, and analyses many of them. On the *Songe du vergier*, see P. Paris, in *Mémoires* vol. xv. (1843) of the Academy of Inscriptions.

MÉZIÈRES, a town of northern France, capital of Ardennes department, 55 m. N.E. of Reims by rail. Pop. (1926) 8,418.

Founded in the 9th century, Mézières was a stronghold belonging to the bishops of Reims, which afterwards became the property of the counts of Rethel. The town was increased by successive immigrations of the people of Liége, flying first from the emperor Otto, and afterwards from Charles the Bold; and also by concessions from the counts of Rethel. Walls were built in the 13th century, and in 1521 it was successfully defended against the Imperialists by the Chevalier Bayard. In 1815 the Germans were kept at bay for six weeks, and in 1871 the town only capitulated after heavy bombardment. Both Mézières and Charleville were taken by the Germans in Aug. 1914. They made Charleville the seat of their High Command in the West, and later the headquarters of the German crown prince.

The town is situated on a peninsula formed by a loop of the Meuse. The river separates it from Arches and the town of Charleville on the north and from the suburb of Pierre on the south. Adjoining Pierre is Mohon, pop. (1926) 7,814, with metallurgical works. The fortifications of Mézières (dismantled in 1886), as well as the citadel still dominating the town on the east, were built under Vauban's direction. Immediately to the east of the citadel runs a canal, which provides river-traffic with a short cut across the isthmus. The parish church (16th cent.) contains inscriptions commemorating the raising of the siege of Mézières in 1521 and the marriage of Charles IX. with the daughter of the emperor Maximilian II. (1570). Mézières is the seat of a prefect and of a court of assizes, and there are manufactures of motor cars, bicycles, and iron and steel castings.

MEZÖTÚR, a town in Hungary near the right bank of the Körös. It is a market and fair town for the cereal and cattle-rearing district in which it lies. It has also small flour mills and important potteries. Pop. (1920) *c.* 27,000.

MEZZOFANTI, GIUSEPPE CASPAR (1774–1849), Italian cardinal and linguist, was born on Sept. 17, 1774, at Bologna, and educated there. He was ordained priest in 1797, and later became professor of Arabic in the university. In 1833 he succeeded Angelo Mai as chief keeper of the Vatican library, and in 1838 was made cardinal and director of studies in the Congregation. He died at Rome on March 15, 1849. He is said to have spoken fluently some fifty or sixty languages.

See Russell, *Life of the Cardinal Mezzofanti* (1857); A. Bellesheim, *Giuseppe Cardinal Mezzofanti* (Würzburg, 1880).

MEZZOTINT or **MEZZO TINTO,** as it was first called, is a process of engraving whereby a copper, or steel, plate is first prepared to produce uniformly black impressions on paper. This is done by pricking the plate with innumerable small holes which will hold ink. In connection with mezzotint, as with all other forms of engraving, the ink used is a thick ink which does not run. After the surface of the mezzotint plate has been prepared, the high lights in the portrait or picture to be produced are obtained by scraping away and burnishing parts of the plate, thus reducing, or obliterating, the small holes, according to the effect desired. The pricking of the plate, originally done with a roulette or small wheel covered with sharp points, was later done with an instrument called a *cradle*, or *rocker*. The

BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

ENGLISH MEZZOTINTS OF THE 18TH CENTURY

1. "Mrs. Carnac." After Sir Joshua Reynolds by John Raphael Smith (1752–1812)
2. "Mary Amelia, Countess of Salisbury." After Sir Joshua Reynolds by Valentine Green (1739–1813)
3. "Lady Hamilton" ("Nature"). After George Romney by John Raphael Smith (1752–1812)
4. "Georgiana, Duchess of Bedford." After John Hoppner by Samuel William Reynolds (1794–1872)

process not only punctures the plate to hold ink, but, at the same time, produces a burr on the surface of the metal, which, cutting into the paper when in the press, causes a deeper absorption of ink, and produces that velvety effect so characteristic of the fine mezzotint engraving in an early impression. The surface of the punctured and roughened plate is left undisturbed where the deepest black is required, and by a graduated scraping of the plate, which removes both burrs and punctures so that ink is held in lesser degrees, middle and light tones are obtained when an impression is taken from it. Dots made with a sharp point on a polished metal surface were long used as an adjunct to engravings. They show on silver plates engraved for Niello (*q.v.*) in the 14th century. Prints on paper from line engravings cut on metal plates, probably copper, were first made about the middle of the 15th century, but dotted, or pointille work does not seem to have been much used for some time after that.

The 17th Century Dutch School.—About the middle of the 17th century, Ludwig von Siegen, a Dutch officer in the Hessian army, who was also an amateur artist, applied the old device of dotted work to a metal plate, by means of a small roulette, and succeeded in producing an excellent print entirely by its use. In 1654, von Siegen met Prince Rupert, count palatine of the Rhine and grandson of James I., at Brussels. Prince Rupert was a skilled amateur artist, and he became deeply interested in von Siegen's invention, which he at once tried. In a short time he produced a very fine piece of rouletting in a print of *The Large Executioner,* after Spagnoletto, a Spanish painter. The curving lines, made by unskilful use of a large roulette, show clearly in the background. William Sherwin was a native of Hertfordshire, and a well known line engraver. He was also a friend of Prince Rupert, who is said to have taught him the new art and presented him with a roulette. Sherwin made mezzotint portraits of Charles II. and of his queen in 1669, both of which were dedicated to Prince Rupert.

The early mezzotinters were mostly Dutchmen, and they did not succeed particularly well. Curiously enough, most of their work was done in England. But eventually, a great Dutch artist, Abraham Blooteling, arrived in England in 1673, and was much attracted by the new art. Blooteling did much splendid work, particularly after Van Dyck, Kneller and Lely. But he did much more for the art of the mezzotint than produce beautiful prints, because he radically changed and improved the technical part of the process. Instead of using only a roulette to produce dark space, he began by roughening the plate all over, so that if printed from, it would show simply a black space, and then he cut away the roughness with a scraper to make the light places as required. This plan produced most brilliant effects. Blooteling also invented a tool, now called a rocker, which is like a very small spade with a toothed edge, and with this powerful instrument a copper or soft steel plate can quickly be roughened all over, rendering the use of the old roulette obsolete. The early users of the rocker roughened their own plates, but now this can be professionally done by the dealers.

The 18th Century English School.—After Blooteling, and during the 18th century, a remarkable school of English mezzotinters became prominent, and did such distinguished work that abroad the process became known as *La manière anglaise.* This pre-eminence was due, not only to their remarkable skill and the great beauty of their work, but also to the fact that there were in England at that time, several portrait painters of the very first rank for them to interpret. We owe the existence of the finest mezzotints ever done to the inspiration of men like Lely, Reynolds, Lawrence, Romney, Hoppner, Constable and several others of lesser reputations.

Early in the 18th century an Irishman, T. Frye, tried several byways of art before he specialized in mezzotint, but he ended by "scraping" a series of large portrait heads after drawings of his own. When in good condition, heads by Frye are extremely decorative. Another Irishman, J. MacArdell, became one of our greatest mezzotinters. Sir Joshua Reynolds had so high an estimation of MacArdell's work that he once declared he would be immortalized by his engravings. This is now beginning to prove true, because Sir Joshua's paintings are in many cases deteriorating badly, whereas a mezzotint, carefully kept under a sunk mount, is extremely long-lived. Richard Earlom (1743–1822) used only the roulette where he wanted shadow. He engraved the *Liber Veritatis* of Claude Lorrain, and by doing so he suggested the *Liber Studiorum* of J. M. W. Turner.

The numerous mezzotints made by Valentine Green (1739–1813) are all of the highest order of excellence. He was especially successful in his rendering of the beautiful full length figures of ladies, painted by Sir Joshua Reynolds, and he frequently printed his engravings in brown ink.

John Raphael Smith began his artistic career as a miniature painter, but eventually became one of the foremost mezzotint engravers. He worked mainly after Sir Joshua Reynolds, but was very happy in his interpretation of Romney's graceful work. Smith made several engravings after his own drawings.

S. W. Reynolds made a series of 357 small mezzotints of portraits by Sir Joshua Reynolds. Mezzotints, however, are not satisfactory when done on a small scale. S. W. Reynolds was, in larger subjects, a highly skilful artist, and engraved many excellent plates after his own work. He did mezzotinting on some of the plates in Turner's *Liber Studiorum.*

William Say used etching as an adjunct to most of his fine mezzotints, but he was never satisfied with the small number of prints that could properly be made from a copper plate. He was the first mezzotinter to experiment with the use of steel instead, but he did not carry his ideas out successfully. Shortly afterwards, however, T. G. Lupton carried farther the experiments, with the use of steel instead of copper. Say seems to have tried with hard steel and Lupton used soft steel very successfully. Instead of being able to print only about 50 proofs of the highest excellence from copper, it was found possible to print about 1,500 from steel, without any appearance of deterioration. The dark places on a mezzotint are those to be looked for in worn prints. They ought to look like black or brown velvet. Steel engravings on mezzotint are often very delicate and charming, but they have a tendency to hardness. The method was also carried out by D. Lucas, but not so successfully as by Lupton. Now copper engravings can be steeled over several times and prints from such plates can never become rare.

Samuel Cousins was an apprentice to S. W. Reynolds, and used etching and line engraving freely with his mezzotint, so much, indeed, that his method is known as the "mixed" style. But his work is effective and very popular. Cousins killed the art of line engraving in England by reason of his fine plate of Bolton Abbey, after Sir Edwin Landseer, published in 1837. This plate proved that such a picture could be produced much more easily and effectively by mezzotint than it could by line engraving.

Among modern mezzotint engravers many are highly skilled, and most of them have chosen particular artists for their especial study. Sir Frank Short has been particularly successful in his interpretation of G. F. Watt's powerful work; C. W. Campbell with the delicate fancies of Sir E. Burne Jones; J. D. Miller follows Lord Leighton; G. P. Robinson, Sir Frank Dicksee; Norman Hirst, W. Draper, and now the process of photogravure has reached such a high state of excellence that little room is left for the earlier art. (*See* also ETCHING; ENGRAVING.)

BIBLIOGRAPHY.—A. Browne, *Ars Pictoria* (1669); J. Evelyn, *Sculptura* (1662), with the first mezzotint ever published in a book, a head of the Large Executioner, by Prince Rupert; J. C. Le Blon, *Coloritto* (1737); H. D. Chelsum, *A History of the Art of Engraving in Mezzotinto* (Winchester, 1786); G. K. Nagler, *Künstler-Lexikon* (München, 1835–52); L. de Laborde, *Histoire de la Gravure en manière noire* (1839); J. Maberly, *The Print Collector* (1844); T. H. Fielding, *The Art of Engraving* (1854); S. Redgrave, *Dictionary of Artists of the English School* (1874); W. G. Rawlinson, *Turner's Liber Studiorum* (1878); P. G. Hamerton, *The Graphic Arts* (1882); J. C. Smith, *British Mezzotinto Portraits* (1883); Sir F. Short, *On the Making of Etchings* (1888); Sir H. von Herkomer, *Etching and Mezzotint Engraving* (1892); H. Paton, *Etching, Drypoint, Mezzotint* (1895); H. W. Singer and W. Strang, *Etching, Engraving and other Methods of Printing Pictures* (1897); Sir F. Wedmore, *Fine Prints* (1897); A. Whitman, *Masters of Mezzotint* (1898); J. Frankau, *John Raphael Smith* (1903); C. J. Davenport, *Mezzotints* (1904).

(C. DA.)

MFUMBIRO or **KIRUNGA,** general names for a chain of volcanic mountains extending across the central African rift-valley immediately north of Lake Kivu. The range completely blocks the valley at this point, forming a divide between the rivers flowing north to the Nile and the waters of Lake Kivu, connected through Tanganyika with the Congo system. The chain consists of two groups of mountains, surrounded by a vast lava field. The lavas belong to a nephelinite suite with leucite and melilite as frequent minerals. The western group lies directly north of Lake Kivu, and contains two active volcanoes, Kirunga-cha-gongo, the nearest to the lake (11,194 ft.), and Kirunga-namlagira (9,711 ft.), 10 m. farther north. The eastern group contains several higher peaks, Karissimbi (14,683 ft.), Mikeno (14,385 ft.) and Muhavuru (13,562 ft.). The latter is the mountain to which the names Mfumbiro and Kirunga were originally applied and its crater contains a lake. Some 6 m. W. of Muhavuru is Sabyino (Sabinjo), 11,881 ft. high. The eastern peaks are snowclad for a part of the year. North of these high mountains is a district, extending towards Lake Albert, containing hundreds of low peaks and extinct volcanoes. It is to this region that the name Umfumbira or Mfumbiro is said properly to belong.

Mfumbiro, *i.e.*, Muhavuru, was first seen by a white man in 1861, J. H. Speke obtaining a distant view of the cone, which was also seen by H. M. Stanley in 1876. Its true position was first ascertained by Franz Stuhlmann in 1891. In 1894 Count von Götzen travelled through the region which was subsequently explored by E. S. Grogan, Maj. St. Hill Gibbons, Capt. Herrmann, Dr. R. Kandt, Sir Alfred Sharp (1912) and others, the chief heights being determined in 1903. In 1907–08 the range was geologically and topographically examined by the duke of Mecklenberg's expedition. By the Anglo-German agreement of the 1st of July 1890 "Mount Mfumbiro" was included in the British sphere in East Africa.

Bibliography.—Count von Götzen, *Durch Afrika von Ost nach West* (1895); Captain Herrmann, *Vulkangebiet des zentralafrikanischen Grabens* (Berlin, 1904); Adolf Friedrich, duke of Mecklenburg, *Ins Innerste Afrika* (Leipzig, 1909); Sir Alfred Sharpe, "The Kivu Country," *Geogr. Journ.* (1916).

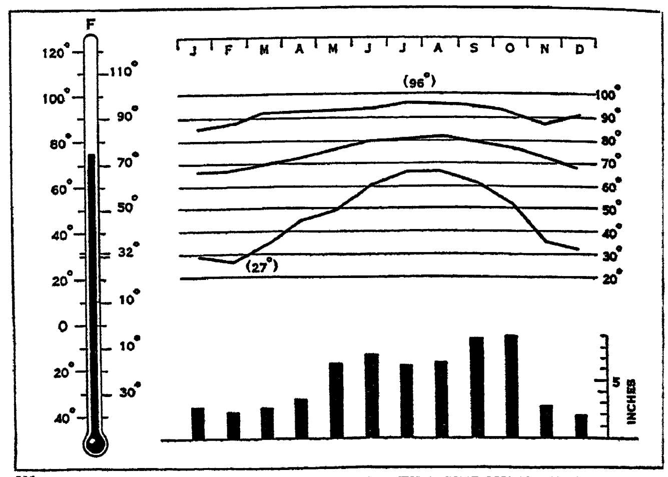
MHOW, a town of Central India, with British military cantonment, within the state of Indore. Pop. (1921), 31,737. It is one of the chief military stations of India. There are two high schools, a Zoroastrian and a Canadian mission, the Dorabji Pestonji dispensary, and a gaol.

MIAGAO, a municipality (with administration centre and 94 *barrios* or districts), on the south coast of the province of Iloilo, island of Panay, Philippine islands, about 25 m. west of Iloilo, the provincial capital. Pop. (1918), 24,556. The climate is comparatively cool and healthy. The most important local industry is the weaving of abacá and *piña* fabrics. In 1918, it had 2,717 household industry establishments with outputs valued at 849,300 pesos; and seven sugar mills. Of the 17 schools, 12 were public. The language spoken is a dialect of Bisayan.

MIAMI, a tribe of North American Indians of Algonquian stock, first found in south-eastern Wisconsin, about 1750. Their civilization was advanced and they lived in stockaded towns.

MIAMI, a town of Gila county, Arizona, U.S.A., 6 m. S.W. of Globe (*q.v.*) on Federal highway 180 and the Southern Pacific railway. Pop. (1920), 6,689; and in 1930 it was 7,693. It is a great copper-mining camp of the Globe-Miami district (which ranks third in the United States in the production of copper), in a cattle-raising and truck-farming region, containing many and varied mineral deposits and much beautiful scenery.

MIAMI, a city of south-eastern Florida, U.S.A., the county seat of Dade county; on Biscayne bay, at the mouth of the Miami river, from which a canal extends to Lake Okeechobee. It is on federal highways 1 and 94; has two municipal and one commercial airport; and is served by the Florida East Coast and the Seaboard Air Line railways, the Pan-American Airway and various steamship lines. The population was 69,754 (32% negroes) in 1925 (State census); 131,286 in 1926, after annexations of territory (special enumeration under the supervision of the Federal Census Bureau); but was 110,637 in 1930 by Federal census. Miami is the metropolis of south-eastern Florida, with a history which justifies its sobriquet "the magic city." Founded in 1896, by 1927 it had an assessed valuation of $389,853,131; its bank clearings in 1926 totalled $855,200,000; and in January 1928, it celebrated the completion of a programme of improvements costing $300,000,000. The city (on latitude 25° 47′) has a sub-tropical climate and vegetation. The average monthly mean temperature ranges from 66·5° F in January to 81·4° in August, and the extremes on record are 27° and 97°. Facilities are at hand



Weather graph of Miami, Florida. The mercury indicates the normal annual mean temperature, the centre curve shows the normal monthly mean temperature, the curves above and below, the highest and lowest temperatures ever recorded, and the columns indicate the normal monthly precipitation

for every conceivable sport and variety of recreation compatible with the climate. The harbour and channel (3·5 m.) to the ocean have been deepened by the Federal Government to 25 ft., accommodating large ocean-going vessels, and improvement of the inland waterway to Jacksonville is under way. Along the bay for 15 m. runs a 100 ft. boulevard, bordered with royal palms, and a water-front park has been created by filling in 43 acres. A 27-story county courthouse was completed in 1927, and office buildings and hotels are on a corresponding scale. Miami has extensive commercial fisheries, and its manufacturing industries (with an output in 1927 valued at $10,249,710) are already important and diversified. It ships large quantities of grapefruit, oranges, limes, pineapples, avocados, and other fruits, coco-nuts, and early vegetables.

In 1896 Henry M. Flagler extended the Florida East Coast railway to Miami (then a little Indian trading post consisting of two dwellings, a storehouse, and the small stone Ft. Dallas, erected in 1836 during the Seminole wars), and began the construction of the Royal Palm hotel. On July 28, 1896, the city was incorporated, with a population of 260. By 1910 it had grown to 5,471; by 1920 to 29,571. It was one of the principal foci in the rush to Florida which began in 1922. At the opening of the winter of 1925–26, when the boom was at its height, adventurers were arriving from all parts of the United States by rail, steamer, automobile, mule and on foot, at the rate of 6,000 a day, and leaving at the rate of 2,000 a day. Shelter was at a premium. Building was pushed at top speed, and tent colonies sprang up until they presented a serious sanitary problem. In September 1926, the city was seriously damaged by a West Indian hurricane, but it escaped with slight loss in the storm of 1928. The city is under a commission-manager form of government.

MIAMI, a city near the north-eastern corner of Oklahoma, U.S.A., on the Neosho river and federal highway 66; the county seat of Ottawa county. It is served by the Frisco, the Kansas, Oklahoma and Gulf, and electric railways. The population was 6,802 in 1920 (93% native white) and was 8,064 in 1930 by the Federal census. It is the metropolis of the principal lead and zinc mining district of the state, which in 1926 produced ores containing 65,473 tons of lead and 253,897 tons of zinc. There are smelters and various other manufacturing industries. Miami was founded in 1893 and incorporated as a city in 1895.

MIAMISBURG, a village of Montgomery county, Ohio, U.S.A., 11 m. S.S.W. of Dayton, on the Miami river and Federal highway 25. It is served by the Baltimore and Ohio, the Big Four and the Erie railways, and by interurban electric and motorbus lines. Pop. 4,383 in 1920; in 1930 it was 5,518. It is in the heart of the tobacco district of the State, and has flour, pulp and paper mills, and various other manufacturing industries.

MIANTONOMO (1565?–1643), chief of the Narraganset tribe of North American Indians, nephew of their grand sachem, Canonicus (d. 1647). He seems to have been friendly to the English colonists of Massachusetts and Connecticut, though he was accused of being treacherous. In 1637 he permitted John Mason to lead his Connecticut expedition against the Pequot Indians through the Narraganset country, and in 1638 he signed for the Narraganset the tripartite treaty between that tribe, the Connecticut colonists and the Mohegan Indians, which provided for a perpetual peace between the parties. In 1643 a quarrel broke out between the Mohegan and the Narraganset, and Miantonomo led his warriors against those of Uncas, the Mohegan sachem. He was defeated and captured at what is now Norwich, Conn., and was later tried at Boston. A committee of five clergymen, to whom his case was referred, recommended that he be executed, and the commissioners accordingly sentenced him to death and chose Uncas as his executioner. Miantonomo, who was kept in ignorance of this sentence, was taken to the scene of his defeat and was there tomahawked in cold blood by Wawequa, the brother of Uncas. There is a monument to Miantonomo in Sachem's Park, Norwich, Conn.

MIANWALI, a town and district of India in the Punjab. The town is situated on the left bank of the Indus, 655 ft. above sea-level. Pop. (1921) 9,115. The district was formed in 1901, after the creation of the North-West Frontier Province, out of the Cis-Indus portions of Bannu and Dera Ismail Khan districts. Area, 5,395 sq.m. Pop. (1921), 358,205. About three-quarters of the district lies to the east of the Indus. Along the river is a low fertile tract, liable to floods. The remaining upland, known as the Thal, is barren and sandy, cultivable only where irrigation is possible. In the north-east the district includes the western flank of the Salt Range. The part of the district west of the Indus is a level and fairly fertile plain. The chief agricultural products are wheat and other grains and oil-seeds. Hides and wool are also exported, together with small quantities of alum (abundant in the Salt Range), salt (from the Salt and Maidani ranges), and coal of poor quality, which is found at several points.

BY COURTESY OF THE UNDERWOOD PRESS SERVICE, LONDON

A MIAO OF SOUTH-WESTERN CHINA WITH HIS SON

MIAOTSZE, a hill tribe of southern China, of Northern Burma and Indo-China. At one time they occupied the fertile lands of central China, but were driven into the mountains of the southern provinces. They were driven out of Hunan about 800 B.C. and were finally crushed by the emperor K'ien-Lung. (*See* also MAN.)

See Playfair, *The Miaotzu of Kwei-chow and Yunnan* (1877).

MIAOULIS, ANDREAS VOKOS or BOKOS (1768–1835), Greek admiral and politician, was born in Negropont. He settled in the island of Hydra east of the Morea, and with the islanders took an early and active part in the Greek War of Independence. As early as 1822 Miaoulis was appointed navarch, or admiral, of the swarm of small vessels which formed the insurgent fleet. For the events of the struggle *see* GREEK INDEPENDENCE, WAR OF. He continued to be the naval chief of the Greeks till Lord Dundonald entered their service in 1827, when he retired in order to leave the English officer free to act as commander. When independence had been obtained, Miaoulis in his old age was entangled in the civil conflicts of his country, as an opponent of Capodistrias and the Russian party. He had to employ his skill in the employment of fireships against them at Poros in 1831. He died on June 24, 1835 at Athens.

MICA, a group of widely distributed rock-forming minerals, some of which have important commercial applications. The principal members of the group are muscovite, biotite, phlogopite and lepidolite (*q.v.*). The name is the Lat. *mica,* a grain, but is confused with *micare,* to glitter, the German word for mica, *Glimmer,* having also the meaning of glitter.

Mineralogical Characters.—The micas are characterized by a very easy cleavage in a single direction and by the high degree of flexibility, elasticity and toughness of the extremely thin cleavage flakes. They all crystallize in the monoclinic system, often, however, in forms closely resembling those of the rhombohedral or orthorhombic systems. Crystals have usually the form of hexagonal or rhomb-shaped scales, plates or prisms, with plane angles of 60° and 120°, and, with the exception of the basal planes, are only rarely bounded by smooth and well-defined faces. The different species have very nearly the same forms and interfacial angles, and the crystals not infrequently occur intergrown together in parallel position; those of Vesuvian biotite are the best developed.

When a cleavage flake of mica is struck a sharp blow with a blunt needle-point a "percussion figure" or six-rayed star of cracks is developed; the rays intersect at angles of approximately 60°, and the pair most prominently developed are parallel to the plane of symmetry of the crystal. A similar six-rayed system of cracks, bisecting the angles between the rays of the previous set, is produced when a blunt punch is gradually pressed against a sheet of mica; this is known as the "pressure figure." These cracks coincide with planes of easy separation or of gliding in the crystal; they are especially useful in helping to determine the crystallographic orientation of a cleavage flake when crystal faces are absent. Sheets of mica which have been subjected to earth-movements are frequently cracked and ridged parallel to these directions, and are then valueless for economic purposes.

In their optical characters the micas exhibit considerable variations. The indices of refraction are not high, the mean index being about 1·58–1·60, but the double refraction is very strong (0·04–0·05) and is negative in sign. The angle between the optic axes varies from 70–50° in muscovite and lepidolite to 10–0° in biotite and phlogopite; the latter are thus frequently practically uniaxial. The acute bisectrix of the optic axes never deviates from the normal to the basal plane by more than a degree or two, hence a cleavage flake of mica will always show an optic figure in convergent light when placed on the stage of a polarizing microscope. The plane of the optic axes may be either perpendicular or parallel to the plane of symmetry of the crystal, and according to its position two classes of mica are distinguished. To the first class, with the optic axial plane perpendicular to the plane of symmetry, belong muscovite, lepidolite, paragonite, and a rare variety of biotite called anomite; the second class includes zinnwaldite, phlogopite, lepidomelane and most piotites. Dark coloured micas are strongly pleochroic.

The different kinds of mica vary from perfectly colourless and transparent—as in muscovite—through shades of yellow, green, red and brown to black and opaque—as in lepidomelane; the former have a pearly lustre and the latter a submetallic lustre on the cleavage surfaces. Sheets very often show coloured rings and bands (Newton's rings), due to the interference of light at the surfaces of internal cleavage cracks. The sp.gr. varies between 2·7 and 3·1 in the different species. The hardness is 2–3; smooth cleavage surfaces can be just scratched with the finger-nail. Micas are bad conductors of heat and electricity, and it is on these properties that many of their technical applications depend. Inclusions of other minerals are frequently to be observed, and flattened crystals of garnet, films of quartz, and needles of tourmaline are not uncommon. Cleavage sheets are frequently disfigured and rendered of little value by brown, red or black spots and stains, often with a dendritic arrangement of iron oxides. Minute acicular inclusions, probably of rutile, arranged parallel to the rays of the percussion figure, give rise to the phenomenon of "asterism" in some micas, particularly phlogopite; a candle-flame or spot of light viewed through a cleavage sheet of such mica

appears as a six-rayed star.

Chemical Composition.—The micas are extremely complex and variable in composition. They are silicates, usually orthosilicates, of aluminium together with alkalis (potassium, sodium, lithium, rarely rubidium and caesium), basic hydrogen, and, in some species magnesium, ferrous and ferric iron, rarely chromium, manganese and barium. Fluorine is also often an essential constituent, and titanium is sometimes present.

The composition of the several species of mica is given by the following formulae, some of which are only approximate, and many attempts have been made to explain the variations in composition. It will be seen that they may be divided into two groups—alkali-micas (potash-mica, etc.) and ferromagnesian micas—which correspond roughly with the division into light and dark micas.

Muscovite	$H_2K\ Al_3(SiO_4)_3$
Paragonite	$H_2NaAl_3(SiO_4)_3$
Lepidolite	$KLi[Al(OH,F)_2]Al(SiO_3)_3$
Zinnwaldite	$(K,Li)_3[Al(OH,F)_2]FeAl_2Si_5O_{16}$
Biotite	$(H,K)_2(Mg,Fe)_2(Al,Fe_2(SiO_4)_3$
Phlogopite	$[H,K,(MgF)]_3Mg_3Al(SiO_4)_3$

The water which is present in muscovite to the extent of 4 to 6%, and rather less in the other species, is expelled only at a high temperature; it is therefore water of constitution, existing as basic hydrogen or as hydroxyl replacing fluorine.

Roscoelite is a mica in which the aluminium is largely replaced by vanadium (V_2O_3, 30%); it occurs as brownish-green scaly aggregates, intimately associated with tellurides of gold in California, Colorado and Western Australia.

Occurrence.—Mica occurs as a primary and essential constituent of igneous rocks of almost all kinds; it is also a common product of alteration of many mineral silicates, both by weathering and by contact- and dynamo-metamorphic processes. In sedimentary rocks it occurs as detrital material.

Muscovite and biotite are commonly found in siliceous rocks, whilst phlogopite is characteristic of calcareous rocks. The best crystallized specimens of any mica are afforded by the small brilliant crystals of biotite, which encrust cavities in the limestone blocks ejected from Monte Somma, Vesuvius. Large sheets of muscovite, such as are of commercial value, are found only in the very coarsely crystallized pegmatite veins traversing granite, gneiss or mica-schist. These veins consist of felspar, quartz and mica, often with smaller amounts of other crystallized minerals, such as tourmaline, beryl and garnet; they are worked for mica in India, the United States (South Dakota, Colorado and Alabama), and Brazil (Goyaz, Bahia and Minas Geraes). The commercially valuable micas of Canada and Ceylon are mainly phlogopite (*q.v.*), which has a rather different mode of occurrence. The mica mined in India is practically all muscovite. The principal mining districts are those of Hazāribāgh in Bengal and Nellore in Madras; in the former district the mica has usually a ruby tint, whilst in the latter it is more often greenish. In the Inikūrti mine, Nellore, "books" of mica measuring 10ft. across, and up to 15ft. across the folia have been found, and rectangular sheets measuring 30 by 24in. and free from cracks and flaws have frequently been obtained.

Uses.—On account of its transparency and its resistance to fire and sudden changes of temperature mica has been much used for the windows of stoves and lanterns, for the peep-holes of furnaces, and the chimneys of lamps and gas-burners. At one time it was used for window panes of houses and the port-holes of Russian men-of-war, being commonly known as "Muscovy glass." Spangles of mica are much used for decorative purposes of various kinds, and the mineral was formerly known as *glacies Mariae* (Ger., *Frauenglas*) because of its use for decorating statues of the Virgin. The *lapis specularis* of Pliny, scattered over the Circus Maximus to produce a shining whiteness, was probably mica. Large quantities of ground mica are used in the manufacture of wall-paper, and to produce a frosted effect on toys, stage scenery, etc. Powdered mica is also used in the manufacture of paints and paper, as a lubricant, and as an absorbent

World's Production of Mica, 1921–25
In Metric Tons
(Compiled by L. M. Jones of the U.S. Bureau of Mines)

Country	1921	1922	1923	1924	1925
North America					
Canada	637	3,038	3,197	3,711	3,647
United States	2,674	6,514	8,243	4,934	9,609
South America					
Argentina*	147	64	87	120	119
Brazil*	46	67	56	79	65
Europe					
Norway*	2	1	10	25	†
Rumania	.	..	6	.	
Russia	†	8	†	†	†
Spain	2	..	3	.	..
Sweden	†	8	5	4	†
Asia					
Ceylon*	5	1	1	..	1
Chosen	11	19	11	23	20
India (British) . . .	1,650	1,619	1,720	2,078	†
Japan	†	15	430	†	†
Africa					
Madagascar*	141	92	165	286	267
Rhodesia, Southern . .	77	60	83	136	132
Tanganyika Territory* . .	3	11	33	57	†
Union of South Africa (Transvaal)	1	3	15	735	1,490
Oceania					
Australia					
Northern Territory . .	1	1	3	3	3
Queensland	..	‡	..	..	1
Western Australia* . .	..	2	..	..	..

*Exports. †Data not available. ‡Less than ½ ton.

World's Production of Sheet Mica, 1921–25
In Metric Tons

Year	United States	India	Canada	Other countries	Total
1921 .	337	1,650	180	436	2,603
1922 .	489	1,619	179	352	2,639
1923 .	936	1,720	412	908	3,976
1924 .	663	2,078	618	1,468	4,827
1925 .	814	*	396	2,098	*

*Data not available.

of nitro-glycerine and disinfectants. Sheets of mica are used as a surface for painting, especially in India; for lantern slides; for carrying photographic films; as a protective covering for pictures and historical documents; for mounting soft and collapsible natural history specimens preserved in spirit; for vanes of anemometers; for mirrors of delicate physical instruments; for various optical and many other purposes. Being a bad conductor of heat it is used for the packing and jackets of boilers and steam-pipes. Other applications depend on the strength of its resistance to acids.

The most extensive application of mica at the present day is for electrical purposes. Being a bad conductor of electricity it is of value as an insulator, and the smooth flexible sheets are much used in the construction of armatures of dynamos and in other electrical machinery. "Micanite" or "micanite cloth"—small sheets of mica cemented with shellac or other insulating cement on cloth or paper—is used for various purposes.

Muscovite and phlogopite are practically the only species used commercially. Phlogopite is rarely found as colourless transparent sheets and is therefore almost exclusively used for electrical purposes. Many other uses of mica might be mentioned: the potassium it contains renders it of value as a manure, and the species lepidolite is largely employed in the manufacture of lithium and rubidium salts.

Mining, Preparation and Value.—Mica mining is an industry of considerable importance, especially in India where, however, methods are very primitive and wasteful. In working downwards in open quarries and in tortuous shafts and passages much of the mica is damaged and a large amount of labour is expended in hauling waste material to the surface. Since the mineral occurs

in definite veins a more satisfactory and economical method of working would be that adopted in metalliferous mines, with a vertical shaft, cross-cuts, and levels running along the strike of the vein; the mica could then be extracted by overhead stopping, and the waste material used for filling up the worked-out excavations.

In dressing mica the "books" are split along the cleavage into sheets of the required thickness, and the sheets trimmed into rectangles with a sharp knife, shears or guillotine, stained and damaged portions being rejected. The dressed sheets are sorted according to size, transparency, colour and freedom from spots or stains. Scrap mica is ground to powder or used in the manufacture of micanite.

See Sir T. H. Holland, "The Mica Deposits of India," *Memoirs of the Geological Survey of India* (1902), xxxiv. 11–121; F. Cirkel, *Mica: its Occurrence, Exploitation and Uses* (Canada, Mines Branch, Ottawa; 2nd edit. by H. S. de Schmid, 1912, No. 118); *Mica* Imp. Mineral Resources Bureau, London, 1922. (L. J. S.)

MICA PRODUCTION

From any one mine the percentage of the output of mica that can be manufactured in the sheets seldom exceeds 10%. Formerly the rejected material was mostly wasted; to-day this scrap mica is in active demand for grinding.

The term *vermiculite* is applied to the group of micaceous minerals which generally are alteration products of mica. Until a few years ago the few known deposits were considered a mineral curiosity. Large quantities have recently been discovered in Colorado and Montana, and have attracted attention to the commercial possibilities. The most pronounced characteristic of vermiculite is great expansion by heating which takes place in only one direction, at right angles to the cleavage.

During expansion the volume increases up to sixteen times the original. At the same time the colour changes according to the degree of heat and the exposure to the air. This change is believed to be caused by the oxidation of the iron in the mica and therefore to vary with the amount of oxygen available. The expanded product has been found to be an excellent heat insulator and sound deadener, and to possess possibilities as a paint and calcimine pigment.

MICAH, the sixth in literary order of the "minor prophets" of the Old Testament, is not to be confused with the 9th century Micaiah (1 Kings xxii.; the gloss in verse 28b, quoting Micah i. 2, and absent from the Greek version, shows that such confusion occurred at an early date). Micah was a younger contemporary of Isaiah, living in the closing decades of the 8th century, though, unlike Isaiah, he belonged to the country, not to the city. He is called "the Morashtite" as being a native of Moresheth-Gath (i.14), *i.e.*, a daughter-village of Gath, in the "Shephelah," a district in which his interest is manifest (i. 10–15).

The editorial title of the book of Micah declares that Micah prophesied "in the days of Jotham (739–734), Ahaz (733–721) and Hezekiah (720–693), kings of Judah." Nothing in the book itself can claim to belong to the reign of Jotham, but the prophecy against Samaria (i.5–8) may have been uttered originally before the fall of Samaria in 722, *i.e.*, in the reign of Ahaz. In its present form, however, it has been incorporated in a prophecy against Judah, belonging most probably, to the years shortly before 701, when a new Palestinian rising provoked Sennacherib's campaign. This prophetic activity of Micah under Hezekiah is confirmed by the direct statement of Jer. xxvi. 17 *seq.*, where Mic. iii. 12 is quoted ("Zion shall be plowed as a field," etc.). The verse quoted forms the climax of Mic. i.–iii., from which chapters only any certain conclusions as to the prophetic message of the historic Micah can be drawn; the remaining sections of the present book (iv.–v., vi.–vii.) consist, in whole or in greater part, of writings belonging to a later period.

The subject-matter of i.–iii. consists of a declaration of divine judgment against Israel, a warning to other nations (i.2). This takes the form of a theophany (i.3,4) and issues in the destruction of the northern and southern capitals (i.5), in which the evil to be punished is concentrated, and in the destruction of idols. The prophet wears the garb of a mourner, and loudly laments the fate that befalls Judah as well as Samaria, in a "dirge" that describes the destruction of the country-side, with many plays on names (i.10–16). The moral evils denounced are the rapacity of "land-grabbers" and the eviction of former owners (ii.1–11), the injustice of rulers and the falsity of prophets (iii.1–8), whose selfish interests dictate their conduct (iii.9–12). Their false confidence in the protection of Yahweh can have but one issue—the destruction of Jerusalem and its temple.

Our only evidence as to the reception of Micah's message by his contemporaries is that afforded by Jer. xxvi. 17 *seq.*, both directly, in the recorded effect on Hezekiah and the people; and indirectly, in the fact that the impression created was remembered a century afterwards. Micah resembles Amos, both in his country origin, and in his general character, which expresses itself in strong emphasis on the ethical side of religion. As the last of the four great prophets of the 8th century he undoubtedly contributed to that religious and ethical reformation whose literary monument is the Book of Deuteronomy.

The remainder of the book bearing the name of Micah falls into two main divisions, viz., iv., v. and vi., vii. Each differs from the first division (i.–iii.) in a marked degree. The second consists mainly of prophecies of restoration including eschatological (iv.1 *seq.*) and Messianic (v. 2 *seq.*) hopes. The third is formed of three or four apparently unrelated passages, on the spirituality of true worship (vi. 1–8), social immorality and its doom (vi. 9–16; vii. 1–6), and Israel's future recovery from present adversity through Divine grace (vii.7–20). It is improbable that much, if any, of these chapters can be ascribed to Micah himself, not only because their contents are so different from his undoubted work (i.–iii.), for which he was subsequently remembered (Jer. xxvi. 18), but because they presuppose the historic outlook of the Exile, or a later age (*e.g.*, iv. 6 *seq.; vii. 7 seq.*). It is neither psychologically nor historically impossible for a prophet of judgment to be also a prophet of comfort; but the internal evidence of composite and (in whole or part) later authorship must outweigh the traditional attachment of these passages to a ms. containing the work of Micah. It is noteworthy that the triple division of the book of Micah (i.–iii.; iv., v.; vi., vii.) corresponds with that of the book of Isaiah (i.–xxxix.; xl.–lv.; lvi.–lxvi.) in the character of the three divisions (judgment; coming restoration; prayer for help in adversity) respectively, and in the fact that the first alone gives us pre-exilic writing in the actual words of the prophet to whom the whole book is ascribed. In both cases, it need hardly be said, the great literary and spiritual value of the later passages ought in no way to suffer prejudice from critical conditions as to their date and authorship. Amongst these passages there are two that call for special notice. The first is the prophecy that the little clan of Ephrathah, which includes Bethlehem, the birthplace of David, is destined to be the source from which comes the future Davidic prince who shall "shepherd" the Messianic kingdom (v. 2, 4; the intervening verse is a gloss, connecting this "Messiah" with a Messianic interpretation of Is. vii. 14). The second is the summary of the fundamental principles of prophetic religion—justice, mercy, and humility (vi. 6–8).

BIBLIOGRAPHY.—The German commentaries of Nowack (1897, 1904), Wellhausen (1898), Marti (1904), Sellin (1922); the French commentary of van Hoonacker (1908); the English commentaries of Cheyne (*Cambridge Bible*, 1882); G. A. Smith (1896, 1927); J. M. P. Smith (International Critical Commentary 1912); H. Wheeler Robinson (in *Peake's Commentary*, 1919); G. W. Wade (*Westminster Commentary*, 1925); T. H. Robinson (in Clarendon Bible, O. T., vol. III. 1926). (H. W. R.)

MICA-SCHIST, in petrology, a rock composed essentially of mica and quartz, and possessing a foliated or schistose structure due to the parallel arrangement of the mica flakes. Mica-schists differ from gneisses principally by the absence of conspicuous alternations of schistose and granular bands characteristic of the latter rocks, and by the paucity of felspar minerals. Between phyllite and mica-schist there are all gradations. Mica-schists possess a greater variety of constituent minerals and are more coarsely crystallized. The mica may be muscovite or biotite; both are often present. Paragonite and fuchsite are rare. In addition to quartz, minor quantities of albite or oligoclase fel-

spar are frequently found. A great number of accessory minerals are known in mica-schists, and when these are conspicuous they may be regarded as constituting special varieties receiving distinctive names. These minerals include almandine garnet, staurolite, kyanite, andalusite and sillimanite. Many of them are indicators of a special grade of metamorphism. Minor accessories include rutile, hematite, ilmenite, tourmaline and zircon.

In nearly all cases mica-schists are metamorphosed sedimentary rocks of the composition of clays, shales and slates, though examples are known which are clearly transmuted acid igneous rocks, such as rhyolites and porphyries. The origin of these latter types, if not decipherable by their field relations, is usually indicated by their bulk chemical composition.

The common associates of mica-schist are quartzites, quartz-schists and limestones, representing sediments of a siliceous and calcareous nature interstratified with clays and mudstones from which the mica-schists are derived.

Like all metamorphic rocks mica-schists are principally found in areas of pre-Cambrian rocks. In the mountain chains of the Alps, the Himalayas, etc., mica-schists of Palaeozoic and Mesozoic age are known as they are seen to pass into sediments containing recognizable fossils. At Bergen, in Norway, Palaeozoic fossils have been found in mica-schists, and some of the Mesozoic schists of the Alps retain identifiable organic remains. Mica-schists are rarely of economic value, being too fissile for building-stones and too brittle for roofing slates. (*See* also SCHISTS.) (C. E. T.)

MICHAEL, an Old Testament name, synonymous with Micaiah or Micah (Num. xiii. 13; 1 Chron. v. 13, *et passim*). In the book of Daniel the name (which means "Who is like God?") is given to one of the chief "princes" of the heavenly host, the guardian angel or "prince" of Israel (Dan. x. 13, 21; xii. 1; *cf.* Enoch xx. 5 and possibly Mal. iii. 1). He holds the secret of the mighty "word" by which God created heaven and earth (Enoch lxix. 14), and was "the angel who spoke to Moses in the Mount" (Acts vii. 38). It was through Babylonian and Persian influence that names were given to the angels, and Michael finds a parallel in Vohumano, "Ahura's first masterpiece," one of the Zoroastrian Amesha-spentas or arch-angels. It is as guardian angel of Israel, or of the Church, the true Israel, that Michael appears in Jude 9 and Rev. xii. 7.

MICHAEL, the name of nine East-Roman emperors.

MICHAEL I. RHANGABES (d. 845), an obscure nobleman who had married Procopia, the daughter of Nicephorus I. He was made emperor in a revolution against his brother-in-law, Stauracius (811).

Elected as the tool of the orthodox party, Michael diligently persecuted the iconoclasts on the northern and eastern frontiers of the empire, but allowed the Bulgarians to ravage a great part of Macedonia and Thrace; having at last taken the field in the spring of 813, he was defeated near Versinikia, and relegated to a monastery in the island of Prote where he died in 845.

MICHAEL II., called PSELLUS, "the stammerer," emperor 820–829, a native of Amorium in Phrygia, began life as a private soldier, but rose by his talents to the rank of general. He had been sentenced to death in December 820 for a conspiracy against Leo the Armenian; his partisans, however, succeeded in assassinating Leo and called Michael to the throne. The principal features of his reign were a struggle against his brother general, Thomas (822–824); the conquest of Crete by the Saracens in 823; and the beginning of their attacks upon Sicily (827).

MICHAEL III. (839–867), "the drunkard," was grandson of Michael II., and succeeded his father Theophilus when three years old (842). During his minority the empire was governed by his mother Theodora (*q.v.*), who entirely neglected the education of her son. As a result Michael grew up a debauchee, and fell under the sway of his uncle Bardas, who induced him to banish Theodora to a convent, and practically assumed the chief control (857); in the wars of the period Michael himself took a more active part. During a conflict with the Saracens of the Euphrates (856–63), the emperor sustained a personal defeat (860), which was retrieved by a great victory on the part of his uncle Petronas in Asia Minor. In 861 Michael and Bardas invaded Bulgaria and secured the conversion of the king to Christianity. On sea the empire suffered under the ravages of the Cretan corsairs; and in 865 the first pillaging expedition of the Russians endangered the Bosporus. In 867 Michael was assassinated by Basil the Macedonian.

MICHAEL IV. (d. 1041), "the Paphlagonian," owed his elevation to Zoë, the wife of Romanus III., who poisoned her husband and married Michael, her chamberlain (1034). Michael, however, being weak and subject to epileptic fits, left the government in the hands of his brother, John the Eunuch. John's reforms of the army and financial system revived for a while the strength of the Empire. On the eastern frontier the important post of Edessa was relieved. The western Saracens were almost driven out of Sicily (1038–40); but an expedition against the Italian Normans suffered several defeats, and subsequently most of the Sicilian conquests were lost (1041). In the north the Serbs achieved a successful revolt (1040), but a dangerous rising by the Bulgarians and Slavs which threatened the cities of Thrace and Macedonia was repressed by a triumphant campaign which the decrepit emperor undertook in person shortly before his death (1041).

MICHAEL V. CALAPHATES, or "the caulker," nephew and successor of the preceding, surnamed after the early occupation of his father. He owed his elevation (Dec. 1041) to his uncle John, whom along with Zoë he almost immediately banished; this led to a popular tumult in consequence of which he was dethroned after a brief reign of four months, and relegated to a monastery.

MICHAEL VI., "the warlike," was already an old man when chosen by the empress Theodora as her successor shortly before her death in 1056. He was unable to check the disaffection of the feudal aristocracy, who combining with an officer named Isaac Comnenus, dethroned Michael (1057).

MICHAEL VII. DUCAS, or PARAPINACES, was the eldest son of Constantine X. Ducas. After a joint reign with his brothers, Andronicus I. and Constantine XI. (1067–1071), he was made sole emperor through his uncle John Ducas. The feebleness of Michael and the avarice of his ministers, were disastrous to the empire. As the result of anarchy in the army, the Byzantines lost their last possessions in Italy (1071), and were forced to cede a large strip of Asia Minor to the Seljuk Turks (1074). These misfortunes caused widespread dissatisfaction. In 1078 two generals, Nicephorus Bryennius and Nicephorus Botaniates, simultaneously revolted. Michael resigned the throne with hardly a struggle.

MICHAEL VIII. PALAEOLOGUS (1234–1282) was the son of Andronicus Palaeologus Comnenus and Irene Angela, the granddaughter of Alexius Angelus, emperor of Constantinople. At an early age he rose to distinction, and ultimately became commander of the French mercenaries in the employment of the emperors of Nicaea. A few days after the death of Theodore Lascaris II. in 1259, Michael, by the assassination of Muzalon, became guardian of the young emperor, John Lascaris. Afterwards invested with the title of "despot," he was finally proclaimed joint-emperor and crowned alone at Nicaea on Jan. 1, 1260. In July 1261 Michael conquered Constantinople through his general Strategopoulos. He thereupon had John Lascaris blinded and banished. For this last act he was excommunicated by Arsenius, and the ban was not removed until the accession of a new patriarch (1268). In 1263 and 1264 respectively, Michael, with the help of Urban IV., concluded peace with Villehardouin, prince of Achaia, and Michael, despot of Epirus, who had been decisively beaten at Pelagonia in Thessaly (1259); Villehardouin was obliged to cede Mistra, Monemvasia and Maina in the Morea.

Subsequently Michael was involved in wars with the Genoese and Venetians, whose influence in Constantinople he sought to diminish by maintaining the balance of strength between them. In 1269 Charles of Sicily, aided by John of Thessaly, made war with the alleged purpose of restoring Baldwin to the throne of Constantinople, and pressed Michael so hard that he consented to the papal supremacy at the council of Lyons in 1274. The union thus brought about between the two Churches was, however, extremely distasteful to the Greeks, and the persecution of his "schismatic" subjects to which the emperor was compelled to resort weakened his power so much that Martin IV. was tempted to enter into alliance with Charles of Anjou and the Venetians for the purpose of

reconquering Constantinople. The invasion, however, failed, and Michael so far had his revenge in the "Sicilian Vespers," which he helped to bring about. He died in Thrace in December 1282.

MICHAEL IX. PALAEOLOGUS, was the son of Andronicus II. and was associated with him on the throne from 1295, but predeceased him (1320). He took the field against the Turks (1301, 1310) and against the Grand Catalan Company (1305), but was repeatedly defeated.

See Gibbon's *Decline and Fall* (ed. Bury, 1911); G. Finlay, *Hist. of Greece* (ed. 1877); G. Schlumberger, *l'Epopée byzantine* (1896); J. Bury, in *Eng. Hist. Rev.* (1889); Meliarakes, Ἱστορία τοῦ βασιλείου τῆς Νικαίας καὶ τοῦ δεσποτάτου τῆς Ἠπείρου, pp. 539–627 (Athens, 1898).

MICHAEL (1596–1645), tsar of Russia, was the first tsar of the house of Romanov, being the son of Theodore Nekitich Romanov, afterwards the Patriarch Philaret (*q.v.*), and Xenia Chestovaya, afterwards the nun Martha. He was elected unanimously tsar of Russia by a national assembly on Feb. 21, 1613, but not till March 24 did the delegates of the council discover the young tsar and his mother at the Ipatievsky monastery near Kostroma. He was crowned on July 22. The first care of the new tsar was to clear the land of the robbers that infested it. Peace was made with Sweden and Poland by the peace of Stolbova (March 10, 1617) and the truce of Deulina (Feb. 13, 1619). The most important result of the truce of Deulina was the return from exile of the tsar's father, who henceforth took over the government till his death in October 1633. Michael died on July 12, 1645.

See R. Nisbet Bain, *The First Romanovs* (Lond., 1905).

MICHAELIS, GEORG (1857–), German statesman, was born on Sept. 7, 1857 at Haynau. He studied law and for some years lectured at the university of Tokyo. He entered the Prussian administration in 1879, and by 1909 had risen to the grade of under-secretary of state in the Prussian ministry of finance. On the outbreak of the World War he was appointed director of the imperial department for the control of the grain trade, and in Feb. 1917 State commissioner for the national food supply. On the retirement of Bethmann Hollweg in July 1917, the military authorities, with the object of avoiding conflict with the civil administration, advised the appointment of a chancellor who would accommodate his policy to theirs. Michaelis, as a colourless Prussian official, was selected, but even in the first weeks of his chancellorship his weakness became manifest. He was confronted with the demand of the parliamentary majority that he should publicly identify himself with the spirit and letter of the so-called Peace Resolution in favour of a peace "without annexation or indemnities" passed by the Reichstag on July 19, 1917. Under the influence of the military authorities he attempted to evade this obligation by declaring himself, in a phrase that became celebrated, the supporter of the resolution "as he understood it." He had still further to compromise himself over the naval mutiny before it was recognised that his position was untenable. He was succeeded by Count Hertling on Nov. 1, 1917. He was then appointed chief president in the province of Pomerania, an office which he held till 1919.

See his autobiographical *Für Staat und Volk* (1922).

MICHAELIS, JOHANN DAVID (1717–1791), German biblical scholar and teacher, was born at Halle, on Feb. 27, 1717, a member of a family which included several good biblical scholars. He qualified as university lecturer at Halle in 1739–40, but he did not feel at home in the pietistic atmosphere of the university at that time, and was glad to accept a position as *privatdozent* at Göttingen. He became full professor in 1750, and remained there until his death on Aug. 22, 1791. His works include *Supplementa* (1784–92) to the Hebrew lexicons; *Spicilegium geographiae Hebraeorum exterae post Bochartum* (1769–80); an interesting autobiography, *Lebens beschreibung* (1793). He also edited the *Orientalische und exegetische Bibliothek* (24 vols. 1771–79; new series, 8 vols. 1786–91).

MICHAEL OBRENOVIĆ III. (1838–1868), prince of Serbia, was the youngest son of Prince Miloš Obrenović I. (*q.v.*). After the abdication of his father (1839) and the death of his elder brother, Milan Obrenović II. (1840), he ascended the throne of Serbia. He began his reign with an ambitious programme of self-assertion abroad and reform within; but alienated Turkey and Austria, while the heavy taxation imposed multiplied the party which had forced his father to abdicate. In Aug. 1842 Vučić, the leader of the malcontents, forced him to leave the country, Alexander Karageorgević, son of Karageorge (*q.v.*), being elected in his place. He married, in 1856, Julia, Countess Hunyadi.

In 1858 Alexander was dethroned in his turn, and Miloš Obrenović I. recalled to the throne; on whose death (1860) Michael succeeded him. His policy was generally wise and moderate. He abolished the oligarchic Constitution of 1839, limiting the powers of the Senate and increasing that of the Skupština; established a regular national army, and reformed the judicature and administration. Meanwhile, he was planning an ambitious foreign policy, negotiating secretly with Bosnian, Bulgarian and Albanian leaders. Had his plans succeeded a great Yugoslavia would have been formed, including Bulgaria under Serbian leadership. He secured the sympathy of France to his plans, and a promise of neutrality from Austria; but his long diplomatic duel with the Turks only succeeded in obtaining the withdrawal of the last Turkish garrisons from Serbia (1867). Before he could take the next step, he was assassinated in the Topčider, near Belgrade, on the night of June 10, 1868.

MICHALAKOPOULOS, ANDREAS (1875–), Greek statesman, was born at Patras, in 1875, and first joined the military school, but subsequently became a practising lawyer. He entered politics in 1910 as an independent, joined the Liberals, and was minister of national economy under Venizelos in 1912 and 1915, and minister of agriculture in Venizelos' Salonika cabinet of 1916. He accompanied his leader to Paris for the peace negotiations; was out of office during the Royalist reaction of 1920–23, but re-elected in 1923, and negotiated the important Greek Refugees loan. In Nov. 1924 he became prime minister and minister of war, and in Jan. 1925, also minister of foreign affairs, holding office for the record period of eight months, despite the difficult situation (*see* GREECE). In June 1925 he was overthrown by General Pangalos (*q.v.*) and subsequently exiled to Naxos. In the "Oecumenical cabinet" formed on Dec. 4, 1926, he again became minister of foreign affairs, a post for which his long experience, his moderate views and his knowledge of languages peculiarly fitted him.

MICHAUD, JOSEPH FRANÇOIS (1767–1839), French historian and publicist, was born on June 19, 1767, at Albens, Savoy. He was a strong counter-revolutionary, and editor of *La Quotidienne*. He was proscribed more than once during the revolutionary period. He entered the Academy in 1814, and died at Passy, Paris on Sept. 30, 1839. His principal work is an *Histoire des croisades*, which was published in its final form in six volumes in 1840 under the editorship of his friend Poujoulat.

See Sainte-Beuve, *Causeries du lundi*, vol. vii.

MICHAUX, ANDRÉ (1746–1802), French botanist and traveller, was born at Versailles on March 7, 1746. In 1779 he spent some time botanizing in England, and in 1780 explored Auvergne, the Pyrénées and the north of Spain. In 1782 he was sent by the French government on a botanical mission to Persia. After two years he returned with a fine herbarium, and also introduced numerous Eastern plants into France. In 1785 he was sent to North America, but on his return in 1797 he was shipwrecked and lost most of his collections. In 1800 he went to Madagascar where he died on Nov. 16, 1802. His work on the flora of North America was a valuable contribution to American botany.

He wrote *Histoire des chênes de l'Amérique septentrionale* (1801) and the *Flora Boreali-Americana* (2 vols., 1803). His son François published a *Histoire des arbres forestiers de l'Amérique septentrionale* (3 vols., 1810–13, Eng. trans., 1817–19).

MICHEL, CLAUDE, known as CLODION (1738–1814), French sculptor, was born on Dec. 20, 1738 in Nancy. In 1755 he came to Paris and entered the workshop of Lambert Sigisbert Adam, his uncle, and on his death became a pupil of J. B. Pigalle. In 1759 he obtained the grand prize for sculpture at the Académie Royale; and in 1762 he went to Rome. Catherine II.

was eager to secure his presence in St. Petersburg, but he returned to Paris in 1771. Among his many patrons were the chapter of Rouen, the states of Languedoc, and the *Direction générale*. He frequently exhibited at the Salon. The agitation caused by the Revolution drove Clodion in 1792 to Nancy, where he lived until 1798. His works include a statue of Montesquieu, a "Dying Cleopatra," and a chimney-piece at present in the South Kensington Museum. One of his last groups represented Homer as a beggar being driven away by fishermen (1810). Clodion died in Paris on March 29, 1814.

Thirion's *Les Adam et Clodion* (1885) contains a list of the sculptor's works sold between 1767 and 1884. *See* also A. Jacquot, *Les Adam et les Michel et Clodion* (1898).

MICHEL, CLÉMENCE LOUISE (1830–1905), French anarchist, called *la Vierge rouge de Montmartre,* was born at the château of Vroncourt (Haute-Marne) on May 29, 1830, the daughter of a serving-maid, Marianne Michel, and the son of the house, Étienne Charles Demahis. She was brought up by her father's parents, and received a liberal education. After her grandfather's death in 1850 she was trained to teach, but her refusal to acknowledge Napoleon III. prevented her from serving in a state school. She found her way in 1866 to a school in the Montmartre quarter of Paris, where she threw herself ardently into works of charity and revolutionary politics. During the siege of Paris she joined the ambulance service, and untiringly preached resistance to the Prussians. On the establishment of the Commune she joined the National Guard. She was with the Communards who made their last stand in the cemetery of Montmartre, and was closely allied with Théodore Ferré, who was executed in Nov. 1871. This ardent attachment was perhaps one of the sources of the exaltation which marked her career, and gave many handles to her enemies. When she was brought before the 6th council of war in Dec. 1871 she defied her judges and defended the Commune. She was sent as a convict to New Caledonia, among her companions being Henri Rochefort, who remained her friend till the day of her death.

The amnesty of 1880 found her revolutionary ardour unchanged. She travelled throughout France, preaching revolution. For being concerned in a Paris riot in 1883 she was condemned to six years' imprisonment, but was again released in 1886. She was touring France and lecturing on behalf of anarchist propaganda when she died at Marseilles on Jan. 10, 1905.

Her *Mémoires* (1886) contain accounts of her trials. *See* also E. Girault, *La Bonne Louise* (1906).

MICHEL, FRANCISQUE XAVIER (1809–1887), French scholar, was born at Lyons on Jan. 18, 1809. He edited the works of many mediaeval French writers, and the French Government, recognizing their value, sent him to England (1833) and Scotland (1837) to continue his researches there. In 1839 he was appointed professor of foreign literature in the *Faculté des lettres* at Bordeaux. Between 1834 and 1842 he published editions of a large number of works written between the 11th and 14th centuries in French, English and Saxon, including the *Roman de la rose* and the *Chanson de Roland*. He died in Paris on May 18, 1887.

MICHELANGELO (Michelagniolo Buonarroti) (1475–1564), the most famous of the great Florentine artists of the Renaissance, was the son of Ludovico Buonarroti, a poor gentleman of that city, and of his wife Francesca dei Neri. The Buonarroti Simoni were an old and pure Florentine stock of the Guelf faction. Ludovico was barely able to live on the income of his estate, but boasted that he had never stooped to add to it by mercantile or mechanical pursuits. He held the appointment of podestà or resident magistrate for six months, from the autumn of 1474, at Castello di Chiusi and Caprese in the Casentino. At Caprese, on March 6, 1475, his second son Michelagniolo or Michelangelo was born. The child was put to nurse with a marble-worker's wife of Settignano. His mother died a few years later, after bearing three more sons. While still a young boy Michelangelo determined, in spite of his father's opposition, to be an artist. He had sucked in the passion, as he used to say, with his foster-mother's milk. After a sharp struggle his stubborn will overcame his father's pride and at thirteen he was articled as a paid assistant in the workshop of the brothers Ghirlandaio. Domenico Ghirlandaio, bred a jeweller, had become by this time the foremost painter of Florence. Michelangelo studied also, like all the Florentine artists of that age, in the Brancacci chapel, where the frescoes of Masaccio, painted some sixty years before, still held their own; and here, in reply, to a taunt he had flung at a fellow-student, Torrigiano, he received the blow on the nose which disfigured him for life.

Sculpture.—Though Michelangelo's earliest studies were directed towards painting, he was by nature and predilection much more inclined to sculpture. In that art he presently received encouragement and training under the eye of Lorenzo dei Medici. On the recommendation, it is said, of Ghirlandaio, he was transferred, before the term of his apprenticeship as a painter had expired, to the school of sculpture established by Lorenzo in the Medici gardens. Here he could learn to match himself against his great predecessor, Donatello, one of whose pupils and assistants, the aged Bertoldo, was director of the school, and to compare the works of that master and his Tuscan contemporaries with the antiques collected for the instruction of the scholars. Here, too, he could listen to discourses on Platonism, and steep himself in the doctrines of an enthusiastic philosophy which sought to reconcile with Christian faith the lore and the doctrines of the Academy. Michelangelo remained a Christian Platonist to the end of his days; he was also a devoted student of Dante. His powers soon attracted attention, and secured him the favour of his patrons in spite of his rugged exterior and scornful unsociable temper. A notable work of this period is the marble Centauromachia (Casa Buonarroti, Florence), a fine work in full relief: Michelangelo followed the antique in his conception and treatment of the nude but the arrangement is his own.

Michelangelo had been attached to the school and household of the Medici for barely three years when, in 1492, Lorenzo died. Lorenzo's son Piero dei Medici inherited the position but not the qualities of his father; Florence soon chafed under his authority; and towards the autumn of 1494 it became apparent that disaster was impending. Michelangelo was constitutionally subject to dark and sudden presentiments, and without awaiting the popular outbreak, which soon followed, he took horse with two companions and fled to Bologna. There he was received with kindness by a member of the Aldovrandi family, on whose commission he executed two figures of saints and one of an angel for the shrine of St. Dominic in the church of St. Petronius. After about a year, work at Bologna failing, and his name having been included on the list of artists appointed to provide a new hall of assembly for the great council of Florence, Michelangelo returned home.

He found a friend in another Lorenzo, the son of Pierfrancesco dei Medici, for whom he executed a statue of the boy St. John. Having also carved a recumbent Cupid in imitation of the antique, it was suggested to him by the same patron that it should be so tinted and treated as to look like a real antique, and sold accordingly. Michelangelo for amusement lent himself to the counterfeit, and the piece was then actually sold for a large sum, as a genuine work of antiquity, to a Roman collector, Raffaelle Riario, cardinal di San Giorgio; the dealer appropriating the profits. When the cardinal discovered the fraud he caused the dealer to refund; it was represented to Michelangelo that if he went to Rome the amateur who had just involuntarily paid so high a tribute to his skill would certainly befriend him. He arrived at Rome for the first time at the end of June 1496. He received no countenance from the cardinal di San Giorgio; neither did the banished Piero dei Medici, who also was now living at Rome, do anything to help him. But Michelangelo won the favour of a Roman nobleman, Jacopo Galli, and through him of the French cardinal Jean de Villiers de la Grolaie, abbot of St. Denis. From the former he received a commission for a "Cupid" (sometimes identified with the cupid in the Victoria and Albert Museum but this, if by Michelangelo, must belong to a later date) and a "Bacchus," (Bargello, Florence), from the latter for a "Pietà" (St. Peter's, Rome). Equal originality of conception and magnificence of technical execution mark the two contrasted subjects.

Michelangelo's stay in Rome at this time lasted from the summer of 1496 till that of 1501. The interval had been one of extreme political distraction at Florence, which had created an atmosphere most unfavourable to art. Nevertheless Ludovico Buonarroti, who in the troubles of 1494 had lost his permanent appointment in the customs, and had come to regard his son Michelangelo as the mainstay of his house, had been repeatedly urging him to come home. A spirit of family duty and family pride was the ruling principle in all Michelangelo's conduct. During the best years of his life he submitted himself sternly and without a murmur to pinching hardships and almost superhuman labour for the sake of his father and brothers. Having now, after an illness, come home in 1501, Michelangelo was requested by the cardinal Francesco Piccolomini to adorn with a number of sculptured figures a shrine already begun in the cathedral of Siena in honour of Pope Pius II. Four only of these figures were ever executed, and those not apparently, or only in small part, by the master's hand.

A work of greater interest in Florence itself had diverted him from his engagement to his Sienese patrons. This was the execution of the famous colossal statue of David, popularly known as "the Giant." It was carved out of a huge block of marble on which another sculptor, Agostino d'Antonio, had begun unsuccessfully to work forty years before, and which had been lying idle ever since. Michelangelo had here a difficult problem before him. Without much regard to the traditional treatment of the subject or the historical character of his hero, he carved out of the vast but cramped mass of material an adolescent, frowning colossus, tensely watchful and self-balanced in preparation for his great action. The result amazed every beholder by its freedom and science of execution and its victorious energy of expression. The best artists of Florence debated on what site it should be set up, and the terrace of the palace of the Signory was chosen, in preference to the neighbouring Loggia dei Lanzi. Here accordingly the colossal "David" of Michelangelo took, in the month of May 1504, the place which it continued to hold until in 1882 it was removed for the sake of protection to a hall in the Academy of Fine Arts, where it inevitably looks crushed and cabined. Other works of sculpture belong to the same period: among them a second "David," in bronze and on a smaller scale, commissioned by the maréchal Pierre Rohan and left by the young master to be finished by Benedetto da Rovezzano, who despatched it to France in 1508 and which is no longer extant; a great rough-hewn "St. Matthew" (Bargello, Florence), begun but never completed for the cathedral of Florence; a "Madonna and Child" executed on the commission of a merchant of Bruges and still to be seen in the Church of Notre Dame at Bruges; and two unfinished bas-reliefs of the same subject, one at the Diploma Gallery, Royal Academy, London; the other in the Bargello, Florence.

Painting: Early Works.—Neither was Michelangelo idle at the same time as a painter. Leaving disputed works for the moment out of sight, he in these days at any rate painted for his and Raphael's common patron, Angelo Doni, the "Holy Family" now in the Uffizi at Florence. The unfinished painting of "the Virgin and Child with Four Angels" in the National Gallery, London has been confidently claimed for Michelangelo; but it lacks his strength and mastery. In the autumn of 1504, the year of the completion of the "David," he received from the Florentine state a commission for a work of monumental painting on a heroic scale. Leonardo da Vinci had been for some months engaged on his great cartoon of the "Battle of Anghiari," to be painted on the wall of the great hall of the municipal council. The gonfalonier Piero Soderini now procured for Michelangelo the commission to design a companion work. Michelangelo chose an incident at the battle of Cascina during the Pisan war of 1364, when the Florentine soldiery had been surprised by the enemy in the act of bathing. He dashed at the task with his accustomed fiery energy, and had carried a great part of the cartoon to completion when, in the early spring of 1505, he broke off the work in order to obey a call to Rome which reached him from Pope Julius II. In the unfinished cartoon of the "Bathers" the qualities afterwards proverbially associated with Michelangelo—his *furia*, his *terribilità*, the tempest and hurricane of the spirit which accompanied his unequalled technical mastery and knowledge—first found expression.

Second Visit to Rome.—Michelangelo had not been long in Rome before Pope Julius entrusted to him the task of executing a sepulchral monument to be completed during his lifetime. The design being approved, the artist spent the winter of 1505–1506 at the quarries of Carrara, superintending the excavation and shipment of the necessary marbles. In the spring he returned to Rome, and when the marbles arrived fell to with all his energy at the preparations for the work. For a while the pope followed their progress eagerly. But presently his disposition changed. In Michelangelo's absence an artist who was no friend of his, Bramante of Urbino, had been selected by Julius to carry out a new architectural scheme, viz., the rebuilding of St. Peter's church. To the influence and the malice of Bramante, Michelangelo attributed the unwelcome invitation he now received to interrupt the great work of sculpture in order to decorate the Sixtine chapel with frescoes. Soon, however, schemes of war and conquest interposed to divert the thoughts of Julius from artistic enterprises. To add to the artist's discomfiture, when he went to apply for payments due, he was first put off from day to day, and at last actually with scant courtesy dismissed. At this he took horse and left Rome, and before the messengers of the pope could overtake him was safe on Florentine territory. Michelangelo's flight took place in April 1506. Once among his own people, he turned a deaf ear to all overtures made from Rome for his return, and stayed throughout the summer at Florence.

Statue of Pope Julius at Bologna.—During the same summer Julius planned and executed the victorious military campaign which ended with his unopposed entry at the head of his army into Bologna. Thither, under strict safe-conduct and promises of renewed favour, Michelangelo was at last persuaded to betake himself. Julius received the truant artist kindly, as indeed between these two volcanic natures there existed a natural affinity, and ordered of him his own colossal likeness in bronze, to be set up over the principal entrance of the church of St. Petronius. For the next fifteen months Michelangelo devoted his whole strength to this new task. In the technical art of metal casting he was inexperienced, and the work was cast by a Milanese whom Michelangelo had called, and on Feb. 21, 1508, the majestic bronze colossus of the seated pope, robed and mitred, with one hand grasping the keys and the other extended in a gesture of benediction and command, was raised to its station over the church porch. Three years later it was destroyed in a revolution. The people of Bologna rose against the authority of Julius; his delegates and partisans were cast out, and his effigy hurled from its place. The work of Michelangelo, after being trailed in derision through the streets, was broken up and its fragments cast into the furnace.

Sixtine Chapel.—Meanwhile the artist had followed his reconciled master back to Rome. The task that here awaited him, however, was the execution of the series of paintings in the Sixtine chapel. Painting, he always averred, was not his business; he was aware of his enemy's hopes that a great enterprise in fresco-painting would prove beyond his powers; and he entered with misgiving and reluctance upon his new undertaking. Destiny, however, so ruled that the work thus thrust upon him remains his chief title to glory. The only work which in all his life he was able to complete as he had conceived it was this of the decoration of the Sixtine ceiling. The pope had at first desired a scheme including figures of the twelve apostles only. Michelangelo proposed instead a design of many hundred figures embodying the story of Genesis from the Creation to the Flood, with accessory personages of prophets and sibyls dreaming on the new dispensation to come, and, in addition, those of the forefathers of Christ. The whole was to be enclosed and divided by an elaborate framework of painted architecture, with a multitude of nameless human shapes supporting its several members or reposing among them—shapes mediating, as it were, between the features of the inanimate framework and those of the great dramatic and prophetic scenes themselves. The pope bade the artist do as he pleased. By May 1508

the preparations in the chapel had been completed and the work begun. Later in the same year Michelangelo summoned a number of assistant painters from Florence. He soon dismissed them, and carried out the remainder of his colossal task alone, except for purely mechanicai and subordinate help. The physical conditions of prolonged work, face upwards, upon this vast expanse of ceiling were trying in the extreme.

After four and a half years of toil the task was accomplished. Michelangelo had been harassed alike by delays of payment and by hostile intrigue. Absolute need of funds for the furtherance of the undertaking constrained him at one moment to break off work and pursue his inconsiderate patron as far as Bologna. This was between September 1510, by which time the whole of the great series of subjects along the centre of the vault were completed, and January 1511, when the master set to work again and began filling the complicated lateral spaces of his decorative scheme.

The main field of the Sixtine ceiling—in form a depressed barrel vault—is divided in Michelangelo's scheme into four larger, alternating with five smaller fields. The following is the order of the subjects depicted in them: (1) the dividing of the light from the darkness; (2) the creation of sun, moon and stars; (3) the creation of the waters; (4) the creation of man; (5) the creation of woman; (6) the temptation and expulsion; (7) the sacrifice of Noah; (8) the deluge; (9) the drunkenness of Noah. The figures in the last three of these scenes are on a smaller scale than those in the first six. In numbers 1, 3, 5, 7 and 9, the field of the picture is reduced by the encroachments of the architectural framework with its seated pairs of supporters, commonly known as "Slaves" or "Atlases." Flanking these smaller compositions, along the lateral spaces between the crown of the vault and the walls on either side, are seated figures of prophets and sibyls alternately; two other prophets are introduced at each extremity of the series—making seven prophets and five sibyls in all. In the triangles to right and left of the prophets at the two extremities are the death of Goliath, the death of Holofernes, the brazen serpent and the punishment of Haman. In the twelve lunettes above the windows are groups of the ancestors of Christ, their names designated by inscriptions, and in the twelve triangles above them (between the prophets and sibyls) other kindred groups crouched or sitting. These last are all shown in relatively simple human actions and household relations, heightened but not falsified by the artist's genius, and rising into majestic significance from roots deep in daily human nature. The work represents all the powers of Michelangelo at their best. Disdaining all the accessory allurements of the painter's art, he has concentrated himself upon the exclusive delineation of the human form and face at their highest power. His imagination has conceived attitudes and combinations of unmatched variety and grandeur, and countenances of unmatched expressiveness and power. As for the intellectual meanings of his vast design, they are inexhaustible, and can never be perfectly defined. Whatever the soul of this great Florentine, the spiritual heir of Dante, with the Christianity of the middle ages not shaken in his mind, but expanded and transcendentalized, by the knowledge and love of Plato;—whatever the soul of such a man, full of suppressed tenderness and righteous indignation, and of anxious questionings of coming fate could conceive—that Michelangelo has expressed or shadowed forth in this great scheme of paintings. The powers of the artist seeem to have expanded with the progress of his work. He seems to have begun (as the spectator entering the chapel has to begin) with what is chronologically the last subject of the series, and rising in ascending scale of majesty through the successive acts of creation from the last to the first.

Death of Pope Julius.—The Sixtine chapel was no sooner completed than Michelangelo resumed work upon the marbles for the monument of Julius. But four months only had passed when Julius died. His heirs immediately entered (in the summer of 1513) into a new contract with Michelangelo for the execution of the monument on a reduced scale. What the precise nature and extent of the original design had been we do not know, only that the monument was to stand four-square and free—a thing hitherto unknown in Renaissance sepulchral architecture—in one of the chapels of St. Peter's But the new design was to consist of a great three-sided structure, two courses high, projecting from the church wall, and decorated on its three unattached sides with statues. A much injured and not indisputable sketch by the master at Berlin, with a copy of the same by Sacchetti, are supposed to show the design at this stage of its reduction. The entire work was to be completed in nine years' time. During the next three years, it would seem, Michelangelo brought to completion three at least of the promised figures, for which the blocks had reached Rome from Carrara as early as July 1508; and they are among the most famous of all existing works of the sculptor's art—namely, the "Moses," now in the church of S. Pietro in Vincoli at Rome and the two "Slaves" at the Louvre.

The "Moses," originally intended for one of the angles of the upper course, is now placed at the level of the eye in the centre of the reduced monument. The prophet supposed to have just found the Israelites worshipping the golden calf, sits heavily bearded and draped, his head raised and turned to the left, his right arm grasping the tables of the law—an incarnation of majestic indignation and menace. The work, except in one or two places, is of the utmost finish. The "Slaves" at the Louvre are youthful male figures of equally perfect execution, nude but for the band which passes over the breast of one and the right leg of the other. One, with his left hand raised to his head, his eyes almost closed, seems succumbing to the agonies of death; the other, with his arms bound behind his back, looks upward still hopelessly struggling. All three of these figures were finished between 1513 and 1516.

By 1516 Michelangelo's evil star was again in the ascendant. Julius II. had been succeeded on the papal throne by Cardinal Giovanni dei Medici under the title of Leo X. The Medici, too, had about the same time re-established their sway in Florence. The consequence to him of the rise to power of the Medici was a fresh interruption of his cherished work on the tomb of Julius. Leo X. and his kinsmen were full of a new scheme for the adornment of the façade of their own family church of San Lorenzo in Florence. Michelangelo offered his services for the new façade. They were eagerly accepted, although for a moment the idea had been entertained of entrusting the work to Leonardo da Vinci. The heirs of Julius at the request of Leo allowed their three-years'-old contract to be cancelled in favour of another, whereby the scale and sculptured decorations of the Julian monument were again to be reduced. Michelangelo soon produced for the San Lorenzo façade a design of combined sculpture and architecture as splendid and ambitious in its way as had been that for the original monument of Julius. The contract was signed in January 1518, and the artist went to Carrara to superintend the excavation of the marbles.

When all was well in progress there under his own eye, reasons of state induced the Medici and the Florentine magistracy to bid him resort instead to certain new quarries at Pietrasanta, near Serravalle in the territory of Florence. Hither Michelangelo accordingly had to transfer the scene of his labours. Presently he found himself so impeded and enraged by the mechanical difficulties of raising and transporting the marbles, and by the disloyalty and incompetence of those with whom he had to deal, that he was fain to throw up the commission altogether. The contracts for the façade of San Lorenzo were rescinded in March 1518, and the whole magnificent scheme came to nothing. Michelangelo then returned to Florence, where proposals of work poured in on him from many quarters. The king of France desired something from his hand. The authorities of Bologna wanted him to design a façade for their church of St. Petronius; those of Genoa to cast a statue in bronze of their great commander, Andrea Doria. Cardinal Grimani begged hard for any picture or statue he might have to spare. Lastly his friend and partisan Sebastian del Piombo at Rome besought him on Raphael's death to return at once to Rome, and take out of the hands of the dead master's pupils the work of painting still remaining to be done in the Vatican chambers. Michelangelo complied with none of these requests. All that we certainly know of his doing between 1518 and 1522 is the blocking out in the rough of four more of

the "Slaves" for the tomb of Julius, and carrying out a commission, which he had received from three citizens of Rome as early as 1514, for a statue of the risen Christ. The roughed-out "Slaves" now stand in the Academy of Fine Arts, Florence; the Christ, practically finished by the master but with the last touches added by pupils, stands in the church, for which it was destined, of Sta. Maria sopra Minerva at Rome.

Return to Florence and Patronage of the Medici.—The next twelve years of Michelangelo's life (1522–1534) were spent at Florence, and again employed principally in the service of the Medici. The plan of a great group of monuments to deceased members of this family, to be set up in a new sacristy or mortuary chapel in San Lorenzo, was first broached to Michelangelo in 1520 by Cardinal Giulio dei Medici. No practical impulse, however, was given to the work until Giulio had in his turn become pope in 1523 under the title of Clement VII. First Clement proposed to associate another artist, Sansovino, with Michelangelo in his task. This proposal being on Michelangelo's peremptory demand abandoned, Clement next distracted the artist with an order for a new architectural design—that, namely, for the proposed Medicean or "Laurentian" library. When at last the plans for the sepulchral chapel or "Sagrestia nuova" took shape, they did not include, as had been at first intended, memorials to the founders of the house's greatness, Cosimo (*pater patriae*) and Lorenzo the Magnificent, or even to Pope Leo X. himself, but only to two members of the house lately deceased, Giuliano, duke of Nemours, and Lorenzo, duke of Urbino. Michelangelo was still engaged on the execution of this work—his time being partly also taken up by the building-plans for the Medicean library—when political revolutions interposed to divert his industry. In 1527 came to pass the sack of Rome by the army of Charles V., led by the connétable de Bourbon, and the apparently irretrievable ruin of Pope Clement. The Florentines seized the occasion to expel the Medici, and set up a free republican government once more. Naturally no more funds for the works in San Lorenzo were forthcoming, and Michelangelo, on the invitation of the new signory, occupied himself for a while with designs for a group of Hercules and Cacus, and another of Samson and the Philistines—the latter to be wrought out of a block of marble which had been rough-hewn already for another purpose by Baccio Bandinelli. Soon, however, he was called to help in defending the city. Clement and his enemy Charles V. having become reconciled, both alike were now bent on bringing Florence again under the rule of the Medici. Michelangelo was appointed engineer-in-chief of the fortifications. He spent the early summer of 1529 in strengthening the defences of San Miniato; from July to September he was absent on a diplomatic mission to Ferrara and Venice. Returning in the middle of the latter month, he found the cause of Florence hopeless from internal treachery and from the overwhelming strength of her enemies. One of his dark seizures overcame him, and he departed again suddenly for Venice. There for a while he remained, negotiating for a future residence in France. Then, while the siege was still in progress, he returned once more to Florence; but in the final death-struggle of her liberties he bore no part. When in 1530 the city submitted to her conquerors, no mercy was shown to most of those who had taken part in her defence. Michelangelo believed himself in danger with the rest, but on the intervention of Baccio Valori he was presently taken back into favour and employment by Pope Clement. For four years more he continued to work at intervals on the completion of the Medici monuments, with the help from 1532 of Giovanni Montorsoli and other pupils, and on the building of the Laurentian library. In 1531 he suffered a severe illness; in 1532 he made a long stay at Rome, and entered upon yet another contract for the completion of the Julian monument, to be reduced now to a still more shrunken scale and to be placed not in St. Peter's but in the church of San Pietro in Vincoli. In the autumn of 1534 he left Florence for good. What remained to be done in the Medici chapel was done by pupils, and the chapel was not finally opened to view until 1545.

The Medici Monument.—The statues of the Medici monument take rank beside the "Moses" and the "Slaves" as the finest work of Michelangelo in sculpture. They consist of a Madonna and Child and of the two famous monumental groups, each composed of an armed and seated portrait-statue in a niche, with two emblematic figures reclining on each side of a sarcophagus below. The "Madonna and Child" (left unfinished because the marble was short in bulk) combines the divers qualities of realistic motive and natural animation with learned complexity of design and imposing majesty of effect. It was set up finally—not in accordance with the artist's first intention—against a blank wall of the chapel, and flanked by statues of SS. Cosmo and Damian, the work of pupils. The portraits are treated not realistically but typically. In that of Lorenzo seems to be typified the mood of crafty brooding and concentrated inward thought; in that of Giuliano, the type of alert and confident practical survey immediately preceding action. At the feet of the duke Giuliano recline the shapes of "Night" and "Day"—the former a female, the latter a male, personification; the former sunk in an attitude of deep but uneasy slumber, the latter (whose head and face are merely blocked out of the marble) lifting himself in one of wrathful and disturbed awakening. As grand, but far less violent, are those of the two companion figures that recline between sleep and waking on the sarcophagus of the pensive Lorenzo. Of these, the male figure is known as "Evening," the female as "Morning." In Michelangelo's original idea, partly founded on antique precedent in pedimental and sarcophagus groups, figures of "Earth" and "Heaven" were to be associated with those of "Night" and "Day" on the monument of Giuliano, and others—no doubt of a corresponding nature, with those of the Morning and Evening Twilight on that of Lorenzo. These figures afterwards fell out of the scheme and the recesses designed for them remain empty. Michelangelo's obvious and fundamental idea was to exhibit the elements and the powers of earth and heaven lamenting the death of the princes. River-gods were to recline on the broad bases at the foot of the monuments. These too are lacking. They were never finished, but a bronze cast from a small model of one of them, and the torso of a large model, have lately been identified, the former in the National Museum and the latter in the Academy at Florence.

Other Works, 1522–1534.—"Victory" marble (National Museum, Florence). A youthful conqueror standing over a bearded enemy, whose shoulders he crushes down with his left knee. Fine and finished work: whether intended for one of the emblematic Victories of the Julian monument, or having some connection with the "Hercules and Cacus" and "Samson and the Philistine," subjects undertaken for the Signory in 1528, must remain uncertain. For the former of these two subjects a wax model at the Victoria and Albert Museum, for the latter a plaster model at the Casa Buonarroti, are claimed, perhaps rightly, as original. "David" (formerly called "Apollo"), marble, unfinished (National Museum, Florence). Both the authenticity and the approximate date of this fine work are beyond doubt: of its origin and destination we are uninformed. "Crouching boy," marble, unfinished (the Hermitage, St. Petersburg). Another masterly sketch in marble; the seated lad stoops forward between his parted knees, having both hands occupied with his left foot; the figure blocked out of the marble, with the least possible sacrifice of the material; the subject and motive enigmatical. "Cupid," marble (Victoria and Albert Museum); probably, but not quite certainly, authentic; if so, then of 1530 or thereabouts; its identification with the early Cupid done for Jacopo Galli at Rome in 1496 is untenable.

Later Life in Rome.—Michelangelo had fully purposed, as soon as he could get free of his task on the Medici tombs, to devote all his powers to the completion of the Julian monument in accordance with the new contract of 1532. But his intention was again frustrated. Pope Clement insisted that he must complete his decorations of the Sixtine Chapel by painting anew the great end wall above the altar, adorned until then by frescoes of Perugino. The subject chosen was the Last Judgment; and Michelangelo began to prepare sketches. In the autumn of 1534, in his sixtieth year, he settled for the remainder of his life, at Rome. Immediately afterwards Clement died, and was succeeded by a Farnese under the title of Paul III. Even more than his predecessor, Paul insisted on claiming the main services of Michelangelo for himself.

For the first seven years after the artist's return to Rome, his time was principally taken up with the painting of the colossal and multitudinous "Last Judgment." This being completed in 1541, he was next compelled to undertake two more great frescoes—one of the Conversion of Paul and another of the Martyrdom of Peter—in a new chapel which the pope had caused to be built in the Vatican, and named after himself—Capella Paolina.

The fresco of the "Last Judgment" in the Sixtine Chapel is probably the most famous single picture in the world. In it Michelangelo shows more than ever the omnipotence of his artistic science, and the fiery daring of his conceptions. But the work, so far as its deplorably deteriorated condition admits comparison, is hardly comparable in the qualities of colour and decorative effect to the earlier and far more nobly inspired frescoes of the ceiling. It is to these and not to the "Last Judgment" that the student must turn if he would realize what is best and greatest in the art of Michelangelo.

The frescoes of the Pauline Chapel are on their part so injured as to be hardly susceptible of useful study or criticism. In their ruined state they bear evidence of the same tendencies that made the art of Michelangelo in its latest phase so dangerous an example to weaker men—the tendency, that is, to seek for unqualified energy and violence of action, both in place and out, for "terribleness" *quand même,* and to design actions not by help of direct study from nature, but by scientific deduction from the abstract laws of structure and movement. At best these frescoes can never have been happy examples of Michelangelo's art.

Other Works of 1534–1549. SCULPTURE.—During the fifteen years when Michelangelo was mainly engaged on these paintings, he had also at last been enabled to acquit himself, although in a manner that can have been satisfactory to none concerned, of his engagements to the heirs of Julius. Once more the influence of the pope had prevailed on them to accept a compromise altogether to their disadvantage. By a final contract dated 1542, it was agreed that the "Moses" executed thirty years before, seated on a low plinth in a central recess, should be the chief figure of the new scheme; in niches at either side of him were to be standing figures of "Leah" and "Rachel." These Michelangelo himself executed hastily with the help of assistants. To pupils entirely was left the carrying out of the upper cornice, with the recumbent effigy of the pope occupying the centre of a weak and incongruous architectural scheme, a Madonna and Child in a niche above, and a prophet and a sibyl in recesses at either side. Meantime all idea of incorporating any of the "Slaves" in the new design had been abandoned. The master gave the two that had been finished in 1513–1516 to Robert Strozzi, who gave them to Francis I. "Brutus," marble (National Museum, Florence). Probably executed soon after 1539, in memory of the tyrannicide Lorenzino de' Medici. To the end of this period or to a year or two later belongs the infinitely pathetic unfinished sketch in marble of a life-size "*Pietà*" (Palazzo Rondini, Rome)—the mourning mother, standing on an elevation behind her son, holds his body upright in front of her by the shoulders. Still later, after 1550, is the more complicated and more finished group of the "*Pietà*," with the corpse of Christ collapsing in utter relaxation through the arms of those who try to uphold it: this Michelangelo destined for his own sepulchre; it stands now in the cathedral at Florence.

PAINTING.—"The Entombment of Christ" (National Gallery, London). This unfinished painting bears all the marks of Michelangelo's design, and must have been begun from a cartoon by him, probably of about 1535–1540.

For nearly all his great life-works mentioned above, preparatory sketches and studies by the master's hand exist. These, with a large number of other drawings, finished and unfinished, done for their own sakes and not for any ulterior use, are of infinite value and interest to the student. Michelangelo was the most learned and scientific as well as the most inspired and daring of draughtsmen, and from boyhood to extreme old age never ceased to practise with pen, chalk or pencil. There are some 250 genuine sheets scattered amongst various collections, chiefly public; those in England (at the British Museum, the University Galleries, Oxford, and the Royal Library, Windsor), are quite half the whole number; other important examples remain still at what was for centuries the home of his heirs, the Casa Buonarroti at Florence; others at the Uffizi, Florence; the Venice Academy; the Albertina, Vienna; the Louvre; the Condé Museum at Chantilly; the Berlin Museum; and, not least, the Teyler Museum at Haarlem. By means of these drawings and the many published facsimiles we are best able to trace the progress of the master's genius and its secrets. We see him diligently copying in youth from the frescoes of Giotto, Masaccio, and his own master Ghirlandaio. At this date his instrument was the pen only, used in a manner of hatching: sometimes extremely careful and close, at others fiercely bold and free, and in either case all his own. Sketches and studies thus drawn with the pen exist for the "David," the "Bathers Surprised," the accessory figures for the tomb of Julius as first conceived, and the great series of the Sixtine Chapel decorations. By, or even before, the date of the Sixtine Chapel, chalk, red or black, comes into use along with the pen, and many of the finest studies for the "Slaves" or "Atlases" and other decorative figures of the ceiling are in the latter material (many more studies are preserved for these subordinate figures than for the main compositions). After the Sixtine Chapel period the pen gives way to red or black chalk almost entirely. Sketches are rare for the great abortive scheme of the Julius monument; almost non-existent for the equally abortive San Lorenzo façade; fairly abundant for the various stages of the Medici monument scheme in its architectural parts, but not for the great figures. About the time of Michelangelo's final change of domicile from Florence to Rome (1532–1535) he began the practice of making highly finished and fully shaded drawings of classic or symbolic subjects in red or black chalk for presentation to his friends, especially to young Tommaso Cavalieri, the object of his passionate Platonic affection, from about 1532. The "Fall of Phaeton," the "Tityos," the "Ganymede," the "Men shooting at a Mark," are well-known examples; in this class of work the Windsor collection is far the richest. At the same time, or soon afterwards, were produced drawings little less powerful and finished of Christian subjects, especially the "Crucifixion," "Entombment" and "Resurrection." Then comes the great fresco of the "Last Judgment," for which there exist both general sketches and particular studies. In the few extant drawings for the Capella Paolina a faltering both of the imagination and of the hand become discernible. To the same or to still later years belong many beautiful but somewhat tentative drawings done either directly for, or nearly in the spirit of, the famous "Crucifixion" which he is recorded to have painted with so much devotion for Vittoria Colonna.

Poetry.—During his later years the long-pent human elements of fervour and tenderness in Michelangelo's nature had found utterance such as they had never found before. He had occasionally practised poetry in youth, and there are signs of some transient love-passages during his life at Bologna. But it was not until towards his sixtieth year that the springs of feeling were fairly opened in the heart of this solitary, this masterful and stern, life-wearied and labour-hardened man. About 1533–1534 we find him beginning to address impassioned sonnets—of which the sentiment is curiously comparable to that expressed in some of Shakespeare's—to a beautiful and gifted youth, the young Roman noble Tommaso Cavalieri. Soon afterwards he made the acquaintance of the pious, accomplished and high-souled lady, Vittoria Colonna, widow of the Marquess Pescara. For ten years until her death, which happened in 1547, her friendship was the great solace of Michelangelo's life. On her, in all loyalty and reverence, he poured out all the treasures of his mind and all his imprisoned powers of tenderness and devotion. She was the chief inspirer of his poetry—of which, along with her praises, the main themes are the Christian religion, the joys of Platonic love, and the power and mysteries of art. Michelangelo's poetical style is strenuous and concentrated like the man. He wrote with labour and much self-correction; we seem to feel him flinging himself on the material of language with the same overwhelming energy and vehemence with which contemporaries describe him as flinging himself on the material of marble—the same impetuosity of temperament combined with the same fierce desire of per-

fection, but with far less either of innate instinct for the material or of trained mastery over its difficulties.

Last Years: Architecture.—And so the mighty sculptor, painter and poet reached old age. An infirmity which settled on him in 1544, and the death of Vittoria Colonna in 1547, left him broken in health and heart. But his strength held on for many a year longer yet. His father and brothers were dead, and his family sentiment concentrated itself on a nephew, Leonardo, to whom he showed unremitting practical kindness, coupled with his usual suspiciousness and fitfulness of temper. During the last years of his life he was much employed in the fourth art in which he excelled—that of architecture. A succession of popes demanded his services for the embellishment of Rome. Between 1536 and 1546 he was engaged on plans for the rearrangement and reconstruction of the great group of buildings on the Capitol—plans which were only partially and imperfectly carried out during his lifetime and after his death. For Paul III. he finished the palace called after the name of the pope's family the Farnese. On the death of Antonio da San Gallo he succeeded to the onerous and coveted office of chief architect of St. Peter's church, for which he remodelled all the designs, living to see some of the main features, including the supports and lower portion of the great central dome, carried out in spite of all obstacles, according to his plans. The dome as it stands is his most conspicuous and one of his noblest monuments: the body of the church was completed in a manner quite different from his devising. Other great architectural tasks on which he was engaged were the reconstruction of the Porta Pia, and the conversion of a portion of the baths of Diocletian into the church of Sta. Maria degli Angeli; the great cloister with its hundred columns, now used as the Museo delle Terme, is the only part of this reconstruction which remains as he designed it. At length, in the midst of these vast schemes and responsibilities, the heroic old man's last remains of strength gave way. He died on the threshold of his ninetieth year, on Feb. 18, 1564.

AUTHORITIES.—For the bibliography of Michelangelo, which is extensive, *see* E. Steinmann and R. Wittkover, *Michelangelo-Bibliographie* (Leipzig, 1927). The most important works, taken in chronological order, are the following: P. Giovio, supplement to the fragmentary *Dialogus de viris litteris illustribus*, written soon after 1527, first published by Tiraboschi, *Storia della letteratura italiana* (Modena, 1871); G. Vasari, in *Vite degli più eccellenti architettori pittori, e scultori*, etc. (Florence, 1550); A. Condivi, *Vita di Michelangelo Buonarroti* (1553); this account, for which the author, a pupil and friend of the master's, had long been collecting materials, was much fuller than that of Vasari, who made use of it in rewriting his own life of Michelangelo for his second edition, which appeared after the master's death (1568). The best edition of Vasari is that by Milanesi (Florence, 1878–83); of Condivi, that by Antonio Maraini (Florence, 1927); for English readers there is a useful translation by H. Home (Boston, 1904). *See* also C. Holroyd, *Michael Angelo Buonarroti* with translations of the life of the master by Ascanio Condivi and three Dialogues from the Portuguese by Francisco D'Ollanda (1903). The first additions of importance were published by Bottari, *Raccolta di lettere sulla pittura*, etc. (Rome, 1754; 2nd ed. by Ticozzi, Milan, 1822); the next by Gaye, *Carteggio inedito* (1840). Portions of the correspondence preserved in the Buonarroti archives were published by Guasti in his notes to the *Rime di Michelangelo Buonarroti* (1863), and by Daelli in *Carte Michelangelsche inedite* (Milan, 1865). Complete biographies of Michelangelo had been meanwhile attempted by J. Harford (London, 1857), and with more power by Hermann Grimm, *Leben Michelangelos* (Hanover, 5th ed., 1879). A great increment of biographical material was at length obtained by the publication, in the four-hundredth year after Michelangelo's birth, of the whole body of his letters preserved in the Buonarroti archives, *Lettere di Michelangelo Buonarroti*, ed. G. Milanesi (Florence, 1875). This material was first employed in a connected but too trivial narrative by A. Gotti, *Vita di Michelangelo* (Florence, 1875). Next followed C. Heath Wilson, *Life and Works of Michelangelo Buonarroti* (Florence, 1876), the technical remarks in which, especially as concerns the fresco paintings, are still valuable. Other lives of Michelangelo are by J. A. Symonds, *The Life of Michelangelo* (London, 1893), full of valuable matter on the history and spirit of Michelangelo's times, but not trustworthy in the criticism of his works. *Michelangelo*, by Fritz Knapp, in the *Klassiker der Kunst* series (Stuttgart, 1906) is a very useful compendium. For the early works of Michelangelo the standard authority is H. Wölfflin, *Die Jugendwerke Michelangelos* (Munich, 1891, and later editions). The most elaborate study of the Sixtine frescoes, magnificently illustrated, is by E. Steinmann, *Die Sixtinische Kapelle*, vol. ii. (Munich, 1905). Consult also C. Justi, *Michelangelo* (Leipzig, 1903), and with caution H. Thode, *Michelangelo u. das Ende der Renaissance* (1902–03). Of the poems of Michelangelo the first sound edition is that already referred to, G. Guasti, *Rime di Michelangelo Buonarroti* (1863); in earlier editions the text had been recklessly tampered with, and the rugged individuality of the master's style smoothed down. An edition with German translations was published by Hasenclever (Leipzig, 1875); and a thorough critical edition by Karl Frey (Berlin, 1897); for the English student the translations by J. A. Symonds, in *Sonnets of Michelangelo and Campanella* (1878) are invaluable. On the drawings of Michelangelo *see* especially B. Berenson, *The Drawings of Florentine Painters* (1903). A comprehensive work on the same subject, in which the most important examples are reproduced and discussed, unfortunately not arranged chronologically, is Karl Frey, *Die Zeichnungen Michelangelos* (Berlin, 1908 *seq.*). An elaborate life by the same author (Karl Frey, *Michelagniolo Buonarroti, sein Leben und seine Werke*) is more to be prized for documentary fullness and accuracy than for critical insight. *See* also Romain Rolland, *Vie de Michelange* (1917); E. Steinmann, *Die Portraitdarstellungen des Michelangelo* (Leipzig, 1913).
(S. C.; X.)

MICHELET, JULES (1798–1874), French historian, was born at Paris on Aug. 21, 1798, of a family which had Huguenot traditions. His father was a master printer, and Jules was offered a place in the imperial printing office, but his father sent him to the Lycée Charlemagne, where he passed the university examination in 1821. Shortly after appointed he began to teach history in the Collège Rollin. Soon after this, in 1824, he married. Between 1825 and 1827 he produced divers sketches, chronological tables, etc., of modern history. In 1827 he was appointed maître de conférences at the École normale.

Four years later, in 1831, the *Introduction à l'histoire universelle* showed a very different style, displaying the peculiar visionary qualities which made Michelet the most stimulating, but the most untrustworthy (not in facts, which he never consciously falsifies, but in suggestion) of all historians. The events of 1830 had unmuzzled him, and had put him in a better position for study by obtaining for him a place in the Record Office, and a deputy-professorship under Guizot in the literary faculty of the university. Soon afterwards he began his chief and monumental work, the *Histoire de France*. But he accompanied this with numerous other books, chiefly of erudition, such as the *Oeuvres choisies de Vico*, the *Mémoires de Luther écrits par lui-même*, the *Origines du droit français*, and somewhat later the *Procès des templiers*. In 1838 he was appointed to the chair of history at the Collège de France. He published, in 1839, his *Histoire romaine*. The results of his lectures appeared in the volumes *Le Prêtre, la femme, et la famille* and *le peuple*.

The principles of the outbreak of 1848 were in the air, and Michelet was one of those who condensed and propagated them. When the actual revolution broke out Michelet devoted himself even more strenuously to his literary work.

He began and carried out, during the years between the downfall of Louis Philippe and the final establishment of Napoleon III., an enthusiastic *Histoire de la révolution française*. Despite or because of its enthusiasm, this was by no means Michelet's best book.

The *coup d'état* lost Michelet his place in the Record Office, as, though not in any way identified with the republic administratively, he refused to take the oaths to the empire. But the new régime only kindled afresh his republican zeal, and his second marriage (with Mlle. Adèle Malairet) seems to have further stimulated his powers. While the history steadily held its way, a crowd of extraordinary little books accompanied and diversified it. Sometimes they were expanded versions of its episodes, sometimes what may be called commentaries or companion volumes. In some of the best of them natural science, a new subject with Michelet, to which his wife is believed to have introduced him, supplies the text. These are *Les Femmes de la révolution* (1854), *L'Oiseau* (1856), *L'Insecte*, *L'Amour* (1859), *La Femme* (1860), *La Mer* (1861), and *La Sorcière* (1862). Developed out of an episode of the history, *La Sorcière* has all its author's peculiarities in the strongest degree. It is a nightmare and nothing more, but a nightmare of the most extraordinary verisimilitude and poetical power. Later short works are: *La Bible de l'humanité* (1864), an historical sketch of religions; *La Montagne* (1868); *Nos fils* (1869), a tractate on education; and *Le*

Banquet, posthumously published, a vivid picture of the industrious and famishing populations of the Riviera. Two collections of pieces, written and partly published at different times, are *Les Soldats de la révolution* and *Légendes démocratiques du nord.*

The publication of this series of books, and the completion of his history, occupied Michelet during both decades of the empire. He lived partly in France, partly in Italy, and was accustomed to spend the winter on the Riviera, chiefly at Hyères. At last, in 1867, the *Histoire de France* was finished. In the usual edition it fills nineteen volumes. Michelet was perhaps the first historian to devote himself to anything like a picturesque history of the middle ages, and his account is still the most vivid that exists. His inquiry into manuscript and printed authorities was most laborious, but his lively imagination, and his strong religious and political prejudices, made him regard all things from a singularly personal point of view.

Uncompromisingly hostile as Michelet was to the empire, its downfall and the accompanying disasters of the country once more stimulated him to activity. Not only did he write letters and pamphlets during the struggle, but when it was over he set himself to complete the vast task which his two great histories had almost covered by a *Histoire du XIX siècle.* He did not, however, live to carry it farther than Waterloo. The new republic was not altogether a restoration for Michelet, and his professorship at the Collège de France of which he contended that he had never been properly deprived, was not given back to him. He died at Hyères on Feb. 9, 1874.

See G. Monod, *Jules Michelet: études sur sa vie et ses oeuvres* (Paris, 1905); R. van der Elst, *Michelet, naturaliste: esquisse de son système de philosophie* (1914); G. J. J. Monod, *La vie et la pensée de J. Michelet, 1798–1852* (2 vols. 1923); and L. Refort, *L'art de Michelet dans son oeuvre historique* (1923).

MICHELL, JOHN (1724–1793), English natural philosopher and geologist, was born in 1724, and educated at Queens' College, Cambridge. He was a fellow of his college, and was appointed Woodwardian professor of geology in 1762, and in 1767 rector of Thornhill in Yorkshire, where he died on April 29, 1793. He was elected a fellow of the Royal Society in 1760. In 1750 he published at Cambridge a work of some 80 pages entitled *A Treatise of Artificial Magnets, in which is shown an easy and expeditious method of making them superior to the best natural ones.* Besides the description of the method of magnetization which still bears his name, this work contains a lucid exposition of the nature of magnetic induction. He was the founder of seismology. Michell was the original inventor of the torsion balance, which afterwards became so famous in the hands of its second inventor Coulomb. Michell described it in his proposal of a method for obtaining the mean density of the earth. He did not live to put his method into practice; but this was done by Henry Cavendish (*Phil. Trans.*, 1708). His most important geological essay was that entitled *Conjectures concerning the Cause and Observations upon the Phaenomena of Earthquakes* (*Phil. Trans.*, li. 1760).

Michell's other contributions to science are: "Observations on the Comet of January 1760 at Cambridge, *Phil. Trans.* (1760); "A Recommendation of Hadley's Quadrant for Surveying," *ibid.* (1765); "Proposal of a Method for measuring Degrees of Longitude upon Parallels of the Equator," *ibid.* (1766); "An Inquiry into the Probable Parallax and Magnitude of the Fixed Stars," *ibid.* (1767); "On the Twinkling of the Fixed Stars," *ibid.* (1767), "On the Means of Discovering the Distance, Magnitude, etc., of the Fixed Stars," *ibid.* (1784).

See Charles Davidson, *The Founders of Seismology* (1927).

MICHEL OF NORTHGATE, DAN (*fl.* 1340), English writer, the author of the *Ayenbite of Inwyt.* Nothing is known of him except what can be gathered from his work. It is a literal translation in the Kentish dialect of a French treatise entitled *Le Somme des vices et des vertues* (also known as *Le Miroir du monde* or *Le Livre des commandemens*, etc.), written in 1279 by Laurentius Gallus, a Dominican monk and confessor to Philip III. of France. This work was translated into Flemish, Catalonian, Spanish and Italian, and appears in no less than six English translations. Dan Michel's autograph ms. is preserved in Arundel ms. 57, which states that the work was completed in the year 1340 on the eve of the apostles Simon and Jude by Dan Michel of Northgate, a brother of the cloister of St. Austin of Canterbury. The value of the book is chiefly philological as an authenticated and dated example of the southern dialect.

The *Ayenbite of Inwyt* was edited for the Roxburghe club by the Rev. J. Stevenson in 1855, and for the early English Text Soc. by R. Morris in 1876.

MICHELOZZO DI BARTOLOMMEO (1396–1472), Italian architect and sculptor, was a Florentine by birth, the son of a tailor. He was trained as a goldsmith and at the age of 24 entered the workshop of Ghiberti, whom he assisted on both doors of the Florentine Baptistry and with the statue of St. Mather's for Or San Michele. He assisted Donatello in bronze work such as the "St. Louis" for Or San Michele and the "Salome's Dance" in the Sienese Baptistery. In 1428 he signed the contract for the exterior pulpit of the cathedral at Prato of which the sculpture is by Donatello. His first independent work in sculpture was the tomb of Bartol. Aragazzi, parts of which are at Montepulciano, and of which the Victoria and Albert Museum has two fine figures of angels (1437). Michelozzo's great friend and patron was Cosimo de' Medici, whom he accompanied to Venice in 1433 during his short exile. While at Venice, Michelozzo built the library of San Giorgio Maggiore. The magnificent Palazzo Medici-Riccardi at Florence was designed by him for Cosimo (1444); it is one of the noblest specimens of Italian 15th-century architecture. He built the library, convent and cloister of San Marco in Florence (1437–1452). In 1446 he succeeded Brunneleschi as architect of the Duomo. In 1448 he executed the tabernacle at S. Miniato for Piero de' Medici. The beautiful silver statuette of the Baptist now in the Opera del Duomo is dated 1452. He remodelled the interior of the Palazzo Vecchio, especially the main court and the hall of The Two Hundred. At Milan he remodelled the Palace of the Medici, now Vismara, and built the Portinari Chapel at the church of S. Eustorgio. He was called to Ragusa in Dalmatia in 1464 and there designed the arcade of the Palazzo Rettorale. He also superintended the fortification on the island of Chios. He died in Florence in 1472 and is buried in San Marco

See Hans Stegman, *Michelozzo di Bartolommeo* (Munich, 1888); Fritz Wolff, *Michelozzo di Bartolommeo* (Strassburg, 1900); C. von Fabriczy, *Jahrbuch der Kgl. Preusz. Kss. XXV.* (1904); W. Bode. *Florentiner Bildhauer* (1909); A. Schmarsow, *Nuovi studi intorno a Michelozzo* (Arch. stor. 1893).

MICHELSEN, PETER CHRISTIAN HERSLEB KJERSCHOW (1857–1925), Norwegian statesman, was born at Bergen on March 15, 1857. At the general election of 1903 he was returned to the Storting as a member for the country district outside Bergen. Appointed Prime Minister in the spring of 1905 Michelsen played a leading part in the events which resulted in the dissolution of the union with Sweden and the establishment of the new kingdom of Norway. In 1907 he definitely retired from politics and died near Bergen on June 29, 1925.

MICHELSON, ALBERT ABRAHAM (1852–), American physicist, was born in Strelno, Germany, Dec. 19, 1852. His parents moved to San Francisco, Calif., where he studied in the public schools. He graduated from the U.S. Naval Academy in 1873, and was instructor in physics and chemistry there (1875–79). He was then for a short time in the *Nautical Almanac* office. From 1880 to 1882 he studied in Berlin, Heidelberg and Paris. He resigned from the Navy in 1881. In 1883 he was appointed professor of physics at the Case school of applied science, Cleveland, O., and six years later accepted a similar position at Clark University. In 1892 he was appointed professor and head of the department of physics at the University of Chicago. He early directed his researches to the velocity of light, and while in Cleveland invented his interferometer for measuring distances by means of the length of light-waves. His researches enabled him to revise and improve upon the achievements of Fizeau in respect of the velocity of light. He perfected the methods for experimenting, and determined with great precision the speed at which light travels.

Michelson measured a metre in terms of the wave-length of cadmium light for the Paris Bureau International des Poids et Mesures. The consequence is that the metre bar, hitherto carefully safeguarded in Paris, can easily be replaced, since its length

is known in terms of an absolute unit. In 1892 he was a member of the Bureau International des Poids et Mesures and in 1897 of the International Committee of Weights and Measures. He was president of the American Physical Society in 1901, of the American Society for the Advancement of Science in 1910, and of the National Academy of Science (1923–27). He received medals and prizes from many learned societies, and in 1907 was awarded the Nobel Prize for physics. During the World War he rejoined the naval service and devoted his entire time to new devices for naval use. His range-finder was adopted as part of the U.S. Navy equipment. In 1920 he was able to demonstrate by means of light interference that the diameter of Betelgeuse was 260,000,000 miles. This was the first approximately accurate determination of the size of a star. He published *Velocity of Light* (1902); *Light Waves and Their Uses* (1903); *Studies in Optics* (1927); and numerous papers in scientific journals. He was the first to be appointed "distinguished service professor" at the University of Chicago (1926). (For the "Michelson-Morley experiment" in interference of light, with its bearing on the Einstein theory, *see* RELATIVITY.)

MICHELSON-MORLEY EXPERIMENT. A celebrated experiment carried out by A. A. Michelson and E. W. Morley, to attempt to measure a velocity of the earth through the ether by the effect which such a velocity might be anticipated to have on the velocity of light. Had such a velocity been established, axes fixed in the ether could have been taken as standards of fixed position, to which all velocities could be referred, and in this sense we should have been able to talk of the absolute velocity of a material body, as distinct from the relative velocity of two material bodies. The failure of Michelson and Morley to detect any influence of the earth's motion on the velocity of light really formed the starting point of Einstein's theory of relativity (*see* RELATIVITY), and it is on account of its importance for this theory that the experiment is so fundamental, and has been so often repeated.

In the experiment light is sent along two paths at right angles to one another. If the luminiferous ether were a fixed medium, obeying the laws of such a wave-carrying medium as an elastic solid (or, to be more correct, if less suggestive, of a medium obeying the laws represented by Maxwell's original equations) then the time of the passage of the light should be greater for a to-and-fro path in the direction of the earth's motion through the ether than for a to-and-fro path, of equal length, at right angles to the direction of motion. More precisely, when light goes from a source to a mirror at distance l and back, and both source and mirror are moving with the same velocity v, the time taken is $\frac{l}{c-v}+\frac{l}{c+v}$ when the motion is in the direction of the rays, and is

$$\frac{2l}{c}\Big/\sqrt{\left(1-\frac{v^2}{c^2}\right)}$$

when it is crosswise, c being velocity of light. These expressions are approximately $\frac{2l}{c}\left(1+\frac{v^2}{c^2}\right)$ and $\frac{2l}{c}\left(1+\frac{1}{2}\frac{v^2}{c^2}\right)$ respectively, so that the difference depends on $\left(\frac{v}{c}\right)^2$ which, on account of the smallness of all terrestrial velocities compared to the velocity of light, is very small and requires the greatest refinement of experimental skill for its detection. (*See* RELATIVITY.)

If, therefore, the apparatus can be set so that one path lies in the direction of motion, and can then be turned through a right angle, the two beams of light will interchange their rôles, the one which in the first position travelled the faster travelling the slower in the second position. If, further, a system of interference fringes is formed by the two beams, as is done in the Michelson interferometer (*see* INTERFEROMETER), then it follows at once that this fringe system will shift when the apparatus is slowly rotated, so that it must pass through the two positions just specified twice per revolution. Michelson and Morley looked for, but failed to find, any shift of fringes of the order of magnitude to be expected on the hypothesis of a fixed ether.

Preliminary experiments were carried out by Michelson alone in 1881; the experiment with Morley, of a superior order of accuracy, was performed in 1887. In the experiment of 1887 the interferometer was mounted on a heavy block of stone which was carried by a disc of wood floating in a tank of mercury: this arrangement enabled the apparatus to be rotated smoothly without causing any strains to be set up. To increase the light path, and so the effect to be sought, each of the interfering beams was reflected several times backwards and forwards: four mirrors were used to replace each of the single mirrors in the simple form of interferometer, and their supplementary mirrors. The total length of the path of either beam was about 1,100 cm. With such a path length the difference of times to be expected on the fixed ether hypothesis, though only about 1 in 100,000,000, should give rise to a displacement of ·4 of a fringe. But the actual displacement measured was at most a fortieth of this value. In carrying out the experiment the orbital motion of the earth alone was considered, the sun being considered at rest. (The rotational motion of the earth produces a velocity which is, of course, negligibly small compared to the orbital motion.) Readings were made for sixteen different directions, the stone being kept slowly turning and the observations taken by the experimenter walking round with it. The experiment was carried out at midday, when the velocity relative to the sun is in the plane of the apparatus, and at 6 P.M., when the velocity is normal to the plane of the apparatus. To see if there was a velocity of the solar system as a whole through the ether, which might, by a remote chance, have cancelled out the orbital motion at the particular month of the experiment, it was proposed to repeat the experiment every three months. Recent experiments have put this possible explanation of the negative effect out of court.

The experiment is of such fundamental importance that it has been much repeated, with a view both to increasing the accuracy and to investigating suggested explanations of the negative effect, other than that offered by the theory of relativity. In 1904, that is, a year before Einstein first put forward his theory, Morley and Miller carried out new measurements. It had been suggested that the contraction in the direction of motion demanded by the Fitzgerald-Lorentz hypothesis (*see* RELATIVITY) might be a property of particular materials only, and that it would be desirable to try the effect of replacing the stone on which the interferometer parts were mounted by other substances. Morley and Miller used both a wooden and a steel framework to support the apparatus, which was floated on mercury, as in 1887. The path length was increased to 3,224 cm., which is 55 million wave lengths of yellow (sodium) light, so that the fringe displacement should, on the hypothesis of a stationary ether, be 1·1 fringes in place of the ·4 fringes of 1887. In the cellar at Cleveland where the apparatus was mounted the effect was less than one hundredth of this amount, which is alternatively expressed by saying that these results show that the velocity of the earth with reference to a hypothetical stationary ether is at most 3 kilometers (say 2 miles) a second. (The shift is, of course, proportional to the *square* of the velocity, and the earth's orbital velocity is about 30 kilometres per second.) Morley and Miller took into account the motion of the solar system towards a certain fixed point in the heavens, and compounded this with the velocity of the earth in the solar system when computing the magnitude and direction of the velocity of the apparatus.

In 1905 and 1906 Morley and Miller removed their apparatus from the cellar and installed it in a light shed at a height of 300 feet above Lake Erie, to see if possibly the nature of the immediate surroundings, whether massive or no, affected the "ether wind" which the experiment was designed to detect. A possible effect of about $\frac{1}{10}$ of the calculated value was detected, but it was not clear whether this was a spurious effect of temperature. It would be a result of the first importance, constituting a grave blow to the theory of relativity, if an actual effect, which varied with the height above sea level or with the surroundings, could be definitely established, and therefore in 1921 and again in 1925 D. C. Miller carried out experiments of the Michelson and Morley type at Mount Wilson, about 1,800 metres (6,000 feet) above sea

level. To avoid possible magnetic effects the steel frame used in the earlier experiments was later replaced by a concrete frame. Miller, as a result of several thousand readings, arrived at the conclusion that there was a small positive effect, about 9 kilometers per second, as against the full orbital velocity of 30 kilometers per second, and also considered that the experiments in the cellar at Cleveland showed a still smaller positive result. He attempted to explain his results by a drift of the solar system in a direction nearly normal to the plane of the ecliptic. These experiments of Miller naturally attracted much attention, but it appears almost certain that the positive effect must be due to unrecognised sources of error, possibly to temperature effects. It has, for instance, been pointed out, notably by Thirring, that the measurements of Miller are not consistent among themselves, from the point of view of his explanation.

To check Miller's results R. J. Kennedy repeated the experiment, using an ingenious modification of the interferometer, produced by making a small step, only one-twentieth of a wave length in height, on one of the totally reflecting mirrors. This produces two fringe systems bordering on one another, which enables a very slight displacement of the interference patterns, of the order of 4 thousandths of a fringe, to be detected. Kennedy's apparatus was comparatively small, the light path being only 4 metres, and sealed up in a case containing helium, the refractivity of which is only one-eighth that of air, at atmospheric pressure. The experiments were carried out at times of day when Miller's effect should be greatest, but no positive effect was ever found. although a shift one-quarter as great as that measured by Miller would have been detected. K. K. Illingworth has repeated Kennedy's experiments, likewise finding no positive result (1927). Both Kennedy's and Illingworth's experiments were carried out in a constant temperature basement at Pasadena, California, which gives defenders of the reality of Miller's effect a possible line of criticism, namely that while no positive result can be found in a sheltered spot, where massive surroundings check the "ether wind," this does not prove that a small positive effect does not exist at a height, in a free situation. This last possibility is, however, removed by the experiments of Piccard and Stahel, carried out at intervals from 1926 to 1928. These workers placed the apparatus in a free balloon, the chief measurements being made at a height of 2,500 metres. The apparatus was a small interferometer of Michelson-Morley pattern, with multiple reflections. The fringes were registered photographically, on a moving film, and the balloon was kept in steady rotation by small air screws. No trace of an effect was ever found.

In January, 1929, Michelson published a preliminary account of a repetition of the Michelson-Morley experiment carried out by himself in collaboration with Drs. Pease and Pearson, with new refinements: the results, in contradiction to Miller's, were negative.

We may therefore say that the broad result of a series of experiments of Michelson-Morley type is that no motion of the earth through the ether can be detected by an influence on the velocity of light. For theoretical implications *see* RELATIVITY.

BIBLIOGRAPHY.—Brief accounts of the Michelson-Morley experiment are given in the standard text-books of light, cited under LIGHT, and the experiment is discussed in all books on relativity (*q.v.*). The most important original papers are:—A. A. Michelson and E. W. Morley, *Philosophical Magazine*, 24, 449 (1887); E. W. Morley and D. C. Miller, *Philosophical Magazine*, 9, 680 (1905); D. C. Miller, *Proceedings National Academy of Sciences*, 11, 306 (1925); H. Thirring (criticism of D. C. Miller's results), *Zeitschrift für Physik*, 35, 723 (1926); J. R. Kennedy, *Proceedings National Academy of Sciences*, 12, 621 (1926); K. K. Illingworth, *Physical Review*, 30, 692 (1927); A. Piccard and E. Stahel, *Naturwissenschaften*, 14, 935 (1926); 15, 140 (1927); 16, 25 (1928); A. A. Michelson, *Nature*, 123, 88 (1929). (E. N. DA C. A.)

MICHIGAN (mĭsh'ĭ-gan), known as the "Wolverine State," is one of the north central group of the United States of America. It is situated between latitudes 41° 44′ and 47° 30′ N. and longitudes 82° 25′ and 90° 31′ W., and consists of two peninsulas,—the upper or northern and the lower or southern—separated by a strait. The upper peninsula is bounded north by Lake Superior; east by lakes Superior, Huron and Michigan, and by Whitefish bay and St. Mary's river, which separate it from the Province of Ontario, Canada; south by lakes Huron and Michigan and the straits of Mackinac, which separate it from the lower peninsula; and south-west and west by Wisconsin, and the Menominee, Brule and Montreal rivers, which separate it from Wisconsin. The lower peninsula is bounded north by lakes Michigan and Huron and the straits of Mackinac, east by lakes Huron, St. Clair and Erie and the St. Clair and Detroit rivers, which separate it from Ontario; south by Ohio and Indiana, and west by Lake Michigan. In size Michigan ranks 21st among the States of the Union, its total area being 57,980 sq.m. of which 500 sq.m. exclusive of its Great Lakes jurisdiction, are water surface.

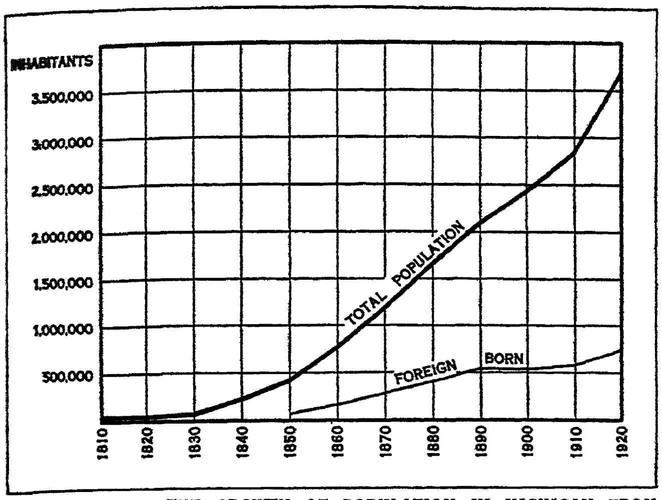
Physical Features.—The northern part of the State is rugged mountainous "old land," not completely worn down by erosion; and the southern part is a portion of the old coastal plain, whose layers contain salt, gypsum and some inferior coal. Lake Huron, on the east, and Lake Michigan on the west of the lower peninsula are each 581½ ft. above sea-level, and Lake Superior on the north of the upper peninsula is 602 ft. above sea-level. For the most part the surface of the State is gently undulating and at a slight elevation above the lakes, but low marsh lands are common to many sections; the north part of the lower peninsula is occupied by a plateau of considerable dimensions, and the north-west part of the upper peninsula is rugged with hills and mountains. Crossing the lower peninsula from Saginaw bay west by south through the valleys of the Saginaw, Maple and Grand rivers, is a depression—the former channel of an old glacial river—in which elevations for a considerable area are less than 100 ft. above the lakes. To the south-east of this depression a water-parting with summits varying from about 400 to 600 ft. above the lakes extends from a point between Saginaw bay and Lake Huron, south by west, to the south border of the State and beyond. The east slope descends quite rapidly to a low flat belt from 5 to 40 m. wide along the east border of the State south from Lake Huron. From Lake Huron to the south-east shore of Saginaw bay a wide sandy beach

MAP SHOWING THE MAIN ROADS IN MICHIGAN

is followed northward by precipitous shores abounding in rocks and bluffs. West of the divide and south of the depression, southwest Michigan is occupied by the valleys of the St. Joseph, Kalamazoo and Grand rivers, by the gently rolling uplands that form the parting divides between them, and by sand dunes, which here and there rise to a height of from 100 to 200 ft. or more along the shore of Lake Michigan, and are formed on this side (but not on the Wisconsin side) of the lake by the prevailing west winds.

The surface of the upper peninsula is more irregular than that of the lower peninsula. A portion extending through the middle

from east to west and south, from west of the centre of Green bay, is either flat and even swampy or only gently undulating. Eastward from Green bay are two ranges of hills; the one lining the south shore and ranging from 100 to 300 ft. in height, the other close to or touching the north shore and reaching in places an elevation of 600 ft. above Lake Superior. The famous Pictured rocks in Alger county on the lake shore, east of Munising, form the



GRAPH SHOWING THE GROWTH OF POPULATION IN MICHIGAN FROM 1810–1920, AND THE PERCENTAGE OF FOREIGN BORN

west portion of this north range; they display a wide diversity of shapes as well as a great variety of tints and hues, especially of grey, blue, green and yellow. The most rugged portion of the State is farther west. South and south-east of Keweenaw bay, in the Marquette iron district, is an irregular area of mountains, hills, swamps and lakes, some of the mountain peaks of the Huron mountains (in Marquette county) rising to an elevation of 1,400 ft. or more above the lake. These and a peak in the Porcupine mountains (2,023 ft. above the sea) in the north-west part of Ontonagon county are the highest in the State. To the south of this is the Menominee iron district, marked somewhat regularly by east and west ridges. Extending in a general north-east and south-west direction through Keweenaw peninsula to the Wisconsin border, and beyond, is the middle of three approximately parallel ranges, separated from each other by flat lands, with here and there an isolated peak (in the Porcupine mountains) having an elevation of from 900 to 1,400 ft. above the lake. The northern portion of these ranges, together with Isle Royale some distance farther north, which is itself traversed by several less elevated parallel ridges, contains the Michigan copper-bearing rocks; while to the south, along the Wisconsin border, is the Gogebic iron district.

The rivers of the entire State consist of numerous small streams of clear water. In the interior of the upper peninsula, along the east border of the lower peninsula south from Lake Huron, and in Saginaw valley, they are rather sluggish; but many of the larger streams of the lower peninsula have sufficient fall to furnish a large amount of water-power, while the small streams that flow into Lake Superior from the central portion of the upper peninsula as well as some of the larger ones farther west, have several falls and rapids; in places also they are lined with steep, high banks. Most of the larger rivers of the State—the Muskegon, Grand, St. Joseph, Manistee and Kalamazoo—are in the west portion of the lower peninsula. Several thousand lakes of clear water, formed by glacial action, dot the surface of the State, and many of them are lined with picturesque woodland shores. Islands in lakes Superior, Michigan and Huron are scarcely less numerous.

Fauna and Flora.—Mammals include black bear, moose, deer, lynx, wolves, coyotes, wildcats, porcupine, fox, squirrels, hares, rabbits, musk rats, minks, weasels, skunks, racoons and woodchucks. The only woodland caribou now known in United States proper are found on Isle Royale. Among the game birds are quail ("Bob White"), grouse, including "partridges" (ruffed grouse), ducks, geese, coots, brant, woodcocks, snipe and plover, as well as the imported Chinese ring-necked pheasants. Of song birds the favourites are the robin, thrush, bobolink, oriole, chickadee, meadow-lark, cat-bird, blue-bird, wrens and warblers. Among fishes, white fish, wall-eyes, lake trout, perch, herring, sun-fish, bass, sturgeon, pike, chubs, suckers, mullets, sheepheads and German carp abound in the lakes. The speckled, brown and rainbow trout thrive in many of the streams. The area now included in Michigan was a forest, except in the south-west, where there were a few small prairies, possibly cleared by the Indians. The remainder of the south part of this area for about 60 m. along the southern boundary was a part of the great hardwood forest of the Ohio basin with woods varying with soil and drainage: on the drier gravel lands were oak forests consisting of red, black and white oak, hickory, ash, cherry, basswood and walnut; in depressions there were maple, elm, ash, beech, sycamore, poplar and willow; and in the south-east there were a few chestnuts and tulip trees. North of this southern hardwood forest there were pine forests on the sandier land, mixed hardwoods and conifers on the loam and clay, and tamaracks and cedar in the swamps. The sandy lands were in part burnt over by Indians, and there was a growth of scrub oak, aspens and huckleberry bushes. The tamarack and cedar swamps now have a growth, especially on their edges, of spruce, birch, balsam, white pine, soft maple, ash and aspens. In 1920 the woodland area, including stump lands, was estimated at nearly two-thirds of the entire State; but of this area not more than 4,000,000 ac. now bear timber worth cutting. The State controls eight forest reserves, whose area is 356,388 ac., which are being re-forested at a rate of about 10,000 ac. a year. White pine, Norway pine and Jack pine are the only species planted. Two national forest units, embracing about a million acres, were established in 1928.

Soil and Climate.—The soil of the south-west and south-east Michigan is for the most part a dark clay loam; in the north central part of the lower peninsula it is a light sandy loam, along the Huron shore it is heavy with blue clay, in the mining districts of the north-west the rocks are usually either barren or very thinly covered; and elsewhere in the State the soil is generally rich in a variety of mineral elements.

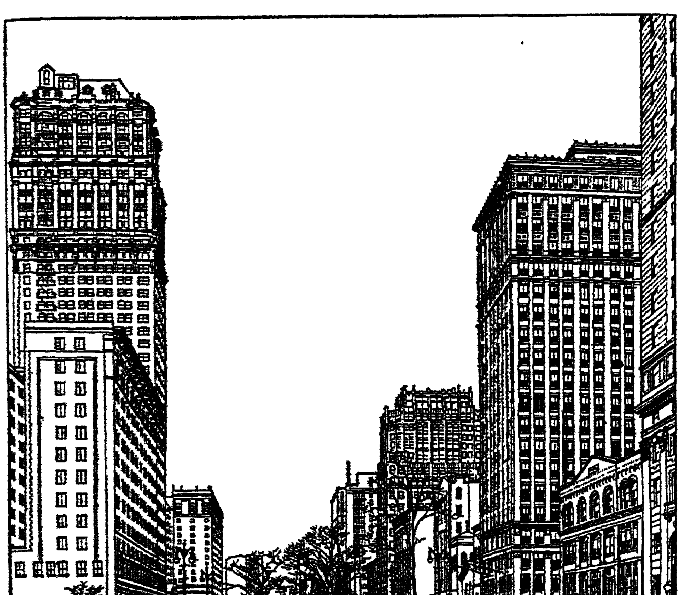
Although the temperature of the entire lower peninsula is considerably influenced by the lakes, yet the prevailing winds being westerly, it is in the west portion of that peninsula that the moderation is greatest, both the summer and winter isotherms being there deflected more than half the length of the peninsula. On the other hand, the prevailing winds of the upper peninsula being north-westerly, the lakes have little effect on the temperature there; and so, while in the south-west the extremes are not great, in the rest of the State they have ranged within two years from 108° to 48° below zero. Throughout the State July is invariably the warmest month, February the coldest; the mean annual temperature is about 45°. The mean annual precipitation is not far from 31 in., a little more than one-half of which falls during the five growing months from May to October; the rain is evenly distributed over all parts of the State, but the snow is exceptionally heavy along the north shore of the upper peninsula.

Government.—The Constitution under which Michigan is now governed was first adopted in 1850, when it was felt that the powers which the first one, that of 1835, conferred upon the executive and the legislature were too wide. In 1908 it was revised.

The Constitution admits of amendment by an affirmative vote of two-thirds of the members of each house of the legislature, followed by an affirmative vote of a majority of the electors voting upon the question; or an amendment may be proposed by an initiative petition signed by 10% of the total number of electors, and such an amendment is submitted to popular vote at the next election and comes into effect only if it receives a favourable majority of the popular vote. Amendments suggested by the legislature have been frequently adopted, and one, adopted in 1862, provided that the question of a general revision of the Constitution shall be submitted to a popular vote once every 16 years and at such other times as might be provided by law. When this question was so submitted for the first time, in 1866, the vote was to revise; but the revision prepared by a convention called for the purpose was rejected at the polls. The revision by the Consti-

tutional Convention of 1907–08 was adopted by popular vote in 1908. The question of revision was again submitted to the electors in 1926 and was rejected by a vote of 285,252 to 119,491. In its present form the Constitution confers suffrage upon every citizen of the United States who is 21 years of age or over and has resided in the State six months and in his township or ward 20 days immediately preceding an election. At the head of the executive department is the governor, who is elected for two years, and who at the time of his election must be at least 30 years of age and must have been for five years a citizen of the United States, and for the two years immediately preceding a resident of the State. A lieutenant governor, for whom the same qualifications are prescribed, is elected at the same time for the same term. Under the first Constitution the secretary of State, treasurer, auditor general, attorney general and superintendent of public instruction were all appointed by the governor, but under the present one they are elected for a term of two years. The State highway commissioner is elected for a term of four years. The governor's salary is fixed by the revised Constitution of 1908 at $5,000 a year. The lieutenant governor succeeds the governor in case of vacancy, and next in order of succession comes the secretary of State. A State administrative board, consisting of all the six elective State officials mentioned, was created in 1921.

Legislature.—The legislature, consisting of a senate of 32 members, and a house of representatives of 100 members (according to the Constitution not less than 64 and not more than 100), meets, in regular session, on the first Wednesday in January in odd-numbered years, at Lansing. Both senators and representatives are elected for a term of two years by single districts, except that a township or city which is entitled by its population to more than one representative elects its representatives on a general ticket. Beginning in 1913 and at each subsequent tenth



BY COURTESY OF THE DETROIT CONVENTION AND THE TOURIST'S BUREAU

WASHINGTON BOULEVARD, IN THE HEART OF THE HOTEL AND SHOPPING DISTRICT OF DETROIT

year, the legislature, under the revised Constitution of 1908, is required to re-arrange the senatorial districts and reapportion the representatives among the counties and districts, using as a basis the returns of the next preceding decennial census; but this obligation has not been strictly followed, the legislature finally in 1925 arranging a compromise calculated to restrict Detroit's representation below that which its population calls for.

No bill can pass either house except by an affirmative vote of a majority of the members elected to that house, and on its third reading the ayes and noes must be taken and recorded; for appropriation bills a two-thirds majority of all members elected to each house is required. All legislation must be by bill, legislation by joint and concurrent resolutions thus being prevented. No bill may be passed at a regular session until it has been printed and in possession of each house for five days; no bill may be passed at a special session on any subject not expressly stated in the governor's proclamation or submitted by special message. The governor has ten days (Sundays not being counted) in which to exercise his veto power (which may be applied to any item or items of any bill making appropriations of money and embracing distinct items), and an affirmative vote in each house of two-thirds of the members elected is required to pass a bill over his veto.

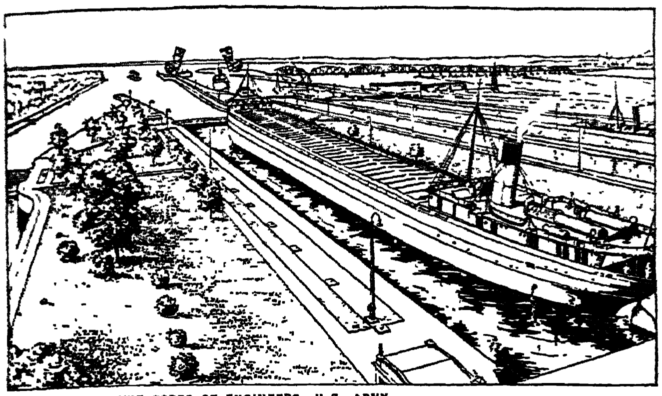
Judiciary.—The administration of justice is entrusted to a supreme court, a continually increasing number of circuit courts, 40 in 1927, one probate court in each county, and not more than four justices of the peace in each township. The supreme court is composed of one chief justice and seven associate justices, all elected for a term of eight years, two retiring every two years; it holds four sessions annually, exercises a general control over the inferior courts, may issue, hear and determine any of the more important writs, and has appellate jurisdiction only in all other important cases. There is only one circuit court judge for a circuit, unless the legislature provides for the election of more; the term of office is six years. Each county elects a judge of probate for a term of four years; he has original concurrent jurisdiction with the circuit court in matters of probate, and has original jurisdiction in all cases of juvenile delinquents and dependents. The legislature may provide for the election of more than one judge of probate in a county with more than 180,000 inhabitants. Justices of the peace are elected by the townships for a term of four years—there are not more than four in each township.

Local Government.—For purposes of local government the State is divided into 83 counties, each of which is in turn divided by north and south and east and west lines into townships. The officers of the township are a supervisor, clerk, treasurer, highway-commissioner, one overseer of highways for each highway district, justices of the peace and not more than four constables, all of whom are elected at the annual township meeting in April. The supervisor, two of the justices of the peace and the clerk constitute the township board, whose duty it is to settle claims against the township, audit accounts, and publish annually an itemized statement of receipts and disbursements. The supervisor is also the township assessor, and the several township supervisors constitute the county board of supervisors who are entrusted with the care and management of the property and business of the county, and may borrow or raise by tax what is necessary to meet the more common expenses of the county. Other county officers are a treasurer, clerk, sheriff, register of deeds, attorney, surveyor and two coroners, each elected for a term of two years, a school commissioner elected for a term of four years, and one or more notaries public appointed by the governor.

City Government.—Under the revised Constitution of 1908 the former classification of cities into four classes and the practice of granting special charters were abolished, and the legislature is required to provide by general laws for the incorporation of cities and villages; "such general laws shall limit their rate of taxation for municipal purposes and restrict their powers of borrowing money and contracting debts." Cities and villages are permitted—upon authorization by the affirmative vote of three-fifths of the electors voting on the question—to own and operate, even outside their corporate limits, public utilities for supplying water, light, heat, power and transportation, and may sell and deliver, outside their corporate limits, water, heat, power and light to an amount not more than one-fourth that furnished by them in each case within their corporate limits; but no city or village of less than 25,000 inhabitants may own or operate transport facilities. Under the revision of 1908, corporate franchises cannot be granted for a longer term than 30 years.

Population.—The first census taken in that portion of the North-west Territory now included in the State of Michigan showed, in 1810, a population of 4,762. The population at other

selected decennial censuses was as follows:—31,639 in 1830; 749,113 in 1860; 1,636,937 in 1880; 2,093,890 in 1890; 2,420,982 in 1900; 2,810,173 in 1910; and 3,668,412 in 1920; an increase of 30·5% within the last decade. The population in 1930 was 4,842,325, an increase of 1,173,913 or 32 per cent. Of the total population in 1920, 1,670,447 were of native parentage; 1,204,545 of foreign or mixed parentage; 726,635 were foreign-born; 60,082 were negroes; and the remaining 6,703 were Indians, Chinese or Japanese. The chief national groups among the foreign-born showed 164,502 natives of Canada (145,867 English; 18,635 French), 103,926 of Poland, 86,047 of Germany, 47,149 of England, 45,313 of Russia, 33,499 of the Netherlands, 30,216 of Italy and 30,096 of Finland. The density of population increased from 63·8 to 84·2 per sq.m. in the decade 1920–30. During the decade 1910–20 the urban population (in places having 2,500 inhabitants or more) increased from 47·2% to 61·1% of the total population. There were 38 cities and 2 villages with 10,000 inhabitants or more in 1930. The population of the following cities in 1930 was: Detroit, 1,568,662; Grand Rapids, 168,592; Flint, 156,492; Saginaw, 80,715; Lansing, 78,397; Pontiac, 64,928; Hamtramck, 56,268 and Jackson, 55,187.



BY COURTESY OF THE CORPS OF ENGINEERS, U. S. ARMY

ST. MARY'S FALLS CANAL, MICHIGAN, THE UPPER APPROACH TO THE LOCKS, SHOWING PARTS OF WEITZEL, POE, DAVIS, AND FOURTH LOCKS

Finance.—The present Constitution (as revised in 1908) forbids the contraction of a State debt exceeding $250,000 except for repelling an invasion or suppressing an insurrection, and the borrowing power of the minor civil divisions is restricted by a general law. The Constitution of 1850 provided that no general banking law could have effect until it had been submitted to the people and had been approved by a majority of the votes cast on the question. This provision was included in the revised Constitution adopted in 1908, with an additional provision that no amendment shall be made to any banking law unless it shall receive an affirmative two-thirds vote of both branches of the legislature. Every stockholder in a bank is made individually liable for the amount of his stock at its par value in addition to the said stock. All banks are subject to the inspection and supervision of the commissioner of the State banking department.

The assessed value of all property in Michigan in 1928 was $8,201,420,920, on which the State levied $20,500,000 in taxes ($4.46 *per caput*). The remainder of the general revenue was secured, principally, from various specific or indirect taxes, such as the inheritance tax and a tax on corporation franchises. The principal sources of the State road funds are the motor vehicle licence fees ($18,616,326 in 1928) and a tax of three cents per gallon on gasolene ($17,683,913 in 1928). The bonded indebtedness of the State on June 1, 1927 was $83,500,000 or a *per caput* debt of approximately $20.

Educational System.—Michigan was a pioneer State in creating the American educational system; she began the organization of it at the time of her admission into the Union in 1837, and has since been noted for the high standard of her schools. Each township operating under the district act has two school inspectors—one being elected at each town meeting for a term of two years—who with the township clerk constitute the township board of school inspectors, and to this board is given authority to divide the township into school districts and to exercise a general supervision over the several schools within their jurisdiction; a township may be organized as a single district, called a "township unit district." The qualified electors of each district having an ungraded school elect a moderator, a director and a treasurer—one at each annual school meeting—for a term of three years, who constitute the district school board, entrusted with ample power to direct the affairs of the school. Each county has a county school commissioner elected for a term of four years, who exercises a general supervision over the schools within his jurisdiction. Finally, at the head of all the public elementary and secondary schools of the State is the State superintendent of public instruction, elected for a term of two years; he is *ex officio* a member and secretary of the State board of education, and a member, with the right to speak but not to vote, of all other boards having control of public instruction in any State institution.

In 1926 there were 866,945 pupils enrolled in the public schools of the State, and 30,327 teachers were engaged in giving instruction. Of the public school enrolment 720,212 were in the kindergarten and elementary grades and 146,733 were in the secondary schools. Private and parochial schools had an enrolment of 101,137. The net expenditures for public elementary and secondary education, in 1926, were $76,654,656 or a *per caput* based on total enrolment of $88.42. The illiteracy rate was 3% in 1920 as against 3·3% in 1910. In many of the public schools vocational courses were added in recent years. At the institutions of higher education, attendance greatly increased. Some of the colleges with church connection shared in this growth; but the chief enlargement was at the University of Michigan and the Michigan State college of Agriculture and Applied Science.

The higher State institutions of learning consist of a university (*see* MICHIGAN, UNIVERSITY OF), four teachers' colleges and normal schools, an agricultural college and a school of mines. The university (at Ann Arbor) was established in 1837, and is under the control of a board of regents elected by the people for a term of eight years, two every two years; the president of the institution and the superintendent of public instruction are members of the board but without the right to vote. The State teachers' colleges are: the Michigan State Normal college at Ypsilanti (1849); the Central Michigan Normal school at Mount Pleasant (1895); the Northern State Normal school at Marquette (1899); and the Western State Normal school at Kalamazoo (1904). All of these are under the State board of education. The Michigan State college of Agriculture and Applied Science at East Lansing, 3 m. east of Lansing, is the oldest in the United States; it was provided for by the State Constitution of 1850, organized in 1855 and was opened in 1857. The College of Mines, at Houghton, was established in 1885. In 1927 there were 14 other institutions of higher learning within the State, but not maintained by it.

Agriculture.—In 1925 18,035,290 ac. or 49% of the land was in farms. Of this amount 9,671,381 ac. were classified as crop land. All farm property in the above year had an estimated value of $1,523,976,902. The number of farms (192,327) in 1925 showed a decrease of 14,626 as compared with 1910. During the period 1920–25 all farm-land decreased from 19,032,961 ac. to 18,035,290. The percentage of tenantry decreased from 17·7 to 15·1 during the same period. The aggregate value of all farm crops in 1926 was $250,600,000. The table below shows the acreage, product and value of the principal crops in 1926.

Crop	Acreage	Product	Value
Tame hay .	2,869,000	4,097,000 tons	$56,539,000
Indian corn .	1,593,000	54,162,000 bu.	39,538,000
Potatoes . .	249,000	29,880,000 bu.	35,856,000
Wheat . .	984,000	17,998,000 bu.	21,958,000
Oats . . .	1,570,000	51,810,000 bu.	20,723,000
Dry beans .	552,000	6,624,000 bu.	18,547,000

Other crops of considerable economic value were sugar-beets, fruits, barley, rye, peppermint and vegetables. Michigan, in 1926 ranked first among the States of the Union as a producer of dry beans and peppermint, and second only to Colorado as a producer

of beet sugar. The growth of mint on the muck lands in the south-western counties is quite as old as the State. Market gardening is an important industry both in the south-west and south-east counties. All the principal fruits are grown in large quantities in what is known as the fruit belt in the south-west; grapes are grown chiefly in the south-western counties. The area nominally in woodland, including farm wood-lots as well as forests and cut-over lands, comprises nearly two-thirds of the State; but of this area not more than about 4,000,000 ac., nine-tenths of which lie in the upper peninsula, now bear good timber. The barrenness of the sandy soil and the shortness of the growing season have hindered the reduction of land to cultivation, and some 10,000,000 ac. (more than a quarter of the State) are thus a deforested desert.

Minerals.—Michigan, with a mineral product valued at $122,-212,254 in 1925, ranked ninth among the States of the Union. Of the mineral products iron-ore, copper, cement, salt and clay products, respectively, were of chief value. Iron was first discovered in the Marquette district along the shore of Lake Superior early in the 18th century, but active operations for mining it did not begin until 1845; in 1877 mining of the same mineral began farther south in the Menominee district, and seven years later farther west along the Wisconsin border in Gogebic county. From 1890 to 1901 Michigan ranked first in the Union as an iron-producing State, but after 1901 its product was exceeded by that of Minnesota. Since the first discovery of iron-ore up to Jan. 1, 1926, a total of about 1,230,000,000 tons had been shipped from the Lake Superior region of Michigan. Copper mining in the State began about the same time as iron mining. The product in 1845 was 12 long tons; in 1926 the product was 174,779,000 pounds. From 1847 to 1887 the product of Michigan exceeded that of any other State; from 1847 to 1883 its copper product was more than one-half that of all the States, but in 1926 more of that mineral was mined in each of the States of Arizona, Utah and Montana than in Michigan. The chief producing region is in the Keweenaw peninsula and its vicinity.

Fields of bituminous coal extend over an area of over 10,000 sq.m. in the south-east portion of the State; but its quality is inferior. The mining of coal began in Jackson county in 1836, but for many years the production increased slowly. The period of greatest average production was the five years, 1916–20 when 1,301,000 short tons were mined annually. The product in 1926 was 649,000 tons. The principal producing area was in Bay, Saginaw, Tuscola and Calhoun counties. Salt wells are numerous in the middle and south-eastern sections of the lower peninsula; the first successful one was drilled in Saginaw county in 1859 and 1860. For a number of years prior to 1893 Michigan was the leading salt-producing State; then New York became the chief producer for several years. In 1926 the State ranked first among the States with a product of 2,260,320 tons of salt. Gypsum is obtained from deposits along the banks of the Grand river in Kent county and in the vicinity of Alabaster along the shore of Lake Huron in Iosco county. In 1925 649,053 tons valued at $5,447,294 were mined. Marl is found in many parts of the State; limestone most largely in the northern part of the lower peninsula, and in the eastern part of the upper peninsula. The presence of these products has given rise to Michigan's large Portland cement industry; in 1926 the State's output was 12,037,000 barrels. Clay products in 1925 had a value of $7,396,071; about 42% of this total represented the value of the pottery product.

Manufactures.—The manufactured products in 1925 were valued at $4,373,186,136, as compared with $1,086,162,000 in 1914, an increase of over 300%. This advance was mainly due to the extraordinary growth of the automobile industry and its concentration in the State. The value of automobiles manufactured increased from $7,996,534 in 1904 to $1,551,990,000 in 1923. In 1926 the motor vehicles manufactured within the State were valued at $1,820,296,128; motor vehicle bodies and parts had an additional value of $921,901,337. About half the motor vehicles manufactured in the United States in 1925 were made in Michigan. The number of wage-earners engaged in this industry in 1914 was 67,538, constituting 24·9% of the total number of industrial wage-earners in the State; these were increased to 234,492 in 1925, their proportion to the whole being 45·5%. Foundries and machine shops with an average number of 31,291 wage-earners in 1925 had a product valued at $162,545,298. Furniture ranked next, with 21,512 wage-earners and products valued at $99,039,416. Other industries of great value included engines and water-wheels ($95,-932,026); paper and wood pulp ($91,149,648); brass, bronze and copper products ($65,594,415); lumber and timber products ($59,569,472); slaughtering and meat packing ($53,932,676); food preparations ($53,423,945); bread and bakery products ($51,358,975); and butter, cheese and condensed milk ($49,300,-693). Michigan led all other States in 1925 in output of chemicals, drugs, engines and water-wheels, motor vehicles and motor vehicle bodies and parts, and threshing machines. The State ranked third in the manufacture of furniture and food preparations. Detroit with its neighbouring cities Highland Park and Hamtramck, produced more than half the manufactured products of the State. In this district centred the motor vehicle, the foundry and machine shop, the meat-packing, and the brass and bronze industries. Flint, with products valued at $422,644,236, was another important motor vehicle manufacturing point.

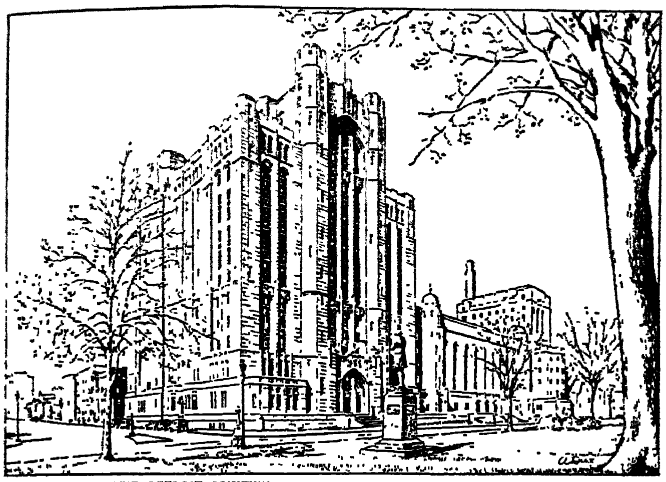
Transport.—The building of railways in Michigan began in 1830, but little progress had been made in 1837 when the State began the construction of three railways and two canals across the southern half of the lower peninsula. Some progress was made, but by 1846 the State proved itself incompetent to carry on the work and sold its interest to private companies. The railway mileage continued until 1910 when it was 9,021; since that date there has been a gradual decrease, the mileage in 1925 being 8,349. The principal lines are the Michigan Central, the Pere Marquette, the Lake Shore and Michigan Southern, the Grand Trunk and the Chicago, Milwaukee and St. Paul. The mileage of electric railways was 1,795 in 1925.

Besides railway communication, Michigan has a coastline of about 1,600 m. and several good harbours. The water communications were extended and improved by several canals, among which are the Sault Ste. Marie, which passes the rapids of the St. Mary's river; the St. Clair Flats, at the north end of Lake St. Clair, by which a deeper channel is made through shallow water; and the Portage lake, in the copper district, which connects that lake with Lake Superior. The traffic through the Sault Ste. Marie canal in 1926 according to the annual report of the chief of engineers, U.S. army, was 85,679,000 short tons, and had a value of $1,063,876,000. During 1925 Michigan harbours made shipments aggregating 20,283,000 tons, with receipts totalling 9,277,000 tons.

An excellent system of State trunk roads is maintained by the State highway department. This department, at the close of 1926, controlled 6,756 m. of roads, of which 6,229 m. were surfaced. The total expenditure for rural highways by the State highway department in 1926 was $36,136,000. The total motor vehicle registration for the year 1926 was 1,125,031.

History.—From 1613 until 1760 the territory now within the borders of Michigan formed a part of New France, and the first Europeans to found missions and settlements within those borders were Frenchmen. Two Jesuits, Raymbault and Jogues, visited the site of Sault Ste. Marie as early as 1641 for the conversion of the Chippewas; in 1668 Marquette founded there the first permanent settlement within the State; three years later he had founded a mission among the Hurons at Michilimackinac; La Salle built a fort at the mouth of the St. Joseph in 1679; and in 1701 Cadillac founded Detroit as an important point for the French control of the fur trade. The bitter strife between the missionaries and Cadillac, and the French system of absolutism in government and monopoly in trade were further obstacles to progress. Even Detroit was so expensive to the Government of the mother country that there was occasional talk of abandoning it; and so during the last 59 years that Michigan was a part of New France there were no new settlements, and little if any growth in those already established. During the last war between the English and the French in America, the Michigan settlements passed into the possession of the English, Detroit in 1760 and the others in 1761. The white inhabitants, mostly French, were subjected to an English rule that until the Quebec Act of 1774 was

chiefly military, and as a consequence many of the more thrifty sought homes elsewhere, and the Indians, most of whom had been allies of the French, were so ill-treated, both by the officers and traders, that under Pontiac, chief of the Ottawas, a simultaneous attack on the English ports was planned. Detroit was besieged for five months and both Michilimackinac and St. Joseph were taken. Moreover, the English policy, which first of all was concerned with the profits of trade and manufacture, gave little more encouragement to the settlement of this section of the country than did the French. By the Treaty of Paris, in 1783, which concluded the American Revolution, the title to what is now Michigan passed to the United States, and in 1787 this region became a part of the North-west Territory; but it was not until 1796 that Detroit and Mackinac (Michilimackinac), in accordance with Jay's treaty of 1794, were surrendered by Great Britain. In 1800, on the division of the North-west Territory, the west portion of Michigan became a part of the newly established Indiana Territory, into which the entire area of the present State was embodied in 1802, when Ohio was admitted to the Union; and finally, in 1805, Michigan Territory was organized, its south boundary being then described as a line drawn east from the south extremity of Lake Michigan until it intersected Lake Erie, and its west boundary a line drawn from the same starting point through the middle of Lake Michigan to its north extremity and then due north to the north boundary of the United States. During the War of 1812, General William Hull, the first governor of the Territory, although not greatly outnumbered, surrendered Detroit to the British without a struggle; in the same year also Mackinac was taken and Michigan again passed under British rule. This rule was of short duration, however, for soon after Commodore Oliver H. Perry's victory on Lake Erie, in September of the next year, Detroit and the rest of Michigan except Mackinac, which was not recaptured until July 1815, were again taken into the possession of the United States.



BY COURTESY OF THE DETROIT CONVENTION AND TOURIST'S BUREAU

THE MASONIC TEMPLE IN DETROIT, THE LARGEST IN THE WORLD

Development.—Up to this time the Territory had still remained for the most part a wilderness in which the fur trade reaped the largest profits, its few small settlements being confined to the borders; and the inaccurate reports of the surveyors sent out by the United States Government described the interior as a vast swamp with only here and there a little land fit for cultivation. The large number of hostile Indians was also a factor in making the Territory unattractive. But during the efficient administration of Lewis Cass (*q.v.*), governor of the Territory from 1813 to 1831, the interference of the British was checked and many of the Indians were removed to the west of the Mississippi; printing presses, established during the same period at Detroit, Ann Arbor, Monroe and Pontiac, became largely instrumental in making the country better known; the first steamboat, the "Walk-in-the-Water," appeared at Detroit in 1818; the Erie canal was opened in 1825; by 1830 a daily boat line was running between Detroit and Buffalo, and the population of Michigan, which was only 4,762 in 1810 and 8,896 in 1820, increased to 31,639 in 1830 and 212,267 in 1840. In 1819 the Territory had been empowered to send a delegate to Congress. By 1832 the question of admission into the Union had arisen, and in 1835 a convention was called in Detroit, a Constitution was framed in May which was adopted by popular vote in October, State officers were elected, and application for admission was made; but a dispute with Ohio over the boundary between the two caused a delay in the admission of Michigan into the Union as a State until Jan. 26, 1837. Since admission into the Union the more interesting experiences of the State have been connected with internal improvements and with banking, which together resulted in serious distress; in the utilization of its natural resources, which have been a vast source of wealth; and in the development of its educational system, in which the State has exerted a great influence throughout the Union. From the beginning of its Government under its first State Constitution in 1835 until 1855, Michigan had a Democratic administration with the exception of the years 1840–42, when opposition to the financial measures of the Democrats placed the Whigs in power. But it was in Michigan that the Republican Party received its first official recognition, at a State convention held at Jackson on July 6, 1854, and from 1858 to 1928 the administration, with the exception of four gubernatorial terms, was Republican.

BIBLIOGRAPHY.—For the history of Michigan *see* H. M. Utley and B. M. Cutcheon, *Michigan as a Province, Territory and State* (1906); Charles Moore, *History of Michigan* (1915); J. V. Campbell, *Outlines of the Political History of Michigan* (1876); T. M. Cooley, *Michigan: A History of Government* (1885), a critical but popular narrative by an eminent jurist; Michigan Pioneer and Historical Society, *Historical Collections: Collections and Researches* (1877–1915); Michigan Historical Commission, *Michigan Historical Publications, University Series* (1916 *seq.*), some of the best recent works on Michigan history and government; Michigan Historical Commission, *Bulletins* (1913 *seq.*): and the *Michigan History Magazine* (1917 *seq.*); George B. Catlin, *The Story of Detroit* (1923). For politics and government *see* Harriette M. Dilla, *The Politics of Michigan, 1865-78* (1914); A. C. Millspaugh, *Party Organization and Machinery in Michigan since 1890* (1917); W. J. McKone, *Michigan State and Local Government* (22nd ed., 1922), a school text; the *Michigan Official Directory and Legislative Manual,* issued biennially by the secretary of State; and the biennial reports of the various State officials and departments. *See* A. C. McLaughlin, *History of Higher Education in Michigan,* in circulars of information of the U.S. bureau of education (Washington, 1891). For population data, etc., *see* the volumes of the *Fourteenth Census of the United States;* the biennial *Census of Manufactures* and the 1926 *Census of Agriculture. The Publications of the Michigan Geological Survey* (Detroit, Lansing and New York, 1838 *seq.*) deal largely with the mining districts of the upper peninsula; A. Winchell, *Michigan: Being Condensed Popular Sketches of the Topography, Climate and Geology of the State* (1873), is in large measure restricted to the southern half of the State; *see* also the bibliography bulletins of the U.S. Geological Survey for special articles relating to Michigan. (L. A. W.)

MICHIGAN, LAKE, the third largest of the Great Lakes of North America and the only one wholly within the boundaries of the United States. It is about 307 m. in length, averages about 70 m. in width, and has a maximum measured depth of 870 feet. The lake is bounded on the north and east by the State of Michigan, on the south by Indiana and on the west by Illinois and Wisconsin. It has a water surface of 22,400 sq. m. and a drainage basin of some 69,040 sq. miles. Taking the average for the past 68 years, its mean surface is 580·94 ft. above mean sea-level, being the same as Lake Huron and 21·28 ft. below that of Lake Superior. The average or normal elevation of the lake surface varies irregularly from year to year. During the course of each year, the surface is subject to a consistent seasonal rise and fall, the lowest stages prevailing during the winter months and the highest during the summer months. In addition to the annual fluctuation, there are occasional oscillations of irregular amount and duration. Sometimes these are apparently seiches, resulting from variations in barometric pressure, which may produce changes ranging from a few inches to several feet, and return to normal, within a few hours. The dangerous storms of the autumn, winter and early spring are usually westerly. Ice interferes with navigation in the northern part of the lake in winter; the average closing and opening dates for navigation in the Straits of Mackinac are Dec. 15 and April 12, respectively.

Harbours.—The harbours along the shores are generally situ-

ated at the mouths of rivers. Most of these rivers are small and unimportant, the larger streams being the Menominee and the Fox, both of which empty into Green bay, the most important arm of the lake. The early plan of improvement consisted of parallel piers protecting a dredged channel; subsequently, at some harbours, detached breakwaters were built to provide additional protection from prevailing storms. In recent years, the injurious effects of storm waves in inner harbours have been relieved by the formation in the lake of a wave-stilling basin, enclosed by breakwaters or piers which converge to an entrance opening in deep water beyond the inner piers, this basin allowing the waves to expand and lose force instead of being conducted through the confined channel between the parallel piers. Such basins now exist at Holland, Ludington, Manistee, Manistique, Two Rivers, Manitowoc, Sheboygan and Racine. The outer harbours at Milwaukee, Chicago and South Chicago (Calumet), protected by breakwaters, afford commodious and safe anchorage for all classes of vessels. The harbours of Port Washington, Waukegan, Indiana Harbor and Gary are entirely artificial, consisting of dredged channels and basins protected by breakwaters and piers. As a result of the improvements made and maintained by the United States and local interests, the harbours are generally accessible to vessels drawing from 14 to 21 ft. at low stages.

The port of Escanaba on the north shore of the lake is an important shipping point for iron ore. Green Bay and Milwaukee are centres of distribution for coal from Lake Erie ports. Near the south end of the lake the Chicago district is a great industrial centre, consuming large quantities of water-borne raw materials, principally iron ore, coal and limestone, which are handled through the important ports of Calumet (South Chicago), Indiana Harbor, Gary and Buffington. Milwaukee, Chicago and Calumet are grain-shipping ports.

The commerce for the calendar year 1927 of the principal ports on the lake in tons is shown in the following table:—

Water-borne Commerce of Ports on Lake Michigan During 1927

Ports	General cargo		Car ferry	Total
	Foreign	Domestic		
Manistique . .	.	6,194	262,754	268,948
Menominee . .	11,147	325,691	419,523	756,361
Green Bay and De Pere . . .	24,498	1,744,156	..	1,768,654
Kewaunee . .	..	2,075	330,603	332,678
Manitowoc . .	11,000	690,563	1,566,912	2,268,475
Sheboygan . .	..	476,030	..	476,030
Milwaukee . .	288,713	5,690,916	2,253,569	8,233,198
Racine . . .	..	256,776	..	256,776
Grand Haven . .	..	223,238	1,015,664	1,238,902
Sturgeon Bay .	..	395,259	..	395,259
Muskegon . .	45,458	386,810	..	432,268
Ludington . ..	..	165,796	2,251,589	2,417,385
Frankfort . . .	..	904	1,566,108	1,567,012
Gladstone . . .	7,816	101,579	..	109,395
Arcadia . .	..	..	..	..
Escanaba . . .	351,712	6,433,273	..	6,784,985
Chicago . . .	440,619	13,654,900	..	14,095,519
Indiana Harbor .	18,004	5,769,915	..	5,787,919
Gary	4,151	5,392,834	..	5,396,985
Buffington . .	..	1,380,688	..	1,380,688

The transfer of loaded freight cars on car ferries on the Great Lakes was inaugurated in 1892 by the Ann Arbor railroad. The present service on Lake Michigan, which is by far the most extensive of its kind in the world, consists of two ferries operated between Grand Haven, Mich., and Milwaukee, Wis., by the Grand Trunk railway; seven between Ludington, Mich., and Milwaukee, Manitowoc, Wis., and Kewaunee, by the Pere Marquette railway; four between Frankfort and Menominee and Manistique, Mich., and between Frankfort, Mich., and Manitowoc and Kewaunee, Wis., by the Ann Arbor railroad.

Engineering.—Lake Michigan is connected at its north-east extremity with Lake Huron by the Straits of Mackinac, 48 m. long, with a minimum width of 6 m.; the water is generally deep and the shoals lying near the usually travelled routes are well marked.

The head of the Illinois river watershed is separated from Lake Michigan by a low divide. In 1848 the Illinois and Michigan canal was constructed from the Chicago river across the divide to the Illinois river at a point just below La Salle, thus permitting through navigation. In 1900 the sanitary district of Chicago completed a drainage canal from the south branch of the Chicago river to the Des Plaines river at Joliet. This, combined with work in the Chicago river, reversed the flow of the latter and permitted the flow of water from Lake Michigan through the canal into the Des Plaines and thence to the Illinois. It also provided a navigable channel 21 ft. deep, with a minimum bottom width of 200 ft., from the lake to a point between Lockport and Joliet, where a power plant was constructed. In 1908 the Illinois waterway was provided for by amendment to the State's Constitution, to be financed by the sale of bonds, to permit navigation from Lockport to Utica, with the intention of connecting the Great Lakes with the Mississippi system. The waterway is designed for 9 ft. depth, and was under construction in 1928. The Federal Government has undertaken the improvement of the Illinois river with a view to securing a navigable channel of the same depth to the mouth, where connection is made with the Mississippi river.

Under authority of Sec. 10 of an act of Congress approved on March 3, 1899, the secretary of war, upon the recommendation of the chief of engineers, issued on March 3, 1925, to the sanitary district of Chicago, a permit to divert from Lake Michigan, through its main drainage canal and auxiliary channels, an amount of water not to exceed an annual average of 8,500 cu.ft. per second, the instantaneous maximum not to exceed 11,000 cu.ft. per second under certain conditions including the requirements that the sewage be artificially treated, that controlling works be constructed to prevent the discharge of the Chicago river into the lake, and that the water service of the city of Chicago be metered. This permit, if not previously revoked or specifically extended, becomes null and void on Dec. 31, 1929. Action has been brought by some of the Lake States to restrain the Chicago drainage district from diverting water from Lake Michigan, and the matter was finally settled by the Supreme Court in favour of the Lake States in January, 1929.

Jean Nicolet is credited with being the first white man to navigate Lake Michigan. Sent west by Champlain on a voyage of exploration, he threaded his way in a birch canoe from Georgian bay through the Straits of Mackinac and thus discovered Lake Michigan in the summer of 1634. Later explorers were Joliet, Marquette and La Salle.

BIBLIOGRAPHY.—*History of the Great Lakes* (1899); *Transportation on the Great Lakes* (War Department, 1926); Bulletins and Charts issued by the U. S. Lake Survey Office (1928); *Document* No. 4, Committee on Rivers and Harbors, 69th Congress, 1st Session; *Annual Report* of the chief of engineers, War Department. (E. JA.)

MICHIGAN, UNIVERSITY OF, situated at Ann Arbor, Mich., is one of the principal educational institutions of the United States. It includes a college of literature, science, and the arts, opened in 1841, a medical school (1850), a law school (1859), a school of dental surgery (1875), a college of pharmacy (1876), a college of engineering, separately organized in 1895, a college of architecture (1913), a school of education (1921), a school of business administration (1924), and a school of forestry and conservation (1927). The graduate school of the university was established as a separate division in 1912. The first summer courses were given in 1894. In 1926–27 there were in all departments 689 instructors and 13,257 students. The university was one of the first in America to admit women, having opened its doors to them in 1870; since 1900 they have constituted nearly one-third of the student body. Up to March 1928 the university had conferred 53,509 degrees. The organic relation of the university to the other schools of the State was well established in 1870 through the establishment of a department of education, the first in any American university, and a provision that graduates from high schools which had been examined and approved by a committee from the university should be admitted without examination.

The libraries of the university comprise a total of 649,912 volumes, of which 441,013 volumes are housed in the General Library Building (1919) occupying the centre of the campus.

The William L. Clements Library of American History, the gift of Regent Clements of Bay City, occupies a separate building (1923) and comprises one of the largest and most valuable collections on Colonial and Revolutionary history in the world.

The university's resources are inventoried at over $35,000,000, of which over $29,000,000 is invested in buildings and lands. The physical property of the university includes 51 larger buildings and many smaller ones. At a little distance from the campus is the great university hospital which with other buildings in the hospital group furnishes bed accommodations for over 1,000 patients and serves as a great hospital centre for the whole State of Michigan. Its administration is entirely in the control of the university.

A noteworthy feature of the university's equipment are the buildings devoted to physical education and sports. In addition to the Waterman Gymnasium for men and the Barbour Gymnasium for women, on the campus, the university possesses a great playground in Ferry Field comprising over 75 acres. Here is the Yost Field House, 345 ft. long by 165 ft. wide, devoted to a year-round programme of intercollegiate sport, while a building equally large for intramural sports was completed in 1928. The football stadium has accommodation for 87,000 spectators.

Recent important developments in the university are: the establishment of the University college (to be open in 1929), including practically all the first and second year students in the university under a united administration; the establishment of a special fund in 1927 for faculty research; the development of special divisions for engineering research and cancer research; the establishment of a series of scholarships for oriental women through the funds left by the late Levi L. Barbour of Detroit; and the inauguration of a programme for the erection of dormitories.

The university is governed by a board of eight regents, two elected biennially by popular suffrage. The internal government rests to a large extent with the president and the members of the faculty of professorial rank organized as the university senate. The principal income of the university comes from the Treasury of the State of Michigan with the annual receipts for the year 1926–27 for all purposes totaling $10,500,000. The university also has a small permanent income of $38,000 derived from the sale of the lands originally set apart by the State for educational purposes under the Ordinance of 1787.

The first incorporation of a university within what is now the State took place in 1817 when the Governor and judges of the Territory established the "Catholepistemiad, or University of Michigania," with a remarkable Greek system of nomenclature for its courses and faculties. Neither this institution, however, nor its successor, which came four years later, the first University of Michigan in Detroit, ever offered courses of a collegiate character. It was not until the admission of Michigan into the Union as a State in 1837 that an Organic Act under the constitution of 1835 made possible the organization of the present university and its establishment at Ann Arbor. The regents first met in June 1837 and plans were begun in 1838. A series of branches were established in neighbouring towns to furnish the necessary students; these were soon discontinued, however, and the whole effort of the newly established Board of Regents centred in the university which opened its doors in 1841. The first division, the department of literature, science, and the arts was much like a New England college. The prospects at first were not promising, but in 1851 a new State constitution provided that the regents should be elected by the people instead of being appointed, as originally provided, by the Governor. They were also directed to choose a president and Henry Philip Tappan (1805–81) was selected. It was under his administration (1852–63) that the present broad and liberal policies of the university were clearly defined. The germ of graduate study was planted and a scientific course was introduced. Gradually the various schools and colleges of the university came into being. In 1871–72 the German seminar method was introduced in graduate work in history, and in 1878 the elective system was established.

BIBLIOGRAPHY.—B. A. Hinsdale, *History of the University of Michigan* (1906); *A Memorial of the Seventy-fifth Anniversary of the Founding of the University of Michigan* (1915); Wilfred Shaw, *The University of Michigan* (1920); also *Annual Reports of the President* (1922–27). (W. B. SH.)

MICHIGAN CITY, a city of La Porte county, Indiana, U.S.A., on Lake Michigan, 40 m. E. by S. of Chicago. It is on federal highways 12 and 20, and is served by the Chicago, Indianapolis and Louisville, the Michigan Central, the Nickel Plate, the Pere Marquette and electric railways, motor bus and truck lines and lake steamers. The population was 19,457 in 1920 (18% foreign-born white) and was 26,735 in 1930 by Federal census. It is the seat of the Northern State prison and a United States Life Saving station, and the see of a Protestant Episcopal bishop.

The commerce of its harbour in 1925 was valued at $1,712,750; and its manufactures in 1927 were valued at $24,987,996. Michigan City was founded about 1830, incorporated as a village in 1837, and chartered as a city in 1867. Since 1922 it has had a commission-manager form of government.

MICHMASH, a place in Benjamin about 9 Roman miles north of Jerusalem (Eusebius, *Onom.*), and the scene of Jonathan's daring exploit against the Philistines (1 Sam. xiv.): mod. Mukhmās, pop. 400. It was re-colonised after the exile (Neh. xi. 31); Jonathan made it his administrative centre (1 Macc. ix. 73), and it was a large village in Eusebius' time. The only archaeological interest is a cave with columbaria. There are megalithic monuments in the neighbourhood.

MICHOACÁN, or **MICHOACÁN DE OCAMPO,** a State of Mexico touching on the Pacific. Pop. (1921) 939,849, chiefly Indians and mestizos. Area, 23,198 sq. miles. Its territory is divided into two nearly equal parts by the Sierra Madre Occidental, the northern part belonging to the great central plateau region, and the southern to an extremely broken region formed by the diverging branches of the Sierra Madre, with their wooded terraces and slopes and highly fertile valleys. The general slope of the southern part is southward to the river Balsas, or Mescala, which forms its boundary-line with Guerrero. The narrow coastal zone on the Pacific is only 101 m. long and has no ports or towns of importance, the slopes being precipitous and heavily wooded and the coast-belt sandy, hot and malarial. The Lerma, on the northern frontier, and the Balsas on the southern, are the only rivers of importance in the State, their tributaries within its boundaries being small and swift-flowing. There are several large and beautiful lakes in the State, the best known of which are Pátzcuaro and Cuitzco. Lake Chapala lies on the northern boundary. Michoacán lies within the most active volcanic region of Mexico: Jorullo (4,262 ft.) is near its southern line, and Colima (12,750 ft.) is north-west of it in the State of Jalisco. The climate is for the most part temperate and healthy, but it is hot along the Pacific coast. Michoacán is essentially a mining region, producing gold, silver, lead and cinnabar, and having rich deposits of copper, coal, petroleum and sulphur. The natural products include fine cabinet and construction woods, rubber, fruit, palm oil and fibres. The soil of the valleys is highly fertile, and produces cereals in the higher regions, and sugar-cane, tobacco, coffee and tropical fruits in the lower. Though the plateau region was settled by whites soon after the Spaniards came to Mexico, there are districts on the southern and Pacific slopes that still belong almost exclusively to the Indians. Besides Morelia, the capital and largest city, the principal towns of the State are: La Piedad (pop. in 1921, 12,115), an important commercial town on the Lerma river and on the Mexican Central railway, 112 m. N.N.W. of Morelia; Zamora (in 1921, 13,863), 75 m. W.N.W. of Morelia; and Uruapan (in 1921, 13,689), on the Mexican National, 55 m. S.W. of Morelia in a mountainous district celebrated for the fine quality of its coffee.

MICKIEWICZ (mĭk-ē'ā-vĭts), **ADAM** (1798–1855), Polish poet, born near Nowogrodek, in the Russian government of Minsk, where his father, who belonged to the lesser nobility, had a small property. The poet was educated at the Vilna university; but, becoming involved in political troubles as a member of a secret patriotic student society, he was imprisoned for a time by the Russian Government and afterwards ordered to live in Russia. He had already published two small volumes of miscellaneous

poetry at Vilna, and at St. Petersburg he was a great favourite in society. In 1825 he visited the Crimea, which inspired a collection of sonnets.

In 1828 appeared his *Konrad Wallenrod*, a narrative poem describing the battles of knights of the Teutonic order with the heathen Lithuanians. Here, under a thin veil, Mickiewicz represented the sanguinary passages of arms and burning hatred which had characterized the long feuds of the Russians and Poles. The object of the poem, although evident to many, escaped the Russian censors, and it was suffered to appear. It is a romance in the Byronic vein and contains two beautiful lyrics. After a five years' exile in Russia the poet obtained leave to travel abroad; and he never saw his native country again. Visiting parts of Germany and Italy, he paid his homage to old Goethe at Weimar, and was received very cordially. It was on these wanderings of his that Mickiewicz wrote the greatest scenes of his fantastic drama *Dziady* (Forefathers' Eve), the subject of which is the half-pagan religious commemoration of their ancestors practised among the peasantry of the Slavonic nations. Interwoven with this subject from folk-lore, there is, in the earlier portion of the poem (the so-called "Fourth Part") a dramatic account of an unhappy early love affair of the poet's, and, in the later and more important portion, called the "Third Part," a picture of his own and his Vilna fellow-students' sufferings in the Russian prison, and a powerful poetic statement of the workings of his genius while a mystical religious philosophy was being produced in his mind by the influence of personal and national suffering.

Mickiewicz' acknowledged masterpiece is his epic poem *Pan Tadeusz,* published in 1834. Its scene is laid in Lithuania on the eve of Napoleon's expedition into Russia in 1812, and its subject is a family feud among the country gentry, happily terminated by a wedding. In this epic idyll, Mickiewicz gives us a picture of the homes of the olden-time Polish nobility and gentry, with their somewhat boisterous but very genuine hospitality, their meals and manners and pastimes, and their readiness for patriotic sacrifice in the service of their country. Turning to the land of his childhood with the loving eyes of an exile, he gives us delightful descriptions of Lithuanian skies and forests: through the medium of his poetry, the modest landscape of the Lithuanian country-side has become dear and familiar to every Pole, and to many readers outside Poland.

In 1832 Mickiewicz left Rome for Paris, where most of his later life was spent in poverty and unhappiness. He had married a Polish lady, Celina Szymanowska, who became insane. In 1838–39, he occupied the chair of Latin Literature in the University of Lausanne, Switzerland. In 1840 he became professor of Slavonic languages and literature in the Collège de France. His last lecture was given on May 28, 1844. He had fallen under the influence of a mystic named Towianski. His lectures became a medley of religion and politics, and thus brought him under the censure of the Government. A selection from his lectures contains some good sound criticism; the philological part is necessarily defective, but the poet shows much intuitive insight into the history and mentality of the Slavonic races, especially of Poland and Russia. In his later years, Mickiewicz endeavoured to turn from poetry to active work for the cause of his country's deliverance. In 1848, he attempted to form a Polish volunteer legion in Italy, but the attempt came to nothing. In 1849 he founded a radical French newspaper, *La Tribune des peuples,* but it only existed a year. His last composition was a Latin ode in honour of Napoleon III. On the outbreak of the Crimean War he was sent to Constantinople to assist in raising a regiment of Poles to take service against the Russians. He died suddenly there in 1855, and his body was removed to France. In 1890 his remains were disinterred and buried in the cathedral of Cracow, the Westminster Abbey of Poland.

Mickiewicz is one of the greatest among Slavonic poets. He is one of the best products of the so-called romantic school in Polish literature. While that literature was cribbed and confined by 18th century classicism, the country was full of legends and picturesque stories which only awaited the coming poet to put them into shape. Hence the great popularity among his countrymen of his ballads each of them being connected with some national tradition. Besides *Konrad Wallenrod* and *Pan Tadeusz,* attention may be called to his early poem *Grazyna,* which describes the adventures of a Lithuanian chieftainess against the Teutonic knights. A fine vigorous Oriental piece is *Farys.* Very good, too, are the odes to Youth and to the historian Lelewel; the former did much to stimulate the efforts of the Poles to shake off their Russian conquerors. It is enough to say of Mickiewicz that he has obtained the proud position of the representative poet of his country; her customs, her superstitions, her history, her struggles are reflected in his works. He is the great voice of Poland appealing to the nations in her agony.

Bibliography.—The poet's life has been written, and his correspondence edited, by his son, Ladislas Mickiewicz (4 vols., Poznan, 1890–1895, French *Life* in 1 vol., Paris, 1888). The standard modern Polish work on Mickiewicz is that of Professor J. Kallenbach (*Adam Mickiewicz,* 2 vols., 4th edition, Lwów, Ossolineum, 1925). In English, see *Adam Mickiewicz, the National Poet of Poland,* by Miss Monica M. Gardner (London, Dent, 1912). Translations into English of *Konrad Wallenrod* and *Pan Tadeusz* were made by M. H. Dziewicki and Miss Biggs (1881–85), and more recently, by Professor G. R. Noyes in California and his students (*Pan Tadeusz,* 1917; *Konrad Wallenrod and other Writings,* 1925, University of California Press; *Forefathers' Eve,* prologue and scenes 1–5 of Part Third, 1926, London, Eyre and Spottiswoode). (R. Dy.)

MICKLE, WILLIAM JULIUS (1735–1788), Scottish poet, son of the minister of Langholm, Dumfries-shire, was born on Sept. 28, 1735. He was educated at the Edinburgh high school, and became a brewer. He failed in business, and went to London in 1763. There he published (1765) "a poem in the manner of Spenser" called the *Concubine* (afterwards *Syr Martyn*); was appointed corrector to the Clarendon Press, and translated the *Lusiads* of Camoens into heroic couplets (specimen published 1771, complete work, 1775). Scott read and admired Mickle's poems in his youth, and founded *Kenilworth* on his ballad of *Cumnor Hall,* which appeared in Thomas Evans's *Old Ballads . . . with some of Modern Date* (1784).

BY COURTESY OF THE MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA

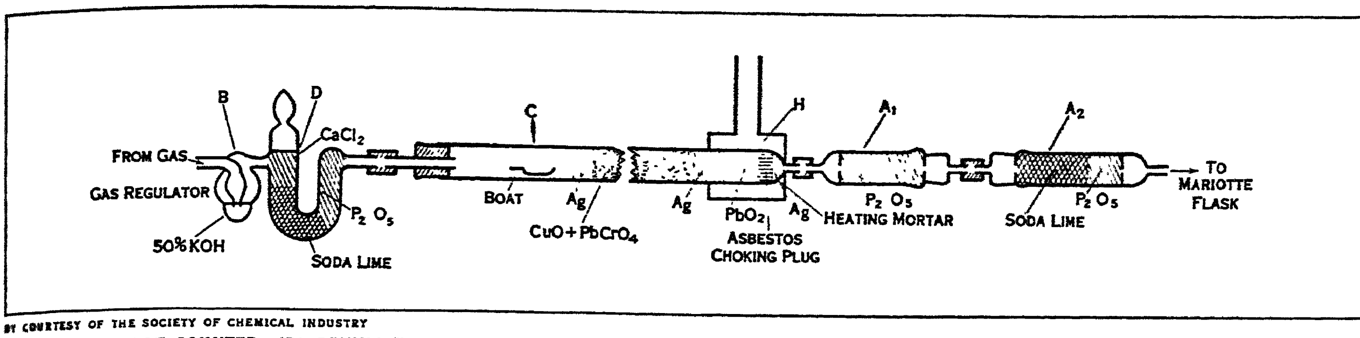
MICMAC INDIAN OF NOVA SCOTIA, CANADA

MICMAC. An Algonkin people of Nova Scotia and northern New Brunswick, probably discovered by Cabot in 1497. They formed a confederacy of seven tribes: their name means "allies." They were non-agricultural and made much use of canoes and fish. They were consistently friendly to the French and hostile to the English settlers, whom they fought bitterly after the cession of Acadia to Great Britain. Estimated at 3,000 to 3,500 during the seventeenth and eighteenth centuries, they now number nearly 4,000. Their dialect differs considerably from that of their neighbours, so that they may represent a fairly early offshoot of the Algonkin family. (A. L. K.)

MICON, a Greek painter of the middle of the fifth century B.C. He was closely associated with Polygnotus of Thasos, in conjunction with whom he adorned the Painted Stoa, at Athens, with paintings of the battle of Marathon and of the Greeks and Amazons. He collaborated with the same artist in paintings in the Theseum and the Anaceum, and was esteemed also as a sculptor of athletes.

MICROANALYSIS, CHEMICAL. Chemical analysis (*see* Chemistry, Analytical) becomes chemical microanalysis when the quantities of substances examined or measured are very small. The power to deal successfully with minute quantities of material has been acquired as a consequence, in the first place, of the increased precision of such instruments as the microbalance and the spectroscope, and, in the second, of a general advance in analytical knowledge and technique.

Microchemical methods are of the highest importance because of their ever-increasing application, not only in chemical, biochemical, and pathological research, but also to daily life and industry. Artificial products and the products of animal and



BY COURTESY OF THE SOCIETY OF CHEMICAL INDUSTRY

(B) BUBBLE COUNTER, (D) DRYING TABLE, (C) COMBUSTION TUBE, (H) HEATING MORTAR, (A_1) WATER-ABSORBING TUBE, (A_2) CARBON DIOXIDE-ABSORBING TUBE

vegetable life are usually obtained as mixtures, more or less complex, which can be separated by physical means (distillation, crystallisation, dialysis, etc.), into component parts consisting each of a more or less pure chemical substance. The identification of these substances and the control of their purity depend ultimately upon chemical analysis. The recognition and estimation of traces of impurities, frequently a matter of great public importance, must generally be carried out by microchemical methods; and it is becoming increasingly appreciated that quantitative microanalysis often affords the most rapid and economical means of examining even bulk products and chemically pure substances. This is particularly true of the products of research, many of which can be isolated only with difficulty and in minute quantities and yet often exercise the most important functions. It is only necessary to mention in this connection the vital rôles played by catalysts and promoters in chemical processes, and those of the vitamins, hormones, and enzymes, in biochemical phenomena.

Microanalysis may be either *qualitative, i.e.,* concerned only with the detection of the kinds of substances present; or it may be *quantitative,* being then concerned also with the proportions in which the substances occur. Thus, it might be required to know whether strychnine were present in a given drug, or whether human blood were present as a given stain; or again, it might be required to decide whether the proportion of arsenic in a given foodstuff (beer or cocoa) exceeded a certain limit. Speaking quite generally, it may be said that the quantity of material required for, or measured in, a given microanalysis is from 1 to 2% of that in the large-scale or macroanalysis. The methods employed in microanalysis are usually essentially similar to those in the corresponding macroanalysis. This is particularly the case in:

Quantitative Microanalysis, in which the classical methods of analysis for elements and radicals (*see* CHEMISTRY: *Analytical*) are preserved in refined forms. These developments have taken place since 1910, and are due principally to Fritz Pregl of Graz. They have been rendered possible by the elaboration, by W. H. Kuhlmann of Hamburg and by others, of a chemical microbalance capable of determining loads (up to 20 grams) to within two or three thousandths of a milligram; of being manipulated with ease and rapidity; and of retaining sensitiveness during many years.

General methods are now in use for the quantitative estimation of the following elements and radicals: Carbon and hydrogen, nitrogen, chlorine, bromine, iodine, sulphur, selenium, tellurium, phosphorus, arsenic, copper; carboxyl-, methoxyl-, ethoxyl-, methylimido-, and acetyl-groups. In addition, metals in salts; ash content; water content; and molecular weight (ebullioscopic method) may be microanalytically determined.

The weight of material required for each determination varies from 0·5 to 15 milligrams (0·0005 to 0·015 gram); it is usually from 3 to 5 milligrams (0·003 to 0·005 gram.). The microanalytical methods are at least as accurate as the large-scale methods, in some cases more so; they are much more rapid than the latter; and they involve economy in respect of power, bench space, and materials. The necessary skill and accuracy to operate the methods is easily acquired by any chemist. There can be little doubt that these methods are rapidly replacing the older and more cumbrous processes, and that their general adoption will greatly accelerate the progress of chemical and biological knowledge.

A brief outline of one of the most important processes is given below:

Determination of Carbon and Hydrogen.—A weighed quantity (3 to 5 milligrams) of the substance, placed in a small platinum boat, is burned in a current of oxygen (dried by passage through the tubes B and D) in the apparatus shown in the diagram. The hard-glass tube, C, is 40 cm. in length, and contains a filling of chemicals (as indicated in the diagram) designed to arrest the escape of nitrogen, sulphur, halogens, and other products which might vitiate the analysis. The remaining gaseous products of the combustion, water and carbon dioxide, are swept over with air, and are retained, respectively, in the tubes A_1 and A_2, which are weighed on the microbalance both before and after the experiment. From the gains in weight of these tubes, the amounts of hydrogen and carbon in the original material are calculated. The gas pressures at different points of the apparatus are carefully regulated, and the temperature of the lead peroxide is maintained at 180° C by means of the external heating device shown at H. Practically all classes of organic substances may be analysed with great accuracy in this apparatus.

Reference may be made also to the semi-micro-analytical methods, requiring 50 milligrams and upwards of material, of H. Ter Meulen, who has employed manganese dioxide in the combustion tube. Especially worthy of notice is his method of determining oxygen in organic compounds by heating in hydrogen in the presence of a nickel catalyst. (H. Ter Meulen and J. Heslinga, *Recueil des Travaux chimiques des Pays-Bas,* 1922 *et seq.*)

Some of the following methods of qualitative micro-analysis, may be applied quantitatively also, *e.g.,* spectroscopic analysis. (*See* A. B. P. Leme, *Comptes rendus,* 1918, *166,* p. 465, and *Zeitschrift für das Gesamtgebiet der Mikrochemie und Mikrophysik,* W. Muller, Vienna; 1923 *et seq.*)

Qualitative Microanalysis.—Since each chemical produces its own characteristic spectrum, an examination, by means of the spectroscope (*q.v.*), of the flame or spark spectrum of a substance reveals the identities of the elements present. The delicacy of the method far transcends that of the most sensitive chemical reactions. Thus, the presence of one hundred-thousandth part of a milligram of lithium may be revealed by means of the spectroscope; or, again, five hundred-thousandths of a milligram of the rare gas, neon, present in the atmosphere, may be detected. In this manner the metallic elements gallium, rubidium, indium, caesium and thallium were discovered. The absorption spectra (*q.v.*) of many inorganic and organic substances are also characteristic, thus enabling the presence of these substances to be recognised. Examples are: copper sulphate; the blood pigments (haemoglobin and oxyhaemoglobin); and the porphyrins.

Far more widely employed, however, are the purely chemical methods which depend upon the production, on the addition of reagents to the sample or to its solution, of colorations or of colour changes; of precipitates having characteristic odour, colour, or crystalline form; or of gases or liquids which can be distilled over and identified. These tests, many of which are very delicate, may be specific for particular compounds, radicals, or elements; or for groups of these. Thus, the presence of 1 part of copper in 100

million parts of water is shown by the blue colour produced on the successive addition of alcoholic hydrogen peroxide and guaiacum resin in pyridine. The presence of 1 part of gold in 20 million parts of solution is revealed by the yellow coloration given with *o*-tolidine. Prussic acid (1 part in 2 millions of air) may be detected by means of the blue colour which it gives upon a test paper moistened with a solution containing *o*-tolidine, acetic acid, and copper acetate. There are many hundreds of such tests, some of which are also quantitative.

Methods of manipulating minute quantities of liquids and precipitates have been worked out, particularly by F. Emich of Graz. Thus two drops of a mixture of two organic liquids may be fractionated and the boiling points of each ascertained with accuracy.

Bibliography.—F. Emich, *Mikrochemisches Praktikum* (J. F. Bergmann, Munich, 1924); G. Klein and M. Strebinger, *Fortschritte der Mikrochemie* (F. Deuticke, Leipzig, 1928); A. Lucas, *Forensic Chemistry* (E. Arnold and Co., London, 1921); Behren, *Microanalysis*. For descriptions of special apparatus and methods used in quantitative determinations, the following works may be consulted: F. Pregl, *Quantitative Micro-analysis* (Translated by E. Fyleman, J. and A. Churchill, London, 1924); H. D. K. Drew and C. R. Porter (*Journal of the Society of Chemical Industry*, London 1928, p. 17 T); J. H. Yoe, *Photometric Chemical Analysis* (1929); also articles by Garner in "The Industrial Chemist"; *Abstracts* and *Transactions of the Journal of the Chemical Society* (London). (H. D. K. D.)

MICRO-ASBESTOS, MIKROASBEST, ASBESTPULVER, BURGENLÄNDISCHE ASBESTINE, trade names for a fibrous asbestos product obtained from crumpled and crushed serpentine rocks which occur near Rechnitz, Austria. It is used as a filler in the rubber trade, in absorbent papers and matrix boards, for insulating, in acid and weather resisting paints, in plastics and synthetic resins, for making certain types of flooring, in asphaltic roof compositions, and for many other uses where an inert acid resisting mineral filler is indicated. (*Cf.* Asbestine.)

MICROBE: *see* Filter-passing Viruses.

MICROCEPHALY: *see* Neuropathology.

MICROCLINE, a triclinic potash felspar (*q.v.*) of the same composition as orthoclase ($KAlSi_3O_8$), which it closely resembles in physical and chemical properties. The triclinic character is established by its crystallographic and optical properties, viz., the cleavage angle 001:010 (89°30′), the twinning and the optical extinction. Twinning on the albite and pericline laws is almost universal and produces a characteristic grating or quadrille structure seen in thin sections of the mineral examined in polarized light. This feature and the extinction angle of 15°–17° on the face 001 distinguish the mineral from orthoclase. Laue X-ray photographs of microcline and orthoclase are identical, but the inner crystal structure of these minerals had not yet been determined. The evidence, however, does not support the contention that orthoclase owes its apparent higher symmetry to a submicroscopic twinning leading to zero optical extinction in 001. Microcline is unknown in surface lavas, but is common in plutonic rocks as granite and syenite and in pegmatites. Rare in contact metamorphic zones, it is widely distributed in the crystalline schists. (C. E. T.)

MICROCOSM, a term often applied in philosophical and in general literature to man regarded as a "little world" (Gr. μικρὸς κόσμος) in opposition to the "macrocosm," great world, in which he lives. From the dawn of speculative thought in Greece the analogy between man and the world has been a common-place, and may be traced from Heraclitus and Empedocles, through Plato, Aristotle, the Stoics, the Schoolmen and the thinkers of the Renaissance down to the present day. Thus Lotze's comprehensive survey of mental and moral science is termed *Microcosmus*. The most systematic expression of the tendency indicated by the term is the monadology of Leibniz, in which the monad is regarded as containing within its own closed sphere an expression of the universe, the typical created monad being the human soul.

MICROCOSMIC SALT, so named by the alchemists because it is contained in the decomposing urine of man (the "microcosm") is ammonium sodium hydrogen orthophosphate, $NH_4NaHPO_4 \cdot 4H_2O$. It is interesting historically as being the raw material from which Brand prepared phosphorus, whence it is called "salt of phosphorus." (*See* Chemistry: *Analytical*.)

MICRODISSECTION: *see* Protoplasm.

MICROMANIPULATION. This term has recently been applied to a specialized technique for operating on microscopic objects under the high magnifications of the compound microscope. The operations are made with microneedles (for microdissection), micropipettes (for microinjection) and microelectrodes, held and moved in different planes by a mechanism styled the micromanipulator.

The delicate, rigid tips of the microneedles and micropipettes are usually of glass or quartz; the microelectrodes of salt-filled pipettes or of metal. The injections are made with a syringe connected to the pipette by a coil of capillary tubing. The movements are so accurately controlled that such delicate operations can be made as to puncture and tear a mammalian blood-corpuscle 8 microns (0·008 mm.) or less in diameter. The pipettes for microinjection have apertures less than one micron across.

With this technique colloidal particles and bacteria have been manipulated and isolated, and histological structures microinjected and dissected for physiological studies. The technique has also made possible investigations on the physical and chemical properties of the protoplasm of living plant and animal cells. There is also a micro-radio-puncture technique developed by Tchakotine. (*See* Protoplasm.)

Bibliography.—R. Chambers, *Anat. Record*, vol. 24 (1922); *J. Royal Microsc. Soc.*, p. 373 (1928); Churchill in Gatenby and Cowdry's *The Microtomists Vade-Mecum;* McClung's *Handbook of Microscopical Technique* (1929); T. Péterfi, in Abderhalden's *Handbuch der biologische Arbeitsmethoden* (1923); *Pflügers Archiv. der gesammte Physiol.*, vol. 208 (1927); *Arch. exper. Zellforsch.*, vol. 4; C. V. Taylor, *University of California Publ.*, Zool., vol. 26 (1925); *Proc. Experim. Biol. and Medicine*, vol. 23 (1925); S. Tchakotine, *Comptes Rendus Soc. Biol.*, vol. 85 (1921); *Bollet. Soc. Ital. biol. sperimentale*, vol. 3 (Genoa, 1928). (R. Ch.)

MICROMETER, a name generally given to any device for measuring small angles or dimensions (from Gr. μικρός, small, μέτρον, a measure). In particular a great variety of appliances used for astronomical measurement are called micrometers.

One of the immediate difficulties of accurate measurement of linear dimensions is to secure coincidence between the measuring appliance and the object measured. For inaccessible (celestial) objects, coincidence is, of course, impossible; for accessible objects, *e.g.*, a photographic plate, the plate and the measuring appliance are likely to get in each other's way. The remedy is that either the measuring scale or the thing measured should be *insubstantial*. Certain devices, such as interferometers, can be regarded as representing the first alternative; but, in general, the simplest solution is to arrange that the thing measured shall be insubstantial, viz., an optical image, accessible and offering no interference with our measuring tools, but forming a faithful reproduction to scale of the object whose dimensions we really wish to know. Both in the telescope and the microscope a real image is formed in the focal plane; here we place the "pointer" of our micrometer—a movable wire, a scale ruled on glass, or some other fiducial mark—and move it about in the midst of the ghost that we are measuring. We view the coincident pointer and image through an eyepiece, which acts as a magnifying glass. Most micrometers make use of the principle of the screw; the pointer is displaced uniformly by turning a screw. If, for example, the step of the screw is 0·5 mm., and the screw-head is read to $\frac{1}{1000}$ of a revolution, we measure to 0·0005 mm. (about equal to the wave-length of light). Needless to say, many precautions are necessary if we would actually attain such high accuracy.

Filar Micrometer.—The first micrometer used with a telescope was made by William Gascoigne, about 1638. It consisted of two pointers with parallel straight edges, which could be brought together or separated by turning a screw. He made measurements of the diameters of the sun, moon and planets, which are still extant, and prove that his invention made a very great advance on earlier measurements. The modern successor of this instrument is the *filar micrometer*, in which the two pointers are replaced by parallel wires or spider-webs, carried on metal frames. Two screws are provided, one of which moves

the pair of wires as a whole, and the other alters the separation of the two wires. In most observations, only the reading of the second screw is required, the first screw being merely an aid in setting. Much work formerly done by visual measurement is now done photographically, and the use of the filar micrometer is now mainly for measurement of the separations and position angles of double stars. (*See* also HELIOMETER.)

Travelling-wire Micrometer.—This is an appliance used in conjunction with the transit circle (*q.v.*) which has proved very successful in avoiding magnitude-equation and other systematic errors, and is now generally adopted in fundamental observation. The older method was to tap off on a chronograph the observed times of passage of a star across a series of fixed wires set in the focal plane of the telescope. In the travelling-wire or "impersonal" micrometer, the observer continually turns a screw so as to keep a fine wire or web continually bisecting the moving star image. (The turning of the screw moves the eye-piece as well as the wire, so that the bisected star remains apparently stationary at the centre of the field of view.) Electrical contacts are made when the moving frame reaches definite positions, and the time when the wire, and therefore the star, reaches a series of positions is thus automatically recorded on the chronograph.

Photographic Measuring Machines.—These are examples of the application of the micrometer to the *microscope*. There is a wide variety of patterns, and nearly every observatory has its own form, designed to embody some special improvement, valuable either for securing accuracy or for saving time in the particular work there pursued. Many lines of work involve a prodigious amount of measurement of photographs, and the time-saving factor is therefore of great importance. We can only summarize here some of the typical requirements. The photographic plate must be carried on slides allowing it to move in two perpendicular directions, so that any point of it can be brought directly under the microscope. The frame should have great rigidity, in order that perfect focus may be preserved. The cross-wires, glass scale or other fiducial marks, are in the focal plane of the microscope objective, and are movable in two directions at right-angles by two micrometer screws. The eye-piece is mainly responsible for the magnification. Magnification by the objective is seldom greater than 3:1; there are, in fact, many advantages in using unit magnification, *i.e.*, the image in the focal plane of the objective is the same size as the photograph itself. It may be recalled that in visual observing we magnify with the eye-lens an image formed in the focal plane of the telescope; by inserting a photographic plate in the focal plane this image is materialized and rendered permanent; the objective of the measuring microscope converts this back into an insubstantial image, preferably of the original size, and we then make our deferred examination of it with an eye-lens.

In accurate (as distinct from time-saving) machines, the modern tendency has been towards simpler construction. The secret of success is to remove the difficulties before reaching the stage of micrometric measurement, instead of elaborating the measuring instrument to solve them. In researches on stellar parallax and proper motion, it is necessary to compare two or more photographs of star fields taken at different epochs. In parallax work the photographs are now often taken on the same plate (which is kept undeveloped in the interval between the epochs), the different images of the same star being arranged close together in a symmetrical way. In proper motion work the photograph at one epoch is taken through the glass of the plate, *i.e.*, with the plate "the wrong way round"; the two plates to be compared are then placed film to film so that corresponding images are very near together. In either case the comparison resolves itself into measuring exceedingly small distances between pairs of images, and there are comparatively few sources of error.

Similar principles apply to machines for measuring spectra (celestial or laboratory). Here the motion and measurement are in one dimension only, and a line is a somewhat easier object to set on, either with single or parallel wires, than a star image. Whenever possible the measurements are made relatively to a comparison spectra, so that only small differences of position are to be measured. (A. S. E.)

MICRONESIA (from Gr. μικρός, small, and νῆσος, island), one of the three great divisions of the oceanic islands in the central and western Pacific. Lying to the north of Melanesia, it embraces the following groups: Mariana, Pelew, Caroline, Marshall and Gilbert. For full details of these various groups of islands, *see* Pacific Islands.

ETHNOLOGY

This area, besides countless small islands, comprises the Mariannes or Ladrones (Japan and U.S.A.), the Carolines, East and West (Japan) and Marshall (Japan), and Gilbert (British) groups. The people are a highly mixed stock, Melanesian to an extent, with a Polynesian influence strong in the eastern portion, whilst over all is a later infusion of Malay blood, particularly in the Western Carolines. Their skin colour extends from brown to nearly yellow, the hair is black with a tendency to curl. Eyes are almost black, the cheek bones being highly placed. The stature of the Micronesians is only medium, nor are they so robust as the Polynesians. Everywhere the Chiefly caste is well established, although such influence is not so much hereditary as personal. In languages great differences are found. The basis, however, contains Polynesian roots. Tattooing is much in vogue for both sexes, particularly on the body, slaves being debarred from this privilege. In the main they are an inoffensive and lazy people, but liable at times to get out of hand. As navigators they formerly excelled, whilst in the Marshall group the regular use of charts was common. These, formed from palm strips, showed the relative position of the various islands, and occasionally were elaborate affairs, several feet long. Although accurate to the extent of showing the prevailing winds and ocean swell, they were only of use from the actual island on which they were made. The Ladrones, from their discovery by Magellan in 1521, were controlled by the Spaniards until 1898. Of the original inhabitants little remains, except numerous stone monuments, rapidly falling into decay. To-day, they form a miscellaneous and somewhat degenerate people, of whom immigrants from the Carolines are an important section, outwardly at least, all converts of the former Catholic priests. In Guam, the largest island, records of the original Chamorro religion and social structure hardly exist, the sole records being the somewhat imperfect account of the Jesuit missionary Le Gobien, whose narrative in French was published in 1700. These people, one reads, were hardy and warlike, and opposed the Spaniards for many years and finally ceased to exist as a race. Of the Gilbert group, comparatively little knowledge of old customs remains. The people are a sturdy race, much tinged with Polynesian blood implanted on a Melanesian stock. The possession of a light coloured skin, therefore, was esteemed as occular proof of the dominant Polynesian element, and a custom was in vogue for marriageable girls to undergo a course of "bleaching," extending over a year or more. The chief held great power, and some, particularly the king of Apamama, as recorded by Robert Louis Stevenson, lived in great style. Polygamy was practised and maintained on harem lines, with specially appointed officials; alternatively, slavery was a regular institution, and their numbers were controlled at their masters' discretion. The ordinary method of burial was interment under the dwelling house, although with very important people the body was allowed to shrivel in the sun, and was kept indefinitely, being produced at festivals. Crania were objects of regard and were preserved in a shrine near the dwelling. This survival of a skull cult indicates that the Melanesian element was formerly strong enough to implant some of their customs on the invaders. The presence of the soul was recognized, for after death it passed away to the West, as among the Polynesian peoples. Local legend definitely states that the invaders came from Samoa, some 700 years ago.

The inhabitants of the Marshall group show less admixture of Polynesian blood than the Gilbertese, whilst their social structure and mode of life is more nearly related to the Caroline peoples, a dolichocephalic race. Both groups are composed of a great number of small islands, wherein individual differences exist; in addition a marked contrast is found between the eastern and western portions. The inhabitants of the last offer peculiar fea-

tures, due to Malay, or even Chinese influence. Two excellent accounts of the Pelew Islands at the western end are accessible. That of the wreck of the "Antelope" in 1783 and the narrative of one Amasa Delano, an American ship's captain, in 1791. The Carolines were known to the Portuguese in 1526, being named in 1686 after Carlos II. of Spain. They remained under nominal Spanish control down to 1899, when the group was purchased by Germany. In the island of Ponapé remain great stone enclosures and remains of artificial islands constructed in the quiet waters of the lagoons, evidence of a numerous and energetic population, since formerly these islands were the stepping stones of the early Polynesian immigrants. The investigations of Hambruch in 1910, following those of Christian, show that formerly a vast area of artificially formed land, reclaimed from the shallow water, was occupied by temples, palaces, and burying places. An elaborate social organization was in force, whilst the king was the embodiment of the gods. To-day, the whole area is congested with ruins and abandoned by the few remaining natives. The people are now divided into numerous clans, each having its chief; next, prior to the nominal conversion to Christianity, came the priests, who exercised considerable power and combined the functions of doctors. The chiefs retain to this day considerable power and have great hold on their followers. Little is known of the former religion, which was of an animistic character, and even now certain recognized natural objects are venerated. The Melanesian system of "club houses" for the males is in full force and afford the most elaborate structures in the villages. On the island of Yap this custom is particularly prevalent, and the stone money discs peculiar to this island are disposed round these "club houses" as evidence of wealth. These discs reach a diameter of 12 feet and represent the communal wealth. This stone currency, being the ownership of the community, is an object of pride to the natives, and the Germans, when in possession, enforced local laws by the simple expedient of painting the German arms on the most valued till such time as the village had carried out the Government requisitions. The institution of these "club houses" forms an important part of the social life of the men, the females being excluded, and it is the custom for the young men to reside therein at an early age.

The occurrence of pottery vessels for domestic purposes affords another peculiarity of the western Carolines, where also the betel nut (*Areca cathecu*) is chewed extensively, whilst the natives of the eastern portion are addicted to the use of kava, a true Polynesian custom.

Weaving with the loom is common to both divisions and sexes indifferently; the material used is either fine fibres from the banana, or the hibiscus; elaborate and effective patterns in colour are produced with pleasing effect.

Bibliography.—G. Keate, *An account of the Pelew Islands,* 4to, 3rd ed. (1789); Amasa Delano, *Narrative of Voyages and Travels,* 8vo (Boston, 1817); W. H. Furness, *The Island of Stone Money,* 8vo (1910); F. W. Christian, *The Caroline Islands,* 8vo (1899); Robert Louis Stevenson, *In the South Seas* (Gilbert Group) 8vo (1900); J. S. Kubary, *Kenntnis des Karolinen Archipels* (Leyden, 1889); Akira Matsumura, *The Caroline Islands* (Tokyo, 1918).

(H. G. B.)

MICROPEGMATITE, in petrology, a very fine intergrowth of quartz and alkali felspar, occurring often as the last product of consolidation in many igneous rocks which contain high or moderately high percentages of silica. It shows the same structure on a minute scale as certain pegmatites (*q.v.*) or coarse granitic veins do on a large scale (*see* the article, Petrology); the quartz forms angular patches scattered through a matrix of felspar. In polarized light the separate areas of one mineral all extinguish at the same time, and this proves that even though apparently discontinuous they have the same crystalline orientation. The felspar may be considered an irregular crystal of spongy structure, the interstices being filled up by another spongy crystal of quartz. This kind of mineral intergrowth is said to be "graphic," because the coarsely graphic veins have triangular quartz areas dotted over a felspathic background resembling certain primitive inscriptions. Micropegmatite differs from "graphic granite" only in being so much finer grained that its nature can only be detected with the microscope. The felspar of micropegmatite is usually orthoclase, but sometimes albite, oligoclase or microcline. Occasionally it has crystalline form, and then it has been proved that the quartz may be so disposed that the two minerals have a definite relation between their crystallographic axes (parallel growth). The quartz typically occurs as angular patches. Micropegmatite is often so fine grained that even in the thinnest sections and with high powers it cannot be resolved into its components. This fine micropegmatite resembles threads, having a divergent arrangement. In some rocks the whole ground mass consists of spherulitic growths of fibrous micropegmatite (*see* Quartz-Porphyry); in their centres there is often a quartz or felspar crystal; the outer boundaries of the spherulites are not usually circular but irregular owing to the interlocking of adjacent spherulites at their margins.

In rocks where micropegmatite frequently occurs (*e.g.*, granite, porphyry and granophyre, quartz-diorite) it is usually the last product of consolidation, and represents the mother liquor left over after the other minerals had separated out in more or less perfect crystals. Hence it has no definite form of its own, but fills up the irregular interspaces between the earlier crystallizations. For that reason it has been compared to a eutectic, and supposed to be the mixture of quartz and felspar which has the lowest fusion point. Eutectics are common in alloys and often have a very perfect micrographic structure. The eutectic mixture of quartz and orthoclase has been estimated to contain 70–75° of the latter. This theory, however, is not without its difficulties; analyses of micropegmatite prove that its composition is by no means constant (this may perhaps be due to small admixtures of soda and lime felspars). Furthermore micropegmatite is not always the last consolidation product, as a eutectic should be, but may occur as well-shaped phenocrysts lying in a felsitic or glassy matrix which solidified at a still later time. Micrographic structures in the minerals of igneous rocks prove only that these minerals crystallized simultaneously. (J. S. F.)

MICROPHONE or **TELEPHONE TRANSMITTER,** a device for converting mechanical energy of sound waves into electrical energy with similar vibrational characteristics. The first instrument used for this purpose was the telephone receiver invented by Alexander Graham Bell in 1876, the same type of instrument being then used in a telephone circuit for transmitting and receiving. (*See* Telephone.) The term microphone, however, was first used by D. E. Hughes in connection with his discovery in 1878 that a loose contact in a circuit containing a battery and a telephone receiver may give rise to sounds in the telephone corresponding to the vibrations to which the contact is subject.

Hughes constructed his microphone in the form of a horizontal carbon rod resting in grooves in two carbon blocks, the battery and telephone receiver being connected in series with these blocks.

Microphones have in general been developed on two main lines.

First, as instruments (similar to the Hughes type) where the action is that of an amplifying relay, the impact of sound waves on the microphone causing a variation of energy supplied by a local battery. In this case efficiency is the primary object.

Secondly, as instruments where the electrical energy is mainly derived through the microphone from the mechanical energy of the sound waves, the first considerations being the perfection of frequency characteristic and a linear relation between air pressure and consequent electric current.

The former type has been developed for commercial purposes such as telephone communication systems; the latter for scientific work such as sound measurement (*see* Sound) and for purposes where high quality is essential, as, for instance, in broadcasting and gramophone recording installations.

The conversion of pressure vibrations in the air into corresponding electrical vibrations in an electrical circuit is generally carried out in two operations, which take place simultaneously.

First of all the sound wave impinges on a surface in the instrument (usually known as the diaphragm), which is capable of slight movement. The variation of air pressure on this diaphragm causes it to move to and fro in a manner corresponding to the

backwards and forwards movement of the particles in the air—that is corresponding to the original sound.

The second operation is that in which the diaphragm by its movement causes a corresponding change in some property of an electrical circuit. Thus the diaphragm may be one plate of a condenser producing variations in capacity, or it may be part of an inductive electromagnetic system, or it may cause variations of electrical resistance. In each case variation of current takes place by diaphragm movement.

Thus, in studying the performance of microphones, two things must be considered: first, the mechanical movement of the diaphragm; secondly, the nature of the method in which this movement sets up the changes which we desire.

Commercial Types.—The majority of these are of the loose contact type, the resistance of the contact varying with the pressure applied.

The change of resistance with pressure varies greatly with materials used, and it has been found that particles of carbon in light contact with each other produce the greatest change in resistance when subjected to small variations of pressure.

The electrical A.C. energy produced at the contact, since the power is taken from a local battery, may be many times the energy of the accoustic input, and this may be increased by increasing the current from the battery passing through the contact. But there always exists a slight variation of current at the contact even when no sound waves are impinging on it, which is heard as a hiss in a telephone receiver, and if the current through the contact is increased too much, the hiss becomes a loud crackling noise, due to overheating at the contact points.

Another disadvantage is that the contact or contacts may get into a very insensitive state known as "packing," the remedy for which is an occasional shaking.

The connection between input pressure and output current for this type of microphone is only linear (*i.e.*, proportional) for a very small range of pressures.

Speech transmission and reproduction can, however, be considerably distorted before becoming unintelligible to the human ear, and the efficiency of the microphone can be improved by introducing resonances at certain frequencies which are useful for intelligible transmission. Microphones of this type incorporate diaphragms with natural periods round about 800 cycles per second, and although the lowest and highest frequencies are lost with a considerable decrease in naturalness, the result is sufficiently good, even with the non-linear conditions of normal use, to be

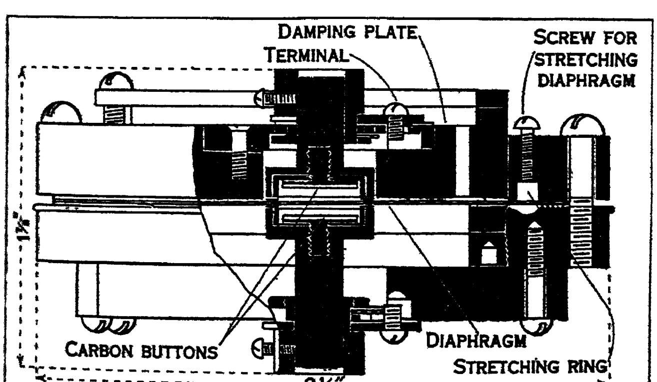


FIG. 1.—WESTERN ELECTRIC DOUBLE-BUTTON CARBON MICROPHONE

intelligible and practicable for transmission over a telephone system.

A familiar type of commercial microphone is one in which the current-varying element or "inset" is a cell consisting of two small carbon electrodes with polished faces, the space between which is filled with carbon granules. One of the electrodes is fixed and the other attached to a circular metal plate, which acts as a diaphragm to receive the sound waves.

This type of microphone, on account of the fact that it deals with only a limited range of frequencies, and also provides non-linear distortion, is quite unsuitable for the transmission of music and natural speech.

High Quality Types.—In recent years a careful study of the response of microphones to sound pressure has been made, with the objects in view of accurate sound measurement and of faithful transmission of speech and music. As a rule, to obtain high quality, efficiency must be sacrificed. Thermionic valve amplifiers must be used to bring the voltages provided by the

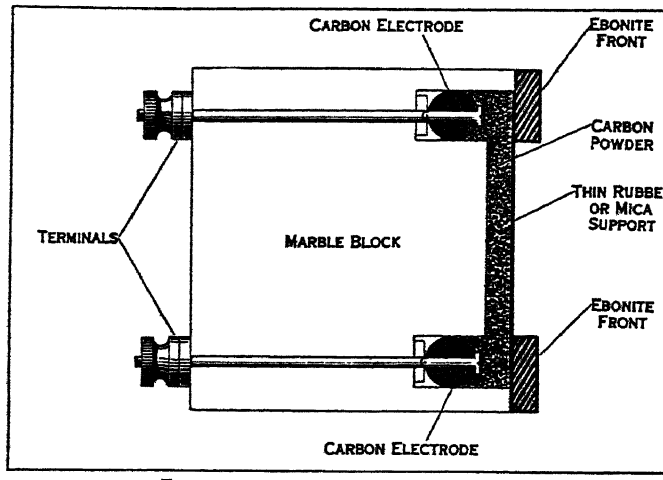


FIG. 2.—REISZ CARBON MICROPHONE

microphone up to the strength required for any particular practical purpose.

This type of microphone must rigidly fulfil certain conditions, while others must be satisfied as far as possible. These conditions are as follows:

(1) The microphone must have a good frequency characteristic. It must be equally responsive throughout the range of frequencies from 25 cycles to 10,000 cycles per second. (2) The condition of linearity must be satisfied for the range of pressures with which it is likely to deal. (3) The microphone must be free from inherent noise or hiss. (4) It must be sensitive so that not too much amplification is necessary to bring the voltage output to a suitable strength. (5) The microphone must be robust so that its essential characteristics in the given conditions of use are retained and it must be easy to install and maintain. (6) It must be sufficiently small to cause no serious disturbance to the sound field.

Usually some sort of compromise must be made, depending on the purpose for which the microphone is to be used.

Two types of carbon microphone come in the "high quality" class. The first, the Western Electric "double-button" carbon microphone (fig. 1) has a diaphragm of duralumin, stretched to a natural period above the useful range of frequencies, and subject to air damping. A capsule of carbon granules is placed on each side of the diaphragm. The second, called the Reisz microphone (fig. 2) has no diaphragm as such, but the sound acts on a layer of very fine carbon granules, placed on a heavy non-conducting block, and held in position by some material such as thin rubber or mica. The flow of current and its variation take place in a direction at right angles to the direction of application of pressure.

Each of these microphones has a fairly good frequency characteristic, and is linear up to moderate sound pressures, but for the largest sound pressure variations met with in practice, the linear relation does not hold and "blasting" or non-linear distortion takes place.

The best known "high quality" microphone is the condenser microphone developed into an instrument of precision by the Western Electric Co., Ltd. (fig. 3).

The diaphragm is of duralumin, and is stretched to a very high natural period and air damped, and held very close to a solid insulated metal plate, the two forming the sides of a condenser.

A stretched diaphragm of this type naturally exihibits very marked resonance characteristics, having a much greater response for its natural frequencies than other frequencies. If damping is increasingly applied all over the diaphragm the resonances tend

to be less marked, and a point will be reached when the frequency characteristic curve becomes almost level corresponding to a fairly equal response for all frequencies under consideration. A further increase in damping will only result in reduction of overall sensitivity. In the first microphones of this type designed by Wente, the diaphragm was stretched to a period of 17,000 cycles per second, thus outside the useful and audible range of

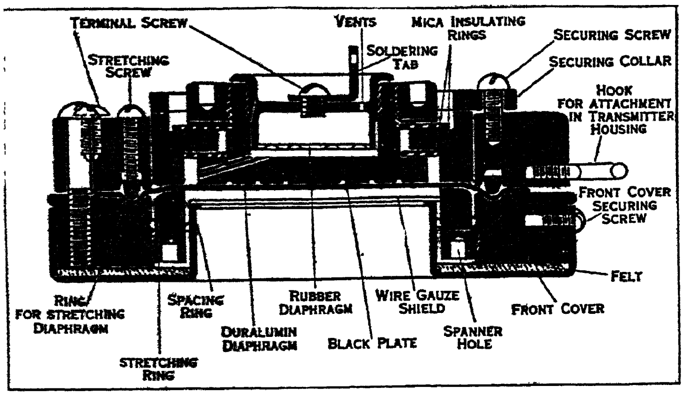


FIG. 3.—WESTERN ELECTRIC CONDENSER MICROPHONE

frequencies, the response inside the range being fairly uniform.

The air damping or cushioning due to the proximity of the fixed plate, which was held at a distance of about three thousandths of an inch from the diaphragm, was adjusted to the correct value by sinking holes in the face of the fixed plate. The type was rather insensitive and large amplification was necessary, but the frequency characteristic could be made practically perfect.

In more recent types which have been developed with a view to obtaining greater sensitivity, the stretching frequency has been reduced so as to bring it into the audible range. The frequency characteristic (*see* fig. 5) is not quite so good, but sufficiently good for most practical purposes.

The advantages of the condenser microphone (*see* fig. 4) besides its good frequency characteristics, are that it is quite linear, and free from background noise. Its chief use is for sound measurement, as it can be calibrated with accuracy, and with careful use retains its calibration for several years. (*See* SOUND.)

Several electrodynamic types of microphone have been pro-

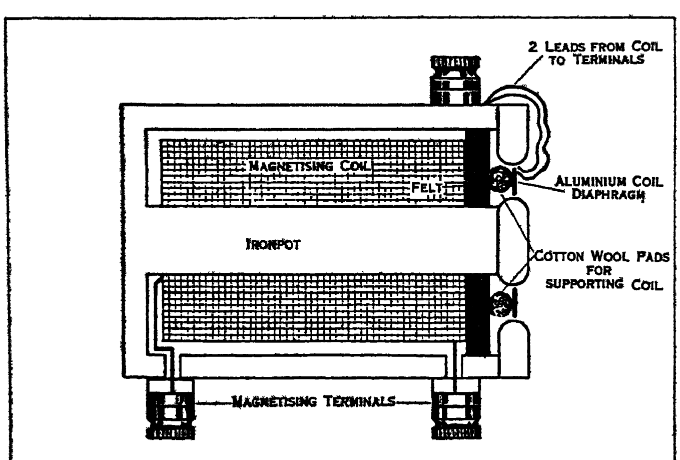


FIG. 4.—SYKES-ROUND ELECTRO-DYNAMIC MICROPHONE

duced. In the Sykes Microphone as perfected by Round (fig. 4) a flat annular ring of aluminium wire is suspended in a magnetic field, and acts as the diaphragm to receive sound waves. In another type developed by Siemens-Halske, the diaphragm consists of a thin strip of aluminium foil suspended in a strong magnetic field.

Although linear these two types have not such perfect frequency characteristics, lacking response to the lowest frequencies.

Various other types of microphones have been evolved for special purposes, but they have not been put to much general use. For instance the hot wire microphone has been developed by Tucker for the detection and location of gunfire and of aeroplanes. The microphone consists of a fine wire grid which is heated by a local battery and connected in a bridge type of circuit. The impact of sound waves cools the grid and the resultant change of resistance is observed. It is insensitive and must be used with resonators to increase the effect. As a consequence it cannot be used for musical purposes.

The glow discharge microphone has been made by the Westinghouse Co., and also in Germany in the form of a capsule consist-

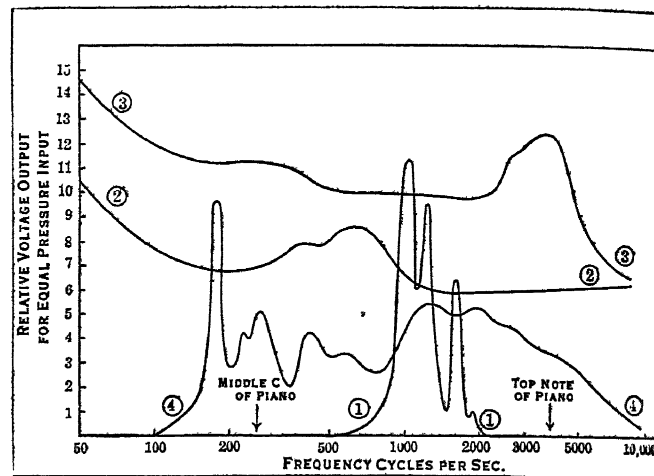


FIG. 5.—FREQUENCY CHARACTERISTICS OF MICROPHONE SHOWING RESPONSE OF DIFFERENT TYPES OF MICROPHONE TO MUSICAL FREQUENCIES (1) Solid back microphone. (2) Reisz microphone. (3) Condenser microphone. (4) Sykes microphone

ing of two electrodes between which an open electric discharge is maintained. The resistance of the discharge varies under the influence of sound waves striking it.

Although sensitive and having a good characteristic, this microphone is not particularly stable, and needs frequent replacement of electrodes.

Crystal microphones, where advantage is taken of piezo-electric effect, have been used for work with high frequencies; and eddy-current microphones where a metal diaphragm in moving in an electromagnetic field sets up currents by induction in a fixed circuit, have been investigated from the point of view of telephone measurement work.

Microphone Amplifiers.—Valve amplifiers for use with microphones have been constructed with practically perfect frequency and linearity characteristics.

Resistance capacity intervalve coupling is used to take care of the former, and the valves are operated on the straight, parts of their characteristics being chosen with sufficient factor of safety in their relative positions, to make sure of the latter.

With carbon and electromagnetic microphones, which are usually of low impedance, a coupling transformer is used to the grid of the first valve of the amplifier. The condenser microphone however has a very high impedance, and it is usual to polarise the microphone by a high voltage battery through a resistance of several megohms, the change in potential across this resistance due to variations in the capacity of the microphone being impressed through appropriate coupling condensers on the grid of the first valve.

Another method of using the condenser microphone is as part of a tuned high frequency circuit of an oscillating valve, variations of capacity causing variations of (high) frequency which can be rectified in a circuit coupled to the original circuit and amplified as required. This method has the advantage that the condenser microphone is not used in a high impedance circuit.

Methods of Measurement.—The measurement of the performance of microphones is difficult on account of the absence of a really fundamental method of sound measurement.

It is however possible to get a fairly good idea of the frequency characteristics of any particular microphone by a method of comparison with a standard. The following four methods have

been evolved, and give results fairly well in agreement although it is very difficult to make proper allowance for the conditions under which measurements by the various methods are carried out:

(1) *Rayleigh Disc.*—A disc of mica about 1 cm. in diameter with a mirror in the centre is suspended by a torsion thread in a sound field. The velocity of the air particles is measured by the angle through which the disc turns, and the value of the sound pressure can be deduced. König and other workers have evolved formulae by which the strength of the sound field can be calculated. The difficulty in this method is that the disc cannot be used in the open air or in a normal sized room on account of its susceptibility to small draughts or gusts of wind. The measurements have to be made in a box lined with sound absorbent material, and it is difficult to estimate exactly the effect of this box on a sound field produced inside it. A given microphone is placed near the disc inside the box and its frequency characteristic determined by a method of comparison.

(2) *Thermophone.*—The Western Electric Co. in developing their condenser microphone have used the thermophone for calibration purposes. It consists of a strip of gold leaf placed in a small enclosed chamber very close to the diaphragm of the condenser microphone. Alternating current of various frequencies is passed through the strip, the thermal action setting up corresponding air pressures at the diaphragm of the microphone. The theory was worked out by Wente, and the microphone can in this way be calibrated.

(3) *Compensation Method.*—This is due to Gerlach who arranged a conducting diaphragm in a strong magnetic field and passed through it a current of the same frequency as that of a nearby sound source, and adjusted the phase and strength of the current so that the diaphragm remained stationary under the two forces due to the sound pressure from the source, and the current passing through itself. The value of the air pressure at the face of the diaphragm can be deduced from the strength of the current. An analogous electrostatic method of measuring sound (field strengths) has also been worked out.

(4) *Electrostatic Method.*—Round has employed a method which can be used in certain cases where the diaphragm is flat and completely open. In front of the diaphragm (which if of non-conducting material is gold plated for the purpose) is brought a solid metal block with a flat face, and pressure is applied to the diaphragm by electrostatic attraction. It is possible thus to obtain the relation between pressure on the diaphragm and voltage output for various frequencies.

Each of the above methods gives either a calibration of a microphone or the measurement of a sound field. In the latter case the calibration of any type of microphone can be obtained by comparison, but it is important, whatever method is used, to know what precautions must be taken and what corrections must be applied to obtain a satisfactory result.

It is believed that the most accurate results are those obtained with a condenser microphone calibrated by means of the thermophone. For this reason the British Broadcasting Corporation, in the method of calibrating microphones for broadcasting purposes which it has developed, uses a calibrated condenser microphone in conjunction with a high quality loud speaker which is capable of producing pure tones at frequencies from 40 to 8,000 cycles per second.

This loud speaker is placed in a room the walls, ceiling and floor of which have been covered with material absorbing over 80% of the sound impinging on them.

The condenser and other microphones are swung on a trapeze at given mean distances in front of the loud speaker, and the resulting voltage from the microphones amplified and measured on a thermo galvanometer. (*See* INSTRUMENTS, ELECTRICAL.) The method of swinging and the existence of lag in the movement of the thermo junction get over the difficulties caused by the standing waves set up between loud speaker and microphone, and by those due to reflection by the walls, and after applying the proper corrections the frequency characteristic of any microphone can be obtained. In the same way the characteristics of any loud speaker can be measured.

The frequency curves of several types of high quality microphone as measured in this manner are shown in fig. 5. The curves are not supposed to indicate the relative sensitivities of the various types.

BIBLIOGRAPHY.—B. S. Cohen, A. J. Aldridge and W. West, "The Frequency Characteristics of Telephone Systems" Jour. I E.E. Vol. 64, Oct. 1926. (This contains a very complete bibliography.) H. D. Arnold and I. B. Crandall, "The Thermophone as a Precision Source of Sound," *Phys. Rev.* 1917, Vol. 10, p. 83. E. C. Wente, "The Condenser Transmitter," *Phys. Rev.* 1917, Vol 10, p. 39; ibid. 1922, Vol. 19, p. 498.
(A. G. D. W.)

MICROSCOPE, an optical instrument for examining small objects or the fine detail or structure of objects (Gr. μικρός, small, σκοπεῖν, to view); it acts in such a way that in the eye a clearly focussed image is formed which is larger than the unaided eye could produce. Microscopes are distinguished as *simple* or *compound.* A simple microscope is generally called a *magnifying glass* and consists of a single positive lens, or of a lens combination which acts as a single positive lens. A compound microscope generally consists of two lens systems each of which acts as a single positive lens. The system nearer the object (called the *object-glass* or *objective*) forms a real enlarged image of the object. This image is then viewed through the second system (called the *eyepiece*) as though it were a real object being examined by a magnifying glass.

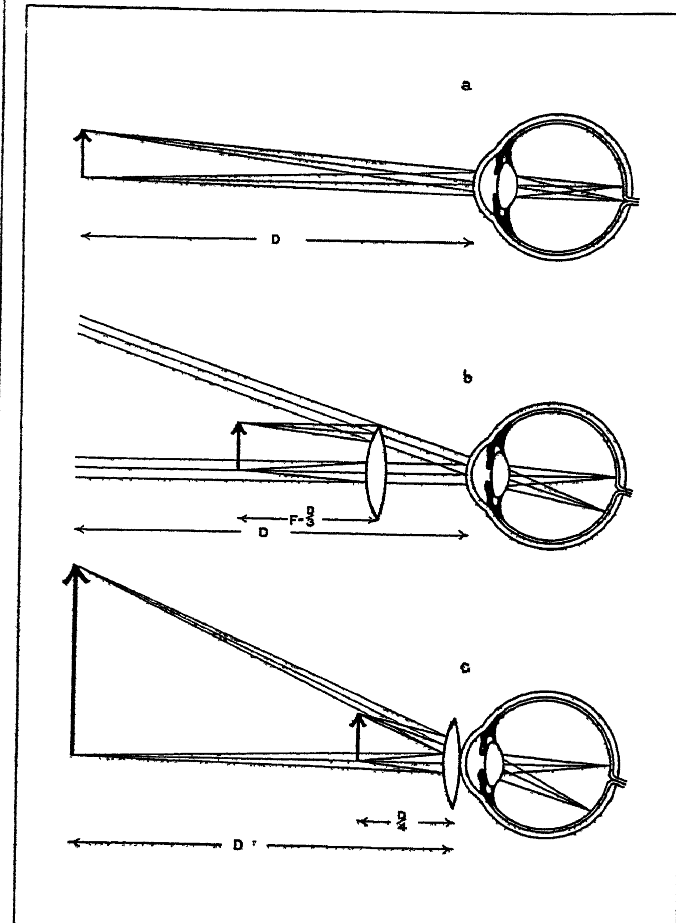


FIG. 1.—MAGNIFYING POWER OF SIMPLE LENS
(a) Object at distance of clearest vision (D), seen with unaided eye. (b) Object at principal focus of a lens having focal length D/3. Image is at infinity. Magnifying power = 3. (c) Object so near to lens that the image is formed at distance D. Magnifying power, if the lens is in contact with the eye, = 4

SIMPLE MICROSCOPE

The distinctness with which the detail of an object can be seen depends on (a) the sharpness of the image produced in the eye and (b) the size of this image. As an object is brought nearer and nearer to the eye, it is seen more and more distinctly, pro-

vided the image is kept sharply focussed on the retina, because the image and image-detail get larger and larger. The upper limit of distinctness is reached when the object is in the nearest position at which its image can be sharply focussed. For the normal eye this distance is taken to be 10 in. or 25 cm., and this is called the *normal distance of clearest vision* (fig. 1.a). By using a simple microscope in front of the eye, it is possible to bring an object nearer than the distance of clearest vision for the unaided eye, and yet to see it clearly (fig. 1.b).

If f is the focal length of the lens and D the observer's distance of clearest vision, the image seen is larger than the largest image that could be seen clearly by the unaided eye in the proportion D/f. This is the *magnifying power* of the lens when used in this way. The assumed standard value for D, is the normal distance of clearest vision, *i.e.*, 10 in. or 25 cm. We thus obtain

$$\text{Magnifying Power} = \frac{10}{f\,(\text{in.})}, \text{ or } \frac{25}{f\,(\text{cm.})}.$$

If the distance between the object and the lens is made somewhat smaller than the focal length of the lens, the rays from the object may be made to enter the eye as though they came from an enlarged object situated at the distance of clearest vision (fig. 1.c). When the lens is held quite close up to the eye and used in this way its magnifying power is given by

$$\text{Magnifying Power} = \frac{10}{f\,(\text{in.})} + 1, \text{ or } \frac{25}{f\,(\text{cm.})} + 1.$$

Magnifying powers of lenses of comparatively long focus are given by the second formula, but the magnifying powers of short-focus lenses are calculated by the first formula. These formulae really give nothing more than standard methods of *rating* a lens in terms of its magnifying properties. Only a person with a distance of distinct vision equal to 10 in. (*i.e.*, only a normal-eyed person) will use a lens so as to obtain its *rated* magnifying power.

When an object is viewed through a fine hole in an opaque screen held close to the eye, the rays from any point in the object enter the eye in such narrow pencils that the image appears sharp, even when the object is well within the distance of clearest vision. A fine hole can thus be used, in a way, instead of a simple microscope.

Regulation of the Rays.—Simple microscopes of moderate or low powers are not usually fitted with diaphragms at all, as the pupil of the observer's eye determines what rays are effective in producing the image seen. The eye is usually placed close up to the simple microscope, so that by moving the eye about in its socket the images of different parts of the object can be brought on to the central portion of the retina, exactly as is done when the eye is examining an object without the aid of a lens.

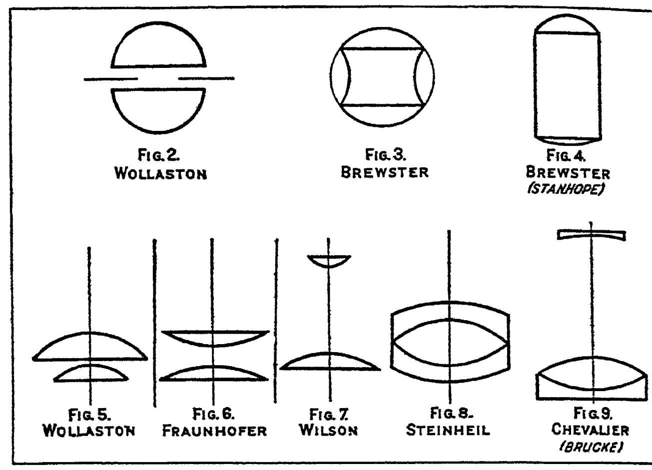
In high-power lenses it is necessary to limit the rays which are allowed to pass through the lens, so as to reduce the effects of the *aberrations* of the lens. This is done by fitting one or more diaphragms, so that only those rays for which the lens is properly corrected can pass through. In order to examine different portions of an object by means of such a lens, it is necessary to move the eye from side to side by moving the whole head, exactly as though the object were being examined through a hole in a screen.

The brightness of an object as seen through a simple microscope remains practically constant as the eye is moved about, unless the rays from the particular portion being observed are partly cut off by the lens mounting, or by a diaphragm in the lens.

With high power lenses the light is often caused to pass through an area smaller than the pupil of the eye. There is then a loss of brightness in the image, and it may be necessary to illuminate the object strongly.

Depth of Focus.—In using a simple microscope to examine a three-dimensional object, different levels in the object can be focussed by making use of the accommodation of the eye, though this range is only very small with lenses of high power. With lenses of low power, or with lenses which have very small apertures, there is also a certain range of depth in the object which appears all to be in focus at once. Actually only the points in one plane are truly focussed at any one time. If circular images on the retina are smaller than about $\frac{1}{5000}$ in., however, they appear sharply defined, hence there is an appreciable depth of focus obtained with lenses of low power or very small aperture, owing to the small angle of the cone of rays entering the eye from any particular point in the object.

Common Forms of the Simple Microscope.—An ordinary convex lens with spherical surfaces does not give a perfect image,



FIGS. 2–9.—VARIOUS FORMS OF SIMPLE MICROSCOPES

owing to the aberrations of the lens. The aberrations with which we are chiefly concerned are (1) chromatic aberration, (2) spherical aberration, (3) astigmatism and (4) flatness of field (*see* OPTICS). To obtain a perfect image it is necessary, therefore, to correct the lens (1) so that it will bring light of all colours to a common focus, (2) so that each zone of the lens will have the same focus as the other zones, (3) so that each oblique pencil of light will come to a point focus after passing through the lens, and (4) so that points lying in one plane in the object will all appear sharply focussed at one time. These corrections can only be carried out by combining together lenses of different powers and made of different glasses, though spherical aberration can be appreciably reduced without using more than one lens.

Among the early lenses which were constructed so as to have reduced spherical aberration is Wollaston's. Wollaston made his lens as two almost hemispherical lenses with a diaphragm mounted centrally between their plane faces. Sir David Brewster improved on this by embedding a diaphragm in a transparent cement used between two hemispheres of glass. He obtained a precisely similar result by grinding a groove round a sphere of glass. Coddington did much towards making this type of lens more widely known and it is generally called the Coddington lens, though Coddington did not invent this nor did he claim to have done so. Brewster also invented a lens in the form of a glass cylinder with its ends ground and polished as spherical surfaces of different curvature. When the more convex end is placed towards the eye, any object held in contact with the less curved end can be seen clearly. This form is usually known as the Stanhope lens.

Among early compound lenses are Wollaston's doublet which consists of two plano-convex lenses the focal lengths of which are in the ratio 3:1, and Fraunhofer's lens consisting of two plano-convex lenses of equal power with their convex sides mounted inwards and separated somewhat from each other. Wollaston's doublet was improved later (1) by introducing a diaphragm between the two lenses, (2) by increasing the separation between the lenses, and (3) by substituting *two* lenses for the smaller lens, thus converting the system into a triplet. The triplet form was used when very high magnifying powers were required.

To correct for chromatic and spherical aberration simultaneously, positive and negative lenses of different powers and made of different types of glass are used in combination as doublet or triplet systems. Combinations of such systems can also be used. Steinheil's *aplanatic* is a typical triplet system of two negative

lenses combined with a single positive. By using suitable combinations of lenses, magnifying glasses having powers $\times$ 40 can be made practically free from aberrations, and satisfactory lenses giving $\times$ 70 and even $\times$ 100 have been produced. A type of lens which, though used as a simple microscope, is designed on the same lines as one form of compound microscope, was suggested by Chevalier and made by Brücke. It consists of a positive achromatic doublet, with a negative lens mounted at some distance behind it.

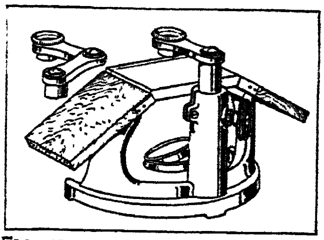
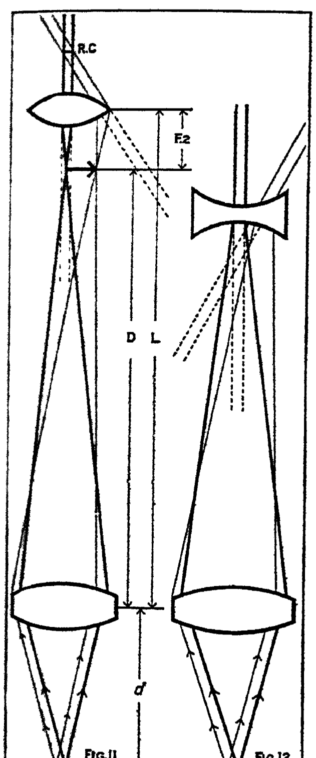


FIG. 10.—DISSECTING MICROSCOPE (BECK)

Stands.—For certain purposes, such as dissection work, it is convenient to mount the simple microscope on an arm which is adjustable relative to a stage on which the object is laid. If a high-power simple microscope is being used, provision must be made for accurate focussing and for adequate illumination of the object. Usually, however, only low-power work is done nowadays with a simple microscope, and for this reason the stands are not generally provided with more than a rack and pinion adjustment, with a mirror beneath the stage for illuminating transparent objects, and with a condensing lens for illuminating opaque objects. Detachable arm rests are fitted to the more complete models and the lens holder is adapted to take lenses of different powers, which are interchangeable one with another.

The stage is either made of plate glass, or as a frame covered with a white opal-glass plate.

For dissecting and similar work it is of advantage if the details of the object can be seen as they are actually disposed in space. To meet this requirement stereoscopic devices are used.



FIGS. 11 & 12.—DIAGRAMMATIC REPRESENTATION OF COMPOUND MICROSCOPES

Paths of the rays through a microscope with a positive lens as eyepiece are shown in Fig. 11. The rays pass through R.C., the Ramsden circle or eyepoint, after leaving the eyepiece. In Fig. 12 are shown the paths of the rays when a negative lens is used as the eyepiece

COMPOUND MICROSCOPE

A compound microscope consists of a positive or converging lens, called the *object-glass*, which forms a real, inverted, magnified image of the object. This image is then viewed by means of a second lens, called the *eyepiece*, which is usually another positive lens or lens system (fig. 11). For certain purposes a negative lens is sometimes used as the eyepiece; this cause an "erect" image to be seen (fig. 12).

If we consider the object-glass as a thin lens, with the object at a distance d on one side of it and the image at a larger distance D on the other side, then the image will be larger than the object in the proportion D/d. This proportion D/d is the *magnification*, M_O, produced by the object-glass. The eyepiece may be considered as a simple microscope, of magnifying power M_E, which is used to examine the magnified image formed by the object-glass. The total magnification obtained is thus equal to $M_O \times M_E$. The distance d is approximately equal to f_1, the focal length of the object-glass, while D may be taken as equal to the "tube-length" (L) of the microscope. This gives M_O equal to L/f_1. The value of M_E is taken as $10/f_2$, where f_2 is the focal length of the eyepiece in inches (see *Simple Microscope*). Hence, if all the quantities are expressed in inches, the magnification obtained is given approximately as

$$\text{Magnification} = \frac{L}{f_1} \times \frac{10}{f_2} = \frac{10L}{f_1 f_2}.$$

With an object-glass and an eyepiece, each of one inch focus, therefore, the magnification obtained, if the tube length is 10 in., would be about 100, or, with a tube length of 6 in., about 60.

THE OBJECT-GLASS

The quality of the image seen in the compound microscope depends primarily on the quality of the real image formed by the object-glass. Any imperfections in this image are magnified when the image is viewed through the eyepiece. The image formed by the object-glass should, therefore, be as sharp as possible, and to secure this the aberrations of the object-glass should be reduced to the smallest practicable values. The object-glass should also have a high *resolving power.*

Resolving Power.—Imagine the lens L (fig. 13.a.) to be a perfectly corrected lens with its aperture limited by a diaphragm, the edges of which are at DD. A luminous point is at O, on the axis of the lens, and an image of this point is formed at I by the lens. This image will not be a point but, in consequence of the diffraction of the light at the diaphragm, will take the form of a bright disk surrounded by concentric dark and bright rings (*see* LIGHT). The brightness of the central disk and of the surrounding system of rings is indicated in fig. 13.b, in which the form of the curved line represents the distribution of brightness in the image plane around I. The diameter of the first dark ring, or the full diameter of the central disk, is represented by the distance dd. The brightness of the disk falls off rapidly towards the edge, and a visual estimate of the diameter would usually put it at about $\frac{2}{3}$ of the full diameter dd. The diameter dd depends on the wave-length of the light emitted by the source at O, and on the angles which the extreme rays make with the axis of the lens.

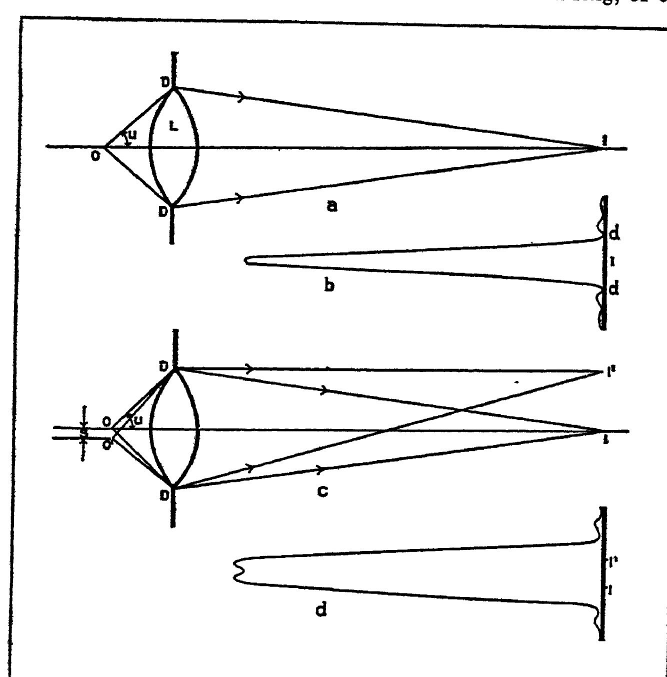


FIG. 13.—RESOLVING POWER OF A LENS

(a) Shows the image-forming rays from a single self-luminous point at O, the "geometrical" image being at I. (b) Distribution of light in the image plane round the geometrical image-point I, is indicated in this figure; the central bright area extends as far as dd. (c) Shows the image-forming rays from two self-luminous points O and O[1], the geometrical images being at I and I[1]. (d) Indicates the distribution of light in the image-plane when O and O[1] are so close together that their images are only just distinguishable

If we have two independent similar point sources at O and O' (fig. 13.c) equidistant from the lens, each of these will produce a disk image with its surrounding system of rings; the centres of the two systems will be at I and I' respectively. If the disks are

completely separated they will be seen clearly, but if they overlap by more than a certain amount they will merge into a single bright area over the centre of which the brightness is almost uniform: the two disks will not then be distinguishable as separate images. In the latter case the *resolving power* of the lens is insufficient to enable O and O' to be resolved as separate point sources. The resolving power of a microscope object-glass is usually stated in terms of the minimum distance which must exist between two details in the object if their images are to be distinguishable as separate images.

Now if the extreme ray OD makes an angle u with the axis of the lens, the two point sources O and O' (fig. 13.c) will give rise to diffraction disks which will be just completely separated if

$$s = \frac{1 \cdot 22\lambda}{\sin u},$$

where λ represents the wave-length of the light emitted by the sources O and O', and s represents the distance between O and O'. The edges of the diffraction disks are, however, only very faint, consequently the images can be plainly distinguished even if the diffraction disks overlap to a quite appreciable extent. The distribution of brightness indicated in fig. 13.d, corresponds to the relation

$$s = \frac{0 \cdot 51\lambda}{\sin u}.$$

Between the two brightest points there is, in this case, a line in which the intensity is 97% of that at the two maxima. This is probably sufficient for the two maxima to be just distinguishable. For a trained observer with eyes of normal acuity, the limit of resolution obtainable may thus be taken as about

$$s = \frac{\frac{1}{2}\lambda}{\sin u}.$$

If the medium has a refractive index n, the wave-length of the light will be shorter than it would be in air, in the proportion $1/n$. We can use λ_a, the wave-length *as measured in air*, in this formula by substituting λ_a/n for λ, when we obtain

$$s = \frac{\frac{1}{2}\lambda_a}{n\sin u}.$$

The quantity $n\sin u$ is a property of the lens, since it depends on u and on the refractive index of the medium in which the lens is intended to be used on the object side; it is called the *numerical aperture* of the lens. For a "dry-front" lens n is unity, and the maximum numerical aperture such a lens can have is 1.

Immersion Lenses.—Many lenses are designed for use with a layer of fluid filling the space between the front of the lens and the object or cover-glass. The maximum numerical aperture such an *immersion lens* can have is determined by the refractive index of the *immersion fluid*, by the refractive index of the cover-glass (if any) over the object, or by the refractive index of the front lens of the object-glass, whichever of these three has the lowest value. The front lens of an immersion object-glass is usually made of crown glass of refractive index 1·508 to 1·525; the cover-glasses most commonly used have a refractive index between 1·515 and 1·525. For most immersion lenses, therefore, a thickened cedar-wood oil, having a refractive index of 1·515 to 1·525, is used as the immersion fluid. For obtaining still higher resolving powers, object-glasses have been made with front-lenses of refractive indices up to 1·66, for use with proper immersion fluids. A *homogeneous immersion* lens is an object-glass designed for use with an immersion fluid having the same refractive index as its front lens.

Aberrations of Object-glasses.—Unless the aberrations of the lens are very small, the actual resolving power will fall short of that corresponding to the numerical aperture, except with certain special methods of illumination which may give a semblance of resolution. In an object-glass, therefore, we require, in addition to a reasonable magnifying power, (a) an appropriately large numerical aperture and (b) the most nearly perfect corrections it is possible to obtain over the whole of this aperture.

Spherical aberration can be corrected by combining together individual lenses, of suitable forms, all made of one kind of glass. A more usual method is to use combinations of lenses of different glasses which may either be cemented or may be mounted at suitable distances from each other and separated by air. This method lends itself to the simultaneous correction of both spherical and chromatic aberrations, and is therefore used for all ordinary microscope object-glasses. In the more powerful object-glasses several individual lenses and lens systems must be used in order to obtain the requisite degree of correction over the whole aperture (fig. 14).

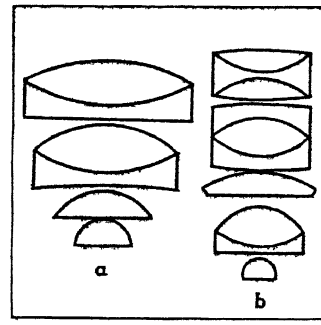


FIG. 14.—EXAMPLES OF LENS SYSTEMS USED IN OBJECT-GLASSES
(a) Achromatic system, (b) apochromatic system

To secure a good image of a small object it is not sufficient merely to correct the spherical aberration for a point on the axis of the object-glass. It is necessary, in addition, that the light in the object plane be brought to focus in the corresponding area in the image plane. Seidel (1856) and Clausius (1864) investigated the conditions which must be fulfilled to obtain this, and showed that there must be a definite relation between the inclinations of the rays on the object side and the inclinations of the corresponding rays on the image side. Helmholtz and Abbe investigated this independently in 1873 with similar results. The condition is, if a ray from a point lying on the axis in the object plane is inclined to the axis at an angle u, the corresponding ray on the image side must be inclined to the axis at an angle u' such that

$$n\sin u = C\sin u',$$

where C has the same value for every ray coming from the point in question. Abbe drew special attention to the importance of this condition being satisfied in designing microscope object-glasses, and gave to it the name of the "sine-condition." If the axial spherical aberration has been corrected but the sine-condition has not been fulfilled, the pencils of rays which come from a point a little off the axis are brought to focus at different distances from the axis on the image side (fig. 15), giving different magnifications according to the zone of the lens through which the pencils pass.

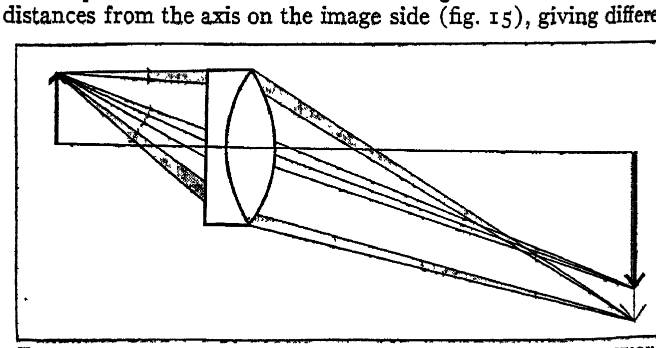


FIG. 15.—EFFECT OF NON-COMPLIANCE WITH THE "SINE-CONDITION"
Rays passing through different zones of the lens produce different degrees of magnification

Chromatic aberrations can be corrected by using lens combinations in which the individual lenses are made of different types of glass. A negative lens of low power, made of flint glass, will produce a dispersion equal and opposite to that produced by a positive lens of considerably higher power made of crown glass. Two such lenses, correctly combined together, will act as a positive lens with a common focus for both the blue and red rays. Such a lens is called an *achromatic lens*.

Although the blue and the red rays of certain selected wave-lengths can be brought to a common focus in this way, rays of other wave-lengths will not come to the same focus as the red and

blue rays, owing to the differences between the relative "partial" dispersions of the two glasses. The lens thus gives an image which is slightly coloured at the edges, and is said to show "secondary colour." In modern *apochromatic* lenses three selected wave-lengths are made to have a common focus; thus only a trace of "tertiary colour" is present and this in some instances is so small as to be unnoticeable. It has not been found possible, as yet, to design apochromatic lenses which give precisely equal *magnification* for light of different colours. This can be corrected by a suitable eyepiece called a "compensating eyepiece" (*see* p. 438). An achromatic lens is usually corrected spherically for *one* colour only, an apochromatic lens should be corrected so as to have no spherical aberration for light of *two* different colours.

Other Aberrations of Object-glasses are:—curvature of field, distortion, astigmatism, and extra-axial coma. These are aberrations of oblique pencils; their effect is to impair the image of any object-details lying off the axis, and to cause the image to lie on a curved surface so that it cannot all be seen in focus at one time. These defects are not of great importance in the ordinary use of the microscope since, if the sine-condition is satisfied, the definition is good over an appreciable area round the centre of the field where the field is flattest. For microphotographic work, however, these aberrations are most objectionable. It is possible to select types of design such that, in correcting the lens for axial, spherical and chromatic aberrations, the aberrations of oblique pencils are kept within small limits over a fairly large angle. Any object-detail to which particular attention is being paid should be brought into the middle of the field of view, *i.e.*, on to the axis of the object-glass.

Monochromatic Object-glasses for Visual Work.—For the purpose of obtaining higher resolving powers than have hitherto been obtainable with achromatic and apochromatic object-glasses, certain *monochromatic* lenses have been made, for use with radiations of one wave-length only. This method makes it possible to obtain full correction for spherical aberration over a numerical aperture larger than that over which combined chromatic and spherical correction has hitherto been satisfactorily accomplished. Modern apochromatic immersion lenses of high quality are made with numerical apertures up to 1·4, while monochromatic lenses, fully corrected up to 1·6, have been designed.

Aberration Produced by a Cover-glass.—A microscopic object-glass is usually designed to be used with an object placed on the axis at a particular distance in front of the lens and covered with a cover-glass of particular thickness and refractive index. The image of such an object will then be formed at a particular distance behind the lens and, if the lens is properly designed and made, this image will be free from spherical aberration. If the cover-glass is not of the proper thickness the image will not be free from spherical aberration and, to correct the aberration thus introduced, the distance between the object and the object-glass must be altered. This will alter the distance between the image and the object-glass, so the length of the microscope tube (the distance between the object-glass and the eye-piece) will have to be altered accordingly.

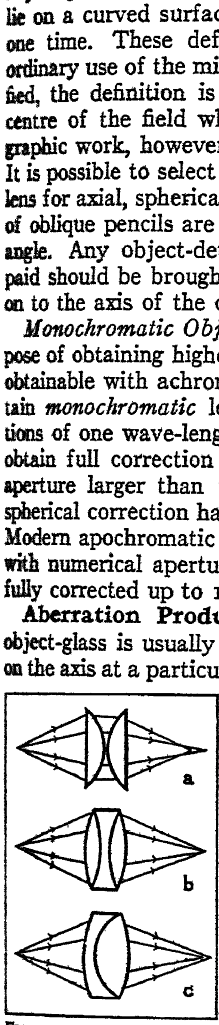


FIG. 16.—CORRECTED AND UNCORRECTED LENS SYSTEMS
(a) Under-corrected, (b) Fully-corrected, and (c) Over-corrected system

The type of aberration introduced is best explained in terms of the aberration of an ordinary uncorrected lens. A system in which the outer rays intersect the axis at a point nearer the lens than the intersection of the central rays is an "under-corrected" system. An "over-corrected" system has a shorter focal length for the central rays than for the outer rays (fig. 16).

The effect of increasing the thickness of the cover-glass is indicated in fig. 17, as is also the way in which a change in the tube-length can be made to correct the aberration thereby introduced. The lens is supposed to be corrected for use with an uncovered object when the image of this object is formed at a distance *L* behind the lens (fig. 17.a). A lens corrected for use with a particular tube-length when used on uncovered objects, can be satisfactorily corrected for covered objects by shortening the tube-length appropriately. Conversely, a lens corrected for covered objects can be used satisfactorily for uncovered objects if the tube-length is appropriately increased.

For use in microscopes with fixed tube-lengths, Amici made separate object-glasses to suit different thicknesses of cover-glass,

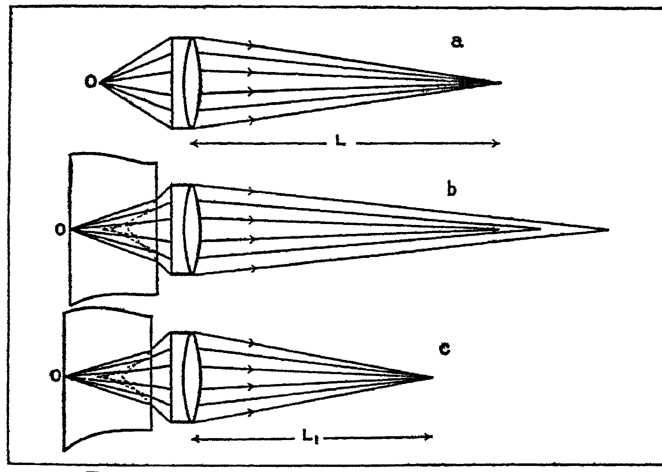


FIG. 17.—ABERRATION INTRODUCED BY A COVER-GLASS
(a) Lens fully-corrected for use with uncovered object when image is formed at distance L. (b) Same lens, with object under cover-glass and focus of central pencils at distance L. Ray system is under-corrected on object side and over-corrected on image side. (c) Same lens, with object as before. By increasing the distance of the lens from the object, the distance of the image is reduced to L_1 and full correction on the image side is obtained

modifying the corrections but preserving the same aperture and power. This was made unnecessary by the introduction in 1837, by Andrew Ross, of object-glasses furnished with a "correction-collar" which enabled the spherical aberration of the object-glass to be adjusted so as to compensate for the aberrations produced by cover-glasses of different thicknesses. The correction-collar was improved later by H. F. Wenham, of the firm of Ross, and still later by Zeiss (fig. 18).

The aberrations produced by refraction at the cover-glass and at the first surface of the front lens of the object-glass can be reduced by filling the space between the object-glass and the object, or the cover-glass, with a medium of higher refractive index than air. Amici introduced the first practical immersion lenses in 1840, using water as the immersion fluid, and improved water-immersion lenses were made by E. Hartnack in 1855. On the suggestion of J. W. Stephenson, Abbe in 1878 investigated the matter and designed the first homogeneous immersion lenses and had these made up by the firm of Zeiss.

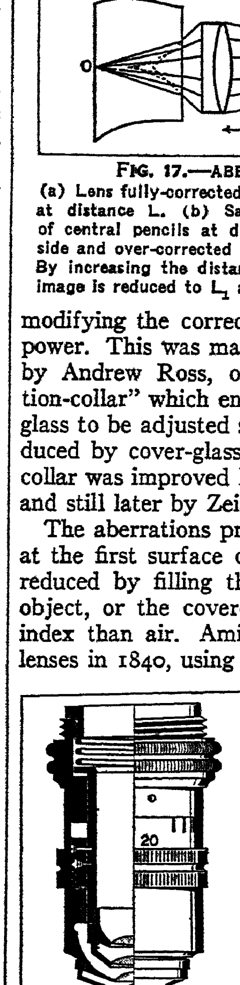


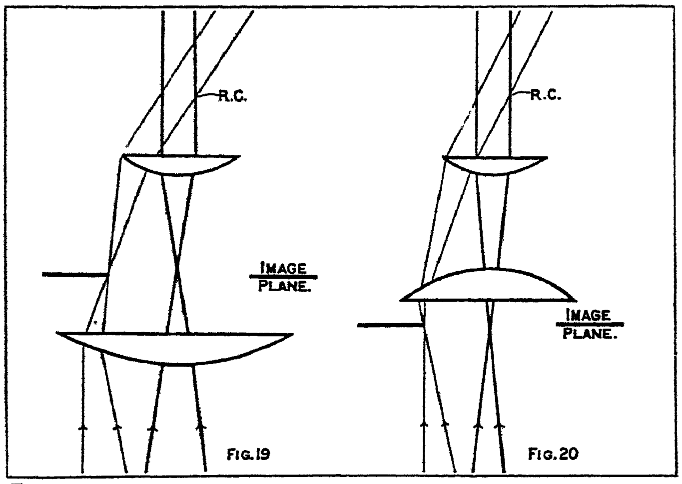
FIG. 18.—OBJECT-GLASS WITH CORRECTION-COLLAR (ZEISS)

The apochromatic immersion object-glass, in virtue of its large numerical aperture and its almost perfect chromatic and spherical corrections, is the most nearly perfect type of object-glass constructed. Since the first apochromatic object-glasses were designed by Abbe about 1886, slight improvements in the degree of correction have been made, but no such marked improvement as that represented by the difference between achromatic and apochromatic object-glasses.

Object-glasses for Ultra-violet Work.—The number of materials suitable for making lenses to be used with ultra-violet radiations is very limited. Most of the solid materials which are transparent to these radiations are unsuitable owing to their doubly-refracting properties, or else are difficult to obtain in sufficiently large pieces of good optical quality. Object-glasses for use with ultra-violet radiations are nearly all designed as monochromatic lenses (see *Aberrations of Object-glasses*).

An achromatic object-glass made of quartz and fluorite was produced in 1900 by von Rohr for ultra-violet work; this lens

had a focal length of about 4 mm. and a numerical aperture of 0·3. In 1904 the firm of Zeiss introduced a series of lenses, made from fused quartz, for use with monochromatic ultra-violet light, having numerical apertures up to about 1·25. In 1926, an object-glass of novel design for use as a water-immersion lens, and another for use as a homogeneous immersion lens, were designed and computed by the British Scientific Instrument Research Asso-



FIGS. 19 & 20.—PATHS OF RAYS THROUGH HUYGHENS' EYEPIECE (FIG. 19), AND THROUGH RAMSDEN'S EYEPIECE (FIG. 20), R.C. DENOTING THE RAMSDEN CIRCLE IN EACH FIGURE

ciation. Lenses made up to these formulae by the firm of R. and J. Beck have numerical apertures of 1·14 and 1·2 respectively, and are fully corrected for use with the monochromatic ultra-violet radiation for which they were computed. The resolving powers of these objectives are equivalent to those obtained with lenses of aperture 2·28 and 2·4 when they are used with green light.

THE EYEPIECE

The eyepiece serves primarily as a magnifying glass which is used to examine the real image formed by the object-glass. The simpler types of eyepiece are made with a large *field-lens* which bends the ray-pencils from the object-glass towards the axis without greatly altering the convergence or divergence of the rays in the individual pencils. Behind this field-lens, and at some distance from it, is a second and much smaller lens which converts each ray pencil into a parallel or only slightly diverging ray system which is capable of being focussed by the eye. After emerging from the second lens, all these pencils pass through a small circular area called the "eye-point" or the *Ramsden circle*. This area is the image which the eyepiece forms of the object-glass aperture. The eye of the observer should be placed at the Ramsden circle in order to obtain the largest field of view and the maximum brightness over that field.

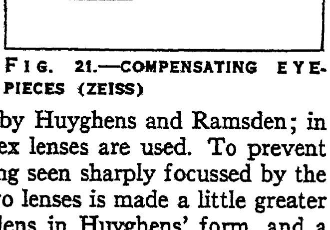


FIG. 21.—COMPENSATING EYEPIECES (ZEISS)

The two types of eyepiece at one time most commonly met with are those originally invented by Huyghens and Ramsden; in both types two simple plano-convex lenses are used. To prevent any dirt on the field-lens from being seen sharply focussed by the eye, the distance separating the two lenses is made a little greater than the focal length of the eye-lens in Huyghens' form, and a little less in Ramsden's form (figs. 19 and 20). The image formed by the object-glass is seen clearly when it lies in a position in front of the field-lens of a Ramsden eyepiece, but with a Huyghens eyepiece the light from the object-glass is intercepted by the field-lens before it has come to focus in the image plane.

The Ramsden eyepiece is convenient to use if the size of the object is to be measured by comparing the size of its image with a scale in the eyepiece fitting. The scale is mounted in front of the field-lens and is made to coincide with the image formed by the object-glass. Any distortion produced by the eyepiece thus affects the image and the scale equally. Except for purposes of this type the Ramsden form of eyepiece is not largely used. In a Huyghens eyepiece the image of the object is formed between the two eyepiece lenses, and hence the comparison scale must be fitted between the lenses. Any distortion produced by the field-lens will, therefore, only affect the image of the object. A comparison of the image with the scale may thus lead to an inaccurate estimate of the size of the object.

These eyepieces, when properly designed, give equal magnification for light of all colours, though the differently coloured images lie in slightly different planes. The eye is much less sensitive to slight "out of focus" effects than to differences of magnification, consequently both types of eyepiece are practically achromatic when properly constructed. The effects of the spherical aberrations of the eyepiece are only small and in practice may be neglected.

The *compensating eyepieces* used to correct the chromatic differences of magnification of apochromatic object-glasses are constructed, in the lower powers, like a Huyghens eyepiece with the second lens replaced by a doublet. This doublet is over-corrected for chromatic aberration. These eyepieces are designed to have a higher magnifying power for red light than for blue so as to correct the chromatic difference of magnification of apochromatic object-glasses; compensating eyepieces can be used with advantage with many high power achromatic object-glasses. In the higher powered compensating eyepieces of certain makers the design is not similar to that of the lower powered compensating eyepieces, a more elaborate system being used (fig. 21). Compensating eyepieces having magnifying powers up to ×100 are obtainable, but it is only with object-glasses of the highest quality that a magnifying power greater than ×25 can be used without making the imperfections of the object-glass image disturbingly apparent. Many other types of eyepieces are made to suit special purposes but it is not possible to describe them in this article.

MODE OF FORMATION OF THE IMAGE IN THE MICROSCOPE

We may take it that the way in which a lens forms the image of a luminous object is understood and generally accepted. The formation of the image of an illuminated non-luminous object requires consideration, however, since the light reaching the lens, whether reflected from, refracted through, or passing round the object, originates from an independent source of illumination, and the object is only "seen" as a result of the way in which it modifies the light which falls upon it. As regards large objects common experience shows that the way in which their images are formed, as in the act of "seeing," can be considered as substantially the same as that in which the images of luminous objects are formed, with the exception that a non-luminous object may, in certain circumstances, be "seen" merely as an opaque mass against a luminous or brightly illuminated background.

At one time it was commonly accepted that an object is seen in the microscope in essentially the same way as larger objects are ordinarily seen, and that the processes involved in forming the microscopic image of a small non-luminous object are the same as those involved in forming the image of a self-luminous body. These were the views put forward by such students as Airy, Arago, Foucault, J. F. W. Herschel, and Helmholtz. When light falls on a very small object, however, diffraction effects, which are not usually observed when the object is large, come into prominence. Abbe made a study of these effects and, as a result of his observations, put forward a new theory of the mode of formation of the image in the microscope. This theory is given in most treatises on the microscope and microscopy and need only be briefly outlined here.

Abbe's Diffraction Theory.—When white light from a distant small source falls perpendicularly on to a diffraction grating, such as could be made by ruling fine lines at regular small intervals through a silver film deposited on glass, much of the light passes straight through the grating in the ordinary way. On

either side of the direct beam, however, beams of coloured light will emerge, the directions of these beams being inclined at various angles to the direct central beam. An object-glass of suitable aperture placed close up to the grating would receive the direct beam and certain of the "diffracted" beams, the number of diffracted beams admitted by the object-glass being dependent on the spacing of the lines in the grating and on the numerical aperture of the object-glass. Each of the beams admitted would give rise to a small image of the source, so that immediately behind the object-glass there would be a central white image of the source with elongated coloured images lying on either side of this. In any particular part of one of these images the light of any one colour vibrates in a manner which bears very precise relationships to the vibrations of light of the same colour in corresponding parts of the other images. As a result, *interference fringes* will be produced in the body tube of the microscope, the distribution of brightness seen in any particular plane being determined by the number and position of the images formed behind the object-glass.

According to Abbe, the "image" seen on looking through the eyepiece is simply the *interference pattern* in the focal plane of the eyepiece. In so far as this pattern is determined by, and therefore characteristic of, the structure of the object, it may be considered to be an "image" of the object, but it cannot be claimed that the form of this "image" bears any true resemblance to the object. Abbe based these views on observations made with gratings illuminated by a parallel or nearly parallel pencil of rays, using object-glasses behind which he could place small diaphragms so that the different diffraction images of the source of light could be cut out or admitted at will. He claimed that the results he obtained in this way are of general applicability, and that the images of non-luminous objects are formed exclusively as the result of interference of the type described, no matter what the structure of the object and irrespective of the way in which the object is illuminated.

To obtain any indication of structure in the object at least two images of the source must be formed behind the object-glass, since two images are required if any interference is to be produced in the body-tube. The smallest numerical aperture that will admit two separate beams of light from the grating (the direct beam and *one* diffracted beam) is given by

$$n \sin u = \frac{\frac{1}{2}\lambda_a}{s}$$

where s is the distance between adjacent similar details in the object, and λ_a is the wave-length of the light used to illuminate the object (as measured in air). In order that a lens of this numerical aperture may admit the two beams, the object must be illuminated obliquely, so that the direct beam is thrown into one side of the object glass aperture and one of the first diffracted beams is just admitted into the other side. The smallest structure-interval that could be resolved by this lens, in the sense that an interference pattern would be produced in the focal plane of the eyepiece, is thus obtained as

$$s = \frac{\frac{1}{2}\lambda_a}{n \sin u}.$$

It will be seen that this result is very nearly the same as that obtained earlier for the resolution of two luminous point sources.

The "Equivalence" Theory.—Many microscopists and physicists did not accept Abbe's theory as being of general applicability, though it was clearly valid under the particular conditions which obtained in Abbe's experiments, *i.e.*, with objects of regular periodic structure illuminated by light from a distant small source. Many experiments were carried out in order to disprove Abbe's theory. Altmann stated in 1880 that the results Abbe had obtained with illuminated gratings, using diaphragms behind the object-glass, could all be reproduced with self-luminous hot-wire gratings when similar diaphragms were used behind the object-glass. Mandelstam carried out these experiments with hot-wire gratings in 1911 and confirmed Altmann's statement. The value of Abbe's experiments as evidence supporting his theory was thus seriously discounted. Evidence based on the experience of microscopists was also put forward as contradicting Abbe's theory, notably by R. Koch in Germany and by Lewis Wright and E. M. Nelson in England. Lewis Wright's views on the mode of formation of the image in the microscope were emphasized by E. M. Nelson's clear demonstrations of the greatly improved images to be obtained by the use of wide axial cones of illumination, as opposed to the narrow axial or oblique pencils more favoured by the adherents to Abbe's theory.

The views held by these people were that, with suitable illumination, any non-luminous body can be considered as "equivalent" to a self-luminous body, and that, under the conditions of illumination commonly used by microscopists, the image is formed in essentially the same way as the image of a luminous body. According to this "equivalence" theory the most perfect resolution should be obtained when the full aperture of the object-glass is being used, *i.e.*, when the cone of illumination is of such an angle that direct rays would, except for such obstruction as the object produces, enter all parts of the object-glass aperture. It usually happens, however, that, as the angle of the cone of illumination is increased from some quite small initial value, resolution is steadily improved at first, but a condition is reached such that further increase of angle of the cone causes contrast in the image to diminish very rapidly, so that resolution, *in the sense of visibility of detail*, is greatly impaired. In the absence of any satisfactory explanation of this phenomenon, it seemed to be in direct conflict with the implications and consequences of the "equivalence" theory, and constituted a formidable stumbling-block to that theory until the causes of the loss of contrast were discovered and were shown to be quite distinct from, and independent of resolution and resolving power proper.

Lord Rayleigh (3rd baron) considered the formation of the microscope image on theoretical grounds, and showed in 1896 that definite interference of the type required by the Abbe theory cannot occur unless the angle of the cone of illumination is small compared with the ratio λ/s, where s is the distance separating adjacent similar details in the object and λ is the wave-length of the light used to illuminate the object (Lord Rayleigh, *Scientific Papers* IV., 1903). This means that, with a wide angle of illumination, the vibrations coming from adjacent points in the object are virtually independent of each other, provided they are separated by a distance which is not small compared with the wave-length of the light used, *i.e.*, each of these points is "equivalent" to a self-luminous point in so far as the light coming from it is concerned.

Theoretical investigations by Mandelstam (1911), Wolfke (1912) and von Laue (1914) confirmed Lord Rayleigh's views. Recently the whole subject has been comprehensively investigated by Berek, and in a series of papers published in 1926 he gives a full discussion of the applicability and limitations of both the theories. The conclusions he arrives at are that, under the conditions of illumination ordinarily used, the image in the microscope is formed, in the main, in the same way as is the image of a self-luminous object. The image thus obtained is a "true" image in the sense that it bears a close resemblance to the object, and has a true "focus-plane." Under the conditions which Abbe used in his diffraction experiments, *i.e.*, with an object of regular periodic structure illuminated by a narrow pencil of almost parallel rays, the only "image" obtained is of the nature of an interference pattern. This "image" has no true focus-plane, the appearance seen in the eyepiece shows very little variation if the eyepiece is moved through quite large distances along the axis of the microscope, and this appearance does not necessarily possess any true resemblance to the object.

The theory that under the conditions of illumination commonly used, the mode of formation of the image in the microscope is, in the main, the same as the mode of formation of the image of a self-luminous object, can thus be taken as well founded. The experimental evidence supporting the theory has accumulated rapidly since the conditions for obtaining contrast have been properly understood. Even before these conditions had been thoroughly investigated, however, important evidence in support of the "equivalence" theory was available from observations made with so-called "dark-ground" illumination (*see* p. 440). According to

the Abbe theory, the resolving power of a lens when used with this form of illumination must necessarily be less than it would be if the object were illuminated with transmitted light. Moreover, no "dry" lens, when used with dark ground illumination provided by a "dry" condenser, could have a greater resolving power than that corresponding to a numerical aperture 0·5. According to the "equivalence" theory the resolving power of a lens should be the same for any method of illumination which ensures that the full aperture of the lens is used. Actual experiment shows that resolving power is not in any way reduced when dark-ground illumination is employed. In fact, the resolution obtainable with this method of illumination often *appears* to be better than that obtainable with ordinary illumination by transmitted light, since dark-ground illumination secures a high degree of contrast in the image obtained. Because of this marked gain in contrast resolution is therefore easily recognizable.

ILLUMINATING APPARATUS AND METHODS OF ILLUMINATION

The methods of illumination commonly used are very varied; each method requires the proper apparatus for its convenient application. The principles involved in some of the most important of these, together with the apparatus needed, are here discussed.

Illumination by Transmitted Light.—To examine an object in this way, light from a suitable source is passed through the

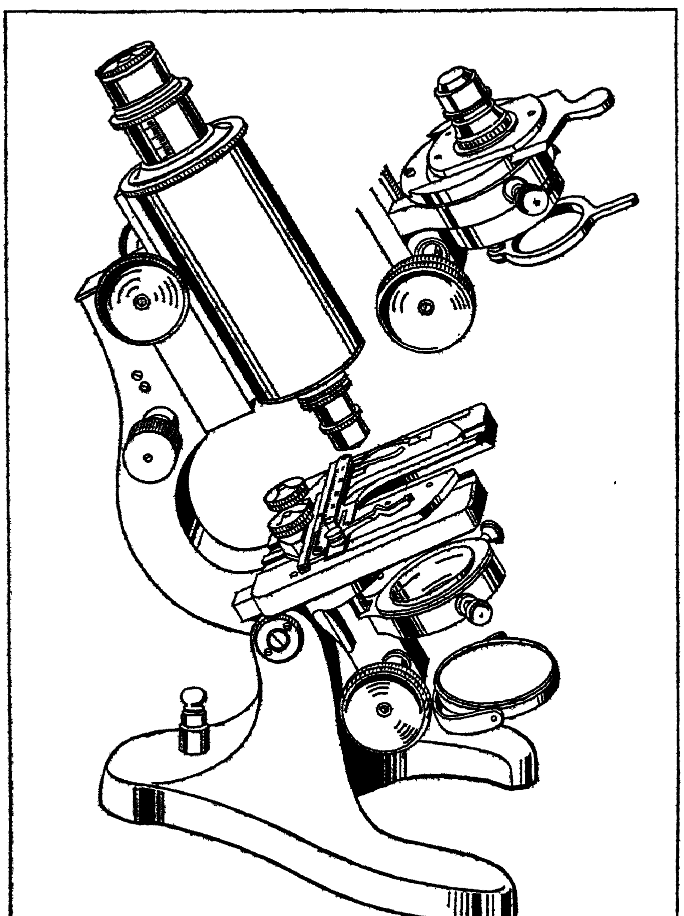


FIG. 22.—MICROSCOPE FOR GENERAL USE (BECK), SHOWING SUB-STAGE ARRANGEMENTS SEPARATELY IN THE SMALLER FIGURE

object and so into the object-glass. Usually the light from the source is reflected from a mirror mounted below the object, the mirror being generally mounted so as to allow of a considerable range of movement both of translation and also of rotation. The mirror may be either plane or concave; usually both types are provided, mounted back to back in a single mount. With a small source of light the plane mirror gives an illuminating beam composed of practically parallel rays. With an extended source the rays reflected from the plane mirror reach the object along directions which give illumination over an appreciable angle. The concave mirror can provide a convergent cone of illumination from quite a small source.

For obtaining an illuminating cone of larger angle than the concave mirror can give, a condenser is interposed between the (plane) mirror and the object. The condenser is a system of lenses capable of concentrating the rays reflected from the plane mirror so that they converge on to the object as a cone of wide angle (*see* fig. 22). A diaphragm, usually of the "iris" type, is fitted below the condenser, in order that the angle of the cone of illumination may be varied conveniently at will. By focussing the condenser so as to form an image of the source, or of a bull's eye lens in front of the source, on to the object, intense illumination of the object is obtained.

Provision should be made for "centering" the condenser in order that the illuminating beam may be truly axial. Dry condensers capable of filling an object-glass having a numerical aperture of 0·95 are obtainable, well corrected for chromatic and spherical aberrations. Immersion condensers are made with numerical apertures as high as 1·4, similarly corrected for chromatic and spherical aberrations and capable of being used with microscope slides of thicknesses up to about 1·5 mm. Immersion condensers are brought up close to the underside of the microscope slide and are put into "immersion contact" with this by filling the space between the underside of the slide and the top surface of the condenser with cedar-wood oil. Immersion condensers are used when it is desired to fill the aperture of an immersion object-glass.

Dark-ground Illumination.—If the condenser aperture is opened wide and a central circular stop is fitted below the condenser, the rays reaching the object form a hollow cone. A similar effect can be obtained by special methods of construction. By choosing an opaque central stop of suitable size, all the *direct* rays from the condenser can be made to pass outside the object-glass, and no light will be received into the object-glass except that which is reflected, refracted, or scattered by the object so as to pass into the object-glass. If the object contains particles, veins, or other structure capable of diverting the rays into the object-glass by any or all of these three processes, such inclusions or structure will be rendered visible in the microscope, and will be seen bright against the dark ground corresponding to the clear homogeneous portions of the object and mounting medium.

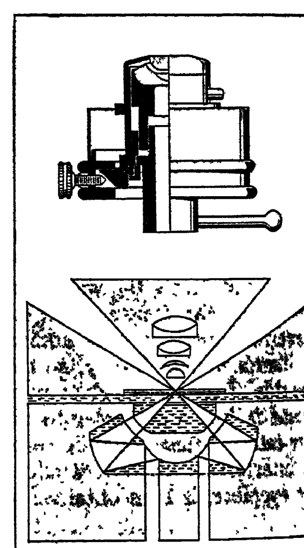


FIG. 23.—IMMERSION DARK-GROUND ILLUMINATOR (BECK)
The paths of the light rays are shown in the lower figure. The upper figure shows a focussing device permitting an image to be focussed when glass slides of different thicknesses are used

Ordinary dry and immersion condensers can be used to give dark-ground illumination if provided with central opaque stops. For work with object-glasses of apertures above 0·65, immersion condensers fitted with central opaque stops can be used, but more satisfactory results are obtained with special immersion dark-ground illuminators. The reflecting systems used in these illuminators give less stray light and at the same time produce a blacker ground.

Most immersion dark-ground illuminators are made for a fixed working distance and are suitable for use with microscope slides of only one particular thickness. The illuminator can be made usable with a thinner slide by packing cover-glasses between the top lens of the illuminator and the underside of the slide, each cover-glass being covered on both sides with immersion oil to provide immersion contact between the top of the illuminator and the

slide. If the slide is too thick there is no remedy. To avoid the inconvenience of a fixed working distance, the firm of R. and J. Beck has introduced an adjustable immersion dark-ground illuminator which, by moving the constituent optical elements relative to each other, can be made to work with microscope slides of any thickness between 0·5 mm. and 1·5 mm.

A dark-ground illuminator computed by E. M. Nelson has the special feature that it will give dark-ground illumination with an object-glass having a numerical aperture as high as 1·4. The working distance of this illuminator is sufficiently large to permit of its being used with slides 0·8–1·4 mm. thick.

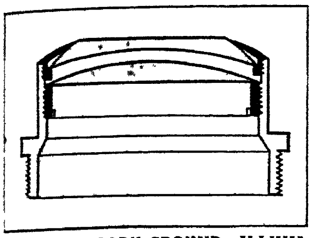


FIG. 24.—DARK-GROUND ILLUMINATOR (WATSON)

Transmitted Polarized Light.—By placing a Nicol's prism, or other polarizing apparatus, between the mirror and the condenser, the object can be illuminated by a cone of light in which the vibrations are all parallel to one direction. If the object has any properties which cause it to modify the state of polarization of the light coming through the *polarizer* and condenser, these modifications can be observed, provided a second polarizing prism (the *analyser*) is used in conjunction with the eyepiece.

If the analyser is set with its polarizing axis at right-angles to that of the polarizer, no light should be seen in the eyepiece,

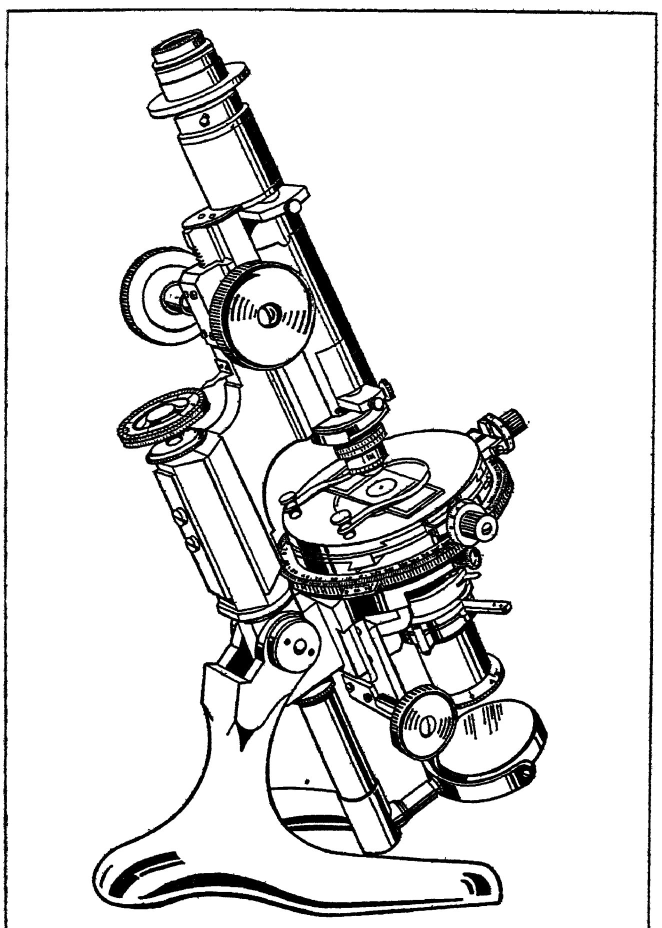


FIG. 25.—PETROLOGICAL MICROSCOPE (SWIFT), AN INSTRUMENT FITTED WITH THE OPTICAL EQUIPMENT REQUIRED TO COVER A WIDE RANGE OF PETROLOGICAL WORK

unless portions of the object have the power of modifying the state of polarization of the illuminating beam. For the complete examination of an object by polarized light, it is necessary to be able to rotate the polarizer and analyser together while keeping the object at rest, or else to rotate the object between the stationary prisms. It is also necessary to be able to rotate one of the prisms relatively to the other. Accessory apparatus of various types is convenient for the special examination of many kinds of objects which show polarization effects, such as fibres and crystals. Microscopes specially equipped with polarizing prisms and accessory apparatus for the examination of objects by polarized light are generally described as petrological microscopes (*see* fig. 25).

Vertical Illuminator.—For examining opaque objects it is necessary to send light down on to the object from above. One

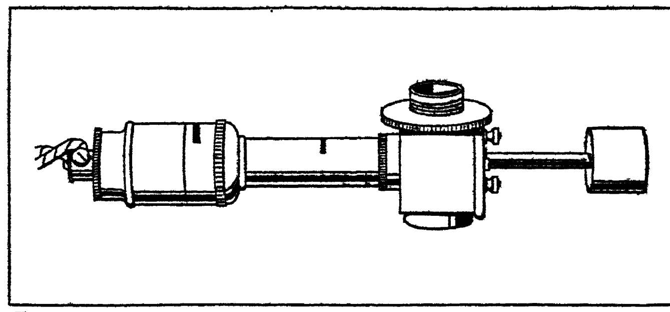


FIG. 26.—VERTICAL ILLUMINATOR (WATSON), A SELF-CONTAINED FORM WITH LAMP, CONDENSER, SLOTS FOR STOPS, REFLECTOR, AND BALANCED WEIGHT; AFTER CONRADY

method of doing this is to mount a cover-glass in a fitting above the object-glass, the plane of the cover-glass being inclined at 45° to the axis of the microscope. Light, admitted through a hole at the side of the fitting, is reflected by the cover-glass down into the object-glass and is brought to focus on the object by the object-glass. The light returning into the object-glass from the object is transmitted with but little loss through the inclined cover-glass, and proceeds to form an image in the usual way. Any inequalities in the cover-glass will tend to impair the resulting image, and in any case this image will be slightly astigmatic owing to the refraction of the light through the inclined cover-glass. To render these effects as small as possible a thin uniform cover-glass should be selected for this purpose.

Prisms, semi-circular mirrors and other types of reflectors are used sometimes instead of the inclined cover-glass just described. Most of these give illumination through only one half of the object-glass aperture, and permit of only the other half being used to form the image of the object. Illumination in this way is apt to cause shadows on the object, while the use of only half the lens aperture causes the resolution to be reduced to one-half, in so far as detail lying parallel to the short dimension of the used aperture is concerned. Furthermore, the portion of the lens used to form the image has a semi-circular aperture which causes the diffraction rings seen round any image detail to depart from their usual circular form. All of these effects may give rise to misleading appearances in the image and may lead to the drawing of false deductions as to the form of the object structure. To avoid these effects, some firms make small annular reflectors for vertical illuminator work. These reflectors send the light down through the outer zone of the object-glass and permit of the rest of the object-glass being used to form the image of the object. Such reflectors do not give rise to misleading effects of the type described above, they merely cut down the available numerical aperture of the object-glass by a small amount. The vertical illuminator is largely used for metallographic work and for examining large opaque objects.

Many object-glasses are unsuitable for use with a vertical illuminator owing to "vertical illuminator glare," *i.e.*, the production of "flare images" which are brought into focus, or nearly into focus, by the eyepiece. These images, which are due to reflections at the various lens surfaces, are superposed on the image of the object, and may render it impossible to see this image properly. Object-glasses for use with a vertical illuminator should be selected for their freedom from this flare effect.

The Ring Illuminator.—An illuminator, which provides "top" illumination without using the object-glass as part of the illuminating system, has been introduced by the firm of R. and J. Beck. This illuminator is an annular lens-mirror reflector. In principle this "ring" illuminator acts in the same way as the

old-fashioned "Lieberkühn" but it is differently constructed, provides much more intense illumination, and is much more convenient.

The object to be examined is mounted on a microscope slide, and on the underside of the slide a small patch stop is gummed if necessary; alternatively an opaque central stop of suitable size can be mounted below the microscope stage. A parallel beam of light is sent up through the stage, and reaches the lens-mirror as a hollow cylinder of light. Any light the object sends back into the object-glass has been either diffusely reflected or scattered by the object. What is seen represents the most natural appearance the object could present if it were enlarged to a degree corresponding to the magnification given by the microscope.

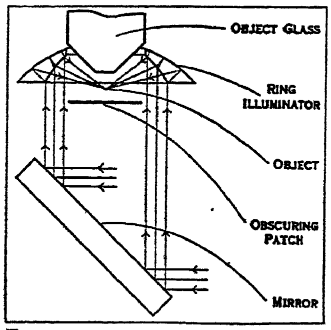


FIG. 27.—APLANATIC RING ILLUMINATOR (BECK), SHOWING HOW LIGHT IS BROUGHT TO FOCUS ON TOP SURFACE OF OBJECT

By building a hollow condenser system round the object-glass, the firm of Chapman and Alldridge has produced a type of vertical illuminator which gives the same kind of illumination as that given by the ring illuminator. A plane mirror is mounted above the condenser with its surface inclined at 45° to the axis of the combined system, an elliptical hole being cut in the mirror to allow of its being fitted round the object-glass. Through a hole in the side of the mount light is admitted. This light is reflected down through the condenser system, and so is brought down to the surface of the object. By adjusting the position of the light source, an image of this source can be brought to focus on the surface of the object at the same time as the microscope is in focus for the object. The appearance of the object resembles that obtained when a ring illuminator is used and, since all the illuminating apparatus is above the object, this type of illuminator is of value in metallographic work, or for use in the examination of any large opaque object. Like the ring illuminator, this illuminator enables "top" illumination to be obtained without incurring any of the difficulties associated with vertical illuminator glare.

Side Illumination.—It is sometimes necessary or useful to illuminate the surface of the object by light projected on to the object from one side and inclined to the surface at almost grazing incidence. This can be done by using a powerful beam, consisting of almost parallel rays, directed slightly downwards on the object. A more convenient way, if great intensity of illumination is required, is to mount a half-lens of high power on the stage of the microscope, so that the principal focus of the half-lens lies in the surface of the object and in the centre of the field of view of the object-glass. An alternative method avoids the production of a coloured image of the source, by a paraboloid reflector.

This method of illumination produces pronounced shadow effects on the surface of the object and shows any surface irregularities in sharp relief. The method is of value in studying the surface contours of objects if due care be taken in translating the appearances seen in the image.

THE MECHANICAL PARTS OF THE MICROSCOPE

While the optical system by which the image is obtained is the most important part of a microscope, the fullest use of this system cannot be made unless the microscope stand is accurately constructed and arranged for the convenient manipulation of the optical parts, the object, and the illuminating system.

The Body Tube and Its Mounting.—The object-glass and the eyepiece are mounted in a body tube, the length of which can be varied so as to allow of the tube-length being adjusted to suit the corrections of the object-glass. The object-glasses are screwed into the bottom end of the body tube and are interchangeable one with another; the eyepieces are made to slide into the upper end of the tube. The body tube is mounted on slides carried by the main limb of the microscope frame, movement of the tube relative to the limb being provided by the coarse and fine adjustments. The coarse adjustment is operated by a rack and pinion mechanism which moves the coarse adjustment slide up and down in machined guides. This type of design is almost universally employed. The fine adjustment slide also works in machined guides, but is operated by a mechanism which is capable of adjusting the position of the body tube by very small amounts. The design of the fine adjustment has attracted the attention of microscope makers for very many years, and the number of designs invented is so great that to describe them here is out of the question.

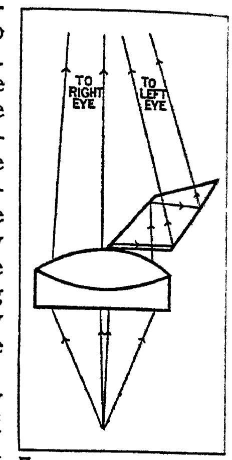


FIG. 28.—WENHAM'S BINOCULAR PRISM
Diagram showing paths of the two rays up to the two eyes

In some instruments the slide of the fine adjustment block fits in guides in the limb, the coarse adjustment slide being carried by guides machined in front of the fine adjustment block. In other instruments this arrangement is reversed. At one time designs were developed in which only the object-glass fitting was carried by the fine adjustment, the object-glass fitting being made to move up or down relatively to the body tube. These designs have practically disappeared.

The fine adjustment should move easily and smoothly, be free from "backlash" and from tendency to stick, and should hold the microscope steady. In microscopes of good make, the body tube can be set by means of the fine adjustment to within $\frac{1}{25,000}$ in. or, in some cases, to within $\frac{1}{50,000}$ in., and can be brought back to its original setting to within similar limits if the fine adjustment is re-set to its original reading after having been altered. In a special instrument made by one English firm, for ultra-violet work, the fine adjustment can be set by means of its indicator so as to bring the body tube to within $\frac{1}{100,000}$ in. of any desired position.

Binocular bodies to allow of the simultaneous use of both eyes are commonly met with. Some instruments are provided with binocular bodies which are interchangeable with the ordinary single-tube (monocular) body. In the binocular bodies prismatic systems are arranged close behind the object-glass, so that light from the object-glass is brought up as two beams of approximately equal intensity, one beam into each eyepiece. Matched pairs of eyepieces are used.

If both eyes receive light from the *whole* of the object-glass aperture, stereoscopic relief is not obtained. To obtain stereoscopic relief, the light coming from the *right* half of the object-glass must be brought up to the *left* eye, and *vice versa*, unless the prism system completely inverts both of the ray systems from the object-glass so as to produce erect images of the object. The binocular prism invented by Wenham in 1861 is the simplest yet devised (1928) for easily giving proper stereoscopic appearances, and this form of prism is commonly used in modern binocular instruments. Wenham's prism brings the rays from the right side of the object-glass up to the left eye, the rays from the left side being allowed to pass on undeviated so as to enter the right eye (fig. 28). The images formed are inverted images in the object, and show proper stereoscopic relief. Many of the early systems did not invert the ray systems so as to produce erect images of the object and gave rise to pseudoscopic effects.

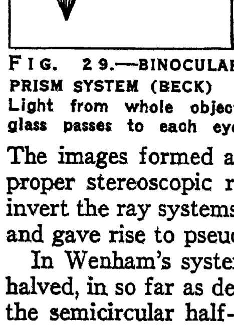


FIG. 29.—BINOCULAR PRISM SYSTEM (BECK)
Light from whole object glass passes to each eye

In Wenham's system the resolving power of the object-glass is halved, in so far as detail lying parallel to the short dimensions of the semicircular half-apertures is concerned. To avoid this, systems are made in which light from the whole object-glass aperture is used in forming each of the images (fig. 29). Stereo-

scopic effects can be obtained with these systems by adjusting the eyepieces so that they produce Ramsden circles separated by a distance slightly less than the distance between the eyes of the observer. When the observer's eyes are placed at the Ramsden circles, the light entering the *right* eye comes mainly from the *left* side of the object-glass and *vice versa.* With a little experience the adjustment required to give stereoscopic relief can be made without difficulty. This may be done more easily perhaps if capped eyepieces are used in which stops with semicircular apertures are fitted, as in Abbe's stereoscopic eyepiece system. The stops are placed in or just below the Ramsden circles, and are used with the curved sides of the apertures outwards. Without these stops it is easy to produce pseudoscopic appearances by making the distance between the Ramsden circles larger than the inter-ocular distance, so that the light entering each eye comes mainly from the wrong half of the object-glass. In the Greenhough binocular two separate microscopes are used, with separate object-glasses (fig. 30). These microscopes are fitted with prismatic erecting systems just below the eyepieces, to produce stereoscopic and not pseudoscopic effects.

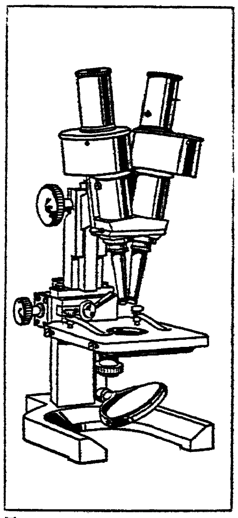


FIG. 30.—GREENHOUGH BINOCULAR (WATSON)
Two separate microscope systems are shown with an "Erecting" prism in each microscope

The Stage.—The stage for carrying the object is usually fixed rigidly to the microscope limb, though in some microscopes it is mounted on slides on the limb and is movable by means of a rack and pinion mechanism. The stage may be a simple plane table on which the object is moved about by hand when different portions are to be examined, or it may be made with slides permitting of movement in two directions at right-angles, and with a bearing to allow of rotation about the axis of the microscope. Centering screws are sometimes fitted so that the axis of rotation may be brought into coincidence with the axis of the object-glass. The stage should be rigidly supported, and should bear the weight of comparatively heavy specimens without serious deflection. The mechanical slides, and the rotation bearings if fitted, should operate smoothly but without tendency to slip under the weight of the movable parts, or under the weight of any specimen likely to be examined. The mechanical slides of the stage should be accurately at right-angles to the axis of the microscope, as should also be the plane in which the stage moves when it is rotated. Except in some metallographic microscopes, the centre of the stage is cut away, to admit light through to the specimen when illumination with transmitted light is required.

The Sub-Stage.—Provision is made below the stage for mounting the illuminating apparatus required for examining an object with transmitted light. The minimum equipment necessary is a mirror which can be moved into various positions, so as to reflect light up through the hole cut in the stage. In the more completely equipped microscopes special sub-stage attachments are fitted. These are adapted to carry a condenser, polarizing apparatus, various stops, a disk of ground glass and colour filters, with an iris diaphragm to permit of varying the cone of illumination provided by the condenser. Geared cells, to permit of rotating various accessories used in the examination of objects under polarized light, such as selenite plates, are often included in the more elaborate sub-stage equipment. The cells used for carrying the stops should be fitted as close as possible to the underside of the condenser, as should also the iris diaphragm.

The sub-stage is usually, but not invariably, carried on a block which slides on the limb of the microscope, and which can be moved up or down by a rack and pinion; the mirror is then mounted on an extension of the limb below the sub-stage slides. The sub-stage condenser fitting should have centring adjustments to allow of the axis of the condenser being brought into line with the axis of the object-glass. The various attachments are generally fitted so that they can be conveniently swung out of position when not required. In most instruments the whole sub-stage can either be swung bodily out of the axis or removed entirely. The sub-stage is often mounted on a pillar attached to the underside of the stage, and is movable up or down on a spiral cut on this pillar. In some instruments there is no proper sub-stage at all, any condenser or other illuminating apparatus being made to slip into a tube fixed under the stage.

The importance of the sub-stage equipment should be strongly urged since, for the systematic study of an object under the microscope, it is necessary to be able to use several different conditions of illumination. A well-equipped sub-stage is essential if this is to be carried out conveniently and, in selecting the equipment for a microscope which is to be used in serious investigations, the sub-stage apparatus should receive as much attention as any other part of the instrument.

Accessory Fittings.—For the greater convenience of the microscopist, fittings of many varieties have been introduced by different makers. Many of these are devised to enable one object-glass to be quickly changed for another, and to minimize the work involved in readjusting the instrument when this is done. The necessity for readjustment arises mainly from minor errors in the mounting of the lenses constituting the object-glass system, or in the mounting of the whole object-glass in the object-glass cell. If critical observation is desired, these errors may necessitate re-centring the condenser, or the object-glass, each time one object-glass is substituted for another.

Rotating nosepieces which carry two or more object-glasses are among the simplest of these accessory fittings. They are not usually provided with centring adjustments for each object-glass, and only permit of the quick changing of one object-glass for another. Interchangeable object-glass carriers, which slide into or clip on to a nosepiece carried by the body tube, are also used. Each object-glass is fitted permanently into its own slide or clip-piece, and is accurately centred once for all. Each object-glass will then be in correct adjustment, so far as centring is concerned, as soon as its carrier is pushed or clipped into position. Similar carriers are made for holding sub-stage condensers. Such accessories, though very convenient in use, are not essential parts of the microscope. For fuller descriptions of them the reader must be referred to the catalogues issued by the various microscope makers.

BIBLIOGRAPHY.—Historical:—Quekett, *Practical Treatise on the Use of the Microscope* (1855); J. Mayall Junr., *Cantor Lectures on the Microscope* (Royal Society of Arts, 1886). General microscopy:—S. H. Gage, *The Microscope and Microscopic Methods* (1925); J. Hogg, *The Microscope* (15th ed., 1898); W. B. Carpenter, *The Microscope and its Revelations* (8th ed. by W. H. Dallinger, 1901); Sir A. E. Wright, *Principles of Microscopy* (1906); E. J. Spitta, *Microscopy* (2nd ed., 1909); C. Beck, *The Microscope* (1923). Theoretical treatment of the microscope:— M. von Rohr, *Die Theorie der optischen Instrumente* (1904); S. Czapski, *Grundzüge der Theorie der optischen Instrumente* (Leipzig, 1904). Technical applications:—R. H. Greaves, *Introduction to Microscopic Metallography* (1924); H. Freundlich, *Elements of Colloidal Chemistry* (Eng. trans., 1925); A. Herzog, *Die mikroskopische Untersuchung der Seide und der Kunstseide* (1924).
(H. JA.; H. Mo.)

MICROSCOPICAL SOCIETIES. The *Royal Microscopical Society* (1839, incorporated 1866), with *Transactions* (1842–1868) and *Journal* (1869, etc.); the *Quekett Microscopical Club* (1865), with a *Journal* (1868, etc.); and the *Postal Microscopic Society* (1873), also with a *Journal,* are located in London. There are suburban societies at Ealing (1877), Hackney (1877), Highbury (1878), South London (1871), and Sydenham (1871). In the provinces may be mentioned those at Bath (1859), Birmingham (1880), Bolton (1877), Bradford (1882), Bristol (1843), Carlisle, Chichester (*Trans.*), Croydon (1870, *Trans.*), Dublin (1840), East Kent (1858), Edinburgh, Liverpool (1868, *Trans.*), Manchester (1880), and Sheffield (1877). In the United States the *State Microscop. Soc. of Illinois,* the *Amer. Soc. of Microscopists* at Buffalo, the *New York Microscop. Soc.;* and the *Amer. Micros. Soc.* at Urbana, Ill., publishing *Trans.* (1895, etc.). Brussels, *Soc. Belge de Microscop.* (1875), *Proc.-verb.* (1875, etc.) and *Annales* (1876, etc.). Berlin, *Ges. f. Mikroskop.* (1877), *Ztschr.* (1878, etc.). Hanover, *Ges. f. Mikroskop.* (1879), *Jahresber.*

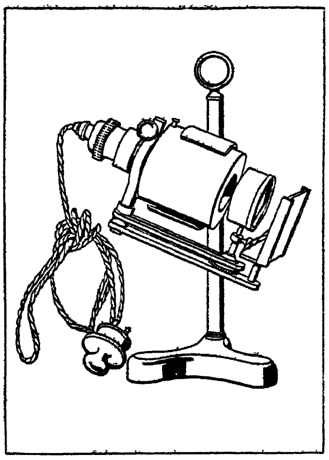
MICROSCOPY, the art of using the microscope. There is little need for stressing the importance of the microscope in the investigation of many widely different problems. In medical, biological, geological, metallurgical and many other kinds of work, the value of the microscope is well understood, and the instrument is used constantly in routine work and in research. In other applications the value of the microscope is being increasingly realized, but its value might be appreciated even more widely if all users of the instrument should make a study of its principles, sufficient to enable them to realize the full implications of their observations. Such study would also prevent erroneous deductions from appearances seen in the image, appearances which might be due to faulty adjustment either of the instrument itself or of the illuminating apparatus. (*See* MICROSCOPE.)

Methods of Illumination Commonly Used.—The most commonly used method of illumination is that in which the object is illuminated by transmitted light. This method is peculiarly liable to give images in which the contrast is seriously impaired due to "glare" effects if the cone of illumination is made sufficiently large for the aperture of the object-glass to be fully utilized. The importance of this method of illumination is not to be belittled, however. It gives information of much value and is convenient to employ; it must, also, be the chief method of examining such objects as thin stained sections of animal and vegetable tissues. The information obtainable with any single type of illumination is necessarily incomplete, however, and should be supplemented where possible by examining the object under other conditions.

Among other methods of illumination ordinary darkground illumination, vertical illumination and side illumination are probably the most commonly used. The ways in which the microscope and illuminating apparatus are adjusted to provide these various forms of illumination are fully dealt with in many treatises and textbooks on the microscope and microscopy (*see* also MICROSCOPE). We must confine ourselves here to emphasizing the necessity of mastering the methods of making these adjustments. The reader is referred to these textbooks, also, for information regarding the appearances obtained in examining objects by these methods and by such other methods as are commonly used in medical, biological, geological and other types of work in which the technique has become almost standardised. We shall restrict ourselves to supplementing that information by giving (*a*) a few examples to illustrate the interpretation of some of the less well-understood appearances obtained by the more usual methods of illumination, and (*b*) descriptions of some of the results obtainable by the use of novel or less commonly used technique, which serve to illustrate the possibilities of extended use of the microscope for obtaining information as to the nature of the object being examined.

The Illuminant.—A powerful lamp with a small radiant will serve as the source of light for every kind of work to be done with the microscope. The use of a small radiant minimises the amount of light reflected down on to the top of the object from the surfaces of the individual lenses in the object-glass, or from the cover-glass, when transmitted illumination is used, and so reduces the loss of contrast due to *lens flare* and *cover-glass glare*. If it is desired to use a larger area of illumination than that obtained by focussing an image of the radiant on to the object, this can be done by placing a bull's eye lens or a piece of ground glass, or both, in front of the lamp, and producing a focussed image of either of these on the object. A small radiant is not essential, however, and much useful work can be done with a simple paraffin lamp or with ordinary gas or electric lamps.

Recognition of Structure.—Although there is a limit to the resolving power of any object-glass, this does not mean that an object-glass cannot give *indications* of structure in objects having structures appreciably finer than the lens could possibly show resolved. Small particles have the power of *scattering* light which falls upon them. The intensity of the scattered light is greatest in directions at right-angles to the illuminating rays, and the percentage of incident light scattered is greater for blue light than for light of longer wave-lengths. The light directly transmitted by an object which contains discrete minute particles is thus deficient in blue and appears as of a yellow or brown colour, while the light seen by looking sideways at the object appears blue. If the particles are regularly arranged in the object there is, in addition to the scattered light, a certain amount of light which leaves the object along definite directions inclined at definite angles to the main beam. This light is *diffracted* light. The diffracted beams obtained from white light are seen as coloured bands, because the vibrations corresponding to the different colours which make up "white" are diffracted along different directions. If the whole of the light in any one diffracted beam is recombined, the resulting "colour" is white. If, however, only part of the light in a diffracted beam is recombined, the colour obtained depends on the colours present in the used part of the diffracted beam.


MICROSCOPE LAMP WITH BULL'S EYE AND SCREEN HOLDER

Many opal glasses, when examined by means of an object-glass of too low a numerical aperture to show the "opal" material as discrete particles, appear of a yellow or brown colour when illuminated with transmitted light. The depth of the colour seen depends on the density of the opal; it is deeper, also, with a narrow cone of illumination than with a cone of wide angle. With darkground illumination giving a hollow cone much wider than that corresponding to the numerical aperture of the object-glass, the opal glass will appear of a marked blue colour. Such appearances of colour can be taken as definite evidence of the existence of particles in the object, even though the particles cannot be seen as separate discrete particles with the particular object-glass used.

Similar effects are obtained with fossil diatoms but the appearances may be complicated by diffraction due to the regular structure of the diatom. The colours seen, whether by transmitted light or dark-ground illumination, then depend on the fineness of the structure in relation to the numerical aperture of the lens. If the structure is much too fine to be resolved by the lens used, the diatom shows as a yellow or brown object with well-marked outlines when examined with transmitted light, and as a blue or whitish-blue object with dark-ground illumination. If, however, the structure is almost resolvable by the object-glass used, areas showing blues and greens or pinks may appear on the diatom when a transmitted cone of suitable angle is used, the colours seen with wide-angle dark-ground illumination being usually approximately complementary to those seen with transmitted light. These colours are due to the admission of portions of the first order spectra into the object-glass, and are indications of a regular structure which is almost resolvable by the object-glass. The intensity of the colours depends on the medium in which the diatom is mounted. Strong colours are shown if the diatom is mounted dry (in air) or in realgar, owing to the large difference of refractive index between the material of the diatom and air (lower) or realgar (higher). A weak colour is shown if the diatom is mounted in Canada balsam or styrax, both of which have refractive indices not greatly different from that of the diatom itself.

Small objects having rounded contours with smooth faces may give rise to a pearly appearance under suitable conditions of either transmitted or dark-ground illumination. This is not necessarily an indication of structure, since the distribution of the pearly light can be shown in some instances to be due to the irregular refractions occurring at the surfaces of the objects. *Tous les mois* starch grains mounted in water show these lenticular refractions very clearly, though there is, in addition, a slight brownish colour discernible on portions of the grains when examined with a narrow cone of transmitted light. This brownish colour is indicative of structure which, in this object, is the result of the growth of one layer over another. The brown colour is very

slight compared with that seen on a diatom such as the *Pleurosigma angulatum*, even when this is mounted in Canada balsam. This indicates that the differences of refractive index in the starch grain structure are only very slight.

Growth structures frequently give double refractive effects, and many instances of animal and vegetable tissues and fibres are known in which evidence of structure can be revealed by examination with polarized light. The use of polarized light in the study of natural and artificial fibres used in the textile and other industries is common, and this method of examination is employed for distinguishing between different types of fibres as well as for controlling various industrial processes connected with the treatment and manufacture of fibres. This method of illumination has considerable diagnostic value in the study of animal and vegetable tissues.

Recognition of Colour.—The colours of stained specimens can be seen quite clearly by transmitted light, but many naturally coloured objects are either so opaque that they appear black by transmitted light or else, with any method of illumination, there is so much general light mixed with the light coming from the coloured object or detail that its precise hue cannot readily be identified. With ordinary dark-ground illumination, surface colours are liable to be masked by light coming through from the lower parts of the object, and the true colours of the surface are not readily perceived. With the *vertical illuminator*, the difficulties arising from this cause are avoided, but the surface colours are much diluted by light regularly reflected from the surface of the object. The *ring illuminator* gives a hollow cone of illumination of wide angle, similar to that used in ordinary dark-ground illumination, the only essential difference being that the ring illuminator reflects the light down on to the surface of the object. As a result of this, illumination by means of the ring illuminator gives a better idea of the true surface colours than that obtained with dark-ground illumination, since the amount of light coming from the surface is bright compared with that coming from lower portions of the object. The ring illuminator also shows up surface colours better than the Vertical Illuminator since, with the former, direct, regular reflections from the surface are largely cut out and the colours seen are diluted with comparatively little of the regularly reflected light. For the study of insect colouring and for much analogous work the Lieberkühn was at one time extensively used as the best method of illumination; the ring illuminator gives essentially the same type of illumination as the Lieberkühn.

If the object under examination has a flaky surface, or is covered with a surface film, it may show iridescent colours such as are seen in a soap bubble. These colours are produced by interference between the light reflected by the upper and lower surfaces of the surface film or surface flake. With light falling almost perpendicularly on the surfaces, the reflected light is of feeble intensity unless the refractive index of the film or flake is high. The interference colours are easily masked, therefore, when a vertical illuminator is used, if the flake or film has a comparatively low refractive index, a little stray light being sufficient to prevent the interference colours from being seen. A film of high refractive index, however, such as a film of oxide or sulphide on copper, gives quite strong interference colours when illuminated with a vertical illuminator.

With the ring illuminator the light strikes the surfaces much more obliquely, and is more strongly reflected because of this. Any of this light which gets into the object-glass should show stronger interference colours than are seen with the vertical illuminator, and this actually occurs if the film or flake is of low refractive index. With a film or flake of high refractive index, however, the amount of light reflected at the first surface is so large that comparatively little light penetrates into the film or flake, and the amount which can be reflected at the lower surface is small. Moreover, the light which penetrates and is reflected at the lower surface is often much weakened by absorption in the film or flake, and the emerging light is of feeble intensity compared with the light reflected at the upper surface. As a result, the interference colours are not in general easily seen when an object covered with a surface film of high refractive index is examined under a ring illuminator.

It may be mentioned, in passing, that these differences can be used to identify the cause of the iridescent colours seen on much antique glass and porcelain. If the interference colours show well under the vertical illuminator and are not seen so well, if at all, when the ring illuminator is used, this is strong evidence that the iridescence is due to a film which has a high refractive index, such as a film of tarnish on a thin metal foil burnt on or just into the glass or glaze, *e.g.*, in "lustre" ware. If, on the other hand, the iridescent colours are shown best with the ring illuminator, they are probably produced by surface flakes of comparatively low refractive index such as result from disintegration of the glass or glaze. Evidence as to the refractive index of the iridescent material can also be obtained if any idea of the thickness of this material can be formed by endeavouring to focus to the levels of its top and bottom surfaces down one edge (not *through* it). If the refractive index is very high, the layer will be too thin for its thickness to be measured, but if the refractive index is comparatively low it should be possible to distinguish a difference of focus between the levels of the top and bottom surfaces when examined with a high power.

These interference colours, whether due to films or flakes, prevent the true colour of the object from being recognised. They can, however, be got rid of by a method now to be described, in which illumination with polarized light is used. This method of illumination also causes much of the regularly reflected light and stray light to be cut out. It is commonly assumed that only doubly-refracting materials will be visible when examined with polarized light when the axis of the *analyser* is at right angles to the axis of the *polarizer* (crossed nicols). This is not so. Reflection at a surface can cause a sufficient change in the state of polarization of the light from the polarizer for an appreciable proportion of the reflected light to be transmitted through the analyser. Moreover, if the surface at which the reflection takes place is coloured, this colour will show up strongly in the light which passes through the analyser.

In order that examination by polarized light may be used satisfactorily for the recognition of surface colour, it is necessary that the refractive index of the reflecting material should differ as much as possible from that of the material which surrounds it. The increased reflection resulting from this is of no advantage, of itself, but this increased reflection is associated with a comparatively large change in the state of polarization produced by the reflection. The visibility of a non-doubly-refracting particle when viewed between crossed nicols is thus dependent in a very large measure on the difference between its refractive index and that of the material in which it is embedded. As a result, particles of high refractive index, such as metals or the more highly-coloured metallic oxides, show up quite strongly when surrounded by almost any transparent medium; whereas particles having a refractive index not greatly different from that of the medium surrounding them, *e.g.*, white "opal" particles in an opal glass, show comparatively feebly, giving but little light compared with that seen on the particles when examined with non-polarized light. To illustrate the ways in which the examination with polarized light can be applied to the identification of surface colours, a few typical examples may be given, though many other applications will occur to the microscopist of experience.

A few flakes of an opal glaze which showed pinkish veins when examined visually, could only be seen as of a brownish-yellow colour with ordinary transmitted light, and as bluish-white by ordinary dark-ground illumination or with the ring illuminator. Transmitted polarized light, even when the nicols were crossed, gave a good deal of general white light owing to the intensity of the opal, and the pinkish colour was completely masked. With the ring illuminator used to reflect polarized light on to the specimen (the polarizer being below the stage as usual), large numbers of coloured particles could be seen when the nicols were crossed, and these particles were of the unmistakable colour of copper. With the nicols parallel, a few of these were distinguishable owing to their having been previously located when the nicols were crossed, but the colours were so much paler that it would have

been impossible to identify the nature of the particles by their colours. Under similar conditions crystals of ferric oxide in a glaze were easily recognized by their deeper red or brownish-red colour.

In a green-gray porcelain "body" of presumably Chinese origin, a few pale-green particles could be detected by careful observation of the porcelain, using ordinary light and a ring illuminator. With polarized light and the ring illuminator a very large number of such particles could be seen, amply sufficient to account for the depth of colour seen when the porcelain was examined visually. Moreover, the colour of the particles was so clearly recognizable that it gave strong presumptive evidence that the particles were a compound of chromium. Subsequent spectroscopic examination identified chromium.

Examination of a tarnished piece of copper by the vertical illuminator showed a flush of colours such as are produced by thin films. With the ring illuminator the whole surface appeared granular except for a few scratches, most of the granules appearing like burnished copper, though a few were blackish. The interference colours were not seen. Examination under the ring illuminator using polarized light, and with the nicols crossed, showed that most of the granules were more crimson in colour than the surface of copper seen in the scratches, and these granules were recognizable as particles of cuprous oxide. The blackish particles showed an intensified darkness of colour; these were particles of cupric oxide.

Diatoms mounted in Canada balsam or styrax are hardly visible when viewed by transmitted light between crossed nicols, but if mounted dry or in realgar they show up brightly unless the main lines in the structure lie parallel to the axis of one or other of the polarizing prisms. As the diatom is rotated, extinction positions highly reminiscent of those obtained with doubly refracting crystals occur, extinction, in the sense of greatly diminished brightness, occurring every 90° of rotation. Reflection surfaces give similar extinctions, and it is very easy to mistake a reflecting surface of any material, whether doubly-refracting or not, for a fragment of a doubly-refracting crystal.

This method of illumination is of very great value in critical microscopy, as can be gathered from the few examples which have been quoted. It is also useful when an object is to be examined with a cone of transmitted light large enough to fill the object-glass aperture, as it enables this to be done without incurring such loss of contrast as results from light reflected by the surface of the cover-glass (cover-glass glare) or by the surfaces of the individual lenses in the object-glass (lens flare). This reflected light is almost entirely stopped by the analyser and, as a result, the full resolving power of the object-glass can be obtained by full use of the object-glass aperture, without any marked loss of contrast such as is usually observed with ordinary transmitted light and a similarly wide-angled cone of illumination. The general appearance of the image when the object is examined between crossed nicols with transmitted light resembles that obtained with dark-ground illumination.

Visibility of Minute Particles or Fibres.—If a particle or fibre is to be visible when examined with transmitted light, using an object-glass of numerical aperture $n\sin u$, the diameter of the particle or the diameter of the fibre must be not less than $\frac{1}{2}\lambda/n\sin u$. Smaller particles or thinner fibres will not obstruct the light sufficiently for the object-glass to resolve the two sets of rays travelling past opposite sides of the obstruction. With dark-ground illumination all the light entering the object-glass is light which has been reflected from or scattered by the object. If, therefore, a particle is large enough, or a fibre thick enough, to send sufficient light up into the object-glass, the particle will be seen as a bright disk, or the fibre as a bright line of light extending much beyond its apparent end as shown by transmitted light.

The visibility of particles and fibres when illuminated by means of a ring illuminator, is similar to that obtained with dark-ground illumination, except in one respect. With dark-ground illumination the light passes up through the lower layers of the specimen and, except when the specimen is very thin, much light may be sent up into the object-glass from these layers. As a result of this, the visibility of any particles or fibres, or of structure generally, may be impaired since, to some extent, the upper layers of the specimen will be illuminated by transmitted light sent up through them from the underlying portions of the object. With the ring illuminator, much of this diffuse transmitted light is avoided and the visibility of particles or fibres is often better than that obtained with ordinary dark-ground illumination.

Minute particles are often much better revealed when intensely illuminated by ordinary dark-ground methods, or by means of a ring illuminator, than when viewed by transmitted light, just as dust particles in a beam of light are visible to an eye looking sideways into the beam but cannot be seen by looking along the beam towards the source of light. Thin objects, such as bacteria or other minute living organisms, in water, are often seen better by means of a lens of moderate numerical aperture, when ordinary dark-ground illumination is used, than by an immersion lens of much higher aperture used with transmitted light. It is worth while emphasising how much work lies within the scope of *dry-front* lenses of numerical apertures of 0·35 to 0·85 if advantage is taken of the high visibility of small particles when intensely illuminated, either by ordinary dark-ground methods or by means of the ring illuminator.

For dark-ground work with object-glasses of numerical apertures between 0·85 and 1·0, immersion object-glasses give more satisfactory visibility of faint objects than do dry object-glasses of corresponding apertures, as stray light from the cover-glass and front surface of the object-glass is largely avoided. For the purpose of rendering very minute particles visible, specially intense dark-ground illumination is used in conjunction with an ordinary microscope. This method of studying minute particles is called *ultra-microscopy*.

The Ultra-microscope.—There is, in theory, no limit to the smallness of a material particle which can be made visible, provided sufficient light can be made to fall on the particle. Bodies of small size have the power of scattering light which falls on them, the intensity of the scattered light being greatest in directions at right-angles to the path of the illuminating beam. Advantage is taken of this in the ultra-microscope, in which the particles to be rendered visible are illuminated by an intense beam of light which is directed through or across the object, in a direction at right-angles to the axis of an ordinary microscope. Each particle scatters some of this light, and the scattered light which enters the object-glass from any one particle is brought to focus as a diffraction disk in the image plane. If the dimensions of the particle are smaller than half the wave-length of the light used, no deductions as to the form of the particle can be made from the appearance of the diffraction disk seen in the image plane. Some estimate of the relative sizes of the different particles can be made from the relative brightnesses of the corresponding diffraction disks, but the diffraction disks will all be of substantially the same size. The size of the diffraction disks becomes smaller and smaller as the numerical aperture of the object-glass used for viewing the particles is increased. Each diffraction disk represents a particle; the number and positions of the particles can thus be determined provided no two particles are so close together that their diffraction disks are practically coincident in the image plane.

The illumination used is of such intensity that an appreciable amount of light is sent into the microscope from a plain slide of glass, either due to lack of homogeneity in the glass, to imperfections of its surface polish, or to fluorescence of the glass. For this reason any specimens which require mounting are usually mounted on slides of polished quartz when they are to be examined by the ultra-microscope. For the examination of fluids the Siedentopf-Zgismondy ultra-microscope is largely used, the fluid being contained in a small chamber fitted with quartz windows, through which a very intense beam of light is passed. The larger the particle and the higher its refractive index relative to that of the surrounding medium, the more readily is the particle seen. With modern methods of illumination, particles of colloidal gold having diameters as small as 1·7 $\mu\mu$ (17 Ångström units, or about $\frac{1}{250}$ of the wave-length of blue light) have been seen.

The ultra-microscope has been used for many purposes, such

as obtaining estimates of the number of smoke particles in the air of different localities, for estimating the amounts of foreign matter in water or in glues, gelatines, etc., as well as for many purposes in connection with the study of colloids. The instrument is also used in investigating the structure of natural and artificial fibres, for the examination of artificial fibres for inclusions, etc. Although the ultra-microscope fails to reveal particles which are separated by distances smaller than the limit of resolution of the object-glass used, the brightness of the haze of light obtained affords a measure of the size and concentration of the particles. Increase of brightness indicates either increase in the number of particles per unit volume or increase in the size of the individual particles. This effect can be made use of in certain work on very minute living organisms and in the study of the growth of minute crystals separating out from solutions. The microscope when used for this kind of work is being employed as a Nephelometer.

Ultra-violet Microscopy.—For the microscopic examination of objects having structures too fine to be resolved by any object-glass when ordinary visible light is used, recourse must be had to methods involving the use of ultra-violet radiations and of lenses made of fused quartz computed for use with ultra-violet light of appropriate wave-length. Glass lenses are opaque to these radiations. In 1904, Dr. Köhler of Jena experimented with ultra-violet light with a view to obtaining resolution of structures previously irresolvable. He used monochromatic radiation of wave-length 275 $\mu\mu$ given by an electric arc between cadmium poles, and projected the image on to a fluorescent screen for visual examination or for focussing in readiness for photographic recording.

In England J. E. Barnard has developed a technique for ultra-violet work which is much simpler than that used by Köhler. In his more recent work described in 1925, he used a combined illuminator made by the firm of R. & J. Beck consisting of an outer system of glass, which acts as an immersion dark-ground illuminator, and an inner immersion system of quartz which enables a transmitted beam to be passed through the object. Both condensers have the same focus, the one for visible light and the other for the ultra-violet radiation used. Either condenser can be stopped out at will, the quartz one by means of a central stop and the glass one by means of an annular diaphragm. The condenser is put in immersion contact with the quartz slide on which the object is mounted, and the object is illuminated with visible light by means of the dark-ground illuminator. The microscope is then focussed so that the object is clearly seen by visible light. The dark-ground illuminator is then closed, the central stop is removed so as to uncover the quartz condenser, and a beam of ultra-violet light is passed into this condenser and focussed by it, without further adjustment, on to the object. The object-glass has not the same focus for ultra-violet light as for visible light, however, so it is necessary to readjust the focus before any photograph can be taken with the ultra-violet light. Arrangements are provided so that by moving the fine adjustment through a known small distance, the requisite readjustment of focus can be made with certainty. If desired, a number of photographs of one object can be taken in succession, so as to show the structure of the object in successive parallel planes separated by distances of the order of $\frac{1}{100,000}$ inch.

The technique developed by Barnard has brought ultra-violet microscopy into an important position in bacteriological research. Bacteria are nearly uniformly transparent to visible light but are not so to certain regions of the ultra-violet spectrum. To photograph bacteria it has hitherto been necessary to stain them with dyes in order to make their outlines or structure visible with transmitted light. In the process of staining, the bacteria are killed, consequently any deductions drawn as to the form and structure of living bacteria are liable to be fallacious if based solely on the microscopic examination of stained specimens. With ultra-violet illumination staining is no longer necessary. Thus, not only is it possible with this new technique to examine the structure of bacteria which have never previously been resolved, but also it is possible to avoid staining the bacteria, so that the structure of living bacteria, whether large or small, can be photographed.

The technique worked out by Barnard offers great promise in other directions, notably in metallurgical research, for determining the detail-structure of metals and alloys. Experimental work to explore the further possibilities of ultra-violet microscopy is in progress, investigations have also been suggested with a view to discovering whether the very short ultra-violet radiations, of wave-lengths about 40 to 60 $\mu\mu$ can be used in microscopy. These Schumann rays are absorbed to a considerable extent by all forms of matter, a layer of air one or two centimetres thick being sufficient to absorb them almost completely, consequently any apparatus in which such rays are employed must be used in a vacuum and must be of the reflecting type.

The Microscope in Metallurgy, Engineering and Spectroscopy.—In metallurgical work an inverted type of microscope is now usually employed, though an ordinary microscope fitted with apparatus for giving illumination from above can also be used. In the more commonly used form, the stage, the microscope proper, the illuminating apparatus and all the other equipment are mounted on pillars carried by slides which can be moved independently along a machined bar, thus forming a type of optical bench. The specimen is illuminated from beneath, vertical or side illumination being provided by various types of apparatus. The illuminated underface of the specimen can be examined visually or can be photographed. The camera is an integral part of the apparatus and is mounted separately from the tube which carries the eye-piece used for visual examination. The same object-glass is used both for visual and photographic work, the change-over being made easily and quickly. Focussing adjustments are fitted to the object-carrier and also to the object-glass support. The fine adjustment can be fitted to either, but is usually on the object-glass support in order that the load it has to carry shall be as small as possible.

The lenses used for metallurgical work should be selected with special regard to the absence of flare when used with a vertical illuminator. Special lenses of high numerical aperture (1·6) for use with (blue) monochromatic light have recently been designed specially for metallurgical purposes, to be as free from flare as possible, to be well-corrected for spherical aberrations and to have as high a resolving power as appears to be feasible with a lens computed for both visual and photographic use.

The mechanical properties of metals and alloys, such as hardness, ductility and tenacity can largely be correlated with their structure as revealed by the microscope. The information provided by the microscope amplifies and extends that obtained from chemical analyses and in other ways, and enables the behaviour of the individual constituents to be more completely followed out when the metal or alloy is subjected to various heat-treatments or to mechanical processes such as forging, hot- or cold-rolling, drawing, pressing, etc.

Microscopes have valuable applications in the workshops as precision measuring devices. The type of microscope for use in the workshop is usually a simple robust instrument having a magnification not greater than about $\times$ 20, with a low-power object-glass and an eye-piece in which a scale or graticule is mounted. The type of graticule or scale used depends on the kind of work in connection with which the microscope is being used, as does also the method of mounting the microscope. For use on flat surfaces the microscope may be rigidly mounted on a plane base, while for other uses, such as in precision screw-cutting, tool- and jig-making, etc., other types of support are used. The microscope is provided with sliding-tube focussing, or with an ordinary rack-and-pinion coarse adjustment. Simple electrical illuminating devices are frequently incorporated with or permanently fitted to these instruments. For examining and measuring screw threads, wires, etc., specially designed microscopes, some of which are of the "projection" type, are used.

It is only possible briefly to point out the properties desirable in the type of attachment which enables the microscope to be used for micro-spectroscopy. It should be so constructed that the object can be brought into the centre of the field and isolated by means of suitable adjustable diaphragms, and arrangements should be made for the spectroscope and slit to be swung in easily when

the object and illumination have been properly adjusted. Provision should also be made for comparing the absorption spectra seen in the microscope with a wave-length scale in the eye-piece and with spectra obtained from known substances. The microspectroscope has many useful applications in the study of colouring matters of vegetable, animal and mineral origin, and can play an important part in micro-chemical work and in the identification of small quantities of fluids or solids having selective absorption for light.

The manifold applications mentioned or indicated in this article show that the microscope can be used for studying by means of light, anything which, as regards size and condition, can be presented to the instrument. It has been said earlier that there is no need to stress the importance of the microscope in medical, biological, geological, metallurgical and many other applications, but it is well to call attention again to its importance in general scientific and industrial work and research. An hour or two at the microscope may not only assist in shaping the problem to be investigated, but it may in many instances enable much laborious work to be avoided, either by solving the problem completely or by indicating those methods of attack most likely to bring a speedy solution. If care be taken to become familiar with the general principles and methods of microscopy, a comparatively small additional experience in any one particular line of work will make the microscope practically indispensable for such work. The many valuable applications of the microscope in science, industry and general education have rightly over-shadowed its use as a means of recreation alone; but it is well to recall the interest, pleasure, enlightenment and inspiration which the microscope can arouse, when used for recreation, as a revealer of unsuspected beauties and of things otherwise unknowable.

For bibliography *see* MICROSCOPE. (H. JA.; H. MO.)

MICROTOMY is the technique of cutting animals or plants or their parts into minute slices. For many years both botanists and zoologists depended on free hand sections made by the razor, and this method is still universally used by botanists except for the finest work. Skilled botanists can cut very thin sections of plant tissues merely by means of a pith mount and a sharp razor, but this method is inapplicable to animal tissues the cells of which are unsupported by stiff cellulose walls, as are those of plants. Consequently the animal histologist, the embryologist or morphologist, who studies the structure of minute animals, and the cytologist, who investigates the structure of individual cells, use special micrological techniques for the preparation of the thin slices of parts of animals with which they are dealing.

Modern microtomy owes its efficiency to two things—first the development of methods of infiltrating tissues and animals with supporting media like gelatine, paraffin wax and celloidin, and second, the development of cutting instruments of precision. The infiltration of tissues with special hardening media is called *embedding;* the special instruments for cutting the tissues into thin slices are called *microtomes.*

BIBLIOGRAPHY.—A. B. Lee, *Microtomist's Vade-mecum* (1921); H. M. Carleton, *Histological Technique* (1926); Mallory and Wright, *Pathological Technique* (1924).

MIDAS, a very old royal, possibly also divine, name among the Phrygians and the Briges (a people living north of Greece). In Greek mythology, the following *märchen,* all of a fairly well-known type, are told of "King Midas." (1) By mixing wine with the water of a spring he made Silenus (*q.v.*) drunk, caught him, and induced him to teach him some of his wisdom. (2) He restored Silenus to Dionysus, who, by way of reward, gave him a wish. Midas wished that all he touched might turn to gold; as this included food and drink he was nearly starved to death, and asked that the gift might be taken away again. The god bade him bathe in the river Pactolus, which has had gold in its sands ever since. (3) He preferred the music of Pan (*q.v.*) or Marsyas (*q.v.*) to that of Apollo; Apollo in wrath gave him ass's ears. He concealed this deformity from all but his barber, who, bursting to tell the secret, dug a hole in the ground and whispered it into that, afterwards filling in the hole. Reeds grew from it, which, whenever the wind blew through them, whispered "King Midas has ass's ears."

See Roscher's *Lexikon, s.v.;* H. J. Rose, *Handbook of Greek Mythology* (1928).

MIDDELBURG, the ancient capital of the province of Zeeland, Holland, in the middle of the island of Walcheren, 4 m. by rail N. by E. of Flushing, with which it is also connected by steam tramway and by ship canal (1873), which continues to Veere on the N.E. coast, with a branch eastward to Arnemuiden. Pop. (1926) 19,020. Middelburg contains many old houses. The town-hall, built about 1512, with a square tower 180 ft. high and a façade adorned with statues contains the city archives and antiquarian and historical collections. The old abbey of St. Nicholas, founded in 1150, and now occupied by the provincial council, has old tapestry of the end of the 16th century.

MIDDELBURG, a town of South Africa, 25° 44′ S. 30° 1′ E.; altitude 4,971 feet. Population 2,705 whites in 1921, falling to 2,600 in 1926: natives (1921) 2,066, Asiatics 158, coloured 114. It is situated 98 m. by rail E. of Pretoria on one of the richest coalfields in South Africa. About 20 collieries are at work and the coal is of very good quality.

Middelburg is also the name of a town in the Cape Province, 250 m. by rail N. by W. from Port Elizabeth. Its population in 1921 included 2,093 Europeans, and 2,278 non-Europeans.

MIDDLE AGES, THE. The term is of course a modern term, coined consciously to define the contrast which its authors felt between the centuries which succeeded the downfall of the ancient world and their own time. To them the world of old Greece and Rome was in some ways nearer to them, more intelligible than the Europe held together by a common religious system. It would seem unnecessary to observe that the men and women who lived during the thousand years or so preceding the Reformation were not conscious of living in the middle ages; and yet, so strong are the associations and implications of the phrase, we often unthinkingly speak of the mediaeval world as though it was a world consciously mediaeval, inhabited by beings who thought of themselves as mediaeval. This absurdity has been accentuated by obeisance to specialism. Conveniently enough, scholars are described as mediaevalists and modernists, or they are said to profess modern or mediaeval history.

Conventional Sense of Term.—A more far reaching reason for using the term "the middle ages," in a more conventional sense is that, as time goes on, it will necessarily become more and more meaningless. The persons who first used it were making a gesture of their sense of freedom, and yet at the same time they were implicitly accepting the mediaeval conception of history as a series of well defined ages within a limited framework of time. They did not speak of the six ages or believe in the chronology o Joachimite prophesy, but none the less they inherited a scheme of history which began with the Garden of Eden and would end with the Second Coming of Christ. In such a scheme the thousan years from the fifth to the 15th centuries after Christ might wel be regarded as a distinct, respectable period of history, whic would stand out clearly in the providential pattern. Nowaday we have discarded the Eusebian chronology; we look back to a almost infinite past and forward to an almost infinite future. I the eyes of a scientist a period of a thousand years is neither her nor there. Moreover, the content of history, both before th middle ages and contemporary with them, has been immensel enlarged. The significance of many aspects of mediaeval life ha been changed by our knowledge of previous civilizations—of th civilizations with which mediaeval Europe was in contact.

Downfall of Rome.—If we set our preconceptions on o side, the middle ages are the period in the history of Europea people, and especially of the western peoples, since the downfa of the Roman empire. The breach between ancient and later hi tory was not so clearly defined as we are wont to say—some di tinguished scholars, for example, led by Pirenne, would deny th there was any real breach until the Mohammedans occupied t Mediterranean,—but the settlement on a large scale of the Ge manic peoples within the borders of the Roman empire and t failure of the central imperial government to maintain itself, we developments so striking as to justify the use of the terms "a

cient" and "mediaeval" to describe the state of society before and after them. It is impossible to fix any date, for tastes differ, and the date 250 or 410 or 476 has only a dogmatic significance in the minds of various historians. It is a convenience like the limits of legal memory or the legal doctrine that the House of Lords and its personnel dates from the year 1295.

The Renaissance.—It is still more impossible to fix any date as marking the end of the middle ages. The view that the fate of Constantinople in 1453 was a catastrophic event, unexpected and devastating, which had violent effects upon the whole temper of western society, is quite discredited. The view that the breach between the papacy and various European countries—an event which we describe as the Reformation—diverted the stream of history or introduced new life into history, has more truth in it, but is grossly exaggerated. If we give a sufficiently wide interpretation to the movement known as the Renaissance, and remember that, although it was most consciously intense during the 15th and 16th centuries, it had no obvious beginning and has had no end, we may define the end of the middle ages as the point, reached in different ways and at different times, at which the spirit of the Renaissance was victorious in political, social and artistic life. There has never been anywhere a complete breach with mediaeval institutions or modes of thoughts.

Development of National States.—The settlement of peoples and the gradual development of national states under the joint influence of native habit and the living traditions of the ancient world were not matters of a day. They required more than a thousand years. Everywhere natural forces and conscious contrivance can be traced together, although the element of contrivance varied very considerably in extent. Two great kingdoms, Germany and Italy, began to lose their political unity almost as soon as they had acquired it; they had to wait until the 19th century before they found it again. Switzerland and the Low Countries (the modern Holland and Belgium) were strongly welded into political units in a process in which it is difficult to disentangle the elements of nature, accident and artifice; but the unity, once acquired, has on the whole been permanent. Only a long and complicated process of events could decide that Portugal was to be separated from Castile, and Castile united to Aragon, that Catalonia was to be part of the kingdom of Aragon and not linked up with the Mediterranean littoral north of the Pyrenees, that Hungary was to be attached to the German marchland of Austria and that the River Tweed was to separate a kingdom of Scotland from England.

In these political developments the effect of Roman imperialism, working through geography and tradition, was not very marked. It might be an obstacle to be overcome, as in Italy and the Rhine valley, or an incentive to unity, as in France. But within the structure of society the element of contrivance was largely proportionate to the strength of classical influence, whether this were continuous or consciously revived. The extent and force of this influence have been the theme of endless discussion. How far the land settlement of the Franks was a continuation of the Roman system in Gaul, whether city life in North Italy and on the Rhine was completely interrupted, or, to take examples of a different kind, the extent to which the folk lore and legendary literature of mediaeval peoples was drawn from native sources or derived from the treasure house of the East and the fancies of sophisticated brains, and whether mediaeval art is mainly popular or "learned" in origin—these are some of the problems which still arouse controversy. On the whole the tendency is to emphasize the extent of the artificial and learned element in later centuries and to minimize the importance of continuous classical survivals in the early middle ages. The continuous and ever present influence of the ecclesiastical system is, it is hardly necessary to say, undisputed and is regarded as exceptional even by those who deprecate the view that it was the really formative factor in mediaeval life.

Mediaeval and Modern Culture.—Whatever the final issue of these discussions may be, it is no longer possible to draw a sharp distinction between culture or intelligence in mediaeval and modern times. Compulsory education and the impact upon our everyday life of scientific inventions are recent developments which separate us in external and possibly in more far reaching ways, from the middle ages, though their civilizing effects are still uncertain. The isolation in which so many people lived in earlier days, and the immense differences in wealth, social importance and external trappings between class and class have largely disappeared; the sum of human happiness and comfort is probably greater than in mediaeval times; but the contrast, once so fashionable, between the ages of darkness and the ages of light has no more truth in it than have the idealistic fancies which underlie attempts at mediaeval revivalism. The fascinating perplexity felt by students of mediaeval life is due precisely to the fact that our forefathers were not barbarians struggling forward, unaided, to a state of civilization; but were vigorous, intelligent, semi-civilized people who fell at every turn under highly sophisticated influences. Even before they settled down in the fifth century they had, more or less consciously, entered upon what is termed the "heroic age," in which an exotic element, derived perhaps from the east by way of the Black sea and the great trade routes of central Europe, gave direction to their barbaric qualities. Some of them, like the Visigoths, fell at once under the influence of Roman jurisprudence.

All in due course were affected by the Church and were introduced to forms of organization, thought, art and conduct which they appropriated as best they could. Three or four centuries later their men of learning came under the steadily increasing influence of Greek thought, as transmitted by the Greek speaking scholars of the Eastern empire, by Arabs and Jews; an influence which reached its height in the 13th century. By this time social contact with the East, never entirely lost, had been deepened by the establishment of western states in the Levant, the result of the crusades. Hence the process of sophistication, if the term may be used, was intensified by new periodic injections. However indigenous the expressions of political, social, literary and artistic life were, they flourished in an atmosphere of self-consciousness. They were not all spontaneous, and were rarely "artless." The results were naturally very varied, some bizarre and grotesque, with the seeds of decadence in them, some simple and effortless, some extraordinarily beautiful; some foolish, others profound; some pagan, others Christian.

Distinction of Values.—These facts help to explain the strange inconsistencies of the mediaeval world. To return to our starting point they also make the usual distinction between the values, moral and intellectual, of mediaeval and later times very misleading. If we search in history for examples of sheer goodness, or of forms of delicate perception, or of intellectual greatness, of legal acumen or of constructive ability, we can find them as readily in the middle ages as elsewhere, just as we find, as nowhere else, depths of religious experience. All that was fresh and vigorous in the European peoples could be drawn out and directed in the service of religion and art, learning, and even of statesmanship. Similarly, it could be perverted into an intensity of persecution or cruelty, into decadent orgies of sophisticated superstition, just as it could respond to eccentric and heretical influences, or find its own vent in ways which seem to us to be startlingly modern. A sedentary society, throwing off a continuous stream of wanderers; a conventional society, ruled by custom, yet indulging all sorts of adventures of the spirit; a pagan society responsive at every turn to the teaching of the Christian religion—such was mediaeval society.

Belief in Custom.—Mankind has not yet found the way to health without belief in its past. It steps back with relief into the old tried paths from the highest, the best thought-out experiments in constructive revolution. Societies, during the thousand years after the fifth century, found health in the vigorous persistence of custom, and the veneration for custom. The essential thing to remember is that mediaeval belief in custom was not a dead weight, but a conscious discipline in a changing world. Lawyers and church have idealized it in the light of their belief in a universe bound together by law. Moreover men instinctively clung to their trust in custom, for the conception of the universe with which they were presented did not permit of that constant discovery of the inner relations of things which we

call science. However speculative or transitory modern science is, it has secured popular allegiance by using the mysteries of nature—heat, electricity and so on—in the everyday service of man, so that conservatism nowadays shares its old power with a belief in science. Yet, as has been well said, modern science was both made possible by the earlier, mediaeval, belief in the reasonableness of the world, and was also an adventurous reaction against the rationalism of mediaeval thought. It was a revolt against the rigidity of law, but the belief in law was at the root of the new investigation into facts. The conception of sovereignty illustrates the same tendency in the political world; it was a recognition of the fact that certain social entities were directing their energies in their own self-regarding way, and a repudiation of the belief (due to a mingling of Christian and Roman ideas) in the unity of mankind under a universal law of nature; yet a long discipline had been required, under the régime of custom, in order to make the conception of sovereignty safe or tolerable. Its value is on the wane, and the trust in law in the mediaeval sense seems to be returning.

Influence of the Church.—The Christian Church shaped the European peoples in two ways. It gave direction to the energy of the robust European peoples, and it offered a higher interpretation of the meaning of life. Suicidal strife, with the succeeding stagnation, was checked. The Romans had impressed on the barbarians a system of law and order which they had neither the ability nor the desire to maintain. The Church maintained this system in its own way and, while accepting the traditional social arrangements of the barbarians, enabled them to develop. The response was very extraordinary. Indeed the danger of absorption was so great that the Church in self defense strengthened its organization and emphasized its unity in the Papacy. Hence we have the interplay of political and ecclesiastical forces which runs through the history of feudal and afterwards of national or urban societies, and profoundly modified the structure of the Church itself. Throughout the middle ages the Church maintained the conception of unity and its claim to interpret the moral law. But its other great function, though sometimes lost in the development of organization, was never forgotten. There again the peoples responded. Their craving for certainties or for adventure was met by the development of dogma, the various monastic experiments, the Crusades. They produced an endless series of saints. They tried to comprehend in their schools and universities the learning of the ancient world and to harmonize it with the teaching of the theologian. They built thousands of buildings, bringing all their energy to expression in the name, if not in the service, of a Church and the saints. Our political systems, our scientific thought, and our art are developed from those of the middle ages, and the conscious reactions against the fundamental ideas of the mediaeval church are a tribute to its strength.

(F. M. P.)

MIDDLEBOROUGH, a town of Plymouth county, Massachusetts, U.S.A., 30 m. S. of Boston, on the Taunton river and served by the New York, New Haven and Hartford railroad. The population was 8,453 in 1920; 8,608 in 1930. It has an area of 70 sq.m. and embraces several villages. There are many shoe factories and various other manufacturing industries. The public library and many of the town's improvements owe their existence to gifts from Thomas Sprout Peirce (1823–1901), a local merchant, and to a trust fund created by his will. The town of Middleborough was established in 1669, from common lands called Namassakett.

MIDDLEBURY, a village of western Vermont, U.S.A., the county-seat of Addison county; on Otter creek, Federal highway 7 and the Rutland railroad, midway between Rutland and Burlington. The population in 1930 was 2,003. It has a beautiful location in the Champlain valley, near the Green Mts., and is the seat of Middlebury college (chartered 1800), which has a campus of 244 ac., a forest preserve of 30,000 ac., an endowment of about $3,000,000 and an enrollment in 1927–28 of 1,145. A settlement was made here in 1773. It was deserted at the opening of the Revolution, almost destroyed by British troops, re-established at the close of that war, and incorporated as a borough in 1813 and as a village in 1832.

MIDDLESBOROUGH, a city of Bell county, Kentucky, U.S.A., in the south-east corner of the State, at an altitude of 1,100 ft., among ranges rising to 3,100 ft.; on Federal highway 25E and served by the Louisville and Nashville and the Southern railways. Pop., 8,041 in 1920 (15% negroes); 10,350 in 1930 by Federal census. The city lies in a valley of the Cumberland mountains, 5 m. N.W. of the Cumberland gap, through which Daniel Boone in 1775 marked the Wilderness road, the thoroughfare of the Kentucky pioneers. It is a summer resort, surrounded by beautiful scenery. It was founded in 1889 and incorporated in 1892.

MIDDLESBROUGH, a municipal, county and parliamentary borough in the North Riding of Yorkshire, England, 238½ m. N. by W. from London on the L.N.E. railway. Population (1931) 138,489. It stands on the south bank of the Tees estuary, 5 m. from its mouth in the North Sea, and is the centre of one of the most important iron-working districts in the world. Where Middlesbrough now stands there were at one time a small chapel and priory founded by Robert de Brus of Skelton Castle. These were dedicated to St. Hilda, and were given, together with some lands by de Brus to the abbey of St. Hilda at Whitby in 1130. The priory fell into ruins at the time of the Reformation and very little trace now remains. In 1801 there were, upon the site of Middlesbrough, only a few farm houses with a population of 25. In 1829 a company styling itself the Middlesbrough Owners bought 50c acres of land and began building. When, in 1830, the Stocktor and Darlington railway was extended to Middlesbrough, it becam a new Tees port; four years later the town was lighted with ga and in 1840 a public market was established. In 1841 the popula tion was 5,709. In 1842, the opening of the docks gave it additiona importance; by 1851 blast furnaces were erected and soon th whole district became a thriving iron centre.

Iron stone was mined in the neighbouring Cleveland Hills; lime stone and coal were at hand, transport was made easy by th presence of the young railway and the navigable river way, whicl meant cheap facilities for export. The town grew so rapidly that i 1853, Middlesbrough was given a charter as a municipal borough it was created a county borough in 1888. Iron and steel workin is the most important industry.

The entrance to the River Tees is protected by two break waters, the South Gare, which was begun in 1863 and took 2 years to build is more than 2½ miles in length; and the North Gar which has been completed for a length of 3,330 feet. Extensiv dredging operations have been carried on in the river; since 185 about 45,477,463 cu.yd. of material have been removed from it bed. In 1863 the depth of water on the Bar was 3½ ft. at lo water of ordinary Spring tides; it is now 20 ft. at low water an 37 ft. at high water. Vessels of heavy tonnage which regularl frequent the river require increased depth of water, and to mee this demand powerful ladder-dredgers are used. The scheme sanc tioned by parliament for the widening of the river from Middle brough to the sea will ultimately result in an additional width i the channel, averaging 350 to 400 feet, to the Middlesbrough Doc entrance. This dock is the property of the L.N.E. railway, an was considerably enlarged in 1926. Its area is 26 acres; the ne entrance is 80 ft. wide and total length of quayage is 6,843 ft 3,350 acres of land have been reclaimed from the foreshore of th Tees, much of it by the deposit of slag from the iron works. A the reclaimed land on the south side has been sold for the co struction of iron and steel works, shipbuilding yards, dry doc and deep water quays. The chemical industry, which owes i creation to the presence of salt and to the by-products of th coking ovens, is becoming increasingly important.

Middlesbrough, being the main port of the river Tees, deals wi the bulk of the trade of the region. Its chief exports are coal ar coke, pig iron, brass, plates and rails, galvanised sheets, chemica and bridge work and girders. Its imports are chiefly ores—irc and manganese—coal and wheat.

See Sir J. Bell, *The Iron and Steel Industry in Cleveland; Report the Tees Conservancy Commission;* Bulmer, *Middlesbrough and Shipping Facilities, South Tees-Side Regional Planning Scheme.*

MIDDLESEX, LIONEL CRANFIELD, 1ST EARL OF (1575–1645), was a successful London merchant, who was introduced to James I. by Henry Howard, earl of Northampton, and entered the royal service in 1605. In 1613 he was knighted and was appointed surveyor-general of customs; in 1616 he became one of the masters of requests, and in 1619 master of the court of wards and liveries and chief commissioner of the navy. He was returned to parliament for Hythe in 1614 and for Arundel in 1621. He took part in the attack on Bacon in 1621, and in the same year was created Baron Cranfield and became lord high treasurer. Impeached by the House of Commons for corruption, he was found guilty by the House of Lords in May 1624, but was pardoned in the following year, and restored to the House of Lords in 1640. He died on Aug. 6, 1645.

MIDDLESEX, a county of England, bounded north by Hertfordshire, east by Essex, south-east by the county of London, south by Surrey, and west by Buckinghamshire. Excepting Rutland, the county is the smallest in England. It lies entirely within the Thames basin and within the geological region known as the London basin. The general slope and dip of the strata is to the south-east. South of an irregular line from Uxbridge, north of Hayes, by Hanwell and Ealing to Hyde park and east of a line from the park to Tottenham, the ground is covered by gravels deposited by the Thames. From this river in the south and from the Lea, forming the eastern boundary with Essex, the gravels rise in a series of terraces. Underneath the alluvial gravels and emerging north of the boundary line, indicated above, lies the London clay. It forms the undulating country around Harrow, Chipping Barnet and Elstree. The highest ground is found along the northern boundary, and near Stanmore the hills are 503 ft. high. These hills send two projections southward, one towards Harrow and the other towards Hampstead. On these ridges are the remains of the sandy and pebbly Bagshot beds which formerly covered the London clay area. Glacial deposits are also present in the county, *e.g.*, the pebbly gravels of Stanmore heath, the clay and sand of Finchley, and chalky boulder clay of Southgate. The Reading beds emerge only in the north-west, near Harefield. The western part is watered by the rivers Colne, Crane and Brent.

History and Early Settlement.—Palaeolithic implements have been found in the river drifts at various points, and Neolithic finds are numerous. Beaker pottery and bronze implements have also been found. In spite of this it is probable that the county never had a large population in prehistoric times, because the lower lands were often marshy and subject to floods, while the higher clay lands were forested. Thus, the majority of the artefacts found probably only indicate lines of movement across the county. In Roman times the eastern border from Tottenham to Waltham Cross was traversed by Ermine street; Watling street ran across the county from Cricklewood towards Elstree, and the Roman road from London to Silchester crossed the county from Turnham Green to Staines, where the Romans had a station.

Middlesex was colonized in the 6th century by an offshoot of the East Saxon tribe, and derived its name from its position between the kingdoms of the East and West Saxons. In a charter dated 704 Middlesex is mentioned as a dependency of Essex, but soon after it acknowledged the supremacy of Mercia, and the Mercian council was held at Brentford from 780 onwards. In the 9th century Middlesex formed part of the Danelagh. The only reference to Middlesex in the Saxon Chronicle occurs in 1011, when it was overrun by the Danes. The Conqueror's march upon London was preceded by a general devastation of the surrounding country. At the time of the Domesday survey, the district north of London had a population of 2,302, and formed the forest of Middlesex.

As a shire, Middlesex probably originated about the time of the frith of 886. During the Saxon period the manors held by the church of Canterbury, the bishop of London and his canons of St. Paul's, and the Abbey of Westminster were held as independent franchises. By charter of Henry I. (confirmed by Stephen and Henry II.) the citizens of London held Middlesex at farm for £300, with power to elect a sheriff from among their number, and by charter from John the shrievalty of both London and Middlesex was granted to the mayor and citizens in fee. By charter of 1242 the common pleas for the county of Middlesex were ordered to be held at the stone cross in the Strand. Under a charter of 1447 the lord mayor was authorized to nominate one of the city aldermen as justice of the peace for Middlesex. The six modern hundreds of Edmonton, Elthorne, Gore, Isleworth, Ossulston, and Spelthorne have been scarcely changed since the Domesday survey, except that Isleworth was then Honeslaw (Hounslow), while in the 12th century hidage a hundred of "Mimes" is mentioned, corresponding with the Domesday hundred of Edmonton. Middlesex has always been included in the diocese of London excepting a small portion which is in that of Oxford. The archdeaconry of Middlesex, which includes part of Essex, is mentioned in 1151.

In 1215 Middlesex was ravaged by King John's army. In the Civil War Middlesex supported parliament. Sir Denzil Hollis was defeated by the Royalists at Brentford in 1642, and in 1645 a fruitless treaty between Charles I. and the parliament was concluded at Uxbridge.

The woollen and leather industries flourished in Middlesex in Norman times; hides were tanned at Enfield, bricks were manufactured, and Heston was noted for its wheat. Paper was manufactured in the 17th century.

Agriculture and Industry.—The soil is not particularly suitable for agriculture and the acreage cultivated, as well as the number of livestock, has decreased rapidly as London has expanded, incorporating villages and covering the land with buildings. The most important cultivation is that of market gardens on the rich alluvium in the Thames valley. The county possesses a number of varied industries which depend for their prosperity on their proximity to the metropolis and on the railway lines, the spread of industries along which is a very marked feature of industrial change for the period after 1918.

Communications.—The county is closely intersected with railways, the following companies affording communications: L.N.E.R., L.M.S.R., S.R., G.W.R., Metropolitan and District. Moreover, in some parts the tramway system has been extended over a wide area from London. The principal canals are the Grand Junction, running west from Brentford to the Colne valley, and thence northward; with a branch (the Paddington canal) connecting it with the Regent's canal in London; and, in the east, the Lea navigation.

Administration.—The part of the ancient county transferred to the county of London under the Local Government Act of 1888 was 31,484 ac. in extent, and 771 were then transferred to Hertfordshire; while under the London Government Act of 1899 the southern part of Hornsey was transferred to London. Area of administrative county 148,691 ac., pop. (1931) 1,638,521. The municipal boroughs are Acton, Ealing, Hornsey, Twickenham. The county is within the Metropolitan Police district and within the jurisdiction of the Central Criminal Court. There is one court of quarter sessions held at the Middlesex Guildhall, Westminster, but no county town. The extra-Metropolitan parliamentary divisions, each returning one member, are Acton, Brentford and Chiswick, Enfield, Finchley, Harrow, Hendon, Spelthorne, Twickenham, Uxbridge and Wood Green. The parl. boroughs are Ealing, Edmonton, Hornsey, Tottenham and Willesden; the first three return one member, the last two, two members to parliament.

See John Norden, *Speculum Britanniae: the firste parte, an historicall and chorographicall description of Middlesex* (London 1593: reprinted 1637 and 1723); Daniel Lysons, *The Environs of London* (1792–96); *Victoria County History, Middlesex.*

MIDDLETON, EARLS OF. JOHN MIDDLETON, 1ST EARL OF MIDDLETON (*c.* 1619–1674), belonged to a Kincardineshire family which had held lands at Middleton since the 12th century. In early life he served as a soldier in France; later he fought against Charles I., being especially prominent at the battle of Philiphaugh. He held a high command in the Scottish army. In 1656 the king made him an earl, four years later commander-in-chief of the troops in Scotland and lord high commissioner to the Scottish parliament. Owing to serious dissensions with the earl

of Lauderdale he was deprived of his offices in 1663. He was afterwards (1667) governor of Tangier, where he died in June 1674.

His eldest son CHARLES, 2ND EARL OF MIDDLETON (*c.* 1640–1719), held several offices under Charles II. and James II., being envoy extraordinary at Vienna, joint secretary for Scotland, and from 1684 English secretary of state. In 1693 he joined the exiled king at St. Germain, where he became his secretary of state.

See A. C. Biscoe, *The Earls of Middleton* (1876).

One of Middleton's kinsmen was SIR CHARLES MIDDLETON, Bart. (1726–1813), comptroller of the navy from 1778 to 1790. In 1805, at a most critical time, although 80 years old, he was appointed first lord of the admiralty by Pitt and was created Lord Barham. It was his experience, industry and energy which made possible the great campaign which ended at Trafalgar. He resigned office in Jan. 1806 and died on Jan. 17, 1813. His barony passed through his daughter Diana (1762–1823) to the Noels, earls of Gainsborough, by whom it is still held.

See *The Barham Papers*, Sir J. K. Laughton, ed. (3 vols., 1907–11) and J. S. Corbett, *The Campaign of Trafalgar* (1910).

MIDDLETON, ARTHUR (1742–1787), American politician and signer of the Declaration of Independence, was born at Middleton Place, S.C., on June 26, 1742. His family was one of the most prominent in the colony. The grandfather, Arthur Middleton (1681–1737), was president of the council in 1721–30 and as such was acting governor in 1725–30, and the father, Henry Middleton (1717–84), was speaker of the assembly in 1745–47 and again in 1754–55, a delegate to the continental congress in 1774–76, and its president 1774–75. Like most wealthy South Carolinians of the 18th century, Arthur Middleton was educated in England—at Hackney, at Westminster school and at St. John's college, Cambridge. In 1773 he returned to South Carolina, and in the controversies between the colonists and the home government became a leader of the Whigs. He was a member of the provincial council of safety in 1775–76, and a delegate to the continental congress in 1776–77. He was captured by the British at Charleston in May, 1780, was exchanged in July, 1781, was again a delegate to Congress in 1781–83, and later served in the State legislature. He died on Jan. 1, 1787, near Charleston.

See Benson J. Lossing, *Biographical Sketches of Signers of American Declaration of Independence* (1854); and Charles F. Jenkins, *The Completed Sets of the Signers of the Declaration of Independence* (1925).

MIDDLETON, CONYERS (1683–1750), English divine, was born at Richmond, Yorks., on Dec. 27, 1683. He graduated from Trinity College, Cambridge, took orders, and in 1706 obtained a fellowship, which he soon resigned. In 1717 a dispute with Richard Bentley, who had demanded a large fee on Middleton's being created D.D., involved him in an acrimonious controversy. He wrote "Remarks" and "Further Remarks" on Bentley's *Proposals for a New Edition of the Greek Testament.* In 1723 he was involved in a lawsuit by personalities against Bentley, which had found their way into his otherwise judicious tract on library administration, *The Present State of Trinity College* (1719), written on the occasion of his appointment as university librarian. Observations made during a visit to Italy on the pagan origin of church ceremonies and beliefs were embodied in his *Letter from Rome, showing an exact Conformity between Popery and Paganism* (1729). This tract probably contributed to the storm which broke out on his next publication (1731). In his remonstrance with Daniel Waterland on occasion of the latter's reply to Mathew Tindal's *Christianity as Old as the Creation,* Middleton laid himself open to the charge of latitudinarianism. He was hotly assailed from many quarters, and retreated with some difficulty under cover of a sheaf of apologetic pamphlets and a more regular attendance at church. His next important work, a *Life of Cicero* (1741), enhanced his reputation at the time, but was in fact largely borrowed from William Bellenden's, *De tribus luminibus Romanorum.* His chief writings are the *Introductory Discourse* (1747) and the *Free Inquiry* (1748) "concerning the miraculous powers which are supposed to have subsisted in the church from the earliest ages." Middleton showed that ecclesiastical miracles must be accepted or rejected in the mass; and he distinguished between the authority due to the early fathers' testimony to the beliefs and practices of their times, and their very slender credibility as witnesses to matters of fact. On July 28, 1750, he died at Hildersham, near Cambridge.

The character of Middleton's intellect was captious and iconoclastic, but redeemed from mere negation by a passion for abstract truth. His diction is generally masculine and harmonious. Pope thought him and Nathaniel Hooke the younger, the only prose writers of the day who deserved to be cited as authorities on the language.

See Sir Leslie Stephen's *English Thought in the Eighteenth Century* (1876). His works, containing several posthumous tracts, but not including the *Life of Cicero,* appeared in 4 vols. in 1752 (5 vols. 1755).

MIDDLETON, THOMAS (*c.* 1570–1627), English dramatist, son of William Middleton, was born about 1570, probably in London. He may probably be identified with one of the Thomas Middletons entered at Gray's Inn in 1593 and 1596 respectively. His earliest work was *The Wisdom of Solomon paraphrased* (1597). He began to write for the stage with *The Old Law,* in the original draft of which, if it dates from 1599 as is generally supposed, he was certainly not associated with William Rowley and Philip Massinger, although their names appear on the title-page of 1656. By 1602 he had become one of Philip Henslowe's established playwrights. The pages of Henslowe's *Diary* contain notes of plays in which he had a hand, and in the year 1607–1608 he produced six comedies of London life, which he knew as accurately as Dekker and was content to paint in more realistic colours. In 1613 he devised the pageant for the installation of the Lord Mayor, Sir Thomas Middleton, and in the same year wrote an entertainment for the opening of the New River in honour of another Middleton. He was frequently employed to celebrate civic occasions, and in 1620 he was made city chronologer, performing the duties of his position with exactness till his death.

At the Globe theatre in 1624 he produced a political play, *A Game at Chesse,* satirizing the policy of the court, which had just received a rebuff in the matter of the Spanish marriage, the English and Spanish personages concerned being disguised as the White Knight, the Black King, and so forth. The play was stopped, after nine performances, in consequence of remonstrances from the Spanish ambassador, and the dramatist and the actors were summoned to answer for it. It is doubtful whether Middleton was actually imprisoned, and in any case the king's anger was soon satisfied and the matter allowed to drop, on the plea that the piece had been seen and passed by the master of the revels, Sir Henry Herbert. Middleton died at his house at Newington Butts, and was buried on July 4, 1627.

He worked with various authors, but his happiest collaboration was with William Rowley, this literary partnership being so close that F. G. Fleay (*Biog. Chron. of the Drama*) treats the dramatists together. The plays in which the two collaborated are *A Fair Quarrel* (printed 1617), *The World Lost at Tennis* (1620), an ingenious masque, *The Changeling* (acted 1624, printed 1653), and *The Spanish Gipsie* (acted 1623, printed 1653). The main interest of the *Fair Quarrel* centres in the mental conflict of Captain Ager, the problem being whether he should fight in defence of his mother's honour when he no longer believes his quarrel to be just. The underplot, dealing with Jane, her concealed marriage, and the physician, which is generally assigned to Rowley, was suggested by a story in Giraldi Cinthio's *Hecatommithi. The Changeling* is the most powerful of all the plays with which Middleton's name is connected. The plot is drawn from the tale of Alsemero and Beatrice-Joanna in Reynolds's *Triumphs of God's Reveng against Murther* (bk. i., hist. iv.), but the story, black as it is, receives additional horror in Middleton's hands.

With Thomas Dekker he wrote *The Roaring Girle, or Moll Cut-Purse* (1610). The frontispiece represents Moll herself in man's attire, indulging in a pipe of tobacco. She was drawn or idealized from life, her real name being Mary Frith (1584–1659?), who was compelled to do penance at St. Paul's Cross in 1612. In the play she is the champion of her sex, and is equally ready with her sword and her wits. Middleton is also credited with a

share in Thomas Dekker's *Honest Whore* (pt. i., 1604). *The Witch*, first printed in 1778 from a unique ms., now in the Bodleian, has aroused much controversy as to whether Shakespeare borrowed from Middleton or vice versa. The distinction between the two conceptions has been finely drawn by Charles Lamb, and the question of borrowing is best solved by supposing that what is common to the incantations of both plays was a matter of common property. *The Mayor of Quinborough*, the scene of which is laid in ancient Britain, was published with Middleton's name on the title-page in 1661; it may date from about 1606. One of its editors, Havelock Ellis, thinks the proofs of its authenticity as Middleton's work very slender.

The plays of Middleton still to be mentioned may be divided into romantic and realistic comedies of London Life. Dekker had as wide a knowledge of city manners, but he was more sympathetic in treatment, readier to idealize his subject. *Two New Playes. Viz.: More Dissemblers besides Women. Women beware Women*, of which the former was licensed before 1622, appeared in 1657. The plot of *Women beware Women* is a double intrigue from a contemporary novel, *Hyppolito and Isabella*, and the genuine history of Bianca Capello and Francesco de Medici. This play, which ends with a massacre appalling even in Elizabethan drama, may be taken as giving the measure—no mean one—of Middleton's unaided power in tragedy.

The remaining plays of Middleton are: *Blurt. Master-Constable, Or the Spaniards Night-walke* (1601–02); *Michaelmas Terme* (1606?), described by A. C. Swinburne as an excellent Hogarthian comedy; *The Phoenix* (1607), a version of the Haroun-al-Raschid trick; *A Trick to catch the Old One* (1606–07); *The Famelie of Love* (played between 1604 and 1607: pr., 1608); *A Mad World, my Masters* (c. 1606; pr., 1608); *Your five Gallants* (1607?, pr. 1608); *A Chast Mayde in Cheapside* (1612? pr., 1630), notable for the picture of Tim, the Cambridge student, on his return home; *Anything for a Quiet Life* (c. 1617, printed 1662); *No Wit, No Help like a Woman's* (c. 1613, printed 1657); *The Widdow* (printed 1652), on the title-page of which appear also the names of Ben Jonson and John Fletcher, though their collaboration may be doubted; Bullen puts the date of its performance in 1608–09. Eleven of his masques are extant. A tedious poem, *The Wisdom of Solomon paraphrased, by Thomas Middleton*, was printed in 1597, and *Microcynicon. Six Snarling Satires by T. M. Gent*, in 1599. Two prose pamphlets, dealing with London life, *Father Hubbard's Tale* and *The Black Book*, appeared in 1604 under his initials. Thus non-dramatic work, even if genuine, has little value.

AUTHORITIES.—His works were edited by Alexander Dyce (5 vols., 1840), with a valuable introduction quoting many documents, and by A. H. Bullen (8 vols., 1885). *The Best Plays of Thomas Middleton* were edited for the Mermaid series (1887) by Havelock Ellis with an introduction by A. C. Swinburne. *See* also P. G. Wiggin, *Inquiry into the Authorship of the Middleton-Rowley Plays* (Boston, 1897), the notice on Middleton in Professor A. W. Ward's *Hist. of Eng. Dram. Lit.* (ed. 1899; ii., 493–540), which contains a full account of Middleton's *Game at Chesse;* and, for the chronology and bibliography of the earlier plays, E. K. Chambers, *Elizabethan Stage*, vol. iii. A careful examination of the parallelisms between the plays of Shakespeare and Middleton is made by D. Hugo Jung in "Das Verhältnis Thomas Middleton's zu Shakspere" (*Münchener Beiträge zur roman. u. engl. Phil.* vol. xxix., 1904).

MIDDLETON, market town, municipal borough, Prestwich and Middleton parliamentary division, Lancashire, England, on the Irk, near the Rochdale canal, and on the L.M.S. railway, 6 m. N.E. of Manchester. Pop. (1931) 29,189. The tower arch of St. Leonard's church is 12th century, the rest dates from 1412, save for the south aisle built in 1524. Two chapels in it are named after two ancient Lancashire families, the Asshetons and the Hopwoods. The Queen Elizabeth grammar-school (Tudor style) was founded in 1572 by Nowell, dean of St. Paul's, London. The prosperity of the town dates from the close of the 18th century. The staple trade is the spinning and weaving of cotton, and the other industries include silk weaving, calico-printing, bleaching, dyeing, iron-founding and the manufacture of soap and chemicals. There are collieries in the neighbourhood. The town was incorporated in 1886. Area, 4,775 acres.

MIDDLETOWN, a city of Connecticut, U.S.A., the county seat of Middlesex county; on Federal highway 5 and the west bank of the Connecticut river, 15 m. S. of Hartford. It is served by the New York, New Haven and Hartford railroad and coasting steamers. Pop. (1920) 13,638 (27% foreign-born white, nearly half from Italy); 1930 Federal census 24,554. Hills and woods add charm to the surroundings, and 3 m. E. are the "narrows" of the Connecticut, an impressive gorge more than a mile long, cut by the river through a rocky barrier. The city is the seat of Wesleyan university (Methodist Episcopal; 1831) which has an endowment of $4,500,000; the Connecticut State hospital (for the insane) with accommodations for 2,180 patients; Long Lane farm, the State industrial school for girls; and the Middlesex hospital. It has diversified manufactures, with an output in 1925 valued at $19,312,494. Middletown occupies the site of an Indian village, Mattabesec or Mattabesett, and was at first known by that name. Settlement by the whites began in 1650. The town was incorporated in 1651 and the city was chartered in 1784. It became a ship-building and commercial centre.

MIDDLETOWN, a city of Orange county, New York, U.S.A., on the Wallkill river, 67 m. N.N.W. of New York city, at an altitude of 700 feet. It is served by the Erie, the Middletown and Unionville and the New York, Ontario and Western railways. Pop. (1920) 18,420 (87% native white); 21,276 in 1930, Federal census. It is surrounded by fertile farming country, rich in beautiful scenery, and there are many summer homes and hotels in the vicinity. The city has railroad shops and a great variety of manufacturing industries, with an output in 1925 valued at $6,154,256. It is the seat of a State homeopathic hospital for the insane, which has about 3,000 patients. Middletown was settled about 1796. It was a half-way house (whence the name) on the Minisink road to western New York, and for a time was a terminus of the Erie railroad. The village was incorporated in 1848 and chartered as a city in 1888.

MIDDLETOWN, a city of Butler county, Ohio, U.S.A., on the Miami river, midway between Cincinnati and Dayton (whence the name). It has a municipal airport, and is served by the Baltimore and Ohio, the Big Four, the Erie and the Pennsylvania railways, inter-urban trolleys and motor-bus lines. Pop., 23,594 in 1920 and 29,992 in 1930. It is the trade centre of a rich and beautiful agricultural region, producing chiefly tobacco, wheat, oats and corn; and has large and varied manufacturing industries (for which the river supplies water-power) with an output in 1925 valued at $56,732,394. Corrugated and sheet steel, paper, paper bags, boxes and gas engines are leading products. The city was laid out in 1802 and incorporated in 1833. It has a commission-manager form of government.

MIDDLETOWN, a borough of Dauphin county, Pennsylvania, U.S.A., on the E. bank of the Susquehanna river, 9 m. below Harrisburg. It is served by the Pennsylvania and the Reading railways. Pop. (1920) 5,920 (90% native white); and 6,085 in 1930 by the Federal census. It has large steel plants, car works, furniture and shoe factories and hosiery mills. The town has an intermediate depot of the Army Air Corps, including Olmstead field. Middletown was founded in 1755 by Quakers and Scotch-Irish, and was incorporated in 1828. It was named from its position midway between Lancaster and Carlisle.

MIDDLE WEST, THE, the northern portion of the central United States and more specifically the States of Ohio, Indiana, Illinois, Michigan, Iowa, Wisconsin and Minnesota.

In his *American Commonwealth* (1888), James Bryce observed that in the United States there were four areas which were diverse in cultural aspects. After a long generation the most recent serious commentator on American affairs, André Siegfried, is still able to note the differentiation that Bryce described. There is an East, a South, a Far West and a Middle West.

The four cultural areas are by no means equal in their social weight. Of the 105 millions of people resident in the States in 1920, the South, with 37 million, led the groups; the East, counting from Philadelphia and Pittsburgh, had 29 million; the Middle West had 26 million, and the Far West 13 million. There is no greater equality in the areas which they roughly occupy; and there is an inversion of order. Of the 2,974,000 sq.m. of land which they cover, the Far West has nearly half, or 1,483,000; the South 947,000, the Middle West 382,000 and the East 162,000. The Middle West thus covers about 13% of the area of the United States and contains nearly 25% of the population. At the time when Bryce wrote their proportion of the population

was already about 25%, as it had been a generation earlier, at the opening of the Civil War in 1860. For 60 years or more these States—Ohio, Indiana, Illinois, Michigan, Iowa, Wisconsin and Minnesota—have retained their constant proportion of the American people and have been regarded, as Bryce regarded them, as "the most distinctively American part of America," and as "one of the most interesting subjects of study the modern world has seen." (*American Commonwealth*, 3rd. ed. 1895.)

It has been noted (under AMERICAN FRONTIER) that the United States was occupied in the 17th century, along its eastern front, where the Atlantic rivers meet arms of the ocean and afford easy lodgment at numerous places between Florida and Nova Scotia. Before the 13 English colonies asserted their independence their people had spread thinly over the Atlantic coastal plain, had passed beyond the geographers' "falls line," and had begun the penetration of the parallel valleys of the Appalachians that open corridors running north-east and south-west between Albany, N.Y., and Chattanooga, Tenn. In the older sections of these original colonies there were already aristocracies of standing before the Continental Congress at Philadelphia undertook to direct their common effort against England. This tidewater section, and its immediate *hinterland*, was to become the East, when a West should arise behind it. It has remained the East until to-day, containing by a natural social drainage the administrative heads of many American institutions, the agencies of control of the wealth of the United States, the executive and legislative establishments of the Government of the United States, and the oldest and most crystalline society that the United States can display. It has also, by its location, received the inflow of immigrant people that have affected all percentages of population, and it has put the immigrant workers into the industrial machine that was the great product of the 19th century. Its constant drift has been towards the social and economic standards of western Europe; and its international commitments in finance have here been paralleled by the strongest of the American sentiments for internationalism in government and a world league.

Out of this old East, came the young West. The American Revolution did not stop, or seriously check, the pioneer process whereby the young, and the landless, and the ambitious among the people of the East sought to better themselves and gain economic independence. The new communities west of the Appalachians began to take shape while the Revolution was under way; and at its close Kentucky and Tennessee were growing rapidly towards statehood. A few years more, and the organization of the territory north-west of the Ohio river became a step that led to other new States in Ohio, Indiana and Illinois. All of these regions came to be known as West; and by this fact gave significance to the term East, which had no special meaning as long as there was no West to contrast with it. The East was the starting point; the West was the derivative. The East was becoming a stable community; the West was on the make. Wealth in the East was showing itself, and was shaping society to its conditions; poverty and debt were the universal qualities of the pioneer West. The people of the East were differentiating, according to their duties and opportunities in life; the West started uniform, and retained its uniformity throughout the greater part of the cycle of pioneer development. For something more than a generation the American sectional antithesis was East and West.

From the point of view of the West, the rise of the South is significant because the process drew away part of the West from the section bearing this name, and although not entirely altering its interests identified it primarily with the States bordering upon the Gulf of Mexico. It was after the second war with England (1812–14) that this differentiation became most apparent, and before the election of Andrew Jackson the result was both visible and ominous. The South stretched across the continent from the tidewater bases in Maryland, Virginia, the Carolinas and Georgia. It thrust itself into the open lands of the public domain as far as these were capable of normal agriculture, and came to an end only along the eastern margin of the high plains of western Texas. It did not provide for the area of the West a precise southern limit, for there was developed a twilight zone running from Kentucky and Tennessee into Missouri where there was a clash of West and South that has not yet subsided. Here, men groped for the key to American politics during the middle third of the 19th century. By its outspoken southern preferences it encouraged the leaders of the South when they thought of secession; by its essential western interests it discouraged them when the issue came to a head in the Civil War. It is to-day so southern that it cannot fairly be described as Middle West; but it is so western that it is no longer a dependable ally of the solid South.

At the outbreak of the Civil War the dominant American sections were East, South and West; and beyond the West there stretched to the Pacific a zone of plain and mountain sparsely sprinkled with inhabitants and not yet organized to any type. When during and after the Civil War this region developed into another new West there was confusion in terminology for it was nearly as different from the West of the middle period as the West was from the East or South. Time brought the nomenclature. The plains and the cow country, the mining camps, and the Pacific slope became the Far West; and Middle West came haltingly into use to describe what had before been West.

There is a topographic unity that helped to shape the old West, and that has not ceased to operate now that it has become the Middle West. The unity began to have an influence when the earliest pioneers crossed the Appalachians. These were not entirely free to choose their crossings. At two or three places the valley roads were designated by easy passes across the mountains. The military leaders of the colonial period had discovered one of them; and in the wake of the armies of Braddock (1755) and Forbes (1758) a procession of homeseekers advanced up the tributaries of the Potomac and Susquehanna until among the hills they met the southern tributaries of the Ohio river, the Youghiogheny and the Monongahela. Half a century later the Cumberland road, following this trail, was the first great Federal venture in internal improvements. It was a venture that had no real rivals until the Erie canal (1825) became effective through New York, and the central trunk line railroads reached the Ohio river at Pittsburgh and Wheeling a quarter-century later. The other great gateway to the Middle West was blazed by Daniel Boone for a land company in 1775, and emptied through Cumberland Gap into the Blue Grass region of Kentucky, the social overflow from Virginia and the Carolinas. Once through these gateways, the pioneer of the Middle West found himself cut off from easy access east by a mountain wall, and thrown into local alignment west by the fact that the rivers of the western slope of the Appalachians start separately as Allegheny and Monongahela, Kanawha, Cumberland and Tennessee, only to end as the Ohio river and to pass as a single stream into the Mississippi. From the Great Lakes to Muscle Shoals of the Tennessee river there was a necessary unity of need, a set of agricultural and climatic similarities, and a fact of separateness from the East. The mountain wall was not too high for the migrant; but it was too high, and the road was too long, for the farm surplus of the West to reach an Eastern market. The uniformities that thus resulted may be studied in detail from the time of the rebellion of Western farmers against the whisky excise (1794) until the time of their demand that greenback money be used to pay the debts of the Civil War (1868); they show themselves in the conspiracies for the opening of the Mississippi river to up-river trade, and in the zest for the conquest of Canada and the control of the St. Lawrence route. In the decade after the war of 1812, their greatest leader, Henry Clay, developed a theory of national integration for their special benefit, but called his programme the "American System," because both he and they genuinely fancied themselves to be America. Never, until the railroad cut across the natural routes indicated by topography, did the West free itself from the coercive control over its destinies, resources and ideas exercised by the Ohio river and the Mississippi. And when at last the railroads brought geographical dominance to an end, the Middle West had acquired a habit of thinking alike; and found a continuing influence to uniformity in a debtor relationship that could not easily be shaken off.

Southern Orientation.—The struggle for the control of

the Federal Government that took shape in the Presidential contest of 1824, and that resulted in Jacksonian victory in 1828, indicated not only a sharp and unified western point of view, but a possible shift in the direction of American destiny. Thereafter the tri-sectionalism of American life and politics was complete, with the West more nearly retaining the same old attitude and faith than either of the other sections. While the South advanced into cotton economics, and all that that implied, the East lost its nearly solid agricultural condition, and was transformed by the rise of manufactures, the accumulation of investable capital, the drift of population into the cities, and the appearance of a social aristocracy founded upon wealth and luxury. By the time of the Mexican War the Astor and Vanderbilt fortunes were ploughing new channels through the field of American business, and establishing new dynasties whose social flowering was to occur after the Civil War. More and more the Eastern cities took on traits of European social organization. Their natural position that made them the receiving hoppers for the influx of aliens after 1840, enabled them to retain large shares of the alien population as permanent members of their society, and from the aliens came traits and customs novel to the older Americanism.

The leaders of Eastern thought continued to think of their section as the legitimate and normal United States. Their Universities, responding to the nourishment of wealth, educated not only their own people but also the youth of all sections, and left an Eastern stamp wherever they made a contact. Their control of capital for investment, whether of their own accumulation or borrowed from Europe, gave Eastern financiers a power of direction and exploitation over the West that they exercised with little check or sympathy for the remainder of the century. Their opportunities for communication made them the centre of journalism and literary production, whose natural tone was that of cultural superiority. They were recruited continuously by a procession of successful Americans from the other sections, who had reached a level at which they demanded larger fields of activity or more sophisticated standards of life; and these generally made haste to slough off the traits of West or South, and to accommodate themselves to the Eastern type with all the ardour of the convert. The differentiation among the sections that had been begun by the rise of the West and the deviation of the South was perpetuated by the absorption of the East within the main currents of the industrial revolution.

Youth was another condition of the pioneer. The heavy labour of frontier development was no task for the old or the infirm. The normal frontier unit was the young or youngish family, all of whose members worked at the common tasks in and outside the cabin home. There were few of the dependent old, or of the middle-aged workers, among them. The mental traits of any pioneer group were those of youth and unbroken spirit. Hope and enthusiasm went with youth and poverty into the making of a Western settlement. It took hope, courage and a willingness to run risks to make a pioneer. One may suppose that, other things remaining equal, the brothers and cousins of an Eastern family who made the break from custom, and sought new homes in the West, were somewhat more adventurous than those who stayed at home. There are "pockets" in the East to-day where sociologists believe that they find a stagnant life that may be attributed to the long-repeated drift of the able and the enterprising to the West or to the cities. The West was enriched, and often was surcharged with an enthusiasm that bore too many traits of youth and lack of information.

Bearing these resemblances, and bound together by the geographic bonds of the Upper Mississippi valley, the people of the Middle West developed a great community whose centre and whose highest uniformity lay within the radius of 500 m. of the tip of Lake Michigan. They were held to their similarities because of their agriculture and because of their financial bonds. There was no great force operating among them which, like the plantation of the South, tended to separate the magnate from the common man: or, like the industry of the East, tended to raise the rich above the poor. Those who became rich were likely to move to the Eastern centres; those who remained in the West continued in a wide and real substantial unity. They lacked both depths and heights. There were few of the very rich; but the very poor were lacking. They were not peasants or proletarians; yet they lacked that acceptance of the going world that makes the bourgeois mind. They were citizens and democrats, and saw nothing incongruous in a Lincoln advancing from the cabin to the White House or in a Grant rising from the tan-yard to be a general of the army. They believed in opportunity, which they had themselves enjoyed; and they conserved it for their children by devoting to their schools and universities the greater portion of their public revenues.

The hundred years that have elapsed since the election of Andrew Jackson have seen this Upper Mississippi valley pass through three generations, and three distinct cultural phases, without losing the high concentration of westernism that was its main characteristic. For the first generation, it was the West, with the other sections of the United States emphasizing its nature by developing along contrasting lines. In the second generation, between the Civil War and the first defeat of William Jennings Bryan (1896) it became imperceptibly the Middle West; not because it was greatly changing in its point of view, but the emergence of the Far West made necessary a change of epithet. And it retained its character largely because it continued to be agricultural, and its unlike or unusual elements tended to be drafted into the East. In the third generation the old spirit has been thrown upon the defensive, as an industrial organization, a working class and an economic independence have broken into the old uniformities. It is likely enough that within the generation to come it will be largely absorbed, and will cease to exist as a geographical section. The whole United States is moving towards class stratification in place of geographic regionalism and the Middle West cannot forever hold its own against the tendencies of the times. Andrew Jackson was the first great indigenous prophet of the West; Robert M. LaFollette was perhaps the last.

Among the conditions whose influence has been to perpetuate the sectional consciousness of the Middle West, there is none that ranks higher or has been more pervasive than that of economic dependence. The frontier was always in debt. In this it did not differ greatly from a large part of society everywhere; but it was unique in the universality of the dependence. By definition, there were few residents in the frontier who possessed free capital. Those who had it stayed away from the frontier. Each new region was built out of the hopes of pioneers and the capital of the East. The poor equities of the West or Middle West, made the eastern capitalist loath to part with his wealth except at a high interest rate and often with bonus to boot. The Westerner, in the period of enthusiasm, was ready to agree to any rate, and inclined to believe that his soil could earn it. But inevitably there came the moment of liquidation. Much of the apparent wealth of the growing Western communities was derived not from the produce of the soil but from the enhancement of nominal land values as population increased. When the sad moment arrived when the Western borrower found himself unable to meet his interest charges, uniformity turned his condition of economic dependence into social or political reactions.

In the more complex East, debtor lived next to creditor, and the tone of his society was commonly dictated by the solvent members. It was hard for repudiation movements to get under way. But when one Westerner was in debt and insolvent, his neighbour was in the same condition. And absenteeism made it as easy to diabolize his creditor as common trouble made it easy for self sympathy to become a local virtue. In two ways at least this tendency has affected the Middle West. Here have originated movements of currency inflation. In the Jackson generation, the West enthusiastically backed up the wrecking of the Second Bank of the United States, largely because it operated as a check upon easy money and Western banks of issue. In the Civil War period, the same Middle West saw no defect in the scheme to pay the creditor of the nation and the holder of Western obligations in legal tender paper money, manufactured by the printing press. Towards the end of the 19th century Bryan swept the Western States with free silver inflation as his panacea for the

common man. Eastern interest in Western investments has tended to hold the sections apart, while Eastern distrust of Western economic theory has tended to confirm the Easterner in his assumption of his own superiority of intellect and virtue.

The Western liability to inflation finance has kept the West apart in a second way: it has created and developed a jealous suspicion of Eastern motive. Under best conditions it is hard for a debtor to love his creditor; under Western conditions of debt it was inevitable that he should hate him. The Eastern centres that controlled the lending of money, and the collection of debts, became synonyms for greed. The Second Bank was an "octopus"; the Civil War bond-holder was "inflated" and grasping; the "gold-bug," if not actually in the pay of Britain, was at least party to a conspiracy of Wall street. Eastern suspicion and Western jealousy came naturally to accentuate the sectionalism, and to prolong the existence of the Middle West. By the very nature of its existence, the Middle West has had few reflective and discriminating exponents of its point of view. Its active fighting leaders have been partisans. The East has drawn off and adopted a large share of its exceptional individuals. The market for literary and artistic wares has forced the Western maker of these to invade the East, and to adapt his output to his custom. The result has been that the Middle West has drawn few conscious pictures of itself, and the historian or literary artist who seeks to identify it must generally work among either the unconscious records of events that were transpiring in the West, or the jaundiced expressions of the alien who visited it and frequently did not like it. It can best be understood when one realizes that the qualities that identify the Middle West are the old qualities engendered along the fighting frontier of the United States in the period when the struggle for existence was a reality; that these qualities, by accident, survived beyond their normal expectation of life; that their uniformity gave them vividness and permanence; and that their normal reflexes are still capable of flaring up to influence affairs to-day, even in an industrialized society.

Bibliography.—Prof. Turner has discussed the Middle West in his *Frontier in American History* (1920); and the literary histories have tried to evaluate it in R. L. Rusk, *The Literature of the Middle Western Frontier* (1925); and L. L. Hazard, *The Frontier in American Literature* (1927). (F. L. P.)

MIDDLEWICH, urban district, Northwich parliamentary division, Cheshire, England, 166 m. N.W. of London, on the L.M.S. railway. Pop. (1931) 5,458. It lies in open country near the river Dane, having water communications with the Trent and Mersey canal, and the Shropshire Union canal. The church of St. Michael and All Angels is of various periods and contains numerous monuments. Old buildings and fine timbered houses occur in the neighbourhood. Middlewich shares in the salt industry common to several towns, such as Northwich and Winsford, in this part of the county; there are also chemical works and a manufactory of condensed milk.

MIDDLINGS, a term applied to various commercial products which may be regarded as occupying a middle position between two other articles. This idea covers the origin of the term when it is applied to wheaten products. Prior to the middle of the 19th century millers used millstones for grinding wheat, and sought at one operation to obtain as much finished flour and finished by-products, *e.g.*, bran, as possible. But they could not by such means avoid making a granular intermediate product, which they called "middlings." This was sold with or without further treatment either for use ultimately as human food or as pigs' food. These alternative purposes are reflected in the present confusing uses of the term. When modern methods of milling were introduced, and particularly when the machines known as "purifiers" were first used, millers were enabled to obtain from "middlings" flours of the greatest excellence, so they then sought to make as many as possible. Ultimately they adopted methods of "gradual reduction" and at an early stage of the milling process are able to granulate the kernel of the wheat berry. (*See* Flour and Flour Manufacture.) These granular products known as semolina (*q.v.*) middlings and dunst are essentially the same in constitution, differing only as to size of particle. For example, semolinas will pass through a mesh of say 20 per lineal inch, middlings through a mesh of say 56 per lineal inch, and dunst through a mesh of say 88 per lineal inch. Middlings so produced are, during the later stages of milling, resolved into finished flour and finished by-products. With recent changes in marketing the term may cease to apply to a by-product of milling.

(A. E. Hu.)

MIDHAT PASHA (1822–1884), Turkish statesman, the son of a civil judge, was born at Constantinople in 1822. His father trained him for an administrative career, and at the age of 22 he was attached as secretary to Faïk Effendi, whom he accompanied in Syria for three years. On his return to Constantinople Midhat was appointed chief director of confidential reports, and after a new financial mission in Syria was made second secretary of the grand council. His enemies caused him to be given the nearly impossible task of settling the revolt and brigandage rampant in Rumelia. His measures were drastic and their success was startling and the Government made him an official of the first rank and restored him to his place in the grand council. He restored order in Bulgaria in 1857. In 1860 he was made vizier and pasha, and entrusted with the government of Nisch, where his reforms were so beneficial that the sultan charged him, in conjunction with Fuad Pasha and Ali Pasha, to prepare the scheme for adapting them to the empire which was afterwards known as the law of the vilayets. He organized the council of State in 1866, and was then made governor of Baghdad, where his success was as decisive as at Nisch, but attended with much greater difficulties. In 1871 the anti-reform influence of the grand vizier, Mahmoud Nedim, seemed to Midhat a danger to the country, and in a personal interview he boldly stated his views to the sultan, who appointed Midhat grand vizier in place of Mahmoud. Too independent, however, for the court, Midhat remained in power only three months, and after a short governorship of Salonica he lived apart from affairs at Constantinople until 1875.

While sympathizing with the ideas and aims of the "Young Turkey" party, Midhat was anxious to restrain its impatience, but the sultan's obduracy led to a coalition between the grand vizier, the war minister and Midhat Pasha, which deposed the sultan in May 1876, and he was murdered in the following month. His nephew Murad V. was in turn deposed in the following August and replaced by his brother, Abdul Hamid II. Midhat Pasha now became grand vizier, reforms were freely promised, and the Ottoman parliament was inaugurated with a great flourish. In the following February, however, Midhat was dismissed and banished for supposed complicity in the murder of Abdul Aziz. Again recalled in 1878, he was appointed governor of Syria, and in August exchanged offices with the governor of Smyrna. But in the following May the sultan again ordered him to be arrested, and although he effected his escape and appealed to the Powers, he shortly afterwards surrendered, claiming a fair hearing. The trial took place in June, when Midhat and the others were sentenced to death. On the intercession of the British Government the sentence was commuted to banishment. The remaining three years of his life were spent in exile at Taif in Arabia, where he died, probably by violence, on May 8, 1884. To great ability, wide sympathies and patriotism he added absolute honesty.

(G. F. B.)

MIDHURST, town, Sussex, England, 12 m. N.E. of Chichester by rail. Pop. (1921) 1,890; rural district (1931) 15,018. Situated near the river Rother. The name of Midhurst (Middeherst, Mudhurst) first occurs under Henry I. It was governed by a bailiff until early in the 19th century. No charter of incorporation is known. In the reign of Henry VI. a market was held every Thursday, and a fair on Whit-Tuesday. Pleasure-fairs are still held on April 6 and Oct. 29, but there is no market. The church of St. Mary Magdalen and St. Denis is Perpendicular. A grammar-school was founded at Midhurst in 1672 and reopened in 1880.

MIDIAN. One of the peoples of North Arabia whom the Hebrews represented as sons of Abraham's wife Ketūrah. The Midianites appear in connection with the gold and incense trade from Yemen (Isa. lx. 6), and the trade between Egypt and Syria (Gen. xxxvii. 28, 36); also as warriors invading Canaan from the

eastern desert, and ravaging the land as similar tribes have done in all ages when Palestine lacked a strong government (*see* GIDEON). Again, they are described as peaceful shepherds, and the pastures of the branch of Midian to which Moses's father-in-law belonged, lay near Mount Horeb (Exod. iii. 1) (*see* KENITES, BALAAM, EDOM.)

MIDLAND, a city of Michigan, U.S.A., on the Titabawassee river, at the mouth of the Pine and the Chippewa, 25 m. N.W. of Saginaw; the county seat of Midland county. It is on federal highway 10, and is served by the Michigan Central and the Pere Marquette railways. The population was 5,483 in 1920 and 8,038 in 1930. It is in a farming, dairying and coal-mining region; has factories making automobile and aeroplane parts, machine tools, toys, guns, etc.; and salt-brine wells of chemical value.

MIDLAND, a manufacturing borough of Beaver county, Pennsylvania, U.S.A., on the Ohio river and the Pennsylvania railroad, 30 m. N.W. of Pittsburgh. Pop. (1920) 5,452 (42% foreign-born white); it was 6,007 in 1930.

MIDLAND BANK LIMITED. This British joint-stock company was in 1928 the world's largest commercial banking institution and had for chairman the Right Hon. Reginald McKenna, a former chancellor of the exchequer during the World War. It had 13,000 employees, with 2,000 branches in England and Wales and over 1,250,000 customers.

The bank was formed under a deed of settlement in 1836 and opened in Birmingham under the title of "The Birmingham and Midland Bank," with a paid-up capital of £28,000. A first dividend of 6% was paid in 1837, and thereafter the rate was raised from time to time until it reached a maximum of 23% in 1876. During this period the paid-up capital had been increased to £300,000 by capitalizing undivided profits and by issuing further shares.

In 1851 and 1862 the bank undertook its first two amalgamations, and in 1873 was registered as an unlimited company under the Companies Act of 1862. In 1880 it became a limited company with an issued capital of 24,000 shares of £60 each, of which £12½ was paid up, £12½ callable and £35 reserved. It then had only three branches, besides its head office in Birmingham, but thereafter the twin policies of amalgamation and branch extension came into full play. The inspiration for this policy came mainly from Mr. (later Sir) Edward H. Holden, who, joining the bank as accountant in 1881, occupied in succession various important positions until finally (1908–1919) he held the dual office of managing director and chairman of the board. To his foresight was due very largely the progress of the bank and its development as a British national institution.

A third absorption was effected in 1883, but from 1889 amalgamations followed rapidly. The policy pursued was distinctive, 30 of the 33 institutions taken over were joint-stock banks as opposed to private firms. Moreover, fusions were complete, with managerial control centralized in the head office of the absorbing bank. The most important of the earlier amalgamations was that with the Central Bank of London, in 1891, which gave the provincial institution a footing in the metropolis and a seat in the London Bankers' Clearing House, and resulted in the transfer of the head office to London. The name was changed to "The London and Midland Bank Limited," and in this year the bank, under the Companies (Memorandum of Association) Act, 1890, substituted a memorandum and articles of association for its old deed of settlement. The position was further reinforced by the absorption of The City Bank in 1898, when the title became "The London City and Midland Bank Limited." The largest amalgamation, that with The London Joint Stock Bank, in 1918, led to a further change to "London Joint City and Midland Bank Limited." The present name was adopted in 1923. Meanwhile, in 1917 the control of the Belfast Banking Company had been secured by an exchange of shares, and in 1920 and 1923 the Clydesdale Bank and the North of Scotland Bank were also acquired. The Midland owns the capital of these affiliated banks, which, however, have preserved their autonomy. In August 1928 the Midland group possessed 2,450 offices. None of these was outside the United Kingdom.

In 1905 the overseas business of the bank was concentrated in a special department, later known as the overseas branch. This branch has sub-offices in important industrial centres and in three Atlantic liners, and a shipping department. The Midland Bank Executor and Trustee Company Limited was formed in 1909. It has a paid-up capital of £200,000, all held by the bank, a reserve fund and undivided profits of £163,000, and branches in four large provincial centres. Various other departments were formed from year to year, and the progress of the bank is thus indicated:

Year	Paid-up capital	Reserve fund	Deposits	Cash	Advances	Net profits	No. of branches
	£ Millions						
1879	·3	·2	2·2	·5*	1·4	·06	4
1900	2·5	2·5	38·3	7·0	19·8	·6	317
1925	12·7	12·7	350·4	53·6	196·7	2·5	1,855
1926	12·7	12·7	368·2	53·0	200·5	2·5	1,904
1927	12·7	12·7	376·1	49·8	206·5	2·6	1,980

*Includes money at call and short notice.

The paid up capital was £13,320,000 in 1928, held by 65,000 individual shareholders. The new head office is in Poultry, London.
(L. C. M.)

MIDLETON, WILLIAM ST. JOHN FREMANTLE BRODRICK, 1ST EARL OF, cr. 1920 (1856–), Conservative statesman, the son of the 8th viscount, was educated at Eton and Balliol college, Oxford, and was president of the Oxford Union. He entered parliament in 1880. He was secretary of state for war (1900–03); and for India (1903–05). He lost his seat for the Guildford division in 1906. In March 1907 he was made an alderman of the London County Council. In that year his father died, and he entered the House of Lords. He was prominent as leader of the southern Unionists of Ireland, in virtue of his position as a landowner in County Cork. In the Irish Convention of 1917–18 this group separated themselves from Ulster, and expressed a readiness to concede a unitary Home Rule government for Ireland, subject to safeguards for the minority of loyalists.

MIDLETON, a town of co. Cork, Ireland, on the River Owenacurra, 13 m. E. of Cork. Pop. (1926) 2,731. The river enters a branch of Cork harbour. Trade is in agricultural produce and there are also whisky-distilleries. Ballinacurra, 1½ m. south, serves as a small port. The grammar school was founded here in 1696.

MIDLOTHIAN or **EDINBURGHSHIRE,** eastern county, Scotland, bounded north by the Firth of Forth, east by the shires of Haddington, or East Lothian, and Berwick, south-east by Roxburghshire, south by Selkirkshire, Peeblesshire and Lanarkshire, south-west by Lanarkshire, and west by Linlithgowshire or West Lothian. Its area (excluding water) is 234,325 acres. The island of Cramond belongs to the county. The Pentland Hills rise boldly in the south-west to heights of nearly 1,900 ft., and extend to within 5 m. of the sea. They are generally of rounded form, and covered with heath or grass. In them the Silurian strata characteristic of the south of the county, and of the southern uplands of Scotland generally, are covered unconformably by lower Old Red Sandstone rocks. The Carboniferous beds are thrown off to the north-west and south-east from the palaeozoic ridge. The Moorfoot Hills, in the south-east, belong to the Silurian area and are a continuation of the Lammermuirs, and attain in Blackhope Scar a height of 2,136 ft. A volcanic series extends from West Kip in the Pentlands to the Braid Hills and isolated heights, prominent in the scenery, are due to this intrusion of igneous rocks, mostly of the age of the calciferous sandstones, which cover a fairly wide area and in their upper portion include valuable oil shales. Of the rivers the Gala flows south to join the Tweed, and the Tyne after a course of 7 m. passes into Haddingtonshire. The others flow into the Firth of Forth. The Esk, which is the longest, drains the district between the Pentlands and the Moorfoot Hills, and reaches the sea at Musselburgh. The Water of Leith flows past Edinburgh to Leith. The Almond forms the boundary between Midlothian and Linlithgowshire. Several of these streams, especially the Esk and the Water of Leith, furnish water power. The only loch is that at Duddingston, but there are several large

reservoirs supplying Edinburgh. Cobbinshaw reservoir supplies the Union Canal connecting the Forth with the Clyde.

Agriculture.—High farming is the rule in the three Lothians. All the area on which wheat can be profitably grown is so occupied; oats, however, is the predominant grain crop, though barley is also raised. Turnips and potatoes are the chief roots. Near Edinburgh sewage farming has been largely developed. The produce consists principally of natural grasses. Sheep and cattle raising and horse breeding are important pursuits. In the neighbourhood of the capital dairy farming is conducted on an extensive scale. Pig-keeping has grown considerably and poultry-farming is carried on near Edinburgh. The nursery gardens are extensive, and there are many orchards.

Other Industries.—Coal is extensively mined on the North Esk. Some iron-stone is obtained and fire-clay occurs at various points. Paraffin is made near West Calder, where valuable oil-bearing shale is worked. Limestone is quarried at Mid Calder, Balerno, Loanhead, Craigmillar, Ratho, etc., and cement is made near Cranston. Freestone is quarried at Penicuik, near Edinburgh, and elsewhere. It is used for pavements and stairs, and for the great docks at Leith, and a number of smaller quarries for the supply of road-material are scattered throughout the county. Owing no doubt to the growth of printing and publishing in the metropolis, the chief manufacturing industry in Midlothian is paper-making. The most important mills, some of them dating from the beginning of the 18th century, are situated on the North Esk at Penicuik and Lasswade. At Balerno, Currie and elsewhere on the Water of Leith there are several mills, as well as near Mid Calder and in Edinburgh. There are carpet factories at Roslin, Bonnyrigg and Dalkeith. The manufacture of gunpowder is also carried on at Roslin and Calder. Iron foundries exist at Dalkeith and around Edinburgh. Dalkeith is famous for oatmeal. The shipping trade is concentrated at Leith and Granton, and there are fishing fleets at Fisherrow and Granton.

Population and Government.—The population was 507,666 in 1911 and 526,277 in 1931, of whom 3,269 spoke both Gaelic and English, and 19 Gaelic only. The chief towns, besides Edinburgh (pop. 1931, 438,998), are Bonnyrigg and Lasswade (4,483), Dalkeith (7,502), Loanhead (3,940), Musselburgh (16,996) and Penicuik (2,750). The county forms a single parliamentary constituency with Peebles, exclusive of Edinburgh county and Leith and Musselburgh burghs. It has been divided by the county council into three county districts (Calder, Gala Water, Lasswade). The shire is under school-board jurisdiction.

History and Antiquities.—Cramond was once a Roman seaport, and various Roman objects have been discovered in its vicinity and along the banks of the Almond. On several heights are remains of early military works—the most important being that on Dalmahoy Hill, Braidwood Castle in the parish of Penicuik, and Castle Greg on the Harburn estate in Mid Calder parish. Picts' houses are found at Crichton Mains, at Borthwick Castle, near Middleton House and elsewhere, the first being especially interesting from the fact that some of the stones bear marks of Roman masonry. There are hut-circles and a fort on Kaimes Hill, near Ratho; a large tumulus, with three upright stones, at Old Liston; a smaller tumulus at Newbattle; a cistvaen or stone burial chest at Carlowrie; and standing stones at Lochend, at Comiston (the Caiy stone), and the "Cat Stane" near Kirkliston. Temple, on the South Esk, was at one time the chief seat of the Knights Templars in Scotland for whom David I. here built a church, now in ruins. (*See* EDINBURGH.)

MIDNAPORE, a town and district of British India, in the Burdwan division of Bengal. The town has a station on the Bengal Nagpur railway. Pop. (1921) 28,965.

The DISTRICT OF MIDNAPORE has an area of 5,055 sq.m. and a population (1921) of 2,666,660. The greater part consists of a large open plain under cultivation but the country along the western boundary, known as the Jungle Mahals, is undulating and in the N.E. corner some hills rise to over 1,000 ft. in height. The eastern and south-eastern portions are swampy, richly cultivated, and thickly populated. The west, which has a lateritic soil partly covered by jungle, is sparsely inhabited. The chief rivers of the district are the Hoogli and its three tributaries, the Rupnarayan, the Haldi and the Rasulpur. The main line of the Bengal-Nagpur Railway passes through the district from east to west; from Kharagpur the East Coast section goes to Madras and the line to Gomoh branches off north to Chota Nagpur. Kharagpur contains the railway workshops and has a population (1921) of 25,280. There are three canals, the Midnapore canal, the Hijli tidal canal, and part of the Orissa coast canal. Drainage works have been constructed for a water-logged area in the south; there is also an extensive system of embankments. Silk, mats and brass and copper utensils are manufactured.

The early history of Midnapore centres round the ancient town of Tamluk (*q.v.*). In the 16th century it was eclipsed by Hijli which had Portuguese and Dutch settlements. In 1687 Job Charnock occupied Hijli and sustained a long siege by the Mughal forces. The British administration of the district dates from 1760, when Mir Kasim ceded it to the East India Company with Chittagong, and Burdwan when he became Nawab of Bengal.

MIDNIGHT SUN: *see* TWILIGHT.

MIDRASH, lit. "exposition" (*cf.* 2 Chron. xiii., 22: xxiv., 27) or intensive study (*derūsh*) of the spirit of a passage, frequently used of homily and parable in opposition to literal interpretation (*Peshaṭ*): term applied to certain methods of scriptural exegesis and to a class of Jewish writings illustrating these methods. The importance of Midrash to an understanding of Judaism is being recognized more generally. It is now realized that Judaism must be studied from its own sources and that apocrypha and apocalypse, though exceedingly valuable for the light they shed on dissenting sects or shades of quasi-orthodox opinion, do not reflect normal Judaism. These extra-canonical books were excluded just because they were abnormal. The last generation, which was occupied in their recovery and study, tended to overstate their application. To-day stress is laid on material which bears the warrant of unbroken tradition and which is therefore a more faithful mirror of the main body of Judaism.

This material may be divided into three groups:—(1) the rules of the traditional law or *Halakhah* which is systematized in the *Mishnah* (*see* GĀON; TALMUD); (2) the Midrash of the Schools, often called Halakhic (*see* HAGGADAH) or Tannaite (*i.e.*, Mishnaic) Midrash: this may be defined as the scholastic deduction of the traditional from the written law and consists of several works differing in character and style from (1) and from (3), the Haggadic (*see* HAGGADAH) or homiletical *Midrashim,* which are collections of short sermons, of an ethical rather than of a legal nature. The Haggadic Midrash was highly esteemed but it was not as authoritative as the Halakhic. This was natural from the essential difference between the two. *Halakhah* may be dull and legalistic but it is sober, whereas *Haggadah* is rarely dull, often highly imaginative and edifying, but it does not insist on sobriety. It includes many elements of extreme interest in folk-lore, archaeology and history. For example, I. Ziegler's *Königsgleichnisse des Midrasch* (Breslau, 1903) shows how vividly the Midrash illustrates the life and manners of Imperial Rome, especially in the provinces.

The *Halakhah* is deeply spiritual and is designed to stress the divine immanence, simple piety and the saintly life. The parables are mostly homely and the sayings terse, frequently in Aramaic, at one time the vernacular, and not in Hebrew, the language of the schoolmen. But there is also unrestrained fantasy, *e.g.*, stories of the Sindbad the Sailor type, which were not meant to be believed literally. Naturally great play with these has been made by opponents of the Jews, but the authority of the *Haggadah* has never been absolute. It stands in the same relation to theology as a mediaeval miracle-play to canon law or decretals. Thus, on July 20–24, 1263, at the great disputation at Barcelona between R. Moses b. Naḥman and the dominican Pablo Christiani, the former disarmed his opponent by repudiating the *Haggadah,* on which Pablo had based his case, and by declaring that the fables were merely points in sermons, expressing at most the individual opinions of the preacher and lacking the sanction of authority.

Nevertheless, the extent of the fantastic must not be exaggerated. In addition to strict truth and sheer fiction, *e.g.*, between

a genuine fact of archaeology or lexicography, recovered in a parable or exemplified in a saying, and an angelic digression of apocalyptic exuberance, there is an intermediate portion which must neither be categorically denied nor accepted absolutely. This element has been described as pragmatic historiography. There are three types of historical writing, the genetic or scientific, the purely narrative and the pragmatic. Religious historians write pragmatically, but this does not mean fraudulently. Their mental environment subconsciously influences them and they tend to prefer that record which appeals to their own age. They expect to find in the past elements mature only in their own day. But ancient historians must not be brushed aside because they fail to conform to modern standards. Their writings must be carefully tested. This is the way to treat the quasi-historical portions of Midrash. Here we find subjective history but earlier examples may be seen in the Bible, by examining Chronicles, which is a "Midrash" to Kings. Thus the life of Joash in 2 Chron. xxiii. differs in some details from that in 2 Ki. xi. and affords an illustration of the chronicler's methods. (On the Midrashic nature of *Chronicles, see* W. A. L. Elmslie's *Introduction* in *Camb. Bible, Chronicles,* 1916.) Probably the chronicler had access to sources now lost and in the account of Joash a Midrash is actually mentioned. But such Midrashic compilations can be traced even before his date (4th century B.C.).

Pragmatic historiography is exemplified in the various Deuteronomic writers. Similarly the relation between Genesis and the Book of Jubilees should be noted. The Apocrypha to some extent fills the gap between the Old Testament and the Rabbinic *Midrashim*, but, as has been stated, it must be used with care. Judiciously used, the Midrash and the Apocrypha may sometimes present a clue to a lost line of tradition: this tradition may or may not be valuable historically but its recovery is of interest, since it lay before the particular O.T. writer who discarded it or used it only incidentally. Thus Gen. xlviii., 22, contains a cryptic allusion to the capture of Shechem. In Jubilees xxxiv. (about 2nd century B.C.) a story of this war is detailed and similar accounts are preserved in various *Midrashim*. It is unlikely that these were mere elaborations of Gen. xlviii. 22: it may be inferred that an extracanonical tradition continued to survive the compilation of Genesis and ultimately assumed the exaggerated forms now extant. Again, Jewish traditions of Abraham in Ur of the Chaldees recur in the Targums, *Midrashim* and Jubilees (ch. xii., ed. Charles, p. 91; *cf.* also Judith, v., 16 *sqq.*). The legends of his escape from a fiery furnace may have a philological basis, for *'ur* can be interpreted as fire, but the allusion to the redemption of Abraham in Isa. xxix., 22, seems to indicate that older tradition was fuller than the present records in Genesis.

Midrashic exposition was based on the theory of progressive interpretation. Every word of the scriptures had a definite meaning, nay, no single letter was otiose; moreover every word had "70 aspects." This means that generation after generation would extract new lessons, all of which were deemed latent or implicit. Some of these interpretations were arbitrary but more often the arbitrariness lay not in the teaching but in the deduction. When it was desired to point a moral or elicit a law not always the best exemplar was adopted. Thus faulty proof rather than faulty inference is illustrated when the rare word *Be-mikhṣath,* "in-number" (Exod. xii. 4), was used to confirm the *Halakhah* that the man who killed the paschal lamb must know how many people were about to share it. (*Jew. Enc.* VIII., 570.) Many cases of apt deduction can be adduced and deductions, similarly apt or far-fetched, occur also in the N.T. Thus emphasis on a single word is illustrated by Gal. iii. 16, where the argument rests on the word "seed" (and not the plural "seeds") in the proof-text and the same word in Rabbinical writings is used to support other arguments (*cf.* Mishnah, *Ṣanhedrin,* iv., 5: *see* A. Geiger, *Z.D.M.G.* 1858, pp. 307 *sqq.:* S. R. Driver, *Expositor,* IX. [1889], pp. 18 *sqq.*). By the allegorical method Isa. lxi. is applied to Jesus (Luke iv. 16–22).

The more important *Midrashim* are:—

A. Halakhic or Tannaite *Midrashim:*

(1) *Mekhilta,* on Exodus. This begins at xii., the first legislation (the ordinance of the Passover). The later portions of Exodus are not commented on (as they are historical) in the present work, but there is reason to believe that the original was fuller. This famous Midrash was of the school of R. Ishmael, but it was concluded in the school of the patriarch Judah in the 2nd century A.D. (Text, M. Friedmann, Vienna 1870: I. H. Weiss, Vienna, 1865. German trans., J. Winter and A. Wünsche, Leipzig, 1909.)

(2) Another recension of the *Mekhilta,* cited by mediaeval authors, was that of Simeon ben Yoḥai—ed. D. Hoffmann (1905).

(3) *Midrash hag-Gadol,* a composite work on the Pentateuch, compiled in the 13th century, recently discovered in Arabia, contains much lost material. The Midrash is edited in part. (S. Schechter, Camb. 1902: D. Hoffmann, Berlin, 1913.)

(4) *Ṣifra (de-Be Rab),* on Leviticus, which it follows almost verse by verse. Probably redacted by R. Ḥiyya in the beginning of the 3rd century A.D. (Text, M. L. Malbim, Bucharest, 1860: I. H. Weiss, Vienna, 1862. Latin trans. [faulty in parts] in Ugolinus [Thesaurus] xiv.)

(5) *Ṣifre,* on Numbers and Deuteronomy (2nd and 3rd centuries). (Text, M. Friedmann, Vienna, 1864: H. S. Horovitz, Part I., Leipzig, 1917. Germ. trans. [on Deut.] G. Kittel, Stuttgart, 1922.)

B. Haggadic *Midrashim:*

(1) *Midrash Rabba,* on the Pentateuch and Five Rolls. Ed.-princeps, Constantinople, 1512: frequently reprinted, Crit. ed. of Genesis Rabba by J. Theodor (unfinished), (Berlin, 1903– . Germ. trans., A. Wünsche, *Bibliotheca Rabbinica,* Leipzig, 1880–).

(2) *Tanḥuma* (2 recensions) on the Pentateuch, one of the oldest *Midrashim:* mentioned once in the Talmud. (Text, ed. S. Buber, Wilna, 1885: the other recension, Constantinople, 1520–22.)

(3) *Pesiqta (de Rab Kahana),* 33 homilies on the festivals (lectionary, etc.). (Text, ed. S. Buber, Lyck, 1868. Germ. trans. A. Wünsche, Leipzig, 1885.)

(4) *Pesiqta Rabbathi,* a similar but separate collection of 51 homilies of which 28 have a Halakhic exordium. (Text, ed. M. Friedmann, Vienna, 1880.)

(5) Midrash *Shoḥar Ṭōbh* on Psalms, text, Warsaw, 1875.

(6) *Yalquṭ* or "Wallet," title of several midrashic collections.

BIBLIOGRAPHY.—Articles (main and subsidiary) in *Jew. Enc.,* Hastings, *D.N.B.* and *E.R.E.,* G. M. Moore, *Judaism,* I. 125 foll. Cambridge (Harvard), 1927.

MIDSHIPMAN is the title given to the officer ranking below the lowest commissioned officer, which in the British Navy is a sub-lieutenant. A midshipman in the British Navy is senior only to a naval cadet.

Originally a midshipman was a petty officer, but after the Restoration, in 1660, Charles II. with his brother James, Duke of York as Lord High Admiral, decided to train officers for the sea service from an early age. Young lads were sent as volunteers with a "letter of service" instructing the admirals and captains of the warships to which they were drafted that the bearer was to be shown "such kindness as you shall judge fit for a gentleman, both in accommodating him in your ship and in furthering his improvement." Until 1720 these young gentlemen were known as "king's letter boys." Originally, the future officers entered the service at a very youthful age, but at a later stage no boy could be borne on a ship's books until he was 13, except in the case of an officer's son, who might be entered at 11.

First class volunteers were permitted to wear naval uniform. They were generally styled "youngsters" and came directly under the care of the gunner, who was supposed to superintend their mess and general welfare. Their nautical studies were attended to by a school master, or in his absence the captain was expected to take a personal interest in them. At the age of 15, when promoted to midshipmen, they became known as "oldsters" and formed a mess among themselves with the mates. After serving two years they became eligible for promotion to master's mate.

The practice of sending boys to sea at such a very early age proved unsatisfactory, and a Naval Academy was founded at

Portsmouth in 1729, in which forty lads were trained for sea service. In 1773 the school was reorganized and the number increased from forty to seventy. In 1806 it was again reorganized and became known as the Naval College. The number of midshipmen borne in a man of war in 1815 was in proportion to the size of the ship. Thus a first rate was allowed 24, a second rate 15 and a third rate 12 and so on in proportion.

In 1837 the practice of sending boys direct to sea under instructors in the ships superseded the school, but in 1857 the system of preliminary training was reverted to and remains the basis of the supply of officers to the executive branch of the navy to this day. It was in this year that the training ship "Britannia" was established. As the numbers became too great for the one ship, in 1864 a second ship, the "Hindustan" was linked up. It shares the name of the parent ship.

In 1902, under the aegis of Admiral Sir John Fisher, entry into the navy was completely reorganized, the preliminary training being modernized, while the period was extended from two years to about four. The first half of the course was spent at the Royal Naval College at Osborne, Isle of Wight, and the remainder at the newly-built Royal Naval College, Dartmouth. In 1921 Osborne College was abolished and the preliminary training for the greater part of the executive branch of the navy is now carried out at Dartmouth College alone.

Cadets now (1928) join the College, after a competitive examination, at about 13½ years of age. They do 3⅔ years there, after which they are appointed to sea-going ships. When they have served eight months afloat they are rated midshipmen. Special entry cadets, limited in number, enter the service by competitive examination about the age of 17. They do twelve months in a training ship before being rated midshipmen.

As a midshipman an officer serves two years and four months before he is qualified to pass the first of a series of five examinations for eventual promotion to lieutenant. The initial examination is one to test his ability as a seaman. If he proves this to the satisfaction of a board of captains and commanders, he is given the acting rank of sub-lieutenant. He is confirmed in this rank when he has also passed examinations in general education, gunnery, torpedo, navigation and pilotage. Although a midshipman is regarded as being to a large extent under instruction, he is given very definite, if not unduly weighty, responsibilities as an officer, including such duties as complete charge of one of the ship's boats, sometimes one of the smaller guns, a fire control or ammunition supply party, while in the administrative work of the ship he is the principal assistant to lieutenants of divisions and officers of quarters.

Midshipmen selected for the engineering branch of the Navy go to the Royal Engineering College, Keyham, Devonport, where, after duly qualifying, they are promoted to sub-lieutenant.

Paymaster midshipman is the present day title of the subordinate officer who used to be called a clerk R.N. He enters as a paymaster cadet and is promoted after twelve months service afloat.

See Falconer, *Marine Dictionary; King's Regulations and Admiralty Instructions* (H.M. Stationery Office); *Appendix to the Navy List* (H.M. Stationery Office). (E. A.)

THE UNITED STATES

In the U.S. Navy midshipman is the title given to the student undergoing the course at the U.S. Naval Academy (*q.v.*), preparatory to entering the lowest commissioned ranks. As such he is an officer in a qualified sense. He is appointed a midshipman in the Navy, not merely at the Naval Academy, is subject to the orders and regulations of the Navy Department, but does not participate in the benefits of retirement or longevity. He may be ordered to sea duty, although this is not customary except on practice cruises. He ranks after a commissioned warrant officer, and ahead of a warrant officer.

When the naval forces were first established, midshipmen were seagoing officers in training for commissions, with rank and duties similar to those of the British Navy of that time. In the Revolutionary War midshipmen were appointed by the commanders of vessels, but practically all were discharged at the end of the war. In the great expansion after the authorization of a new national navy in 1794, the president was empowered to appoint as many midshipmen as desired. They were appointed from civil life without special regard to education or aptitude, but in the ensuing naval wars with France and the Barbary States, and the War of 1812, theirs was a record of great activity and gallantry. Age at entry was generally 14 to 20, but this varied. Stephen Decatur was warranted a midshipman at 20, and commissioned a lieutenant at 21. David G. Farragut entered at 9, and became a lieutenant at 24. In 1827 the grade of passed midshipman was established. At the age of 20, and having served three years at sea, a midshipman was eligible for promotion to passed midshipman. The time of promotion to lieutenant varied, depending on the vacancies.

In the Navy regulations of 1802, commanding officers were enjoined to consider the midshipmen as "meriting in a special degree the fostering care of their Government," and to see that the schoolmasters (at that date the chaplains) were diligent in instructing them. Later, schoolmasters were added to the ships. However, the system of giving instruction on board ship did not prove satisfactory. This led to proposals from many sources often from the service itself, for a naval school similar to the Military Academy established in 1802. Nearly every secretary of the navy from 1814 to 1845 recommended it. In the meantime the midshipmen received such instruction as the system permitted, at sea, and at the navy yards at Boston, New York, Norfolk and Philadelphia, where professors of mathematics and languages were stationed.

With sail as the motive power, and the old smooth-bore ordnance, "the young gentlemen of the watch" could master the elements of their profession at sea, even if they did not acquire a liberal education. But the advent of steam and the swift advances in the arts and sciences soon made more efficient instruction imperative. Congressional action continually failed, but in 1845 secretary of the navy George Bancroft set up a naval school on the site of Ft. Severn, Annapolis, Md., by concentrating there all the equipment and instructors available, and ordering the attendance of all midshipmen undergoing instruction at the navy yards. Acting midshipmen, aged 13 to 16, attended one year; they were then warranted midshipmen and served at sea for three years; then returned for another year's study, final examinations and promotion to passed midshipmen. In 1850-51 the Naval school was reorganized as the U.S. Naval Academy.

For many years the Navy Department had been free to appoint as many midshipmen as it pleased. In 1845, Congress provided that midshipmen should be appointed from each State or Territory in proportion to the number of representatives and delegates. This principle has been adhered to.

The students at the Naval Academy have been called, in turn, acting midshipmen, midshipmen, cadet midshipmen and cadet engineers, naval cadets, and again, midshipmen. From 1873 to 1912 the academic course was six years, the last two of which were spent at sea. In 1912 the course was reduced to four years, the midshipmen, upon graduation, being commissioned as ensigns in the line or staff corps of the Navy, or as second lieutenants in the Marine Corps.

See J. R. Soley, *Historical Sketch of the Naval Academy* (1876); Park Benjamin, *The United States Naval Academy* (1900); Ralph Earle, *Life at the U.S. Naval Academy* (1917); *Navy Regulations* (1802, 1814, *et seq.*); *Navy Registers; Naval Academy Registers and Regulations Governing the Admission of Candidates into the U.S. Naval Academy as Midshipmen*, published by the Bureau of Navigation, Navy Department. (S. S. R.)

MIDSOMER NORTON, an urban district in Somersetshire, England, 12½ m. S.S.W. of Bath on the G.W. railway. Pop. (1931) 7,490. The town is situated between two branches of the river Somer. The church of St. John the Baptist, mainly Perpendicular, has in its tower three bells presented by Charles II. Both this town and the adjacent urban district of RADSTOCK (pop. 3,661) have a considerable trade in coal, which is mined in the vicinity. The coalfield extends north-westward towards Bristol. The industries include manufacturing of textiles and leather goods.

MIDWIFERY: *see* OBSTETRICS.

MIDWIFE-TOAD: *see* ALYTES.

MIERES, a town of northern Spain, in the province of Oviedo, 12 m. by rail S.E. of Oviedo, on the river Caudal, a tributary of the Nalon. Pop. (1920), 40,560. Mieres is the chief town of a mountainous, fertile and well-wooded region in which coal, iron and copper are extensively mined and sulphur and cinnabar are obtained in smaller quantities. The town contains large iron foundries and chemical works, and has an active trade in fruit, cider, timber and live stock.

MIEREVELT (MIEREVELD or **MIREVELDT), MICHIEL JANSZ VAN** (1567–1641), Dutch painter, was born at Delft on May 1, 1567, the son of a goldsmith, who apprenticed him to the copperplate engraver J. Wierix. He subsequently became a pupil of Willem Willemz and Augustyn of Delft, until Antonio van Montfort (Blockland), who had seen and admired two of Mierevelt's early engravings, "Christ and the Samaritan" and "Judith and Holofernes," invited him to enter his school at Utrecht. He remained at Utrecht till the death of Montfort (1583), and then settled at Delft. Devoting himself first to still life, he eventually took up portraiture, and the many commissions entrusted to him necessitated the employment of numerous assistants, by whom hundreds of portraits were turned out in factory fashion. The works which are certainly his are remarkable for sincerity, severe drawing and harmonious colour, but comparatively few of the two thousand or more portraits that bear his name are wholly his handiwork. He went frequently to The Hague, where he entered the guild of St. Luke in 1625. Though Mierevelt is chiefly known as a portrait painter, he also executed some mythological pieces. Many of his portraits were reproduced by Dutch engravers. He died at Delft on June 27, 1641.

The Ryks Museum in Amsterdam has the richest collection of Mierevelt's works, chief of them being the portraits of William, Philip William, Maurice and Frederick Henry of Orange, and of the count palatine Frederick V. At The Hague Museum are the portraits of four princes of the house of Orange, of Frederick V., king of Bohemia, and of Louise de Coligny as a widow. Other portraits by him are at nearly all the leading continental galleries, notably at Brunswick (2), Schwerin (1), Munich (2), Paris (Louvre, 4), Dresden (4), Berlin (2), Hanover (2), London Portrait gallery (7). The town hall of Delft has numerous examples.

MIERIS, FRANZ VAN, called the elder (1635–1681), son of Jan van Mieris, and chief member of a family of Leyden painters, was born, according to Houbraken, at Leyden on April 16, 1635, and died there on March 12, 1681.

Franz took service with Abraham Torenvliet, a glazier who kept a school of design. In his father's jewellery shop he became familiar with the ways and dress of people of distinction. His eye was fascinated in turn by the sheen of jewellery and stained glass; and, though he soon gave up the teaching of Torenvliet for that of Gerard Dou and Abraham van den Tempel, he acquired a manner which had more of the finish of the exquisites of the Dutch school than of the breadth of the disciples of Rembrandt. He seldom chose panels of which the size exceeded 12 to 15 in. Mieris never ventured to design figures as large as life. Characteristic of his art in its minute proportions is a shiny brightness and metallic polish. The subjects which he treated best are those in which he illustrated the habits or actions of the wealthier classes; but he sometimes succeeded in homely incidents and in portrait, and he sometimes ventured on allegory. He often rivalled Ter Borch in the faithful rendering of rich and highly-coloured woven tissues. In the form of his composition, which sometimes represents the framework of a window enlivened with greenery, and adorned with bas-reliefs with figures to the waist, his model is Gerard Dou.

One of his best-known pieces, a party of ladies and gentlemen at an oyster luncheon, in the Hermitage at Leningrad, bears the date of 1659. Another beautiful example, the "Doctor Feeling a Lady's Pulse" in the gallery of Vienna, is dated 1656. In the same gallery is one of his masterpieces "the Cavalier and the Lacemaker," dated 1660. In 1657 Mieris was married at Leyden. On May 14, 1658 he was elected a member of the Guild at Leyden. Of the numerous panels by Mieris, twenty-nine at least are dated —the latest being an allegory, long in the Ruhl collection at Cologne, showing drinking, smoking and dicing, in the year 1680.

Mieris received valuable commissions from Archduke Leopold, the elector-palatine, and Cosimo III., grand-duke of Tuscany. His practice was large and lucrative. If there be a difference between the painter's earlier and later work, it is that the former was clearer and more delicate in flesh, whilst the latter was often darker and more livid in the shadows.

MIFFLIN, THOMAS (1744–1800), American soldier and politician, was born in Philadelphia (Pa.), on Jan. 10, 1744. Mifflin was a member of the Pennsylvania house of representatives in 1772–75, and was sent as a delegate to the first Continental Congress. He entered the continental service in June 1775, was appointed quartermaster-general in August, became a brigadier-general in May 1776, and major-general in Feb. 1777. In the autumn of 1777 Mifflin was a leader of the Conway Cabal which attempted to replace Washington by Horatio Gates. The faction gained sufficient power to secure the appointment of Gates as head and of Mifflin as a member of the board of war. In March 1778, Nathanael Greene superseded Mifflin as quartermaster-general; in October he was removed from the board of war; and in Feb. 1779, he resigned as major-general. Mifflin was a delegate in Congress in 1783 and in November of the same year was made president of that body. He was speaker of the Pennsylvania general assembly (1785–88), president of the State supreme executive council (1788–90) and the first governor of the State (1790–99). He died at Lancaster on Jan. 20, 1800.

See William Rawle, "Sketch of the Life of Thomas Mifflin," in *Memoirs of the Historical Society of Pennsylvania* (vol. ii. part 2, Philadelphia, 1830); and J. H. Merrill, *Memoranda Relating to the Mifflin Family* (Philadelphia, 1890).

MIGNARD, PIERRE (1610–1695), called—to distinguish him from his brother Nicholas—Le Romain, French painter, was born at Troyes in 1610, and came of a family of artists. In 1630 he left the studio of Simon Vouet for Italy, where he spent twenty-two years, and made a reputation which brought him a summons to Paris. Successful with his portrait of the king, and in favour with the court, Mignard pitted himself against Le Brun, declining to enter the Academy of which he was the head, and organizing the opposition to its authority. The history of this struggle is bound up with that between the old gilds of France and the new body which Colbert, for political reasons, was determined to support. Shut out, in spite of the deserved success of his decorations of the cupola of Val de Grace (1664), from any great share in those public works the control of which was the attribute of the new Academy, Mignard was chiefly active in portraiture. Turenne, Molière, Bossuet, Maintenon (Louvre), La Vallière, Sévigné, Montespan, Descartes (Castle Howard), all the beauties and celebrities of his day, sat to him. His readiness and skill, his happy instinct for grace of arrangement, atoned for want of originality and real power. With the death of Le Brun (1690) the situation changed; Mignard deserted his allies, and succeeded to all the posts held by his opponent. These late honours he did not long enjoy; in 1695 he died whilst about to commence work on the cupola of the Invalides. His best compositions were engraved by Audran, Edelinck, Masson, Poilly, etc.

MIGNE, JACQUES PAUL (1800–1875), French priest and publisher, was born at St. Flour, Cantal, on Oct. 25, 1800. He studied theology at Orleans, was ordained priest in 1824 and placed in charge of the parish of Puiseaux, in the diocese of Orleans. In 1833 he went to Paris, and started *L'Univers religieux.* Three years later, he opened at Petit Montrouge, near Paris, the great publishing house which brought out in rapid succession numerous religious works at popular prices. The best known of these are: *Scripturae sacrae cursus completus,* and *Theologiae cursus* (each in 28 vols., 1840–1845); *Collection des auteurs sacrés* (100 vols., 1846–1848); *Encyclopédie théologique* (171 vols., 1844–1866); *Patrologiae cursus completus,* Latin series in 221 vols. (1844–1855, 2nd edition, 1878 *seq.*); Greek series, first published in Latin (85 vols., 1856–1861); with Greek text and Latin translation (165 vols., 1857–1866). Unfortunately these editions do not come up to the requirements of modern criticism. By far the most noteworthy is the Patrology, which was superin-

tended by the learned Benedictine J. B. Pitra. Its vast scope leaves it still unique and valuable, where other editions of special works do not exist. The indices in 3 vols. are arranged so that one may easily find any reference in the patristic writings. In February 1868 a great fire destroyed the whole of Migne's printing premises, but he established a new house in Paris, which was purchased in 1876 by the publishers Garnier Frères. He died in Paris on Oct. 25, 1875.

For a more complete account of Migne's life, *see* the article in the *Catholic Encyclopaedia* (New York, 1906 *seq.*).

MIGNET, FRANÇOIS AUGUSTE ALEXIS (1796–1884), French historian, was born at Aix-en-Provence on May 8, 1796, and died in Paris on March 24, 1884. His father, a Vendean by birth, was a locksmith. François studied at Avignon in the *lycée* where he was afterwards professor (1815); he returned to Aix to study law, and in 1818 was called to the bar. His memoir on *Les Institutions de Saint Louis* was crowned in 1821 by the Académie des Inscriptions et Belles Lettres. He then went to Paris, where he was soon joined by his friend and compatriot, Adolphe Thiers, the future president of the French republic. He became a member of the staff of the *Courrier Français* which carried on a fierce warfare against the Restoration. In 1830 he founded the *National* with Thiers and Armand Carrel. He then became director of the archives at the Foreign Office, where he stayed till the revolution of 1848, when he was dismissed. He had been elected a member of the Académie des Sciences Morales et Politiques, re-established in 1832, and in 1837 was made the permanent secretary; he was also elected a member of the Académie Française in 1836. With the exception of his *Histoire de la Révolution française* (1824), a political manifesto, all his early works refer to the middle ages. For a long time he was occupied with a history of the Reformation, but only one part of it, dealing with the Reformation at Geneva, has been published. His *Histoire de Marie Stuart* (2 vols., 1851) is well worth reading; the author made liberal use of some important unpublished documents, taken for the greater part from the archives of Simancas. He devoted some volumes to a history of Spain, which had a well-deserved success—*Charles Quint, son abdication, son séjour, et sa mort au monastère de Yuste* (1845); *Antonio Perez et Philippe II.* (1845); and *Histoire de la rivalité de François I. et de Charles Quint* (1875). At the same time he had been commissioned to publish the diplomatic acts relating to the War of the Spanish Succession for the *Collection des documents inédits;* only four volumes of these *Négociations* were published (1835–42), and they do not go further than the peace of Nijmwegen; but the introduction is celebrated, and Mignet reprinted it in his *Mélanges historiques.*

See the eulogy of Mignet by Victor Duruy, delivered on entering the Académie Française on June 18, 1885, and the notice by Jules Simon, read before the Académie des Sciences Morales et Politiques on Nov. 7, 1885.

MIGNON, ABRAHAM (1640–1697), Dutch painter, was born at Frankfort. His father, a merchant, placed him under the still-life painter Jacob Merrel, by whom he was taken to Holland about 1660. He then worked under de Heem at Utrecht, where in 1675 he married the daughter of the painter Cornelis Willaerts. Sibylle Merian (1647–1717), daughter of the engraver Matthew Merian, became his pupil and achieved distinction as a flower painter. He died at Wetzlar. Mignon devoted himself almost exclusively to flowers, fruit, birds and other "still life," though at times he also attempted portraiture. His flower pieces are marked by careful finish and delicate handling. His favourite scheme was to introduce roses against a dark background. Fifteen paintings (twelve signed) are at Dresden; six at the Louvre, four at the Hermitage, and others at the museums of Amsterdam, The Hague, Rotterdam, Brussels, Munich, Karlsruhe, Brunswick, Cassel, Schwerin, Copenhagen and Turin.

MIGNONETTE or **MIGNONNETTE** (*i.e.,* "little darling"), the name given to a popular garden flower, *Reseda odorata* (family Resedaceae), highly esteemed for its delicate but delicious perfume. The mignonette is generally regarded as an annual and is a plant of diffuse decumbent twiggy habit, scarcely reaching a foot in height, clothed with bluntish lanceolate entire or three-lobed leaves, and bearing longish spikes—technically racemes—of rather insignificant flowers at the ends of the numerous branches and branchlets. The plant thus naturally assumes the form of a low dense mass of soft green foliage studded over freely with the racemes of flowers, the latter unobtrusive and likely to be overlooked until their diffused fragrance compels attention. It is probably a native of north Africa and was sent to England from Paris in 1742; and 10 years later it appears to have been sent from Leiden to Philip Miller at Chelsea. The small six-petalled flowers are somewhat curious in structure: the two upper petals are larger, concave, and furnished at the back with a tuft of club-shaped filaments, which gives them the appearance of being deeply incised, while the two lowest petals are much smaller and undivided; the most conspicuous part consists of the anthers, which are numerous and of a brownish red, giving the tone of colour to the inflorescence. In the varieties named Golden Queen and Golden Machet the anthers have a decided tint of orange-yellow, which imparts a brighter golden hue to the plants when in blossom. A handsome proliferous or double-flowered variety has also been obtained, which is a very useful decorative plant, though only to be propagated by cuttings; the double white flowers grow in large massive panicles (proliferous racemes), and are equally fragrant with those of the ordinary forms.

Though practically an annual in Great Britain, as already noted, since it flowers abundantly the first season, and is destroyed by the autumnal frosts, and though recorded as being annual in its native habitat by Desfontaines in the *Flora Atlantica,* the mignonette, like many other plants treated in England as annuals, will continue to grow on if kept in a suitable temperature. Moreover, the life of this and certain other plants of this semi-annual character may be prolonged into a second season if their flowering and seeding are prevented. The young plants are grown under glass, and their flowering prevented by nipping off the blooming tips of the shoots, so that they continue their vegetative growth into the second season.

In classifying the odours given off by plants Rimmel ranks the mignonette in the class of which he makes the violet the type; and Fée adopts the same view, referring it to his class of "iosmoids."

The genus *Reseda* contains about 55 species, natives of Europe and west Asia. *R. luteola,* commonly called dyer's-weed or weld, yields a valuable yellow dye. *R. alba* is a fine biennial about 2 ft. high, with erect spikes of whitish flowers.

MIGNONS, LES. In a general sense the French word *mignon* means "favourite," but the people of Paris used it in a special sense to designate the favourites of Henry III. of France, frivolous and fashionable young men, to whom public malignity attributed dissolute morals. The best known of the *mignons* were the dukes of Joyeuse and of Epernon.

MIGRAINE. *Hemicrania, migraine, megrim, brow-ague* and *sick headache* are various terms employed to describe what by some is considered to be a form of neuralgia, and by others as a paroxysmal neurosis or nerve storm. An attack may come on suddenly, but, in general, begins by a dull aching pain in the brow or temple, which steadily increases in severity and extent, but remains usually limited to one side of the head. It attains at times an extreme degree of violence, and is aggravated by movement, loud noises or bright light. There is more or less nausea, and when the attack reaches its height vomiting may occur, after which relief comes, especially if sleep supervene. An attack of this kind may last for a few hours or for a whole day, and after it is over the patient feels comparatively well. It may recur periodically, or, as is more common, at irregular intervals. During the paroxysms, or even preceding them, sensory disturbances may be experienced, especially affections of vision, such as ocular spectra, hemiopia, diplopia, etc. Gout, eyestrain and intestinal toxaemia have been put forward as causes of migraine.

MIGRATION. Migrations, or the shiftings of peoples, have been universal on the earth in space and time, but there have also been migrations or transmissions of cultural objects and ideas which frequently have little relation with the former and these may be termed cultural drifts.

Most primary migrations of mankind may be traced to need

of food. The practice of tilling the soil, in order to obtain a more or less reliable supply of food, by its nature tends to anchor a people to the land, and all permanence of work with a reliable food supply forms an essential condition for continuous residence in one spot; when these fluctuate, unrest arises and individuals or communities are set in motion.

For the greater part of the very long time that man has been in existence he has been merely a collector of food or a hunter. Where game was plentiful or wild vegetable food abundant he could live in moderate sized communities, but normally any country would be very sparsely inhabited, therefore there would be a necessity for migration when the population grew too numerous for the food supply. Usually the game migrate seasonally to seek fresh feeding-grounds, or for other reasons, but this movement may be merely a backward and forward shifting within a particular range and naturally the hunters would accompany them; during the winter months the Eskimos live on the sea coast so as to be able to catch seals on which they mainly depend for food, but in the summer they shift to inland areas, where they can hunt reindeer, or, in the more northerly regions, the musk ox, and also they can then procure more varied diet. Collectors of vegetable food within their various countries have similarly to move where a particular root, seed or fruit crop is ripe. Movements of these kinds though dictated by necessity are to some extent voluntary.

Movements are compulsory when changes of climate or of geographical conditions cause a complete shifting of the flora and fauna, as, for example, during the major and minor fluctuations of temperature in the glacial periods of northern latitudes, northerly or southerly shiftings of the rain belts further south, desiccation, elevation or depression of land, changes in the coast line, and so forth. Man was forced to move as his food decreased or the climate became too rigorous, and the directions in which he moved were similarly conditioned, but in addition were determined to a large extent by open land or by barriers of various kinds. Human movements resulting from these causes may well have been slow, and archaeological evidence shows that even in very early times they extended over the greater part of the earth's surface. A warning may here be given that a similarity in stone implements, for example, does not necessarily imply a strict synchronism for these artifacts in Europe, South Africa, India or Australia. The fluctuating character of many of these phenomena acted frequently as a force-pump or as a suction-pump, at one time expelling a people from a given area at another attracting them towards it. It is obvious that in very early times we can have no historical record of such happenings, but archaeology gives sufficient indications that they occurred.

As examples of historical events of this nature the following may be cited, though what occurred in earlier times can only be inferred, but it is not unreasonable to suppose that they were analogous.

It is obvious that during the advent of a glacial period the increasing fields of snow and ice would drive the people who then lived in north-west Europe (and we have evidence that there were men in England in preglacial times) further south where livelihood was possible, and similarly there would be a southerly shifting of peoples who were accustomed to a genial climate. The formation of a northern ice-cap would result in a southerly shifting of the temperate rain- and storm-belts in proportion to the advance of the ice. Thus the wide belt of northern Africa which is now the desert of Sahara would then be a well-watered, habitable country of grass-land and savanna. The same applies to the arid areas of western Asia. There was, therefore, a continuous stretch of pleasant lands from Central Asia, through Persia, Arabia and north Africa to the Atlantic. When the ice retreated the storm-belt shifted further north and these areas once more became dry and thirsty lands. A recurrent phenomenon of this kind must have occurred with each major glaciation. If we assume that a people long habituated to live on the fringe of the ice-cap and to hunt reindeer and other arctic animals would prefer to continue its mode of existence then it would follow the retreating ice, and it seems as if this had been the case for the Eskimo. Magdalenian man in western Europe lived under arctic conditions and certainly the characters of the Chancelade skull of western France are very similar to those of the Eskimo of arctic North America, but it does not follow that the Eskimo ever lived in Europe. The savanna belt of north Africa and western Asia, just referred to, would afford an easy migration corridor between Asia and Africa, and when that area became uncomfortably dry a movement of population could take place to the north or south. If the people then living there were originally inhabitants of a temperate region they would be more likely to drift northwards than southwards. *(See* CLIMATE, HISTORY OF.)

According to Pettersson a period of maxima of tide-generating force attained its latest phase in A.D. 1434 and has a periodicity of about 1,800 years. In the 14th century the devastating storm-floods of the North sea and the Baltic coasts resulted in cold periods and inundations in the northern countries with their consequences, famine and migrations of the population. About 1,800 years earlier similar storm-floods impoverished the people of the late Bronze age of Scandinavia, and land-elevation and deterioration of climate occurred throughout the north Atlantic. About 700 B.C. the amber trade route shifted from the Elbe and Weser to the Vistula, which indicates that the supply of amber was thenceforth chiefly derived from the Baltic instead of from the North sea, which was then in a tempestuous condition. There are statements in literature which connect the invasion of the Teutons and Cimbri into Gallia and later into Italy with a big inundation of the sea which destroyed their homesteads in Jutland. These catastrophes probably began as early as the 6th century B.C. There were also traditions amongst the Druids that their ancestors had been expelled from the islands on the other side of the Rhine by hostile tribes and by a great invasion of the ocean. Pettersson regards this as the primary cause of the great migrations in the first millennium B.C. which began with the decline of the Bronze-age civilization through catastrophes in nature which forced the inhabitants of the North sea countries to emigrate, and he finds that a maximum of oceanic disturbances must have occurred about the 3rd and 4th century B.C., as also happened about A.D. 1300–1400. He adds, "Apparently a warm, iceless period, which favoured agriculture and shipping and allowed the Scandinavian races to expand in the powerful manner which characterizes the Viking age, must have occurred between the interval of the two maxima of 400 B.C. and A.D. 1400. This prosperous epoch then corresponds to the former post-glacial heat-period or the Kjökken-mödding—and the earliest stage of the Bronze age. The remembrance of the bygone civilization 2,000 years earlier lived in the myths of the German race and found its expression in the *Edda.* According to Victor Rydberg the myths of the *Edda* centre in a great catastrophe in nature, the Fimbul-winter, or "Götterdämmerung," when frost and snow ruled the world for generations. (O. Pettersson, *Ur Svenska Hydrografisk-Biol. Kom. Skrifter,* V., and *cf.* C. E. P. Brooks, *The Evolution of Climate,* p. 147, 1922; *Climate through the Ages* [1926]; *cf.* G. C. Simpson, *Q.J.R. Meteorol. Soc.* liii., p. 213, 1927.)

O. Pettersson (*Ur Svenska Hydrografisk-Biol. Kom. Skrifter,* V.) states that in the 10th and 11th centuries a strong emigration took place from Norway to Iceland and Greenland, one Viking fleet taking 750 to 1,000 persons to Greenland; at this time the climate of Iceland and Greenland was comparatively mild, as there was no ice-blockage of the north coast of Iceland or round southern Greenland. At the end of the 13th century the first signs of an ice blockade appeared and at the close of the 14th century there was a great accumulation of drift ice off the east coast of Greenland. At the close of the 13th and beginning of the 14th century there began an invasion of Eskimo from the north which eventually wiped out the colonies of Norsemen. This invasion must not be regarded as a common raid, it was the migration of a people, and like other big movements of this kind was impelled by altered conditions of nature, in this case the alterations of climate caused by the advance of the ice. The Eskimo then lived further north in Greenland and North America,

but when the climate deteriorated and the sea which gave them their living was closed by ice the Eskimo had to find a more suitable neighbourhood. It should, however, be noted that F. Nansen (*In Northern Mists*, p. ii., 95, 1911) strongly combats the view that the Eskimo gradually overpowered and exterminated the Norsemen. The settlements were almost entirely cut off from Norway, imports of corn and flour finally ceased, stock could not be renewed, and unaccustomed dietary conditions, disease and probable decreased birth-rate in his view sufficiently account for the decline of the settlements and he asserts that this was not due to "the peaceful and unwarlike Eskimo." In any case this illustrates the difficulty of maintaining an artificial migration in a country where conditions are such that Europeans, who are dependent upon fresh supplies from the home country, can barely live. The climatically induced migration of the Eskimo at least reasserted the superior viability of a people long accustomed to special local conditions.

The question whether central Asia is becoming drier has been discussed for many years. Kropotkin held that there is a gradual desiccation irrespective of periods of greater or less rainfall. Ellsworth Huntington has written repeatedly on this problem and in *The Pulse of Asia* (1907); *Palestine and its Transformation* (1911) and other writings has accumulated evidence to show that the fluctuations in the prosperity of ancient civilizations are ultimately due to climatic conditions. Thus in the Nearer East there was progress and peace, save for dynastic wars, when the rainfall was sufficient, but when it began to diminish the peoples of the poor lands and deserts were set in motion. For example, after 1700 B.C. we hear of invasions from the desert and elsewhere. Kassites invaded Media, Elam and Babylonia, and Egypt was swamped by the Hyksos, who brought their families, flocks and herds, and introduced the horse to Egypt, and we know that famine was the reason for the migration of Hebrews into Egypt. For 200 years after the expulsion of the Hyksos Egypt again prospered. About 1400 B.C. the Aramaeans invaded Syria from the south and the Hittites from the north. The second millennium was a period of depression in the ancient East; from Arabia, Central Asia and Europe new nations immigrated into the lands of ancient civilization. This universality was probably due to widespread adverse economic conditions which were beyond human control. This sort of thing has happened time after time, and analogous incidents have doubtless occurred elsewhere among peoples beyond the ken of history. The theory that the increasing aridity of parts of Central Asia is the direct result of climatic change has been disputed by several authorities (*cf.* A. Stein, *Geog. Journ.* lxv., pp. 485–490, 1925; R. C. F. Schomberg, *G.J.*, lxxii., p. 357, 1928).

Elaborate hypotheses have been promulgated about sunken continents. There is a considerable literature about "Atlantis" and Macmillan Brown adduces evidence satisfactory to himself in favour of a sunken continent or, at all events, of great land areas in the Pacific. Naturally the existence of great land masses in these oceans in human times would have had a considerable effect on migrations if, as is claimed, they belong to human times, but, on the other hand, existing distributions can, on the whole, be satisfactorily explained by present conditions.

We do know, however, that great tracts of land have been alternately submerged and elevated within relatively recent times, for example, men hunted game over what is now the North sea, and coastal areas are constantly liable to fluctuations of level. There is thus ample evidence for compulsory migrations or shiftings of populations due to causes entirely beyond the control of man.

The direction in which all migrations take place is conditioned by geographical factors. We may take it as axiomatic that people will usually seek conditions similar to those to which they have become accustomed. This is, on the whole, true for modern emigrations and colonizations. There is a distinct tendency for people to emigrate to similar latitudes or to countries with a climate which resembles that of the home country. Northern Europeans seem to experience greater difficulty in acclimatization in tropical countries than do south Europeans. The subject is a difficult one as it is complicated by habits of life and by tropical diseases, as well as by the effects of heat and moisture. Northern Europeans by taking suitable precautions can live long and healthy lives in the tropics, but it has yet to be shown that their descendants can live the whole of their lives there and indefinitely continue the race. The only definition of a "white man's country" is one which includes the latter proviso. A transplanted population which has to be continually replenished by fresh immigrants and has to be diminished by the return of the children to the home country cannot be described as a true migration, it is merely an occupation of the country. In primitive times, that is, before the period of the means of efficient overseas transport, migratory movements of a people were perforce usually very slow and thus it was possible for acclimatization to take place to some extent *en route*. But this may not have been always operative, as there seem to be indications that the Amerinds of Guiana, for example, are not yet thoroughly acclimatized to their tropical habitat.

We may take it as a general rule that voluntary migratory movement in early times took place only along lines of least resistance. Definite barriers which could not be crossed, or only to a small degree, were ice and snow, oceans, inland seas, lofty, inhospitable mountain ranges, dense forests, jungle-clad, tropical mountain regions, swamps, very poor steppes and deserts. Under exceptional circumstance or through dire necessity these might be partially negotiated by small bands, but normally they would prove to be definite obstacles to the migration of whole communities. On the other hand, grassy plains and plateaux, savanna or bush veldt, loess lands, etc., afforded highways for migration. On the whole, mountain ranges running east and west do form appreciable barriers, those running from north to south may do so for people wanting to travel east or west, but for those travelling from north to south, or vice versa, they may afford toilsome but practicable bridges along which people accustomed to a temperate climate might cross unhealthy tropical regions, all the time keeping to healthy conditions. It is, however, unwise to suggest actual routes for prehistoric migrations until geographers and others have provided maps which give the orography, climatic conditions and flora; for these determine the lines of least resistance or, at all events, the routes along which difficulties could be readily overcome, and at the same time the maps would supply information concerning routes which would be quite impracticable.

Another type of barrier is found in densely populated areas, the inhabitants of which, if strong enough, would prevent a migration across their territory. The same applies to a country which had a strong military force or contained a warrior population. There are many examples of this. Artificial barriers such as dykes and ramparts or walls may prevent movements for, at all events, some time. As Ujfalvy suggests: "The building of the great wall of China was an event fraught with the greatest consequences, and one may say without exaggeration that it contributed powerfully to the premature downfall of the Roman Empire." (C. de Ujfalvy, *Les Aryens au nord et au sud de l'Hindou-Kouch*, p. 24, 1896.) Barriers are thus relative, and only in rare cases are they insurmountable.

There are certain means of transport which greatly facilitate movements of peoples, such as beasts of burden and boats. The domestication of the few animals that could be utilized for riding and drawing of vehicles is confined to the Old World, though in Peru llamas are used to carry burdens and to a slight extent for riding, and dogs were utilized in North America to drag travaux on the plains and sledges in the arctic regions. The domestication of the reindeer for hauling sledges is confined to the arctic regions of the Old World and possibly this idea arose from the example of draught cattle. Only to a limited extent were these animals aids to movements of peoples. Probably somewhere in central western Asia before 5000 B.C. took place the domestication of camels, cattle, horses and asses. Although invaluable for arid areas the camel has a restricted use, and it is not suitable for and does not thrive in most countries or climates. Cattle can be employed almost everywhere except where there is intense cold

or great scarcity of water. Their rate of progress is slow, but we know that ox carts or wagons were used for human transportation in the Bronze age, and in our own time the trekking of the Boers in South Africa was accomplished in the same manner. A pastoral or semi-pastoral people can only migrate along a country which affords sufficient pasturage and water—mountains, deserts and swamps are practically insuperable for such peoples. A further barrier for migration is found in the tsetse fly, ticks and other insect pests, which afford intermediate hosts of the parasites of various kinds of cattle diseases; these have been especially operative in Africa. The use of the yak and sheep in Tibet as beasts of burden has had no effect on migrations. The horse on account of its speed has rendered possible rapid raids of nomad peoples, which would prepare the way for more leisurely mass movements, since communities moving with their flocks and herds cannot travel faster than the slowest of these. The horse reached Sumeria from the north about the time of Hammurabi and later the conquest of Egypt by the Hyksos was greatly facilitated by their horse-drawn war chariots, for it was not till subsequently that cavalry were employed in warfare. Wherever the horse has been taken it has facilitated human movements, and so, to far less extent, has the ass.

We may well believe that for many thousands of years large stretches of water proved very effective barriers to migration. Rivers might be crossed on floating logs and rafts; later would come dug-outs and such craft as the coracle and allied skin boats of the Old World and the bull-boat of North America, which are practically skin-covered baskets; certainly very early there were floats and incipient boats made of bundles of reeds, etc., and doubtless also bark canoes and skin floats; but none of these would be efficient for long distances on open seas. It seems improbable that the Tasmanians, for example, could have crossed Bass strait as it now is in the floats of bundles of bark that they possessed when first discovered. It was not until canoes were provided with side-planks that seaworthy vessels were available for oversea commerce, warfare and colonization. The invention of outriggers to steady such craft occurred in the Indian ocean, either in the East Indian archipelago or in India, but nowhere else; and it was by this discovery, together with that of lashing two canoes together to form a double canoe, that the migrations of the Polynesians all over the Pacific became possible. Some maintain that the invention of sea-going craft was due to the ancient Egyptians, but there is also a case to be made out for at least an independent invention in the Persian gulf or possibly in India. Peake and Fleure are of opinion that "between 4000 and 3500 B.C. the Sumerians arrived probably by sea, at the head of the Persian gulf, bringing with them for the first time into Mesopotamia herds of dairy cattle, an advanced copper culture, and a habit of decorating objects by means of inlaid slabs of mother-of-pearl and other materials." (*The Corridors of Time,* III., p. 95, 1927.) But there were two earlier civilizations in Mesopotamia.

Not only superior means of transport by land or sea, but possession of more deadly weapons or improved implements for daily needs have given their owners decisive superiority when coming in contact with worse equipped peoples. These advantages have been potent factors in producing changes of population.

It is probable that a migration induced by an attraction is much rarer than one produced by an expulsion. The simplest cases of migration by attraction are those of peoples living on poor steppes or plateaux adjoining cultivated land or rich valleys. Agricultural peoples, as a rule, are averse to and ill-prepared for war and the more prosperous their circumstances the more they are likely to be enervated by their very civilization. They are thus liable at all times to be attacked by neighbouring brigands, who in some cases retire to their barren homes with their booty, but in others remain among the conquered people, and, assimilating with them, in due course become more civilized, and in their turn are subject to invasions from their barbarian kinsmen of the borders. The walled towns of ancient Greece in the centre of valleys opening out to the sea point to a danger from the brigands of the mountains and possibly also from pirates from the sea. The inhabitants of the rich plains of Assam have always been subject to raids and settlements by the hill tribes. The earliest records of the Nearer East show (and this has continued to the present day) that the pastoral peoples have preyed upon the agriculturalists and have frequently colonized considerable areas.

Hunger and loot are not the only impulses towards migration. The restless disposition of the "winners of the West" of North America was not due to an inability to maintain an existence in the eastern States nor to an expectation of speedy riches. A craving for land is only a partial explanation; sentiment and a reaction against even the slightest of social restraints had a good deal to do with it, as it had for the trekking of the Boers. Gold rushes are different, as wealth may thus be speedily gained by rapid exploitation.

Migrations have taken place to gain freedom from social, political or religious bondage, like the exodus of the Hebrew bondmen from Egypt, the voyage of the "Mayflower" or the migration of the Flemings and Huguenots into Britain. Religious enthusiasm may stimulate race expansion and lead to shiftings of populations as seen in the histories of Buddhism, Christianity and Islam. The partnerships of the crescent and the sword, of the cross and the gold of El Dorado, have been based upon a double enthusiasm which has led to migrations.

The movements of peoples which are sufficiently dramatic for the ordinary historian to record are often of less importance than the quiet, steady drift of a population from one area into another, as, for example, the emigration from Europe to America in modern times. Movements may result in a noticeable or even fatal depletion of a country, and the parent country may remain desolate or may be filled up in course of time by an alien people as in the case of eastern Germany and the Slavs in the 4th and 5th centuries A.D.

An excellent example of the migration of cultures is given by Prof. V. Gordon Childe in his paper on "The Danube thoroughfare and the beginnings of civilization in Europe" (*Antiquity,* i. p. 79, 1927), in which he traces the spread of culture along the deposits of loess in the Danubian region. The evidence seems to point to the fact that the majority at least of the people were long established in this region before the little settlements of Aegean fishers became outposts of Troadic commerce and led to the opening up of mines of cinnabar, gold, copper and tin. Childe says: "The discovery and original exploitation of the Bohemian tin deposits and hence the inauguration of a bronze industry in Central Europe was due to explorers coming up the Danube from the south-east. Now the first dated bronze objects found in a definite context in Britain come from the graves of the so-called Beaker Folk, who reached these islands from Central Europe. It therefore seems likely that we owe our first metallurgy in the long run to those explorers from Troy whose tracks we have been following up the Danube. So not only was that river one of the routes by which a so-called 'neolithic' culture reached north-western Europe, it was also a channel in the diffusion of the arts of metallurgy northward and westward from the Ancient East."

In his *Dawn of European Civilization* (1925) Prof. Childe traces in detail the growth and spread of culture up to the Middle Bronze age. His view is that the cultures of the collectors and hunters and fishers of epipalaeolithic times do not in any real sense constitute points of transition from the palaeolithic to the neolithic culture, but that the latter gradually spread westwards. "Peasants with stone hoes and axes opened up its valleys to cultivation; hunters and herdsmen blazed the trail through its primaeval forests; mariners in dug-out canoes sailed the seas to the isles of the West; prospectors with picks of horn and flint revealed the treasures of the earth and crossed mountain passes in search of merchandise. These explorers were the forerunners of Greeks and Phoenicians; the paths they discovered have been followed by Roman roads and modern railways" (p. 14). He regards the Occident as "indebted to the Orient for the rudiments of the arts and crafts that initiated man's emancipation from bondage to his environment and for the foundation of those spiritual ties that co-ordinate human endeavours. But the peoples of the West were not slavish imitators; they adapted the gifts of the East and united the contributions made by Africa and Asia

into a new and organic whole capable of developing on its own original lines" (p. 13).

Owing to the great amount of careful archaeological investigation in Europe the cultural history of that region is becoming increasingly clear, but when data are available it will probably be found that the same general principles have obtained elsewhere. New techniques, ideas, and ideals are continually spreading, sometimes slowly, sometimes with considerable rapidity, but the recipients by no means adopt them wholesale, they accept what appeals to them and usually in so doing they modify them to their own particular needs or idiosyncrasies. We may regard this as being true for all times and all places.

With regard to customs and religious ideas and ceremonies there is probably always some personal influence, though the results may be disproportionate to the numbers of the culture-bearers; in these instances the racial drift may be inappreciable, or may not affect the physical characters of the local population in the least, while the cultural drift may be very conspicuous. A good illustration of this last is seen in the spread of European culture and religion by Christian missionaries, but it is by no means confined to these. The gradual spread of cults and customs has been proved by careful investigations among many peoples and it can be traced in action as well as by inference. Wirz has shown that in the last 50 years a secret cult has been adopted from communities on the coast, by three villages on Lake Sentani (in north New Guinea). These three villages have since drawn together and look down upon the neighbouring villages which have not adopted the cult. (*Tijds. v. Ind. Taal-Land-en Volkenkunde*, lxiii., p. 53, 1923.) There is a tradition that the teaching of ceremonies, including the elaborate death ceremonial, was introduced into the western islands of Torres straits by two culture heroes from New Guinea and there are other folk-tales of migratory culture-heroes instructing the people in better ways of living. The great religious cult of Murray Island was brought by what can only be described as the missionary zeal of the western islanders, and most of the funeral ceremonies and many sacred songs admittedly came from the west. (*Rep. Camb. Anth. Exped. to Torres Straits*, v. 1905; vi., 1908.) An interesting parallel occurred also in Fiji. Two culture heroes are reported to have distinctly stated that they went to Fiji to teach the cult associated with large stone enclosures, *Nanga* (A. B. Joske, *Internat. Arch. f. Ethnogr.* ii., p. 258, 1889). In all these instances there is not the slightest trace in tradition or elsewhere of secular aggression. A. B. Deacon has traced the spread of the Kakihan Society from Ceram to New Guinea and Melanesia (*Folklore*, xxxvi., p. 332, 1925).

Since 1911 G. Elliot Smith has affirmed the diffusion of culture from Egypt to every part of the world; his views are stated in his *The Migrations of Early Culture* (1915) and he gives an account of the development of "the new teaching" in the second edition of *The Ancient Egyptians* (1923), where he stated "There can no longer be any doubt that the essential elements of civilization did really originate in Egypt." He gives a number of arts, practices, and beliefs which he affirms were carried by Egyptian seamen to various countries. These became centres of secondary diffusion, and ultimately this culture-complex reached America across the Pacific. In *The Evolution of the Dragon* (1919) he suggests that these culture-bearers were seeking for "givers of life," which W. J. Perry is "convinced" is "one of the most important generalizations ever made in the study of human society" (*The Children of the Sun*, 1923). In this book and in several others (*The Megalithic Culture of Indonesia*, 1918; *The Growth of Civilization*, 1924, etc.), Perry has elaborated the details of the spread of this so-called "Archaic Civilization." For criticisms of this theory and the methods of its promulgators *cf.* J. L. Myres, *Folk-lore*, xxxvi., p. 15, 1925; *The Geographical Teacher*, xiii., pp. 8, 152, 155 (1925); H. St. L. B. Moss, *The Quarterly Rev.*, No. 494, and more recently Roland B. Dixon, *The Building of Cultures* (1928), in which he gives a careful discussion of the diffusions of cultures and a criticism of various theories of diffusion.

The evidence for the migrations of unlettered peoples is to be sought mainly in the physical characters of peoples, their artifacts, customs, folk-tales and language. Each of these sources of information has to be utilized with great caution as there are many dangers of erroneous interpretations of actual facts. As a rule every tribe or isolated community has definitely characteristic artifacts, but if these are found to be subject to modification it has to be determined whether there has been a local evolution or whether, as is most probable, influences have come in from elsewhere, in which case the change may be due to a "racial drift" or to the imitation of objects obtained by trade or loot, that is, a cultural drift. The introduction and methods of utilization of domestic animals and plants is analogous to the foregoing. For instance, the introduction of the horse into America was due to a racial drift, but its employment by the Plains Indians and the Amerinds of the pampas of South America was a culture drift. A good example of a simple culture drift is the spread of the use of tobacco over Africa and New Guinea. Finally, language is a criterion for racial contact, but not necessarily for a migration on a large scale.

For a general account of the main racial migrations the reader is referred to A. C. Haddon, *The Wanderings of Peoples* (1911); Grafton E. Smith, *The Migrations of the Early Culture*, London and New York, 1915; *Brief List of References on Racial Migration*, Library of Congress, Select List No. 708, Wash. 1922; *The Races of Man and their Distribution* (1924). (A. C. H.)

MODERN HISTORY

A new epoch in migration and in world history commenced with the great geographical discoveries, which opened up to Europe vast continents containing unlimited natural resources. The early movements from Europe were prompted by the spirit of adventure and the search for gold. Trading centres were next established and population began to flow from the Old World to the New Portugal and Spain established settlements in South America in the 16th century, and by 1570 it is estimated that there were 100,000 white men in the overseas empire of Spain. The first English settlements overseas date from the early 17th century. French migration to Canada also began in the 17th century. In 1664 the population of French Canada was 2,500, and by 1760, the date of the British conquest, this had reached to 70,000.

EMIGRATION TO THE UNITED STATES

The population of the United States in 1790 was 4 millions. In 1926 it was estimated at 105,000,000 (excluding the coloured population). The immigration from Europe into America during the past century, which has been mainly responsible for this growth, has been, both in its volume and its variety, the most remarkable peaceful mass movement of population in history.

The number of immigrants who entered America previous to the year 1820 is not accurately known, but it is supposed to have averaged from 5,000 to 6,000 a year and the total number of immigrants from the time of the foundation of the National Government down to 1820 was probably not more than 250,000. The total number of immigrants from 1820 to 1927 was 37,000,000, of whom 32,000,000 came direct from Europe.

In 1820 the number of arrivals was 8,385 and by 1830 it had reached over 20,000. During the decade 1830–40 some 60,000 immigrants annually were admitted, while from 1840–46 the average number was about 90,000. Down to 1846, the first 70 years in America's national life, the total number of immigrants was less than 1,600,000, whereas in that period the population of the United States grew from 3,000,000 to 21,000,000.

In 1847 the great tide of immigration began with an enormous influx from Ireland, following upon the potato famine, and two years later political troubles led to heavy immigration from Germany. From 1847 to 1854 immigration ranged between 250,000 and 400,000 per annum.

During the ten years 1847–56 approximately 3,000,000 immigrants entered America—twice the total number that had arrived during the previous seventy years. Immigration slackened during the Civil War period, but increased again thereafter, until by the year 1890 the total number of immigrants admitted to the United States had reached a figure of over 15,500,000.

The financial crisis of 1893 temporarily checked immigration, but the upward trend was resumed, and during the twenty-four years 1891–1914 the total number of immigrants was 16,500,000. In each of the six years 1905–07, 1910 and 1913–14 the number exceeded a million. The greatest number of immigrants arriving in any one year was 1,285,000 in 1907.

These figures include numbers of people who did not remain permanently in the United States, but the following table shows the population of the United States at each census, the decennial increase, and the average net immigration (*i.e.*, excess of arrivals over departures) during the period 1790–1925:—

United States Population at Each Census, Decennial Increase, and Net Immigration: 1790–1925

Census year	Population		Net immigration in the decade
	Total	Decennial increase	
	Millions	Millions	Millions
1790	3·9	..	..
1800	5·3	1·4	..
1810	7·2	1·9	..
1820	9·6	2·4	..
1830	12·9	3·3	0·1
1840	17·1	4·2	0·6
1850	23·2	6·1	1·6
1860	31·4	8·2	2·7
1870	38·5	7·1	2·4
1880	50·2	11·7	2·5
1890	62·9	12·7	4·3
1900	76·0	13·1	3·2
1910	92·0	16·0	5·6
1920	105·7	13·7	3·1
1925	115·4	9·7	2·0

The total immigration into the United States and the immigration from Europe during the period 1820–1927 by decades was as follows:—

	Total	Europe
1821–30	151,824	106,508
1831–40	599,125	495,688
1841–50	1,713,251	1,597,501
1851–60	2,598,214	2,452,660
1861–70	2,314,824	2,065,270
1871–80	2,812,191	2,272,262
1881–90	5,246,613	4,737,046
1891–1900	3,687,564	3,558,978
1901–10	8,795,386	8,136,016
1911–20	5,735,811	4,376,564
1921–27	3,278,576	2,013,304
Total 108 years 1820–1927	36,933,379	31,811,797

The proportion of the total immigrants from various countries of Europe during specified decades is shown in the following table:—

Country	(Percentages of total)			
	1861–70	1881–90	1891–1900	1901–10
Austria Hungary	·33	6·7	16·0	24·4
Italy	·51	5·9	17·7	23·3
Russia	·10	4·0	13·9	18·0
British Isles	44·90	28·0	17·9	9·8
Germany	34·00	27·8	14·0	3·9
Denmark, Norway and Sweden	5·40	12·5	10·0	5·7

A very important change took place during the period from 1880 to 1910 in the racial composition of the immigrants. Up to 1880 the peoples of northern and western Europe had predominated, but after 1880 the bulk of the immigrants came from southern and eastern Europe. In each of the two decades 1871–80 and 1901–10 the total immigrants from western Europe numbered approximately 2,000,000, whereas the total from southern and eastern Europe increased from 200,000 in the first of these two periods to over 6,000,000 (70·8% of the total) in the second. In the five years 1911–15 out of a total immigration from Europe of 3,796,000, the number from southern and eastern Europe was over 3,000,000 or 79% of the total.

Up to 1917 this enormous volume of immigration was admitted without restrictions upon the white races other than (a) the exclusion under the Immigration Act of 1882 and subsequent legislation of certain undesirable classes, *e.g.*, criminals, paupers and physical and mental defectives, etc. (b) those imposed by the Alien Contract Labour Law of 1885 forbidding the entry of any person under a contract made previously 'to perform labour or service of any kind in the United States.'

The proportion of arrivals excluded under the provisions of the various Immigration Laws was negligible, the total number debarred in 1913 being 20,000 or 1·4% of the total applicants for admission.

The problem of the assimilation of the various elements included in this vast volume of immigration was giving rise to some anxiety before the World War. A policy of restriction was advocated as far back as 1880. American labour organizations had long been in favour of some form of restriction, and a commission appointed by President Roosevelt in 1910 reported that immigration restriction "was demanded by economic, moral and social considerations" and suggested a restriction law on a percentage basis. Experience during the World War raised the issue in an acute form, and a clause was inserted in the Consolidating Immigration Act of 1917 prohibiting the entry of illiterates over 16 years of age. This proved ineffectual in producing the desired effect. It was anticipated that the close of the World War would be followed by an influx from Europe which would equal, and perhaps exceed, anything which had hitherto been experienced. That this fear was not without foundation was shown by the fact that 430,000 immigrants entered the United States in 1920 and over 800,000 in 1921.

The United States Immigration Act, 1921.—In order to meet this situation emergency legislation was passed and came into operation on June 2, 1921, which limited "the number of aliens of any nationality who may be admitted under the immigration laws to the United States in any fiscal year . . . to 3 per centum of the number of foreign-born persons of such nationality resident in the United States as determined by the United States census of 1910."

This fixed the total annual immigration at 357,803 and that from Europe at 353,747, approximately one-third of the number of European immigrants during the years 1913 and 1914. The proportion or quota for Great Britain and Ireland under this law was 77,342, for Germany 68,059, for Italy 42,057, for Poland 25,827, for Russia 34,284 and for Sweden 20,042. Certain categories of persons were excluded from the quota arrangements.

This Act not only limited the aggregate numbers of immigrants. It was also selective in character, in that its effect was to reduce the proportion of immigrants from southern and eastern Europe to less than one-half of the total, viz., 198,000 from northern and western Europe and 158,000 from southern and eastern Europe.

The object of the law was, however, partially defeated by increased immigration from Canada and Mexico, which were not included within the scope of the quota provisions, and from which aliens could enter provided they had been resident in a country on the American continent for one year (subsequently amended to five years). In consequence of the increase in immigration from Canada and Mexico the total immigration during the three years 1922–4 during which the law was in operation was actually on the up-grade, as will be seen from the following figures:—

Immigration Into the United States, 1920–4

Fiscal year	Oversea	Continental	Total
1920	287,615	142,386	430,001
1921	702,153	103,075	805,228
1922	243,195	66,361	309,556
1923	343,140	180,779	522,919
1924	416,870	290,026	706,896
Total	1,992,973	782,627	2,774,600

Clandestine immigration by land and sea added to these totals.

The Act of 1921 was only a temporary measure in order to allow time for framing a more permanent policy of restriction. This was embodied in the Immigration Act of 1924 (the "Johnson Act").

The Immigration Act, 1924.—This Act came into force on July 1, 1924, and assigns a temporary maximum limit of about 160,000 to the number of immigrants from Europe to be admitted in any one year, that number to be ultimately reduced to 150,000 per annum. (This total is exclusive of immigrants from countries outside the operation of the law and of non-quota immigrants.) The main provisions of the Act are:—

(i.) In any year there shall be admitted to the United States not more than 2 per centum of the number of foreign-born individuals of any nationality resident in Continental United States as determined by the United States census of 1890. This constitutes each country's quota. The minimum quota of any nationality is 100. The census of 1890 was chosen because it was considered that the census record of that year showed that the number of foreign-born persons then corresponded better than later censuses to the racial composition of the United States population in 1924. On this basis the annual quotas allotted to the principal countries of emigration are as under. For comparison the quotas allotted under the 1921 Act are also shown, and the average immigration from the countries mentioned during the decade 1901–10:—

	Quota 1921–2	Quota 1924–5	Average Immigration 1901–10
Northern and Western Europe			
Belgium	1,563	512	4,163
Denmark	5,619	2,789	6,528
France	5,729	3,954	7,337
Germany	67,607	51,227	34,150
Great Britain and Northern Ireland	77,342	34,007	52,595
Irish Free State	..	28,567	33,906
Netherlands	3,607	1,648	4,826
Norway	12,202	6,453	44,003
Sweden	20,042	9,561	
Switzerland	3,752	2,081	3,499
	197,463	140,799	191,007
Southern and Eastern Europe			
Austria Hungary	13,089	1,258	214,526
Czechoslovakia	14,357	3,073	..
Italy	42,128	3,845	204,587
Poland	30,977	5,982	..
Rumania	7,419	603	5,300
Russia	24,405	2,248	159,370
Yugoslavia	6,426	671	..
	138,801	17,680	583,783

The total immigration from south and eastern Europe was reduced to less than one-fifth of that from northern and western Europe, the proportion being 15% and 84% respectively. The effect is still more noticeable if the emigration to the United States from the most important European countries of emigration in 1914 is compared with that during the years 1921–7:—

desirable types. Immigrants from other countries on the American continent do not come under the law at all if born in one of those countries, but if born elsewhere they can only be admitted as part of the quota of their country of birth, *i.e.*, a person born in Great Britain can only be admitted from Canada if he can be included in the British quota.

(iii.) Aliens ineligible to become naturalized citizens under the United States naturalization laws are not admitted excepting under existing Treaty stipulations. This provision excludes the Japanese. Japanese immigration had previously been governed not by a formal treaty, but by a "Gentleman's Agreement" under which the Japanese Government agreed to limit the entry of its subjects into the United States.

(iv.) The Act also provided that after July 1, 1927, the total number of immigrants in any one year was to be reduced to a total of 150,000, the quota of each nationality being the proportion of 150,000 determined by the ratio between the number of inhabitants having that national origin to the total population of the United States in 1920. This is known as the "national origin" plan. It did not take effect on July 1, 1927 Congress postponing its operation for a year. On this basis, according to proposals laid before Congress in March 1928, the principal alterations would be the increase of the quota of Great Britain from 34,007 to 66,000, and the reduction of the quota of Germany from 51,227 to 25,000, of the Irish Free State from 28,567 to 17,500 and of Norway, Sweden and Denmark from 18,803 to 11,000.

The national origin plan was intended to give immigrants from the various countries representation approximately proportional to the number of people of their own nationality domiciled in the United States. In principle it seemed fairly easy to work out such representation; in practice it has proved difficult and the provisional quotas to be allotted have been changed several times.

The restrictive legislation was two-fold in its intention: (i.) to reduce the number of immigrants so as to afford an opportunity for assimilation; (ii.) to allow future immigration on a scale designed to preserve a reasonable degree of homogeneity in the population of the United States. "The myth of the melting pot has been discredited. . . . The day of unalloyed welcome to all peoples, the day of indiscriminate acceptance of all races has definitely ended" (Johnson).

The effect on the proportion of the English-speaking races (English, Irish, Scotch and Welsh) entering the United States is shown in the following table:—

Immigration Into the United States of English and Non-English Speaking Races

Year	Total immigration	English-speaking	Non-English speaking	Percent of total English	Percent of total Non-English
1914	1,218,480	107,199	1,111,281	8·8	91·2
1921	805,228	120,080	685,148	14·9	85·1
1922	309,556	64,172	245,384	20·7	79·3
1923	522,919	131,159	391,760	25·1	74·9
1924	706,896	200,265	506,631	28·3	71·7
1925	294,314	121,911	172,403	41·4	58·6
1926	304,488	115,293	189,195	37·8	62·2
1927	335,175	111,735	223,440	33·3	66·7

Immigration Into the United States from Certain Countries of Europe, 1914 and 1921–27

Country	1914	1921	1922	1923	1924	1925	1926	1927
England, Scotland, Wales	48,729	51,142	25,153	45,759	59,490	27,172	25,528	23,669
Germany	35,734	6,803	17,931	48,277	75,091	46,068	50,421	48,513
Ireland	24,688	28,435	10,579	15,740	17,111	26,650	24,897	28,545
Norway, Sweden, Denmark	29,391	22,854	14,625	34,184	35,577	16,810	16,818	16,860
Austria	134,831	4,947	5,019	8,103	7,505	899	1,102	1,016
Hungary	143,321	7,702	5,756	5,914	5,806	616	906	813
Italy	283,738	222,260	40,319	46,674	56,246	6,203	8,253	17,297
Russia	255,660	6,398	17,143	17,507	12,649	1,775	1,766	1,183

(ii.) Certain classes of immigrants are exempted from the quota arrangements, *e.g.*, the dependants of previous immigrants naturalized in the United States, and certain other individual

The policy of restriction has been based mainly on considerations of race-dilution, literacy, standards of living, etc. It remains to be seen what will be the economic effect of the closing

*Oversea Migration From and Into Great Britain and Ireland for the Years 1913 and 1920–27**

Year	British Empire				Foreign		Totals	
	British N. America	Australia	New Zealand	Other parts	U.S.A.	Other parts	Great Britain and N. Ireland	Great Britain and Ireland
1913: Out	190,854	56,779	14,425	23,158	94,691	9,657	..	389,394
In	26,288	12,351	2,446	20,440	16,619	7,565	..	85,709
Balance	*164,566*	*44,428*	*11,809*	*2,718*	*78,072*	*2,092*	..	*303,685*
1920: Out	118,837	28,974	14,853	35,930	77,151	9,357	..	285,102
In	24,341	12,854	2,568	24,114	17,084	5,094	..	86,055
Balance	*94,496*	*16,120*	*12,285*	*11,816*	*60,067*	*4,263*	..	*199,047*
1921: Out	67,907	27,751	11,513	29,606	56,393	6,307	..	199,477
In	21,055	8,861	1,568	21,063	13,925	4,895	..	71,367
Balance	*46,852*	*18,890*	*9,945*	*8,543*	*42,468*	*1,412*	..	*128,110*
1922: Out	45,818	39,099	12,259	21,234	49,902	5,784	..	174,096
In	16,197	8,310	2,223	22,957	12,611	5,728	..	68,026
Balance	*29,621*	*30,789*	*10,036*	*−1,723*	*37,291*	*56*	..	*106,070*
1923: Out	88,290	39,967	9,392	19,413	93,076	6,146	256,284	269,680
In	12,424	8,384	2,204	21,426	7,042	6,126	57,606	61,686
Balance	*75,868*	*31,583*	*7,188*	*−2,013*	*86,034*	*20*	*198,678*	*207,994*
1924: Out	63,016	38,599	11,061	19,541	17,315	5,842	155,374	174,451
In	15,822	8,295	2,321	20,918	10,880	5,876	64,112	66,611
Balance	*47,194*	*30,304*	*8,740*	*−1,377*	*6,435*	*−34*	*91,262*	*107,840*
1925: Out	38,662	35,006	11,730	19,827	29,549	5,820	140,594	170,774
In	13,939	7,737	1,964	18,699	8,045	5,951	56,335	58,490
Balance	*24,723*	*27,269*	*9,766*	*1,128*	*21,504*	*−131*	*84,259*	*112,284*
1926: Out	49,632	44,513	16,565	21,596	28,740	5,555	166,601	196,642
In	10,481	7,599	2,172	18,827	6,261	5,723	51,063	52,849
Balance	*39,151*	*36,914*	*14,393*	*2,769*	*22,479*	*−168*	*115,538*	*143,793*
1927: Out	52,916	40,991	7,841	20,985	25,662	5,110	153,505	180,653
In	12,570	8,032	2,511	19,071	6,765	6,766	55,715	57,619
Balance	*40,346*	*32,959*	*5,330*	*1,914*	*18,897*	*−1,656*	*97,790*	*123,034*

*Note: Figures for the years 1913 and 1920–2 include the whole of Ireland: for the years 1923–7 the detailed figures in the table are exclusive of the Irish Free State.

The totals in the last column include for the years 1923–7 the figures for the Irish Free State, for purposes of comparison.

of the main source of the unskilled labour supply of the United States. Unskilled labour in the past has been drawn mainly from the new immigrants and the supply of skilled labour largely from their children, since the tendency is for the more laborious and less remunerative tasks to be left to immigrants. The immigrants under the quota law are not likely to be of the type which will fill the places in the industrial system left vacant by the old type of immigrant. One effect of the restriction on overseas immigration is already apparent; it has encouraged the movement of negroes from the agricultural southern States to the industrial North and it is drawing from across the Mexican border immigrants who are presumably no more desirable from a biological point of view than those European races excluded by the quota law. It has also led to increased immigration from Canada, from which country and from Mexico there is in addition a considerable amount of illegal immigration. The extension of the quota arrangement to countries on the American continent and an aliens registration law have been advocated. For the National Origins Act of 1929, *see* UNITED STATES, *Population and Social Conditions.*

MOVEMENT OF POPULATION WITHIN THE BRITISH EMPIRE

For nearly two centuries emigration has been a habit with the British people. Beginning in the 16th century there has been a continuous flow of population from the British Isles to all parts of the world. The stream has fluctuated with changing conditions in Great Britain and in the countries overseas, but since it began, although it has sometimes slackened, it has never ceased.

The first British settlements overseas date from the 17th century, when colonies were established in Virginia, Massachusetts, Bermuda and Barbados. Emigration did not attain large proportions in the 18th century, but between 1820 and 1914 over 16,000,000 people left the United Kingdom to settle overseas. From this total must be deducted the number of foreigners who emigrated by way of Great Britain, of whom no separate record was kept before 1852, and also the number of emigrants who returned. On a rough estimate, however, it is probable that the net emigration from Great Britain amounted to 10,000,000 during the hundred years from 1820. The figures reflect the influence upon emigration of conditions in Great Britain and overseas; for instance, the Irish potato famine of 1846 and gold discoveries in California and Australia resulted in an average outflow of 286,000 a year in the nine years 1846–54. Later, the agricultural crisis of 1880–90 was responsible for a large increase in emigration.

Statistics.—The above table shows the British migration movement to and from countries outside Europe for the years 1913 and 1920–27.

The United States was for a long time the chief destination of British emigrants. Between 1815 and 1906 out of every 100 British emigrants 65 went to the United States, 15 to Canada, 11 to Australia and 7 to other parts of the empire. But these proportions changed in later years. The United States still headed the list up to 1904, but after that the dominions absorbed the larger portion, viz., 62% in 1910, 70% in 1912, 75% in 1919, 71% in 1920 and 79% in the years 1920–7.

In 1914 and previous years the flow of population from Great Britain averaged 350,000 per annum, of which 200,000 went to the dominions. During the years 1920–27 the total migration averaged 206,000 per annum, of which 163,000 went to the dominions.

Assisted British Migration.—At the close of the Napoleonic Wars the rapid growth of population and the prevalence of distress led to the adoption of a measure of State-aided migration and to the formation of colonization societies. The first settlements in the Cape of Good Hope and New Zealand were the outcome of this movement. Changes in conditions in Great Britain and the acquisition of responsible Government by the 'colonies,' who took over their own Crown Lands (by the sale of which assisted emigration had been financed), resulted in the gradual abandonment

of the policy and the grant of State-aid ceased in 1878. Numerically it had little effect on British emigration during the 19th century, for of the 8½ million emigrants during the period 1815–75 only 350,000 were assisted. It had a very considerable effect, however, in stimulating settlement in the dominions. Between 1878 and 1919 no encouragement was afforded by the British Government towards emigration although the question of State-aid was again raised during the period of distress in 1884–5. Nor was anything done (apart from the establishment in 1886 of an office—the Emigrants' Information Office—to collect and publish accurate information with regard to the British colonies) to direct migration to the British dominions rather than to foreign countries.

Since 1919, however, the British Government has again been endeavouring to encourage and direct migration from Great Britain. The importance of oversea settlement (as the movement of population within the empire is officially designated to distinguish it from emigration to foreign countries) was strongly emphasized by the Dominions Royal Commission (1917), which urged the need for a more effective supervision and direction of migration by co-operation between the Home Government and the Governments of the dominions.

At the close of the World War it was felt that the prospect of settlement overseas would appeal strongly to ex-soldiers and the British Government granted free passages to ex-service men and their dependents who desired to settle overseas within the empire. Under this scheme 82,000 souls were assisted to settle in the dominions.

The conference of prime ministers of the empire held in 1921 recommended co-operation between the home and dominion governments in a comprehensive policy of empire land settlement and empire directed migration. In accordance with this recommendation the Empire Settlement Act was passed in 1922. This Act, which forms the basis of the British Government's policy of State-aided overseas settlement, remains in force until 1937 and empowers the British Government to spend up to £3,000,000 per annum in co-operation with the government of an oversea dominion or with public or private organizations in Great Britain or overseas in schemes for assisting settlement in the dominions. The contribution of His Majesty's Government must not exceed one-half of the cost of any scheme.

The assistance granted towards oversea settlement under the Empire Settlement Act takes various forms. Assisted passage schemes have been arranged which considerably reduce the cost of travel to the settler, free passages are granted to young persons, and to single women in many cases. Assistance is given to enable suitable persons to settle on farms of their own in the dominions, and courses of training and testing in the United Kingdom have been arranged to prepare men and boys for farm work overseas, and women for household work. Under an arrangement between the Home Government and the Government of the Commonwealth of Australia the latter has agreed to raise loans for the purpose of making advances up to £34,000,000 at a low rate of interest to the State Governments in Australia for expenditure on approved schemes of settlement and development. The British Government contributes as a free grant towards interest on the loans one-fifth of the total amount raised, and Australia undertakes to absorb a total of 450,000 settlers from the United Kingdom within a period of ten years.

The work of voluntary organizations both in the United Kingdom and overseas is subsidized by the Governments on both sides. (*See* also OVERSEAS SETTLEMENT COMMITTEE.)

The table in next column shows the total migration from Great Britain and Northern Ireland, the total to places within the empire, and the total number of persons assisted under the Empire Settlement Act during the years 1923–27.

Year	Total migration overseas	Total migration within Empire	Total assisted migration
1923 . . .	256,284	157,062	36,185
1924 . . .	155,374	132,217	41,044
1925 . . .	140,594	105,265	39,529
1926 . . .	166,601	132,306	65,530
1927 . . .	153,505	122,733	63,027
Total . .	872,358	649,583	245,315

In each of the years 1926 and 1927 of those who went to places within the empire 50% were assisted. The proportion of assisted migrants to Australia was 73% and 71%, to Canada 42% and 55%, and to New Zealand 71% and 56%, in 1926 and 1927 respectively.

It is generally admitted that the results which have attended the working of the Empire Settlement Act have not been entirely satisfactory. In spite of an immediate surplus of population in Great Britain and of the grant of State-assistance on a liberal scale both the total migration from Great Britain and that to the dominions are less than in the period before 1914. The effect of the grant of State-aid has to a large extent been offset by the severe restrictions which the dominions have found it necessary to impose on the classes of persons to whom assistance can be granted.

Whilst it is impossible to say what would have been the rate of migration since 1919 in the absence of State assistance it is certain that the grant of State-aid has not resulted in any increase in the numbers of persons proceeding overseas, and it is very probable that had it not been for the United States quota restrictions the outflow to the dominions might have been smaller than it actually has been. In this sense the quota law has furthered Great Britain's policy of diverting people to the dominions. But whilst the United States absorbed large numbers of industrial workers, in the dominions the main openings for British settlers are on the land. For this reason the dominions do not offer to a mainly industrial people (safeguarded by extensive systems of social insurance) the same attractions as the United States. Great Britain has large numbers of skilled industrialists surplus to her immediate requirements who could with advantage to Great Britain be settled overseas. The dominions are, however, unable to encourage the immigration of industrialists as such, partly on account of the undeveloped state of their secondary industries, and partly on account of the attitude towards any form of immigration except that for agricultural work of the urban populations in the dominions, who naturally desire to safeguard their own position and to protect their standards of living. The door is open into the dominions, of course, for all classes of workers from Great Britain who can pay their own passages, but the high cost of ocean passages, particularly in the case of Australia, acts as an effective bar to any large stream of unassisted migration.

British Migration Policy.—The object of Great Britain's policy of oversea settlement is the distribution of the white population of the empire in the most efficient manner both from the point of view of the economic development of the empire and of its security. The policy is essentially one of close co-operation between the Home Government and the Governments of the dominions. In Great Britain the population is congested, in the oversea dominions there is ample room for additional population, and unless the dominions are peopled with British stock they will be filled with alien people from other parts of the world. A redistribution of population is recognized as necessary both in the interests of the empire itself and also for the reason that the reservation of vast areas for settlement by the British race cannot be justified if advantage is not taken of them. Whilst the policy is not a temporary one for dealing with depressed economic conditions in Great Britain it is claimed that its fulfilment should do much to stabilize industrial conditions both in the mother-country and in the oversea dominions.

The British empire includes both countries of emigration and countries of immigration and has its own problems to solve arising from this fact. The position created by the restrictions imposed by the dominions on Asiatic immigration has in the past presented delicate problems. By the end of the 19th century the question of Asiatic immigration had become acute in the dominions and restrictive legislation began to appear. After much discussion the principle appears to have been accepted by all the Governments concerned that the policy of building up new nations within the

empire is incompatible with the idea that any British subject, whatever his race, shall have full right of ingress to any part of the empire. At the Imperial War Conference of 1918 it was laid down that 'it is an inherent function of the Governments of the several communities of the British Commonwealth, including India, that each should enjoy complete control of the composition of its own population by means of restriction on immigration from any of the other communities.'

In Canada, foreign immigration is also causing some concern. During the ten years prior to 1914 British immigrants constituted the larger proportion of Canadian immigration, but the proportion of foreign immigrants from Europe has been steadily increasing until it exceeds that of British stock. In 1927 there were 52,940 immigrants of British extraction as against 82,136 from other European countries. This predominance is further accentuated by the considerable emigration from Canada to the United States, of which only one-sixth, according to the United States statistics, is foreign. If immigration to Canada continues to maintain these proportions it is only a matter of years before the predominant race in the Dominion ceases to be of British origin.

MIGRATION OVER LAND FRONTIERS

The migration which has been noted over land frontiers (Continental migration) has long been a feature of the movement of population in all parts of the world. In Europe it is mainly of a seasonal and temporary character as opposed to overseas migration, which is primarily a movement for permanent settlement.

France for many years has been dependent on foreign labour. In 1911 there were 1,159,835 foreigners in France, mostly Italians, and agricultural labour was regularly recruited abroad by official organizations. Germany also depended, after its industrial expansion began, on the seasonal migration of labourers from Poland, to the number of 250,000 a year for the harvest season alone.

Since 1918 Continental migration has increased in importance, not only on account of the larger numbers involved but on account of the political difficulties to which the movement has given rise. The work of reconstruction in France and Belgium and the restoration of the industries of those countries after the World War could only be effected by the aid of large numbers of labourers from other European countries. Continental migration in Europe has been further stimulated by restrictions on overseas emigration, for the demand for labour in France, Belgium and Luxemburg, supplied an outlet for the surplus population of Europe denied admission to the United States.

Before 1914 Germany was the principal employer of foreign labour (almost entirely agricultural) but since 1918 Germany has required only a fraction of its pre-war supply, has restricted the entry of foreign workers, and is seeking outlets for her own people. France, on the other hand, has been absorbing a largely increased, although fluctuating, volume of foreign labour. In 1923 and 1924 the number rose to over 250,000 a year, but has since declined considerably. The great majority of the immigrants into France were Italians.

The influx of foreign workers into the various countries of Europe has raised very difficult economic and social problems—questions of hygiene, national security, the legal and social position of the migrants, their status under the social insurance systems of the country of immigration. With a view to smoothing over these difficulties a large number of international arrangements have been concluded. Treaties or agreements have been entered into by France with Poland, Italy, Czecho-Slovakia, Belgium and Austria; by Italy with France, Luxemburg, the Serb-Croat-Slovene Kingdom and Albania; and by the Argentine Republic with Austria, Belgium, Denmark, Italy, Spain, etc.

Continental Migration—America.—The two main features of continental migration in America are (*i.*) the movement northward of the negro population of the United States; and (*ii.*) migration across the Canadian and Mexican borders.

(*i.*) The practical cessation of immigration from Europe during the World War and the increasing demand for labour led to a remarkable development in the negro problem in the United States. Large numbers of negroes from the southern States migrated to the industrial centres of the North attracted by the high wages and the conditions of town life. The restrictions placed upon immigration from Europe after the war further encouraged this movement, for the supply of unskilled labour in the United States has been drawn in the past largely from new immigrants.

(*ii.*) The reduction of oversea immigration has also been accompanied by increased immigration from Canada, which from the point of view of both countries is open to objection. To Canada it means that its immigration from Europe is being largely off-set by the movement across the border. During the three years 1925–7 the total immigration into Canada from overseas amounted to 340,000. During the same period it is estimated that 282,000 Canadians crossed into the United States. This emigration was only partially counter-balanced by the return of 144,000 Canadians temporarily resident in the United States.

On the other hand, from the point of view of the United States, it means that the restrictions placed upon immigration from Europe are being to a large extent rendered ineffective, for although persons born in Europe can only enter Canada on the quota of their respective countries of birth, the difficulty of controlling the movement across the border is so great that illegal immigration ("the bootlegging of aliens") is conducted on a considerable scale. More effective control appears to be essential if the United States immigration policy is to be maintained.

The shortage of labour in the southern States caused by the movement of negroes to the North and by the restrictions on immigration from Europe was met by a considerable immigration of Mexicans across the border.

The net addition made to the Mexican population of the United States in 1927 was 69,685, which was 15,237 more than in 1926, and 24,667 more than in 1925. It is probable that the quota law will have to be extended to Mexico and other countries on the American continent and further steps taken to check illegal immigration.

MIGRATION LEGISLATION AND INTERNATIONAL REGULATIONS

Restrictions and Control of Emigration and Immigration.—It has already been made apparent that the feature of the migration movement of the 19th and early 20th centuries was its comparative freedom from restrictions. So far as the white races were concerned, countries of immigration only interfered to the extent necessary to protect themselves from the incursion of persons regarded as undesirable, whether for medical or moral reasons, or of those likely to become a burden on the community. Since the World War, however, restrictions have been imposed upon the movement of population by countries of immigration which go beyond considerations of this nature, and, in addition, countries of emigration have imposed restrictions for national or political reasons. Migration has become subject to strict Government control, political intervention and methodical planning.

In the first place, countries of immigration have become much more strict in regard to civil and medical tests; immigrants are subjected to a process of selection and only admitted with severe restrictions in regard to numbers; occupational tests are enforced in many cases, and racial discrimination is applied even against the countries of Europe. Reference has already been made to the United States policy. South American and other countries have adopted somewhat similar restrictions. Brazil, Uruguay and Argentine, which before 1914 encouraged white immigration, have restricted it to certain classes, and even at times suspended immigration entirely. Canada restricts immigration from certain countries on the continent of Europe to *bona-fide* agriculturalists, prohibits assisted migration (except from Great Britain), and practically excludes certain European races entirely. Australia and New Zealand discourage, and have taken power to exclude, the immigration of any but British stock. France, which, since 1918, has been, in point of numbers, the second most important country of immigration, has also found it necessary to place limitations on the numbers of foreign immigrants.

The considerations which the countries of immigration have in view are sometimes economic, sometimes the safe-guarding of

standards of living; with others the motive is racial, either to limit the numbers of certain stocks or to preserve a territory as an area for the settlement of a particular race.

Countries of emigration are also adopting policies of restriction, or at any rate of control. Some of the new nations in Europe, *e.g.*, Czechoslovakia, Lithuania, from which there was formerly a considerable outflow of population, regard emigration as a danger to their national strength and for this reason have adopted a restrictive policy. Other countries, in order to protect their nationals prohibit or discourage emigration to territories where conditions are regarded as unsuitable. Some countries, *e.g.*, Italy, compelled, owing to the lack of suitable colonies of their own, to enrich foreign economic systems with the labour of their nationals, endeavour to turn the emigration of their people to national advantage and to secure concrete economic and political benefits for the nation as a whole, the increase of national influence abroad and the creation of fresh markets for national products. Emigrants are encouraged to preserve their original nationality and to return with their savings to the mother-country.

No country since the World War has devoted more consideration to the question of migration than has Italy. The annual increase of population in Italy amounts to 500,000 per annum. Some 200,000 Italians were formerly absorbed annually in the United States, but by the quota law this outlet has been practically closed. France for a time took the place of the United States as a field for Italian emigration, but the restrictions which France later imposed upon foreign immigrants made it necessary for Italy to seek outlets for her population in other countries, where for various reasons Italians were not always welcomed. One of the aims of Italy's policy has, therefore, been that of overcoming the objections to her emigrants by raising their standard and improving their equipment. Italy herself controls and apportions her emigration and restricts it to persons most likely to prove acceptable overseas, and for whom there is a reasonable prospect of employment. The difficulty which Italy has experienced in finding suitable outlets for her population overseas may be the cause of the change of attitude on the part of the Italian Government towards the population question. According to this, the Italian Government would appear to regard the growth of the Italian population with less apprehension than formerly and has adopted the view that Italy must conserve her man-power. With this object, it has been announced (1927) that emigration, which impoverished the nation, both from the point of view of quantity and quality, must be restricted, and reserves of population allowed to go abroad only when it is desirable to encourage an organic colonization movement.

Conflicting national policies necessarily arise from the divergence of interests between countries of emigration and countries of immigration. The tendency of the former is to encourage emigrants to retain their former nationality in their new homes, whilst countries of immigration naturally desire the rapid assimilation of the immigrants. The application of the United States quota law gave rise to protest in a number of countries and the policy of exclusion in regard to Asiatics pursued in the United States and in the British dominions has been unwelcome, especially to Japan. The new French Law on nationality has been regarded by Italy as a menace to emigration from that country, whilst the emigration policy of the Italian Government itself has sometimes been regarded as incompatible with the national sovereignty of other countries.

This evolution from practically complete liberty of movement to increasingly strict regulation has had considerable effect on migration both in regard to extent and character. The total number of emigrants is falling in comparison with the period prior to 1914. On the other hand there is probably very much less wastage of human material under the modern system.

The increase in the cost of transport has a further restrictive effect on the movement of population, and has led to many Governments affording financial help to suitable emigrants, *e.g.*, the policy of State-aided migration within the British empire, and the assistance afforded to emigrants by the Italian Government through the Institution for Colonization and Work Abroad (the I.C.L.E.) which was formed in 1921 with a large capital subscribed by Italians at home and abroad to finance Italian settlement in foreign countries. The Japanese Government subsidizes emigration societies and assistance towards migration is also afforded or is in contemplation by the Governments of some of the countries of northern Europe. The grant of assistance, is, however, as a rule so circumscribed by conditions imposed by the countries of immigration that its stimulating effect on migration is insufficient to counteract the restrictions in other directions.

Asiatic Immigration.—All the Anglo-Saxon communities overseas have placed restrictions which practically amount to exclusion upon the immigration of Asiatics. The immigration of Chinese into Australia was restricted by legislation as early as 1855. In the United States Chinese are excluded under the Chinese Exclusion Act of 1882. Restrictions on Japanese immigration are later in date, and in spite of long agitation by California (the State most affected) no special restrictions were placed on Japanese immigration into the United States until the so-called "Gentleman's Agreement" of 1907 which was an understanding between the Governments of the United States and Japan by which the latter voluntarily undertook to adopt and enforce administrative methods designed to check immigration into the United States. Under the Immigration Act, 1924, Japanese are excluded by the provision under which aliens ineligible to become American citizens are not admitted except under existing Treaty stipulations. It was the refusal of the United States Government to regard the "Gentleman's Agreement" as in the nature of a formal treaty which gave rise to such resentment in Japan.

South Africa, Australia and New Zealand have by various methods provided for the exclusion of Japanese subjects. Canada failed to take similar action but later sought to remedy the omission by a Gentleman's Agreement limiting yearly admissions to 400. This Agreement has not worked satisfactorily.

The Japanese, in consequence of these restrictions, have turned their attention to the South American countries, but their success has for various reasons been slight. It was officially announced in 1926 by the Japanese Government that Japan would no longer endeavour to send her emigrants to countries which did not wish to receive them. (*See* CHINESE IMMIGRATION.)

International Regulation.—The practically unrestricted liberty which characterized the movement of population prior to 1914 made arrangements between nations relating to migration unnecessary, except in the case of Asiatic immigration into certain countries. The problems and difficulties which have arisen since the World War in regard to the movement and distribution of population have transformed migration into an international question. New situations have been created by the artificial restrictions which obstruct the movement of population and migration itself has changed in direction and character. Social legislation has everywhere increased and the welfare of its emigrants is a matter of concern to every nation. The increase in Continental migration and the desire of each country to protect the interests of its emigrants, and sometimes to derive political and economical advantage from their movement, has given rise to questions regarding the transport, and the social and legal status of migrants, which could only be adjusted by diplomatic arrangements between the countries concerned. Such arrangements arise from a certain coincidence of interests between nations. Countries with a deficient labour supply and those with available labour are equally concerned in organizing the movement of population so as to eliminate possible causes of friction. The co-ordination of these arrangements is obviously desirable. This function was allotted to the International Labour Office which was established by the Peace Treaty, 1920, and one of whose duties is that of securing equality of economic treatment in any country for all workers legally resident therein.

A recommendation in favour of reciprocity of treatment as between national and foreign workers was passed by the first International Labour Conference at Washington in 1919. This conference appointed an International Emigration Commission which met in 1921 and considered such questions as the co-ordination of national legislation on the subject of migration, equality

of treatment of foreign workers, the elimination of agents interested in promoting emigration, and the creation of national systems of labour exchanges and information offices. At subsequent sessions of the International Labour Conference recommendations have been passed and draft conventions adopted dealing, among other things, with the communication to the International Labour Office of statistical and other information regarding migration; the equality of treatment of foreign workers as regards workmen's compensation; the protection of emigrant girls and young women, and the simplification of the inspection of emigrants, on board ship. A standing International Commission assists the International Labour Office in the work of endeavouring to give effect to the recommendations of the Conference.

In 1924, at the invitation of the Italian Government, an International Emigration Conference was held at Rome at which about sixty countries were represented. This conference to a large extent duplicated the work of the International Labour Conferences but it had the advantage of including the United States, which is not a member of the International Labour Office. The Rome conference dealt mainly with the technical and legal problems, similar to those discussed at the various International Labour Conferences, and was not of a diplomatic character. One of the most important resolutions was that dealing with the "Charter of Emigrants," which was an attempt to embody in a declaration the general principles which should govern legislation and international agreements for the regulation of migration and the treatment of emigrants. Some of the recommendations (and particularly the Charter) were not acceptable to certain countries as they were regarded as embodying principles such as the encouragement of migrants to cling to their former nationality or to involve too great a measure of State control. The Charter covered political and judicial questions which were regarded as outside the scope of a technical conference and others were considered to fall more properly within the scope of the international organizations set up under the Peace Treaties.

The matters dealt with at the Rome conference were further discussed at a second International Emigration Conference which was held in Cuba in 1928.

All measures of the nature referred to have as their object the protection and welfare of the emigrant and whilst they involve the strict control of migration they do not raise difficult political questions. There is a further international aspect of migration, however, which raises problems of a different character. The restrictions placed upon immigration by oversea countries have increased the difficulty of the population problem in Europe. The Rome conference revealed how closely the regulation of migration touches the sovereignty of the different States, and the difficulties in the way of international uniformity on even technical questions. It is clear that the divergence of view between countries of immigration, and countries of emigration on matters of policy will be much more acute. On the one hand is the desire of a country to determine the composition of its own population by admitting only such persons and races and in such numbers as it considers it can assimilate; on the other, the need for outlets for surplus population. The claim that any country with a sparse population must be ready to admit the overflow from a densely populated country has to be reconciled with the right of every country to protect its standards of life against incursions from outside and to safeguard itself from racial admixture.

Bibliography.—For statistical information *see* the Board of Trade Tables of Emigration and Immigration from and into the United Kingdom in 1914 (295, 1914) and previous years; the Board of Trade Journal (monthly); The Year Books of the British Dominions; The Annual Reports of the United States Commissioner-General of Immigration; Migration Movements, 1920–24 (Series No. 2, 1926) and the Monthly Record of Migration (International Labour Office). *See also*; for the United States question H. P. Fairchild, *Immigration* (1923); L. R. Garis, *Immigration Restriction* (1927); Lothrop Stoddard, *Reforging America* (1927); for British migration, *see* E. A. Belcher, *Migration within the Empire* (1924); Sir J. A. Marriott, *Empire Settlement* (1927); A. Demangeon, *The British Empire* (1925, Bibl.); C. M. MacInnes, *The British Empire and its Unsolved Problems* (1925); Annual Reports of the Oversea Settlement Committee (Cmd. 3,088; 1928); for Italy *see* the publications of the Commissariato Generale dell' Emigratione (Rome); general, *see* Sir L. Chiozza Money, *Peril of the White* (1925); Helmer Key, *European Bankruptcy and Emigration* (1924); and the *New Colonial Policy* (1927); J. W. Gregory, *The Menace of Colour* (1925, bibl.); H. Cox, *The Problem of Population* (1922); *Proceedings of the World Population Conference 1927* (1927); J. W. Gregory, *Human Migration and the Future* (1928, bibl.); *Migration Laws and Treaties, International Labour Office* (1928). (W. Gt.)

MIGRATION OF ANIMALS. While it is among birds (*see* Birds, Migration of) that migration is seen in its most typical form, it also occurs in many other animals, and it is to these that this article refers. But there has been an unfortunate tendency to apply the term in a loose way to many movements of animals very different from the migrations of birds. Migration in the strict sense, defined in reference to its most typical expression in birds, is a racial custom, enregistered in the animal's constitution, and takes the form of a periodic or seasonal mass-movement between a breeding place and some other environment in which breeding does not occur. Migration therefore implies that the animals concerned have two haunts in which they regularly live at different seasons of the year or at different phases of their life. It is illustrated among seals, turtles, toads, by such fishes as salmon, and by such crustaceans as land-crabs. It is a pity that a convenient term should be blurred by an application to phenomena which it does not fit. The following should be excluded from the rubric of migration. (*a*) Roaming movements in search of food, whether at short intervals or at different seasons, are not migratory. The march of the Scandinavian lemmings, when they have exhausted the vegetation of a district, is not a migration, nor is the devastating swarming of locusts. (*b*) Mass-movements, of fishes for instance, that are not related to reproduction, but are instigated by marked changes in the physical conditions or in the dependent distribution of the food should not be mixed up with migrations. (*c*) The movements of larval animals from their birthplace to another more suitable environment, as when the larvae of shore animals become pelagic and return to littoral waters at metamorphosis. It would be just as unprofitable to apply the term migration to the movement of may-fly nymphs out of the water, or the movement of liver-fluke cercariae out of their water-snail host. The word has been similarly misapplied to the striking march of processionary caterpillars from the pine-trees along the ground until they find suitable soft soil into which to burrow for pupation. (*d*) The various forms of extension of geographical range, which may be very impressive as in the incursions or "invasions" of sand-grouse into Britain, or may be, as is more frequent, very gradual and hardly perceptible from generation to generation. The passive diffusion of gossamer spiders by the wind, or of marine animals by oceanic currents, is certainly not migration. Yet the term is persistently applied to the often striking mass-movements of butterflies and some other insects, which are usually, if not invariably, dispersal-movements.

Distinctive Features.—The distinctive features of true migration are: (*a*) It is a racial custom, with a hereditary basis, but activated by particular stimuli, internal and external. (*b*) It is of regular recurrence, seasonal or periodic, or occurring when the animal reaches a particular age or state. (*c*) It is a geographical or topographical change from one haunt to another, one being the breeding-place. In typical cases there is a return journey, as in migrant birds. In some cases, such as the common eel, the adults die after spawning, and the return journey is thus confined to the young.

The scope of migration has been admirably summarized by A. L. Thomson (*Problems of Bird Migration*, 1926). "To deserve the description 'migratory,' in its strict sense, movements need not necessarily have a very great geographical amplitude, but at the least they must involve a definite change of locality. They must be purposive in that the change of scene is associated with some definite advantage which serves as its raison d'être, and there must be return movements to the original area. They must be periodic in that they correspond to some recurrent change either in the environmental conditions themselves or in the animal's reaction thereto. True migrations are changes of habitat, periodically recurring and alternating in direction, which tend to secure optimum

conditions at all times."

Mammals.—Perhaps the best instances of true migration in mammals are to be found among seals. The Alaska fur seal (*Callorhinus alascanus*) winters as far south as California, and returns in spring across the north Pacific for 2,000 miles to its breeding place on the Pribilof islands. Cetaceans, being more thoroughly adapted to marine life than the pinniped carnivores, do not need to come to the shore to breed, yet there is evidence of migratory movements. The same may be said in regard to reindeer, but the facts are not easy to understand. The Newfoundland caribou (*Rangifer terranovae*) moves in autumn from the stormy uplands, where the grazing is apt to be buried deep in snow, to the less strenuous conditions towards the south coast of the island. The southward movement takes place after the mating season, usually late in October, and is normally somewhat leisurely, at a smart walking pace, unless the wintry conditions set in very abruptly. The reindeer travel mostly by day, along more or less well-trodden paths, in relatively small companies, and in single file. The earlier companies consist mainly of does, fawns and young stags, while the later companies consist mainly of the big stags. In the spring there is a return movement, when the does are heavy with young, which is somewhat divergent from avian migration. Too much must not be made of this difference, yet it must be admitted that the so-called reindeer "migration" approximates to the mass-movements of gregarious ungulates of steppe-like areas when the dry season compels them to "follow the grass." Moreover some caribous are practically resident both in northern and southern Newfoundland. There is no doubt that some bats take gregarious flights on a large scale, while others may pass in crowds every evening from the mainland to an adjacent island, just as starlings do. But it is doubtful whether these mass-movements can be included within the rubric of migration.

Reptiles.—Some of the marine turtles are good instances of true migrants. Thus the loggerhead (*Caretta caretta*), a carnivorous species of tropical and intertropical seas, visits many sandy shores to deposit the eggs on the beach. The newly hatched young make persistently for the sea, moved, as G. H. Parker has shown, by a constitutional obligation to go down a slope and to walk in the direction of the most open low horizon. The vegetarian green turtle (*Chelone midas*), which deposits its eggs on sandy beaches in the West Indies, has a migrational range not known to exceed 50 miles. It spends ten months of the year in the relatively shallow coastal waters, for though sometimes found in the open ocean, its normal haunt is bound to be not very far from the seaweed-growing region. Some of the sea-snakes are true migrants, coming periodically to shore to give birth to their young among the rocks.

Amphibians.—A familiar sight in spring in some places is the march of toads from a considerable distance to a particular pond or marsh where they breed. When, some months later, the tadpoles have become small toads, there is a journey in the opposite direction, the parents having returned inland some time previously. The same is true of the crested newt in Britain, but the distances covered are not so great. Similarly in the common grass frog there is a summer movement from the water to the fields. The return to the water, or to the vicinity of the water, is autumnal, not vernal, as in toads, and it is not so well-defined.

Fishes.—The term migration has been mistakenly applied to many mass-movements of fishes, *e.g.*, herring and mackerel, which have no connection with a return to a particular spawning-ground or type of spawning-ground. These non-migrational movements are largely explicable in terms of changes in the distribution of the planktonic and other organisms on which the fishes feed, or what may come to the same thing, in terms of changes in temperature, salinity, oxygenation, carbon dioxide tension, and so forth. No mass-movement of fishes should be ranked as migrational unless directly concerned with approaching or leaving a spawning area.

True migration is familiarly illustrated in the salmon (*Salmo salar*). The eggs are liberated, often in midwinter, on suitable gravelly stretches of the river-bed. There are successive stages of alevins, fry, parr and smolts. The last, when over two years old, pass down the rivers to the sea, usually in early summer. A vigorous nutritive life is spent in the sea, where the food consists largely of herrings and mackerel; the salmon may remain there for several years. Adolescent salmon, which have not quite put on the adult characters are called grilse, and are normally three or three and a half years old, having descended to the sea as smolts the previous year. These may ascend the rivers and may spawn as grilse; but the grilse stage is often passed through in the sea, so that the maiden fish entering the fresh water for the first time are often "salmon." The adult salmon eat very little, if at all, in fresh water; they return to the sea, if they can, after spawning. In some cases it has been proved by marking that salmon return from the sea to their own particular native river (*see* SALMON).

When a migratory fish comes inshore or ascends the rivers to spawn, the term anadromous is used, with its counterpart catadromous, when the spawning occurs in deepish salt water; other useful terms for different types of movement have been defined by Meek. The researches of Schmidt show that the chief breeding area of the European eel, *Anguilla anguilla*, is in deepish water in the south-western part of the north Atlantic, somewhat north of the West Indies. Thence the transparent larvae (leptocephali) gradually make their way, helped by currents, towards the European coasts. As they approach, being over two years and a half old, and having traversed, it may be, 2,000 miles, they undergo a remarkable metamorphosis, from a knife-blade-like to a slender cylindrical shape, and are then known as elvers. These ascend the rivers and often pass to lakes, feeding voraciously and growing quickly, continuing their nutritive life for 5–8 years, the females taking longer to assume the characters of maturity. The physiological restlessness that then sets in prompts a migration down the rivers and out to sea, a journey taking several months. Adult eels seem to die after spawning, so that there is no return journey to fresh water except for the next generation (*see* EEL).

Similarly the large marine lamprey, *Petromyzon marinus*, ascends the rivers to spawn and succumbs soon afterwards. The larvae remain larvae, known popularly as "niners," technically as "Ammocoetes," for three years or so, and then, assuming the adult characters, they go down to the sea to put on flesh. The basal fact in the interpretation must be that lampreys were originally freshwater animals, as most of the lamprey species always are, whereas the common eel had originally a deep-water marine home, and took secondarily to fresh waters. In the interior of New York State *Petromyzon marinus* does not go down to the sea, but passes from river to lake, and from lake to river. Such secondary telescopings of the typical life-history are very significant.

Invertebrates.—Most of the so-called migrations of invertebrates are misunderstandings. The great flocks of butterflies, and dragonflies and other insects that have been described are very impressive, but all the evidence is in favour of regarding them as occasional dispersal movements. On the other hand, there is genuine migration in the movements of land-crabs (*Geocarcinus*) and robber-crabs (*Birgus*) from the interior to the shore. In the sea the larvae are hatched out, and in the sea all the youthful stages are passed. From the sea there is a return of the adults to their inland retreats, and later on they are followed by their offspring.

BIBLIOGRAPHY.—R. Collett, "On *Myodes lemnus* in Norway," *Proc. Linn. Soc.* (1878); J. Schmidt, *First Report on Eel Investigation, 1913* (Conseil permanent international pour l'exploration de la mer, 1913, and subsequent years); A. Meek, *The Migrations of Fish* (London, 1916); W. L. Calderwood, *The Life of the Salmon* (London, 1922); A. L. Thomson, *Problems of Bird Migration* (London, 1926); C. S. Elton, *Animal Ecology* (London, 1927). (J. A. TH.)

MIGUEL, MARIA EVARIST (1802–1866), usually known as DOM MIGUEL, whose name is chiefly associated with his pretensions to the throne of Portugal, was the third son of King John VI. of Portugal, and of Carlota Joaquina, one of the Spanish Bourbons; he was born at Lisbon on Oct. 26, 1802. In 1807 he accompanied his parents in their flight to Brazil. In 1822 his father swore fidelity to the new Portuguese constitution which had been proclaimed in his absence; and this led Carlota Joaquina, who was an absolutist of the extremest Bourbon type, and hated her husband, to seek his dethronement in favour of Miguel her favourite son. The insurrections which ensued (*see* PORTUGAL) resulted in

her imprisonment and the exile of Miguel (1824), who spent a short time in Paris and afterwards lived in Vienna, where he came under the teaching of Metternich. On the sudden death of John VI. in May 1826, Pedro of Brazil, his eldest son, renounced the crown in favour of his daughter Maria da Gloria, on the understanding that she should become the wife of Miguel. Miguel swore allegiance to Pedro, to Maria, and to the constitution which Pedro had introduced, and was appointed regent in July 1827. He arrived in Lisbon in Feb. 1828, and, regardless of his promises, dissolved the new Cortes in March; having called together the old Cortes, with the support of the reactionary party of which his mother was the ruling spirit, he got himself proclaimed sole legitimate king of Portugal in July. His private life was characterized by the wildest excesses, and he used his power to oppose all forms of liberalism.

The public opinion of Europe became more and more actively hostile to his reign, and after the occupation of Oporto by Dom Pedro in 1832, the destruction of Miguel's fleet by Captain (afterwards Sir Charles) Napier off Cape St. Vincent in 1833, and the victory of Saldanha at Santarem in 1834, Queen Christina of Spain recognized the legitimate sovereignty of Maria, and in this was followed by France and England. Dom Miguel capitulated at Evora on May 29, 1834, renouncing all pretensions to the Portuguese throne. He lived for some time at Rome, where he enjoyed papal recognition, but afterwards retired to Bronnbach, in Baden, where he died on Nov. 14, 1866.

MIHALACHE, ION (1882–), Rumanian politician, was born on March 3, 1882. In 1914 he entered politics, and after the World War founded the Peasant (Tsaranist) party first in Bessarabia, and then extended its organization to the rest of the country. In the first elections held after the war in 1919, the Peasant party won 70 seats in the Chamber of Deputies and Mihalache was appointed minister of agriculture in the Vaida-Voivod cabinet, which office he held until March 1920, when Vaida-Voivod resigned with the entire cabinet. He remained one of the leaders of the combined National-Tsaranist oppositional bloc.

MIHRAB, a term in Mohammedan architecture given to the niche which in a mosque indicates the direction of Mecca; sometimes called prayer niche.

MIKADO (Japanese for "exalted gate") is the poetical title associated by foreign countries with the sovereign of Japan; the Japanese title, corresponding to "emperor," is *tennō*. The history of the mikados takes us back to very early times, but from 1600 to 1868 the real power was in the hands of the shoguns, who nevertheless were in ceremonial theory always successively invested with their authority by the mikado. The revolution of 1867 restored the real power into the mikado's hands. (*See* JAPAN: *History;* and MEIJI TENNŌ.)

MIKIR, a hill tribe, numbering some 90,000, in Central Assam, calling themselves Arleng. Racially they appear intermediate between the Naga and Kuki groups. Their language, unwritten, belongs to the Tibeto-Burman group. The religious belief is animistic, showing marked Hindu influence. The dead are burned with dancing and ceremony after retention in the house for the period required for the necessary arrangements. True Mikir dress closely resembles that of their neighbours the Khasis, but Assamese dress is now common. The tribe is divided into patrilineal exogamous clans. Villages are small and houses are built on piles. For cultivation, the jungle on the hillsides is cleared and burned. (J. P. M.)

See Lyall and Stack, *The Mikirs* (1908).

MIKKELSEN, EJMAR (1880–), Danish explorer, was born on Dec. 23, 1880, and educated in Copenhagen. He went to sea in 1894, and afterwards travelled extensively. He joined many expeditions of exploration; to the east coast of Greenland (with Amdrups, 1900); to Franz Joseph's Land (Baldwin-Ziegler, 1901–02); in the northern Atlantic (International Hydrographic expedition, 1903–04); north of Alaska (in joint command with Leffingwell, 1906–08); north-eastern Greenland (in command, 1909–12). In 1924 he commanded an expedition to Scoresby sound, and in the following year an experimental fishing cruise to west Greenland. He has published several accounts of the expeditions in which he took part.

MIKLOSICH, FRANZ VON (1813–1891), Austrian philologist, was born at Luttenberg, Styria, on Nov. 29, 1813. He graduated at the university at Gratz, and was for a time professor of philosophy there. In 1838 he went to Vienna, where he took the degree of doctor of law. He gave up law for the study of Slavonic languages and from 1844–62 held a post in the imperial library. His works revolutionized the study of Slavonic languages. From 1849 to 1886 Miklosich occupied the newly created chair of Slavonic philology at the university of Vienna. He became a member of the Academy of Vienna and the upper house. His writings deal also with Rumanian, Albanian, Greek, and the language of the gypsies. Miklosich died on March 7, 1891.

His numerous works include a noteworthy review of Bopp's *Comparative Grammar* (1844).

MIKULOV, a town in Moravia, Czechoslovakia, near the Austrian frontier at the foot of the Pavlovske hills. The town is mainly of local importance by reason of viticulture, cloth manufacture and the Jurassic limestones in the vicinity which are burnt for lime. The principal feature is the Heiliger Berg which has 16 chapels and a church in Byzantine style. Pop. (1923), 7,699.

MILAN (Ital. *Milano,* Ger. *Mailand,* anc. *Mediolanum, q.v.*), city, Italy, capital of the province of Milan, 93 m. by rail E.N.E. of Turin. Pop. (1921) 816,986 (town); 836,046 (commune). It is the seat of an archbishop, the headquarters of the III. army corps, the chief financial centre of Italy and the wealthiest manufacturing and commercial town in the country. It stands on the little river Olona, near the middle of the Lombard plain, 400 ft. above sea-level.

The plain around Milan is extremely fertile, owing to the richness of the alluvial soil deposited by the Po, Ticino, Olona and Adda, and to the excellent system of irrigation. From the cathedral roof, it presents the appearance of a vast garden divided into square plots by rows of mulberry or poplar trees. To the east, this plain stretches in an unbroken level, as far as the eye can follow it, towards Venice and the Adriatic; on the southern side the line of the Apennines from Bologna to Genoa closes the view; to the west rise the Maritime Cottian and Graian Alps, with Monte Viso as their central point; while northward are the Pennine, Helvetic and Rhaetian Alps, of which Monte Rosa, the Saasgrat and Monte Leone are the most conspicuous features. In the plain itself lie many small villages and here and there a larger town like Monza or Saronno, or a great building like the Certosa of Pavia makes a white point upon the greenery.

The summer is intensely hot, winter very cold, snow is often seen, and the thermometer is frequently below freezing-point.

In shape Milan is a fairly regular polygon (within which the still smaller rectangular nucleus of the Roman city may be recognized: *see* MEDIOLANUM), and its focus is the splendid Piazza del Duomo, from which a number of streets radiate in all directions, connected by an inner system of streets, constructed just outside the canal which marks the site of the town moat (the arches of Porta Nuova are almost the last trace of the inner circuit, constructed after the destruction of the city by Frederick Barbarossa, to which also belonged the Porta dei Fabbri, demolished in 1900), and by an outer circle of boulevards, just beyond the outer enceinte of the city, erected by the Spaniards in the 16th century. But the city is growing far beyond these, and in 1926 its circumference was about 8 miles.

At one end of the Piazza del Duomo is the cathedral. It is built of brick cased in marble from the quarries which Gian Galeazzo Visconti gave in perpetuity to the cathedral chapter. Begun in 1386, it was then the largest church in existence, and now, after St. Peter's at Rome and the cathedral of Seville, it is the largest church in Europe; it covers an area of 14,000 sq.yd. and can hold 40,000 people. The interior is 486 ft. long, 189 ft. wide; the nave is 157 ft. high, and the distance from the pavement to the top of the tower is 356 ft. The style is very elaborate Gothic, but the work was continued through several centuries and after many designs by many masters, notably by

Amadeo, who carried out the octagonal cupola (the pinnacle of which dates from 1774), and by Tibaldi, who laid down the pavement and designed a baroque façade, begun after his death in 1609, but only completed, by Napoleon's orders, in 1805–13. The church is cruciform, with double aisles to the nave and aisles to the transepts. The roof is supported by fifty-two pillars with canopied niches for statues instead of capitals; the great windows of the choir have stained glass of 1844. To the right of the entrance is the tomb of Archbishop Aribert (1045), while beside him rests Archbishop Otto Visconti (1295). In a crypt under the choir lies the body of the cardinal saint Carlo Borromeo, who consecrated the cathedral in 1577. It is contained in a rock-crystal shrine, encased in silver, and is vested in magnificent robes blazing with jewels. The roof of the cathedral is built of blocks of marble, and the various levels are reached by staircases carried up the buttresses; it is ornamented with a profusion of turrets, pinnacles and statues, of which last there are 4,440, of various styles and periods.

There are two noteworthy palaces in the Piazza del Duomo. The first is the former Palazzo Reale (now belonging to the municipality) dating from 1772, but occupying the site of the earliest mansion of the Viscontis and the Sforza; its great hall is a handsome chamber with a gallery supported by caryatides. Built into the palace is the ancient church of San Gottardo (1330–36), a Romanesque building built by Azzone Visconti in 1328–1339, and the scene of the murder of Giovanni Maria Visconti in 1412. Its campanile is a beautiful example of early Lombard terra-cotta work. The second palace is that of the archbishops, with a fine façade. It has a fine court with double colonnades. The Palazzo della Ragione, in the Piazza dei Mercanti, just west of the Piazza del Duomo, the central point of the mediaeval city, is a brick edifice (1223–1238) with portico on the ground floor and a large hall on the upper. Close by to the south is the beautiful Loggia degli Osii, erected in 1316, with two open porticos, one above the other, in black and white marble.

Among the most interesting buildings in Milan is the historic church of S. Ambrogio. The church was built by St. Ambrose in 386–389, but as it stands it is a Romanesque basilica of the 11th–12th century, with a brick exterior, galleries over the façade, and perhaps the most perfectly preserved atrium in existence. The wooden door belongs to the original 4th century church; it has carvings with scenes from the life of David. The pulpit is also fine (11th–13th cent.). In a great silver reliquary (modern) in the crypt lie the bones of St. Ambrose, above which rises the high altar, which retains its original reliefs in gold and silver enriched with enamel and gems, and are the work of one Vuolfvinus, a German (835). The baldacchino, with sculptures of the 12th or early 13th century, is borne by four ancient columns of porphyry, with 9th-century capitals. In the tribune are fine mosaics of the 12th century, and in the Basilica Fausta mosaics of the 5th. The lofty brick campanile (789–824) is among the earliest in Italy. The court of the neighbouring canonica is by Bramante. S. Lorenzo, in the south portion of the town, dates from before A.D. 538, but was several times burnt down and restored. The chapel of S. Aquilino, possibly part of the original structure, contains mosaics of the 5th or 6th century; while excavations have shown that its foundations, and apparently those of the whole church, rest upon a mass of architectural fragments taken from Roman buildings; the pavement of a bath was laid over them at a later date, and over this again the chapel was built. In plan the church is an octagon, supported at the corners by four square towers in brickwork. The interior with its two orders is a very fine one, and its influence on Renaissance architects has been very considerable. The portico outside it with its 16 Corinthian columns is a later addition, with use of ancient materials. S. Eustorgio, one of the largest Gothic churches in Milan, dates, as it stands, with its campanile, from the 13th century. It has some interesting mediaeval sculpture, and a fine chapel (Cappella Portinari), with a good dome and a beautiful frieze of angels (1462–1468), and containing the splendid sculptured tomb of Peter Martyr (*q.v.*), the masterpiece of Giovanni di Balduccio of Pisa (1339).

S. Vincenzo in Prato (835); S. Satiro, founded in 879; S. Babila, etc., are interesting for their Romanesque architecture. The small domed structure on the left of S. Satiro is earlier than the church, while the campanile is part of the original structure. The reconstruction of the church of S. Satiro was Bramante's earliest work in Milan (after 1476). The choir is painted in perspective (there was no room to build one), the earliest example of this device, which was so frequently used in baroque architecture. The octagonal sacristy (before 1488), has niches below and a gallery above, and stucco decorations by Bramante himself (the frieze with putti and medallions is by Agostino de Fondotis of Padua). The Cistercian abbey-church of Chiaravalle, 5½ m. south of Milan, is a fine brick building in the plan of a Latin cross, with nave and two aisles with round pillars, with a lofty domed tower, in the so-called Romanesque Transition style, having comparatively slender round pillars and cross vaulting, while the exterior is still quite Romanesque. It was founded in 1135 by St. Bernard and consecrated in 1221. It is interesting as the model for the plan of many other churches in Lombardy, *e.g.*, S. Maria del Carmine and S. Francesco in Pavia. S. Maria Incoronata is unique as a double Gothic church, in the horizontal sense (1451–1487).

Of secular buildings of the beginning of the 15th century, the most notable is the Casa dei Borromei, which still preserves its Gothic courtyard. It has a good collection of Lombard pictures. The Gothic church of Santa Maria delle Grazie was built by the Dominicans about 1460. The choir, crossing, and dome, with elegant external decorations in terra-cotta and marble, are by Bramante (*c.* 1492). Adjoining the church is the convent, with fine cloisters, by Bramante; in the former refectory Leonardo da Vinci (*q.v.*) painted his celebrated "Last Supper."

The interior of San Maurizio has effective frescoes by Luini and his contemporaries. It was erected by Giovanni Dolcebuono, a pupil of Bramante, to whom is also due S. Maria presso S. Celso (the interior and the baroque façade are by Alessi to whom the fine church of S. Paolo is also due). The renowned Biblioteca Ambrosiana, rich in mss., was erected in 1603–1609 by Fabio Manzone, to whom the Palazzo del Senato is also due. There is also a picture gallery, in which is Raphael's cartoon for his fresco the "School of Athens" in the Vatican. The Ospedale Maggiore was founded in the reign of Francesco Sforza. The entire edifice is covered externally with terra-cotta; its façade was designed by the Florentine Antonio Averulino and begun in 1457.

The city is rich in works of art, for Milan, with the introduction of the early Renaissance style by Filarete and Michelozzo after 1450, became the home of a Lombard school of sculpture among the chief masters of which may be mentioned Giovanni Antonio Amadeo of Pavia (1447–1522), Cristoforo Solari, and, the last of them, Agostino Busti, known as Bambaia (*c.* 1480–1548) whose work may be seen in the cathedrals of Como and Milan and in the Certosa of Pavia.

Towards the close of the 15th century, the refined court of Lodovico Sforza attracted such celebrated men as Bramante, the architect; Gauffino Franchino, founder of one of the first musical academies, and the immortal Leonardo da Vinci from whose school came a number of brilliant artists. Later Leone Leoni of Arezzo achieved fame as a sculptor.

The picture gallery of the Brera occupies an imposing palace with a good courtyard by Ricchini. It also contains a library of some 350,000 volumes, a collection of coins numbering about 60,000, and an observatory. The Brera Gallery possesses Raphael's famous "Sposalizio," many pictures and frescoes by Luini, Gaudenzio Ferrari and Bramantino; and a collection of the works of Carlo Crivelli (*fl.* 1480), while the Venetian school is well represented by works of Paolo Veronese, Paris Bordone, Gentile Bellini, Cima da Conegliano, Bonifazio, Moroni and Carpaccio.

The Castel Sforzesco, or Castle of Milan, stands in the Parco Nuovo; it was built in 1450 by Francesco Sforza on the site of one erected by Galeazzo II. Visconti (1355–1378) and demolished in 1447 by the populace after the death of Filippo Maria Visconti.

After many vicissitudes it was restored—including especially the splendid entrance tower by Antonio Averulino (Filarete, 1451–1453), destroyed by a powder explosion in 1521—in the 15th-century style, and it is now a most imposing pile. Some fine windows with terra-cotta decorations are preserved. The archaeological museum is housed here: it contains Roman antiquities and mediaeval and Renaissance tombs and sculptures. Several rooms bear traces of the decorations executed under Galeazzo Maria and Lodovico il Moro. (*See* LEONARDO DA VINCI.) In the upper rooms is placed a large collection of Milanese and central Italian ceramics, stuffs, furniture, bronzes, ivories, enamels, glass and historical relics, with a picture gallery.

The finest modern thoroughfare is the Via Dante (1888), running from the Piazza de' Mercanti to the spacious Foro Bonaparte, and thence to the Parco, a great public garden in which stands the Castello Sforzesco.

To the north of the castle is the Arena, a kind of circus erected by Napoleon in 1806; while facing the castle on the opposite side of the park is the Arco della Pace, begun by Napoleon in 1806, but finished by the Austrians in 1833. The Piazza del Duomo, the centre of Milanese traffic, is connected with the neighbouring Piazza della Scala by the famous Galleria Vittorio Emanuele (1865–67), a great arcade in the form of a Latin cross, with an octagon in the centre, crowned at the height of 160 ft. with a glass cupola; it is roofed with glass throughout, and is 320 yd. long, 16 yd. wide and 94 ft. high.

Near the Piazza della Scala is the Museo Poldi-Pezzoli, with valuable pictures, textile fabrics, arms, armour and antiquities. In the middle of the neighbouring Piazza della Scala stands Magni's monument of Leonardo da Vinci (1872). Opposite is the celebrated Teatro della Scala, built in 1778 on the site of a church founded by Beatrice della Scala, wife of Bernabò Visconti. After the San Carlo at Naples it is the largest theatre in Europe, and can seat 3,600 spectators. It has an interesting theatrical museum. Looking on to the piazza is the fine Palazzo Marino, the seat of the municipality since 1861; it was built by Galeazzo Alessi in 1558, to whom the side façade and the court are due, but was not completed until 1890, when the main façade was erected by Luca Beltrami. S. Fedele by Tibaldi (1569) is close by. Milan has a university, a large school of engineering, the Bocconi commercial university, and numerous other learned and educational institutions; it has long been a great musical centre. A Verdi museum has been formed. There are many philanthropic institutions, and public charities and services are particularly well administered. Sport and athletics are provided by a number of clubs, notably the Touring Club Italiano, founded in 1894.

Modern industrial development includes construction of locomotives, railway trucks and carriages, steam-boilers and motors, turbines, pumps, metal bridges and roofs. Minor industries are represented by workshops for the production of surgical, musical and geodetic instruments; of telephone and telegraph accessories; dynamos, sewing-machines, bicycles and automobiles and chemicals. In textile industries silk (including artificial silk) holds the first place. Spinning and twisting are as highly developed as the weaving industry. Milan is also the centre of the Italian cotton industry. Cotton-weaving, dyeing and printing are extensively carried on. Linen, flax, jute and wool are also spun and woven. The Milanese manufactures of articles in caoutchouc and of electric cables have acquired a world-wide reputation. In typography Milan is renowned principally for its musical editions and for its heliotype and zincotype establishments. The manufacture of furniture of all kinds is still extensively carried on, Milan being the chief Lombard market and centre of exportation. The towns of Cantù, Meda, Lissone and Carugo supply Milanese firms with most of their merchandise, the furniture being made by the workmen at their own homes with materials supplied by the Milanese buyers, who also advance the capital necessary for working expenses. Theatrical costumes and appliances are also made in Milan, which is an important theatrical centre. House industry is still widely diffused in Milan itself, especially as regards working in gold, silver, vulcanite, bronze and leather. The motive power for much of the industry is supplied by electricity. Milan is also a centre of the export trade in cheese; chocolate, biscuits, etc., are also manufactured. Knitted underwear, fringes, tulles, velvets, gloves, shawls, passementerie, jewellery, etc., are produced besides.

The municipal schools of Milan are well organized; the expenditure on them in 1928 was nearly £5,000,000.

The water supply, from wells some 150 ft. deep in the sub-soil, is fairly good; one of the towers of the Castello Sforzesco is used as a distributing centre, while the sewerage system consists of 48 m. of sewers on the single channel principle, with collectors discharging into the Vettabia, a tributary of the Lambro.

See F. Malaguzzi Valeri, *Milano*, 2 vols. (Bergamo, *Arti Grafiche* 1906) well illustrated.

History.—(For earlier history *see* MEDIOLANUM.)—After the establishment of the Lombard capital at Pavia in 569 Milan remained the centre of Italian opposition to the foreign conquest. The Lombards were Arians, and the archbishops of Milan from the days of Ambrose had always been orthodox. Though the struggle was unequal, their attitude of resolute opposition to the Lombards gained for them great weight among the people, who felt that their archbishop was a power round whom they might rally for the defence of their liberty and religion. When the Lombard kingdom fell before the Franks under Charles the Great in 774, the archbishops of Milan were still further strengthened by the close alliance between Charles and the Church, which tended to confirm their temporal authority, and also by Charles's policy of breaking up the great Lombard fiefs and dukedoms, for which he substituted the smaller counties. Under the confused government of Charles's immediate successors the archbishop was the only real power in Milan. But there were two classes of difficulties in the situation, ecclesiastical and political; and their presence had a marked effect on the development of the people and the growth of the commune, which was the next stage in the history of Milan. On the one hand the archbishop was obliged to contend against the heretics or against fanatical reformers who found a following among the people; and on the other, since the archbishop was the real power in the city, the emperor, the nobles and the people each desired that he should be of their party; and to whichever party he did belong he was certain to find himself violently opposed by the other two. From these causes it sometimes happened that there were two archbishops, and therefore no central control, or no archbishop at all, or an archbishop in exile. These difficulties developed a spirit of independence and a capacity of judging and acting for themselves in the people of Milan. The terror of the Hunnish invasion, in 899, further assisted them in their progress towards freedom, for it compelled them to take arms and to fortify their city, rendering Milan more than ever independent of the feudal lords who lived in their castles in the country. The tyranny of these nobles drove the peasantry and smaller vassals to seek protection for life and property and equality of taxation and of justice inside the walled city and under the rule of the archbishop. Thus Milan grew populous, and learned to govern itself. Its inhabitants became for the first time Milanese, attached to the standard of St. Ambrose—no longer subjects of a foreign conqueror, but a distinct people, with a municipal life and prospects of its own. For the further growth of the commune, the action of the great archbishop, Heribert (1018–45), the establishment of the carroccio, the development of Milanese supremacy in Lombardy, the destruction of Lodi, Como, Pavia and other neighbouring cities, the Lombard league, and the battle of Legnano, *see* the articles ITALY and LOMBARDS.

After the battle of Legnano, in 1174, although the Lombard cities failed to reap the fruit of their united action and fell to mutual jealousy once more, the city of Milan began to grow in material prosperity. After the Peace of Constance (1183) the city walls were extended; the arts flourished, each in its own quarter, under a syndic who watched the interests of the trade. The manufacture of armour was the most important industry. During the struggles with Barbarossa, when freedom seemed on the point of being destroyed, many Milanese vowed themselves, their goods and their families to the Virgin should their city come safely out of her troubles. Hence arose the powerful fraternity of the "Umiliati," who established their headquarters at the Brera, and

began to develop the wool trade, and subsequently gave the first impetus to the production of silk. From this period also date the irrigation works which render the Lombard plain a fertile garden. The government of the city consisted of (*a*) a parlamento or consiglio grande, including all who possessed bread and wine of their own—a council soon found to be unmanageable owing to its size, and reduced first to 2,000, then to 1,500 and finally to 800 members; (*b*) a credenza or committee of 12 members, elected in the grand council, for the despatch of urgent or secret business, (*c*) the consuls, the executive, elected for one year, and compelled to report to the great council at the term of their office.

The bitter and well-balanced rivalry between the nobles and the people, and the endless danger to which it exposed the city owing to the fact that the nobles were always ready to claim the protection of their feudal chief, the emperor, brought to the front two noble families as protagonists of the contending factions—the Torriani of Valsassina, and the Visconti, who derived their name from the office of delegates which they had held under the archbishops. After the battle of Cortenova, in 1237, where Frederick II. defeated the Guelph army of the Milanese and captured their carroccio, Pagano della Torre rallied and saved the remnants of the Milanese. This act recommended him to popular favour, and he was called to the government of the city—but only for the distinct purpose of establishing the "catasta," a property tax which should fall with equal incidence on every citizen. This was a democratic measure which marked the party to which the Torriani belonged and rendered it hateful to the nobility. Pagano died in 1241. His nephew Martino followed as podestà in 1256, and in 1259 as signore of Milan—the first time such a title was heard in Italy. The nobles who had gathered round the Visconti, and who threatened to bring Ezzelino da Romano, the Ghibelline tyrant of Padua, into the city, were defeated by Martino, and 900 of their number were captured. Martino was followed by two other Torriani, Filippo his brother (1263–65) and Napoleone his cousin (1265–77), as lords of Milan. Napoleone obtained the title of imperial vicar from Rudolph of Habsburg. But the nobles under the Visconti had been steadily gathering strength, and Napoleone was defeated at Desio in 1277. He ended his life in a wooden cage at Castel Baradello above Como.

Otto Visconti, archbishop of Milan (1262), the victor of Desio, became lord of Milan, and founded the house of Visconti, who ruled the city—except from 1302 to 1310—till 1447, giving 12 lords to Milan. On the death in that year of Filippo, the last male of the Visconti house, a republic was proclaimed, which lasted only three years. In 1450 the general Francesco Sforza, who had married Filippo's only child Bianca Visconti, became duke of Milan by right of conquest. Francesco was followed by five of the Sforza family, and from the death of the last (1535) till the War of the Spanish Succession (1714) Milan was a dependency of the Spanish Crown. At the close of that war it was handed over to Austria, under whose rule it remained until the Napoleonic campaign of 1796. For the results of that campaign, and for the history of Italian progress towards independence, in which Milan played a prominent part, *see* ITALY. The Lombard campaign of 1859, with the battles of Solferino and Magenta, finally made Milan a part of the kingdom of Italy.

BIBLIOGRAPHY.—The Milanese chroniclers in L. A. Muratori, *Rerum Italicarum Scriptores* (Milan, 1723–51; mod. ed., G. Carducci, 1900, etc.), and *Annali d'Italia* (1744–49); P. Verri, *Storia di Milano* (Milan, 1783–98, later ed. 1851); H. Hallam, *History of the Middle Ages* (1818; many later editions); P. Litta, *Celebri Famiglie Italiane* (Milan, 1819–1902), under "Torriani," "Visconti," "Sforza" and "Trivulzi"; B. Corrio, *Storia di Milano*, edit. A. Butti and L. Ferrario (Milan, 1855–57); C. Cantù, *Grande Illustrazione del Lombardo-Veneto* (Milan, 1858–61); *Mediolanum* (Milan, 1881); L. Beltrami, *Il Castello di Milano* (Milan, 1894); L. del Mayno, *Vicende militari del Castello di Milano* (Milan, 1894); F. Malaguzzi Valeri, *Milano* (Bergamo, 1906); C. M. Ady, *Milan under the Sforza* (1907); E. Galli, *Corso di Storia Milanese* (1920); F. Borghi, *Milano, 1871–1921* (1923); D. Muir, *Milan under the Visconti* (1924).

MILAN DECREE, an order issued by Napoleon on Dec. 17, 1807, extending the ban upon British goods inaugurated by the Berlin Decree (*q.v.*) of Nov. 21, 1806, and forbidding neutrals to trade in goods imported from British dominions. (*See* CONTINENTAL SYSTEM.)

MILANESI, GAETANO (1813–1895), Italian scholar and writer on the history of art, was born at Siena, where he studied law, and in 1838 he obtained an appointment in the public library. In 1856 he was elected member of the Accademia della Crusca, in which capacity he took part in the compilation of its famous but still unfinished dictionary, and two years later was appointed assistant keeper of the Tuscan archives, in Florence; then he took charge of the famous Medici archives, whence he collected a vast body of material on the history of Italian art. In 1889 he became director of the archives, but retired in 1892. His most important publication is his edition of Vasari's works in nine volumes, with copious and valuable notes (Florence, 1878–1885). Of his other writings the following may be mentioned: *Il diario inedito di Alessandro Sozzini* (in the *Archivio storico Italiano*, 1842); *Documenti per la storia dell' arte senese*, 3 vols. (Siena, 1854–56) and *Discorsi sulla storia civile ed artistica di Siena* (Siena, 1862). He also edited a number of Italian classics.

See E. Ridolfi's article in the *Nuova antologia* (May 15, 1895); and A. Virgili's article in the *Atti della regia Accademia della Crusca* (Florence, 1898); also Dom. Colnaghi's *The Dictionary of Florentine Painters* (1928) contains much material which Milanesi collected.

MILAN OBRENOVIĆ IV. (1854–1901), king of Serbia, was born at Jassy, Rumania, on Aug. 22, 1854, son of Miloš Obrenović (1829–1861), the nephew of Prince Miloš I. (*q.v.*), and Maria Katardži, a Moldavian. Early left an orphan, Milan was adopted by his cousin Michael (*q.v.*), educated at Bucharest and Paris, and placed on the throne under a regency, in 1868, on the assassination of Michael. In 1872 he came of age, but retained the Liberal regent, Ristić, as his premier. For the events of his rule as prince *see* EASTERN QUESTION and SERBIA. He proclaimed himself king in 1882.

Milan's Austrophile policy was deeply unpopular, particularly as taxation had become a burden; military service increased and the king's private life was extravagant and unsavoury. In 1875 he had married Natalie, the 16-year old daughter of Colonel Ketčko, a Moldavian in the Russian army. After the birth of their son Alexander (1876), relations between the couple became notoriously strained, and the Russophile party rallied round Natalie. In 1885 Milan embarked on an ill-judged, undesired and ignominious campaign against Bulgaria, being saved from disaster only by Austria's intervention. In 1886 the queen withdrew with her son to Wiesbaden; but in 1888 Milan recovered his son, circulated nauseous scandals about his wife, and finally extorted a divorce, which was illegal in the eyes of the orthodox church. In an attempt to recover his popularity, he suddenly promulgated a new and liberal constitution (Jan. 2, 1889); but on March 6 abdicated in favour of his son, and retired to Paris. In 1892 he renounced his Serb nationality. In Jan. 1894 he reappeared in Belgrade, and on April 29 he and Natalie were reinstated and nominally reconciled, the queen returning in May 1895. Appointed commander-in-chief of the Serb army in 1897, Milan did some really useful technical work, but also inaugurated a cruel persecution of the Russophiles and Radicals. This period was suddenly checked by Alexander's marriage in July 1900. Milan resigned his post and returned to Vienna, where he died unexpectedly on Feb. 11, 1901.

For bibliography, *see* SERBIA: the works of Georgević, *Das Ende der Obrenović* (Leipzig 1905) and *Die Serbische Frage* (Stuttgart, 1909) are detailed for Milan's period and written by a partisan; other literature is more occupied with his ill-doing.

MILÁ Y FONTANALS, MANUEL (1814–1884), Spanish scholar, was professor of literature at Barcelona from 1845 until his death. He was the author of *De los trovadores en España* (1866) and *De la poesía heróico-popular castellana* (1874), an epoch-making work in Hispanic studies which revealed its author as a master of scientific method.

MILAZZO, seaport north coast of Sicily, province of Messina, 22 m. W. of Messina by rail. Pop. (1921), 15,605 (town), 20,454 (commune). It is mainly built on the low isthmus of a peninsula, which stretches some 3 m. farther north and forms a good harbour: but the old town, which contains a castle, mainly

the work of Charles V., lies on a hill above. Milazzo is the ancient *Mylae*, an outpost of Zancle, taken by the Athenians in 426 B.C. In the bay Duilius won the first Roman naval victory over the Carthaginians (260 B.C.).

MILDENHALL, a market town of Suffolk, England, 76½ m. N.N.E. from London by rail. Pop. (1921) 3,370. It lies on the edge of Mildenhall Fen. The church of St. Andrew has an Early English chancel. The remainder is principally Perpendicular with a carved oak roof, ornate north porch and lofty tower with fan tracery within. There is a wooden market cross of the 15th century; the manor house is a gabled building of the 17th century. Flour milling is an industry and there are foundries at Stowmarket nearby. Roman remains have been found.

MILDEW, a popular name given to various minute fungi. Like many other popular names of plants, it is used to denote different species which possess very small botanical affinity. The term is applied, not only to species belonging to various systematic groups, but also to such as follow different modes of life. The corn-mildew, the hop-mildew and the vine-mildew are, for example, parasitic upon living plants, and the mildews of damp linen and of paper are saprophytes; *i.e.*, they subsist on dead matter. The conditions of life and growth of mildew are mainly suitable nutrition and dampness accompanied by a high temperature. The life history of the same species frequently covers two or more generations, and these are often passed on hosts of different kinds (*see* FUNGI).

MILES, NELSON APPLETON (1839–1925), American soldier, was born in Westminster, Mass., on Aug. 8, 1839. He was engaged in mercantile pursuits in Boston when the Civil War began, and he entered the army in Sept. 1861, as a lieutenant of volunteer infantry. He served with distinction in the Peninsular campaign, and at Antietam, Fredericksburg and Chancellorsville, where he received a wound which incapacitated him until 1864. He commanded a brigade at the Wilderness and Spottsylvania, and for his gallant leadership was made brigadier-general of volunteers. He fought in the Cold Harbor and Petersburg operations in 1864–65, and at the close of the war was in temporary command of an army corps. In July, 1866, he was made colonel of a regular infantry regiment. He was promoted brigadier-general U.S.A. (Dec. 1880), and to major-general (April 1890), and in 1895 succeeded Gen. John McA. Schofield as commanding general of the United States army. He was conspicuously successful (1869–86) in dealing with Indian outbreaks, fighting the Cheyenne, Kiowa and Comanche on Llano Estacado (1875) and the Sioux in Montana (1876), capturing the Nez Percés under Chief Joseph (1877), and defeating the Chiricahua Apaches under Geronimo (1886), and he commanded the United States troops sent to Chicago during the railway riots in 1894. He was in nominal direction of military operations during the war with Spain in 1898, though his personal share of the operations was confined to directing the almost unopposed Porto Rico expedition. He was raised to the rank of lieutenant-general in 1900, and retired from active service in 1903. He died in Washington, D.C. on May 15, 1925. Miles was one of the youngest Union generals in the Civil War, commanding when only 25 years of age a corps of 26,000 men. He wrote *Personal Recollections* (1896), *Military Europe* (1898), *Observations Abroad* (1899) and *Serving the Republic* (1911).

MILES CITY, a city of eastern Montana, U.S.A., on the south bank of the Yellowstone, at the mouth of Tongue river, 2,377 ft. above sea-level; the county seat of Custer county. It is on Federal highways 10 and 12, and is served by the Chicago, Milwaukee, St. Paul and Pacific and the Northern Pacific railways. Pop. (1920) was 7,937, 86% native white; (1930) 7,175 Federal census. It is the metropolis of the stock-raising and agricultural district of eastern Montana, an important range-horse market and distributing point for wool, butter, wheat, corn and other produce. Ranches in the vicinity graze from 10,000 to 20,000 head of sheep and cattle. Adjoining the city is the U.S. Range Livestock experiment station (formerly Ft. Keogh) of 57,000 acres. The Milwaukee has division headquarters and extensive repair shops here, and the manufacturing industries include creameries, bottling works, an oil refinery and two establishments which have a world-wide market for their harness and saddles. Lignite coal is mined for local consumption and natural gas is available. The State Normal School conducts a summer session at Miles City. The Eastern Montana Fair, the State Corn Show and the Miles City Round-Up and Historical Show are annual events. The city's assessed valuation of property in 1928 was $10,500,000. Miles City was founded in 1877 and named after Gen. Nelson A. Miles, an experienced Indian fighter, who had previously built Ft. Keogh two miles west. In the early days the principal industry was the hunting of buffalo, and tradition says that as many as 250,000 hides were shipped in a single season. The first railroad reached the city in 1881.

MILETUS (mod. *Palatia*), an ancient city of Asia Minor, on the southern shore of the Latmic Gulf near the mouth of the Maeander. Before the Ionic migration it was inhabited by Carians (*Iliad* ii. 876; Herod i. 146), and pottery found on the spot proves that the site was inhabited, and had relations with the Aegean world, in Minoan times. The Greek settlers from Pylos under Neleus are said to have destroyed the old city and to have built a new one on the coast. Miletus occupied a very favourable situation at the mouth of the rich valley of the Maeander, and was the natural outlet for the trade of southern Phrygia (Hipponax, *Fr.* 45). It had four harbours, one of considerable size, and its power extended inland for some distance up the valley of the Maeander, and along the coast to the south, where it founded the city of Iasus. Its enterprise extended to Egypt, where it had much to do with the settlement of Naukratis (*q.v.*). Very little "Naucratitic" pottery, however, was found on the site, and only in the Athena temple. The Black Sea trade, however, was the greatest source of wealth to the Ionian cities. Miletus, like the rest, turned its attention chiefly to the north, and succeeded in almost monopolizing the traffic. Along the Hellespont, the Propontis and the Black Sea coasts it founded more than sixty cities—among them Abydus, Cyzicus, Sinope, Dioscurias, Panticapaeum and Olbia. All these cities were founded before the middle of the 7th century; and before 500 B.C. Miletus was decidedly the greatest Greek city. Miletus was equally distinguished at this time as a seat of literature. Thales, Anaximander, Anaximenes and Hecataeus all belonged to this city. The three Ionian cities of Caria—Miletus, Myus and Priene—spoke a peculiar dialect of Ionic.

The Mermnad kings of Lydia found in Miletus their strongest adversary. War was carried on for many years, till Alyattes III. concluded a peace with Thrasybulus, of Miletus; the Milesians afterwards seem to have acknowledged the rule of Croesus. On the Persian conquest Miletus passed under a new master; it headed the Ionian revolt of 500 B.C., and was taken by storm after the battle of Lade. (*See* IONIA.) Darius gave up the city to the Carians. The Persians were expelled from the coast in 479 B.C., Miletus became a member of the Delian League (*q.v.*), revolted to Sparta in 412, passed into Carian hands, and opposed Alexander on his southward march, succumbing to a siege (334 B.C.). It was a town of commercial importance throughout the Graeco-Roman period, and received special attention from Trajan. Its harbours, once protected by Lade and the other Tragasaean islands, were gradually silted up by the Maeander, and Lade is now a hill some miles from the coast. Ephesus took its place as the great Ionian harbour in Hellenistic and Roman times. Miletus became the seat of a Christian bishopric and was strengthened by a Byzantine castle *κάστρον τῶν Παλατίων*, built above the theatre.

Excavation has revealed on the north of the ruins a well-preserved Roman theatre on the site of an older Greek building. Cyriac of Ancona described the building as practically complete in his day (1446). East of this was the ancient north harbour, now silted up, and on the hillside above it stood a large heroon of Hellenistic time. South of the harbour head lies the Hellenistic agora with ruins of large magazines of Doric style. South of these again lie a nymphaeum of the age of Titus, and a senate-house of theatral form. On the east opens a great hall surrounded by porticoes and enclosing a high altar of Artemis, once richly adorned with reliefs. The Roman agora lies beyond this

again. A straight street leads south-west from the north harbour to the Didyma Gate in the wall, which runs across the neck of the peninsula and was rebuilt by Trajan, when he undertook to raise the level of the outer quarters of the city; and streets cross this at right angles in the geometric Hellenistic manner. A Sacred Way lined with tombs led to Didymi. Two temples have been discovered, one, on the south-east, being a sanctuary of Apollo Delphinius. This seems to have been the chief temple of the city. The other temple, an archaic sanctuary of Athena, lies west of the stadium.

See O. Rayet and A. Thomas, *Milet et le golfe Latmique* (1877); Th. Wiegand, "Vorläufige Berichte über die Ausgrabungen in Milet," in *Sitzungsberichte* of the Berlin Academy (1900, foll.); A. von Salis, "Die Ausgrabungen in Milet und Didyma" in *Neue Jahrb. f. d. k. Alt.*, xxv. 2, 1910.

MILFORD, a town of New Haven county, Connecticut, U.S.A., on Long Island sound, at the mouth of the Housatonic river, which separates it from Stratford on the west. It is served by the New York, New Haven and Hartford railroad. Pop. (1930) 12,660. The town occupies 25.5 sq.m., and embraces several villages, including the incorporated borough of Woodmont, a popular summer resort, and other beaches. It is a typical old New England town, with a beautiful green of four acres. Many of the inhabitants are descendants of the first settlers, and in the burying-ground are the tombs of Robert Treat, Jonathan Law and other prominent pioneers. The principal industries are agriculture (especially seed-raising), fisheries and a variety of manufactures.

The town was founded in 1639 by the Rev. Peter Prudden and his followers from New Haven and Wethersfield, and was named after the English city. The land was bought from the Indians for six coats, ten blankets, 12 hatchets, 12 hoes, 24 knives, 12 small mirrors and a kettle. A "Church-State" after the model of New Haven was organized, but the town granted the suffrage to six men who were not church-members, and this created an obstacle to its admission to the New Haven Jurisdiction. It was admitted, however, in 1644, on condition that none of the six should hold office in the Jurisdiction. When the members of the Jurisdiction were absorbed by Connecticut (1664) some of the people of Milford, led by Robert Treat, moved to New Jersey and helped to found Newark. The regicides Whalley and Goffe were concealed in Milford from 1661 to 1664.

MILFORD, a town of Worcester county, Massachusetts, U.S.A., and its chief village, which is on the Charles river, 33 m. S.W. of Boston, and served by the Boston and Albany and the New York, New Haven and Hartford railways. Pop. (1920) 13,471 (28% foreign-born white) 14,741, 1930 (Federal census). Within its area of 15 sq.m. is a considerable rural population. There are large quarries of a pinkish-grey granite, widely used for building purposes, and a number of boot and shoe factories and other manufacturing plants, with an output in 1925 valued at $7,844,387. The town was separated from Mendon and incorporated in 1780. The manufacture of boots and shoes was introduced in 1795, and for many years brogans for southern negroes were a specialty.

MILFORD HAVEN, LOUIS ALEXANDER, 1ST MARQUESS OF (1854–1921), British sailor, was born at Gratz, May 24, 1854, the eldest son of Prince Alexander of Hesse, by his morganatic marriage with the Russian countess, Julie Thérèse von Haucke. As Prince Louis of Battenberg he was naturalized as a British subject in 1868 and entered the royal navy in the same year. In 1884 he married Princess Victoria, daughter of the Grand Duke Louis IV. of Hesse. From 1891 to 1894 he was naval adviser to the inspector-general of fortifications and in 1900 was appointed assistant director of naval intelligence at the Admiralty, being made director in 1902. In 1904 he was promoted rear-admiral and after serving as second in command in the Mediterranean was made vice-admiral in 1908. After commanding the Atlantic and Home Fleets, he was in 1912 appointed First Sea Lord of the Admiralty, but in Oct. 1914 press agitation over his German origin brought about his resignation. In 1917 he relinquished his German titles, assumed the surname of Mountbatten and was elevated to the peerage as marquess of Milford Haven. In the following year he retired from the active list of the navy. He became an admiral of the fleet in 1921 and died on Sept. 11 of the same year. (*See* also BATTENBERG and MOUNTBATTEN.)

MILFORD HAVEN, town and seaport in Pembrokeshire, Wales. Pop. (1931) 10,116. The harbour was important in the middle ages as a port of embarkation for Ireland. Henry Tudor landed here in 1485 on his return from France to win the crown of England and Wales. The Hon. R. F. Greville improved the town in 1790 and a few years afterwards a dockyard was established but, with its transference to Pembroke Dock in 1814, and that of the Irish mail station to Holyhead, and with the temporary development of Neyland higher up the Haven, the town declined, but it is now fairly prosperous as the headquarters of a steam trawling fleet and a fish curing station. Milford Haven itself (Welsh: Aberdaugleddau—"the mouth of the two harbours") is as its Welsh name implies, the estuary of the united East and West Cleddau rivers.

MILHAUD, DARIUS (1892–), French composer, was born at Aix-en-Provence on Sept. 4, 1892. He studied at the Paris conservatoire and became one of the group known as the "Six." His most finished work is to be found in his chamber music, which includes five string quartets, two violin and piano sonatas; a sonata for flute and piano, and one for flute, oboe, clarinet and piano; and a "symphony" for the unusual combination of vocal quartet with oboe and clarinet. For piano with orchestra he has written studies and a *Poem;* and for piano alone a sonata and suites. In his incidental music to various Greek plays he shows an appreciation of tragedy which comes as a surprise to those who know him only as a parodist in *Le train bleu* and as a humorist in *Le Boeuf sur le toit,* with its Brazilian tango. Other ballets are: *La création du monde* and *Salade.* He has also written a "musical novel" for the stage, based on *La brebis égarée* by Francis Jammes. *Saudades de Brazil* is an effective dance-suite for orchestra. Three one-act *Opéras-minutes* were produced at Wiesbaden in 1928. For voice he has written three sets of songs: *Soirées de Pétrograd, Poêmes juifs,* and *Catalogue des fleurs* with chamber orchestra.

MILICZ or **MILITSCH** (d. 1374), Bohemian divine, was the most influential among those preachers and writers in Moravia and Bohemia who were forerunners of Huss. In 1360 he was attached to the court of the emperor Charles IV., and he held a canonry in the cathedral of Prague, with the dignity of archdeacon. About 1363 he resigned all his appointments that he might become a preacher pure and simple; he addressed scholars in Latin, and (an innovation) the laity in their native Czech, or in German, which he learnt for the purpose. He was conspicuous for his apostolic poverty and soon roused the enmity of the mendicant friars. The conviction grew in his mind that the "abomination of desolation" was now seen in the temple of God, and that antichrist had come, and in 1367 he went to Rome (where Urban V. was expected from Avignon) to expound these views. He was thrown into prison by the Inquisition. Urban, however, on his arrival, ordered his release, whereupon he returned to Prague, and from 1369 to 1372 preached daily in the Teyn Church there. He was summoned to the papal court at Avignon in Lent 1374, and died there in the same year, not long after being declared innocent. He was the author of a *Libellus de Antichristo,* written in prison at Rome, a series of *Postillae* and *Lectiones quadragesimales* in Latin, and a similar series of *Postils* (devotional tracts) in Czech.

See Count Lützow, *Life and Times of Master John Huss* (1909), pp. 27–38.

MILITARY ACADEMY, ROYAL: *see* WOOLWICH.

MILITARY COLLEGE, ROYAL: *see* SANDHURST.

MILITARY FRONTIER (Ger. Militärgrenze), a former institution and division of the Austro-Hungarian monarchy. When Croatia swore allegiance to the Habsburgs in 1527, after the defeat of Hungary by the Turks at Mohács, Southern Croatia was left half deserted, its inhabitants having fled north before the Turks. The Austrian Government built a series of forts in this zone, and organized the remaining population, with immigrant Serbs and Vlachs, into a defence force under military supervision;

the costs being borne by the Estates of the Austrian provinces proper. This organization was gradually extended, and in 1630 received a formal statute.

By the end of the 17th century, there were three "Generalates," in Karlstadt (Karlovats), Warasdin and Petrinja respectively. The Hungarian and Croat Estates deeply resented the existence of this exception from their authority, and constantly demanded its abolition, especially after Prince Eugène's victories had practically ended the Turkish peril; but the "Grenzer" themselves resisted any change, and the Habsburgs had also now become alive to its usefulness as a weapon against the unruly nobles. Instead of abolishing, they extended it; a new Slavonian district was established in 1702, a Szekler, in East Transylvania, in 1764, and a Wallach in 1766; the Frontier now ran from the Adriatic to the confines of Moldavia.

The "Grenzer" gradually became the backbone of the Austrian army. As its bravest, most loyal and best disciplined troops, they fought in all Austria's foreign campaigns, and under Jellačić took a chief share in crushing the revolutions of 1848–49 in Vienna and Hungary. In 1849 the Frontier was formed into a separate province, with an area of 15,182 sq. m., and a population of 1,220,503, mostly Serb or Croat, with some Vlach or Rumanian. In 1851, however, the eastern portion was incorporated with the rest of Transylvania. The Warasdin frontier passed under civil administration in 1871, the Banat in 1872 and the remainder of the Croat and Slovene districts on July 15, 1881. The tradition, however, remained, and even in the World War the "Grenzer" regiments were comparatively unaffected by nationalist agitation, while a high proportion of Austria-Hungary's highest officers were drawn from the old Frontier.

See F. Vaníček, *Spezialgeschichte der Militärgrenze* (Vienna, 1875); and J. H. Schwicker, *Geschichte der oe. Militärgrenze* (Vienna and Teschen, 1883). (C. A. M.)

MILITARY LAW embraces both a penal code for the maintenance of discipline of the army and also administrative law, which provides for the maintenance of the Army.

It is important to note that in Great Britain the Army Act itself does not take the form of permanent legislation, because it requires to be brought into operation annually by another Act of parliament known as the Army (Annual) Act. In other words, the Army Act is brought up annually for review by parliament and is amended (often considerably).

Administration of Discipline.—The administration of the discipline of the Army is governed not only by the Army Act but by Rules of Procedure (which are made by his majesty in pursuance of the Army Act), by the King's Regulations and by Royal Warrants. The tribunals which dispose of offenders are known as courts martial, of which there are three kinds, (a) general court martial, (b) district court martial, (c) field general court martial (the last is only utilized on active service).

When a soldier is charged with an offence he is, if the offence is deemed serious, placed under close arrest, *i.e.*, he is confined in the guard room in the custody of the non-commissioned officer in charge of the guard. If, on the other hand, the offence is not of a serious nature, he is placed in open arrest, *i.e.*, he is not permitted to leave barracks until his case has been disposed of. The soldier is then brought before his commanding officer who hears the charge, and if it be one he is authorized by the King's Regulations to dispose of, he may either so dispose of it, or he may, if he considers that the punishment which he may award is not sufficient, remand the accused soldier for trial by court martial. If, on the other hand, the offence is not one which he is authorized by the King's Regulations to dispose of, he has no alternative but to remand the soldier for trial by court martial if he thinks that the offence has been committed. On the other hand, however, the commanding officer may, of course, dismiss any charge, if, in his discretion, he thinks it ought not to be proceeded with.

The punishments to which a soldier is liable on conviction by court martial are (1) death, (2) penal servitude (for life), (3) imprisonment, (4) detention, (5) field punishment, (6) discharge with ignominy, (7) if a non-commissioned officer (a) reduction in rank and precedence, (b) reduction in rank, (c) reduction to the ranks, (d) reprimand, (8) fines, (9) stoppages of pay, (10) forfeiture of pay. A warrant officer is liable to similar punishments with slight differences of a technical nature.

Trial by Court Martial.—A court martial is conducted under conditions similar to civil courts. The material difference is that the sentence of the court is not valid until it has been "confirmed" by superior authority. An interesting point in regard to courts martial is that a conviction or an acquittal by a court martial does not bar proceedings being taken for the identical offence in the civil courts. The converse, however, does not apply.

The proceedings of all courts martial are reviewed by the judge-advocate-general who is the legal adviser of the secretary of State. If the proceedings are found by him to be irregular before confirmation, confirmation would be refused and the proceedings thereby nullified. If, on the other hand, the proceedings are reviewed by the judge-advocate-general after confirmation and are found to be invalid they would be quashed by the Army Council and the accused thereby relieved of all consequences of his trial.

In so far as an officer is concerned, his position differs from that of a soldier. First of all the soldier enlists for a particular term of service, which term varies with military requirements. It may be, for example, for seven years with the colours and five years with the reserve, or three years with the colours and nine years with the reserve. On the completion of his term of service the soldier concerned is entitled to be discharged, having completed his engagement. The officer, on the other hand, does not enter into any contract of this nature. When granted a commission by the sovereign he holds that commission at the King's pleasure, and in addition to the penal code to which he is subjected under the Army Act he may be removed from the Army at the king's pleasure, or he may be required to resign his commission, or to retire, under conditions which are indicated in the Royal Warrant for Pay and Promotion.

The penalties to which an officer is liable are (1) death, (2) penal servitude (for life), (3) imprisonment, (4) cashiering, (5) dismissal, (6) reduction in seniority of rank (though this does not involve reduction from a higher rank to a lower rank), (7) reprimand, (8) stoppages of pay.

It was indicated above that the Army Act provided for the rights of officers and soldiers. An officer who thinks himself wronged has a right of appeal either to the Army Council, or through the Army Council to the King. The soldier has a right of appeal through his captain and his commanding officer to a prescribed general officer.

In 1907 the Territorial and Reserve Forces Act was brought into force. This Act was defined as "an Act to provide for the reorganization of his majesty's military forces, and for that purpose to authorize the establishment of county associations and the raising and maintenance of a Territorial Force, and for amending the Acts relating to the reserve forces." In so far as an individual soldier of the Territorial Forces is concerned, this Act provided that men of the Territorial Force should be liable to serve in any part of the United Kingdom, but that no part of the Territorial Force should be carried or ordered to go out of the United Kingdom. The Act also provided that the Army Act should apply to the Territorial Force under the conditions laid down in the Territorial and Reserve Forces Act 1907. For a closer study of this subject reference to the above-quoted Acts is suggested. It is of interest to recall that when this Act was before the House of Parliament grave objection was taken in some quarters to the fact that as the Act stood members of the Territorial Force could be called out for duty in aid of the civil power in the event of riot or disorder, and would, therefore, become "involved" in a trade dispute. A pledge, however, that the Force would not be so used was given by the then secretary of State, and the Bill went through.

The World War.—Punishments inflicted in the field during the World War upon soldiers were (a) death, (b) penal servitude, (c) imprisonment, (d) field punishment (Nos. 1 and 2), (e) forfeiture and stoppages of pay (as also, of course, the minor

punishment of confinement to camp or barracks). Soldiers sentenced to penal servitude were sent to the United Kingdom to undergo their punishment but imprisonment was carried out in so called "military prisons in the field" which were established at the bases. The punishment inflicted in the military prisons in the field consisted actually of deprivation of liberty and other summary punishments which could be awarded by the governor, but did not prevent the carrying out of military training. It was rapidly realized, however, that the withdrawal of soldiers from the Front to undergo terms of imprisonment in the military prisons in the field was a serious menace to the security of the army, and in consequence, in 1915, the Army Suspensions of Sentences Act was passed. Briefly, this act enabled a sentence, no matter how severe, *e.g.*, penal servitude for life, to be suspended, and the offender, therefore, could be retained for duty. The Act still remains in being.

It will be here convenient to make some reference to the methods by which the death penalty was carried out during the World War. The sentence of death can and could only be carried out on active service by the authority and under the confirmation of the general officer commanding in chief. The procedure existing at the outbreak of the War was that the proceedings of the court-martial which sentenced the accused soldier to death were forwarded to general headquarters, where they were reviewed by the judge-advocate-general as to their legality, and were then laid before the commander-in-chief for his decision. All he had to guide him was a copy of the soldier's "conduct sheet," which disclosed his character, together with, possibly, evidence contained in the proceedings as to his character from the soldier's company commander. It was rapidly realized that these particulars provided wholly insufficient data for the commander-in-chief to take a decision of such momentous importance. In consequence, entirely extra judicial procedure was adopted, and a complete picture was presented of the whole circumstances under which the act was committed. The state of discipline of the unit was fully disclosed. The opinion of the various intermediary superior authorities was required as to whether or not the death penalty should be carried out as a deterrent. The fighting value of the unit was brought under consideration, as also that of the soldier concerned, and the soldier's value as a fighting man was made the subject of close investigation and report. Medical opinion and the expert opinion of neurologists was sought, and in cases where nervous breakdown or shell-shock was suggested, the opinion of medical boards was also required. It is gratifying to record that large numbers of soldiers who had been sentenced to death by courts-martial had their sentences commuted and were dealt with under the Army Suspensions of Sentences Act. It is more gratifying to record that 89% of the death sentences which were passed were, in fact, never carried out.

After the War.—Arising out of the experiences of the World War committees set up by the secretary of State for war have sat to consider the difficult question of the infliction of the death penalty for various military offences. As a result the death penalty has been abolished for various military offences and, as an example, it may be mentioned that by amendments of the Army Act of 1928 the death penalty was abolished for the following offences:—(1) leaving his commanding officer to go in search of plunder; (2) forcing a safeguard; (3) forcing or striking a soldier when acting as sentinel; (4) breaking into any house or other place in search of plunder; (5) sleeping or being drunk when acting as sentinel.

During the War also there was much popular feeling evinced against the punishment known as "field punishment" (a definition of which will be found in the *Manual of Military Law*). Field punishment No. 1 no longer exists as it was known at the outbreak of the War, as s. 44 (5) now lays down that field punishment must not take the form of "flogging or attachment to a fixed object." (B. E. W. C.)

United States.—Military law is the body of rules, regulations and doctrines that have been prescribed for the government of the Army and the Navy. In contradistinction to martial law, military law is a permanent code, applicable alike in time of peace and war. It finds its sources in the Constitution of the United States (article I., section 8; article II., section 2, and the Fifth Amendment); in the Articles of War, in Army Regulations, in statutes, general and special orders, circulars and bulletins issued by the military authorities under the direction of the President; in the Manual for Courts-Martial of the United States Army, and in the customs and usages of the service. (These customs and usages are binding only when not in contravention to law. *Martin* v. *Mott,* 12 Wheaton 19.) To these sources of military law should be added the decisions of the courts, the President, the secretary of war, and the opinions of the judge advocate general and the attorney-general. (Davis, *Treatise on Military Law,* 1, 6; 5 Corpus Juris 296.) Army Regulations have the force of law so long as they do not contravene existing law, are not legislative in their nature, and are not inconsistent with treaty obligations. (*United States* v. *Symonds,* 120 U.S. 49; *United States* v. *Webster,* 2 Ware 54.) They must be applicable to the military, be uniform, and not arbitrary or oppressive. (*United States* v. *Mann,* 2 Block 9, 11.) General and special orders issued by the highest authority of the Army are a part of military law. All persons subject to military law are amenable to the government of military law—all officers, cadets, members of the Army nurse corps, warrant officers, and enlisted men.

The first American code was enacted by the Second Continental Congress June 30, 1775, and included sixty-nine articles of war, derived in great part from the British, and was amended on Nov. 7, 1775, by the addition of sixteen provisions. The code of 1806, composed of one hundred and one articles, was the first complete revision of the American code, and remained in force, with few amendments, until 1874. Changes culled from long experience were included in the articles of war of 1920. These new articles provided for a system of appellate review by a board of review and the President for certain general court-martial cases. (Article of War $50\frac{1}{2}$.) They also provided for the appointment upon all general courts of a law member especially equipped to determine questions of law. The articles of war of 1920, introducing many changes in the procedure before courts-martial, with constructive criticism and suggestions, are incorporated in the Manuals for Courts-Martial, United States Army, of 1921 and 1928.

Courts-martial are the tribunals which administer the law in the army. These courts—(a) general courts, (b) special courts, and (c) summary courts (A. W. 3)—appointed by designated military authority, are established under the constitutional power of Congress and are lawful tribunals with penal or disciplinary jurisdiction. They are judicial in their nature. (*Dyne* v. *Hoover,* 61 U.S. 838.) A general court-martial is a court of co-ordinate jurisdiction. Its judgments are entitled to the same respect as res judicata as those of the highest tribunals in the land. (*Grafton* v. *United States,* 206 U.S. 333; *ex parte* Reed, 100 U.S. 13; *Rose* v. *Roberts,* 99 Fed. 948; *Carter* v. *McClaughry,* 183 U.S. 368.) The sentence of a general court confirmed by the President of the United States is altogether beyond the jurisdiction or inquiry of any civil tribunal whatever. (*Smith* v. *Whiting,* 116 U.S. 168; *ex parte* Mason, 105 U.S. 695.) To release a military prisoner from confinement, habeas corpus will not lie unless the sentence under which the soldier is confined is an absolute nullity for want of jurisdiction. (*Ex parte* Watkins, 3 Peters 193. Note in *Bens* v. *United States,* 266 Fed. 152.) (F. W. HA.)

France.—French military law comprises the Law on the organization of the nation in time of war, on the general organization of the Army, on the constitution of cadres and effectives, and on recruiting for the Army, on the principles of the reduction of compulsory service to one year; the development of the "nation in arms" idea; the respect of international agreements, and the protection of frontiers.

The respect of international agreements led France to work out a rational organization of national defence, which would obviously be as efficient in case of danger as it would be useless for wars of aggression or conquest. At the same time the essential point is adequate defence of the country against aggression.

As a result of the World War the security of French frontiers is to-day an undisputed and universally organized dogma. This security can only be guaranteed by an army sufficient in strength and easily mobilized. For 125 years a conception of "the nation in arms" has been before the public mind.

The "nation in arms" idea is the chief outcome of the World War and the French military organization has been framed in accordance with it.

To summarize, in this system the reserves play the most important part; as a consequence, the strength of the standing army may be reduced. From the standing army is to be recruited that of war time. To train, to mobilize and to cover the frontiers, are henceforward the main duties of the standing army.

Germany.—The general principles of German military law are similar to those of Great Britain and many European countries, and the United States system is somewhat similarly framed. There is no permanent president for courts-martial but, as in England, a presiding officer is chosen for each trial.

In different States of Germany different procedures hold for the formation of special summary courts-martial as occasions arise. There are no "Courts of Honour." The proceedings before a German court-martial are usually public except in the case of matters offending public morality, or in any other way compromising public order, and excepting also those cases where publicity is considered injurious to the interests of the forces as a whole. Such are cases of discipline, disclosure of military secrets, plans, etc. Military crimes and offences dealt with in the German Military Code of Penal Law of June 20, 1872 (within the meaning of the notification of Feb. 16, 1926) as acts punishable by law are mainly: (1) Extended unauthorized absence and running away from the flag; (2) self-mutilation; (3) cowardice; (4) serious wrongs against military subordination, as for instance threatening, insult and setting actually at work against superior officers—mutiny; (5) serious wrongs against inferiors, for example actual insult and ill treatment; (6) military theft (embezzlement), plundering; (7) bribery.

The Public Prosecutor acts normally as counsel for the accused. In Germany, however, procedure differs not only from district to district but according to the simplicity or severity of the case. There is no appeal, except for officials attached to the Army. Since the World War a series of changes has been introduced into the various systems in use in the different states and generalization concerning German procedure is now (1929), and will probably be for some years, unsafe. The general principles of courts-martial only have remained unchanged. (X.)

MILITARY RAILWAYS: *see* LIGHT RAILWAYS, MILITARY.

MILITARY SCIENCE, ARTICLES ON. The basic article is that on WAR, and complementary to this are the two important articles STRATEGY and TACTICS. Special forms of warfare are dealt with in the articles GUERRILLA WARFARE and MOUNTAIN WARFARE. The weapons and auxiliary means of warfare are covered in such articles as AMMUNITION; ARTILLERY; CHEMICAL WARFARE; BRIDGING, MILITARY; CAMOUFLAGE; CROSS-COUNTRY TRANSPORT; FORTIFICATION AND SIEGE-CRAFT; MOTOR TRANSPORT, MILITARY; ORDNANCE, etc.

For the structure, or organization, of armies the main article is ARMY. This is supplemented and enlarged by ARTILLERY; BARRACKS; CAVALRY; ENGINEERS; INFANTRY; INTELLIGENCE; MEDICAL SERVICE; SUPPLY AND TRANSPORT; STAFF; and by CONSCRIPTION; MILITIA; NATIONAL GUARD; TERRITORIAL ARMY; VOLUNTEERS and YEOMANRY.

Important aspects of war and armies are treated in the articles such as ARMY (MORALE IN WAR); COLOURS and UNIFORMS. The student of military antiquities will find much information in these, as well as in ENGINES OF WAR; GUARDS; GUN; HELMET; LANCE AND SWORD.

In military history, the chief wars of the ancient world are treated in such articles as GRAECO-PERSIAN WARS; PELOPONNESIAN WAR; PUNIC WARS, as also are the great military organizations, the MACEDONIAN ARMY; ROMAN ARMY and BYZANTINE ARMY. For the more important or famous battles of ancient history, see MARATHON; MANTINEIA; ISSUS; TRASIMEUS; CANNAE; METAURUS; ZAMA; ILERDA; PHARSALUS; ADRIANOPLE; DARAS; TAGINAE, etc. This evolutionary thread is maintained in dealing with the battles of mediaeval history, from TOURS, MANZIKERT and HASTINGS through DUPPLIN, CRECY, POITIERS and FORMIGNY, to RAVENNA and MARIGNANO, while special periods are examined in the MOHAMMEDAN CAMPAIGNS, MONGOL CAMPAIGNS, HUNDRED YEARS' WAR and ROSES, WARS OF THE.

In modern history each of the main wars has an article, *e.g.*, THIRTY YEARS' WAR, GREAT REBELLION, SPANISH SUCCESSION, SEVEN YEARS' WAR, FRENCH REVOLUTIONARY WARS, NAPOLEONIC CAMPAIGNS, PENINSULAR WAR, CRIMEAN WAR, AMERICAN CIVIL WAR, SEVEN WEEKS' WAR, FRANCO-GERMAN WAR, RUSSO-JAPANESE WAR. For the last war, as a whole, *see* the long and important article WORLD WAR, which is supplemented by other articles on each of the great battles or phases, *e.g.*, FRONTIERS, BATTLES OF THE; MARNE, FIRST BATTLE OF THE; MEUSE-ARGONNE, BATTLES OF THE; SOMME, BATTLES OF THE; VERDUN, BATTLES OF; YPRES, BATTLES OF 1914, 1915 and 1917; TANNENBERG, BATTLE OF; CAPORETTO; VITTORIO VENETO; ST. QUENTIN; LYS; CHEMIN-DES-DAMES; MARNE, SECOND BATTLE OF THE; AMIENS; ST. MIHIEL; HINDENBURG LINE; MEUSE-ARGONNE. The more distant theatres of war, such as PALESTINE, SALONIKA, MESOPOTAMIA and EAST AFRICA, are covered in special articles.

MILITIA, a term used generally for organized military forces which are not professional in character and not permanently embodied. (Fr. *milice*, Ger. *Miliz*, from Lat. *miles*, soldier, *militia*, military service.) All ancient armies, with the exception of the personal guards of their leaders, were militias or national levies, remaining under arms for the war or the campaign and returning to their ordinary occupations at the close of each military episode. Militias such as those of the Greek city-states and that of Rome were of course highly trained to the use of arms; so were the barbarian "nations in arms"; which overcame the professionalized Roman armies of the Empire; and although in the Eastern Empire these new fighting elements were absorbed into a fully organized regular arm, in the West the tribal militia system gradually developed into feudalism. The noble and the knight indeed spent the greater part of their lives in the field and devoted themselves from their youth to the cult of arms, but the feudal tenantry, who were bound to give forty days' war service and no more, and the burghers who, somewhat later in the history of civilization, formed the efficient garrisons of the walled towns were true militias. The English "Yeomanry" indeed almost ruled the battlefield.

In the 15th century the introduction of firearms began to weigh down the balance in favour of the professional soldier. Artillery was always the arm of the specialist. The development of infantry "fire-power," with the early arquebus and musket, called for the highest skill and steadiness in the individual soldier, and cavalry too adopted the new weapon in the form of long and expensive wheel-lock pistols. In the new military organization there was no place for the unprofessional soldier. The rôle of the unprofessional combatant, generally speaking, was that of an insurgent—harassing small detachments of the enemy, cutting off stragglers and plundering convoys. Towards the end of the first civil war in England (1645) the country-folk banded themselves together to impose a peace on the two warring armies, but their menace was without effect, and they were easily disarmed by Fairfax and Cromwell, who did not even trouble to hold them as prisoners. The calling out of the *arrière ban* of Franche-Comté in 1675 displayed its ludicrous inefficiency, and thereafter in France, which set the fashion for Europe in all military matters, the "provincial militia," which Louvois and Barbezieux raised in place of the discredited *arrière ban*, was employed partly to find drafts for and partly to augment the regular army.

When a first line army was large enough to absorb the fighting strength of the country there was neither room nor need for a true militia force. This was the case with France under Napoleon's régime, but things were different elsewhere. In Great Britain the county militia (whose special history is briefly sketched below) was permanently embodied during the greater part of the Napoleonic Wars. Destitute as it was of technical and administrative services, of higher staffs and organization, and even of cavalry,

this militia was a regular army in all but name. Combining continuous service with territorial recruiting as it did, it consisted of men of a better stamp than the casually recruited regular forces. In those days, the militia was a county force commanded by the lords-lieutenant and officered by men of influence; it was not administered by the War Office.

In other countries, Napoleon's invading armies had only to deal with regular or professional troops. Once these were crushed, nothing remained for the beaten side but to make peace with the conqueror on such terms as could be obtained. Militias existed in name as organizations, for the production of more or less unwilling drafts for the line, but the fundamental militia obligation of defending the *fatherland* as distinct from defending the *state*, produced only local and occasional outbursts of guerrilla warfare. In the Crimean War, the 1859 war in Italy, the 1866 war in Germany, and other wars (the Hungarian War of 1848–49 excepted) the forces, other than the regular troops, engaged in first line were guerrilleros, insurgents, Garibaldians, etc., and behind the forces in first line there were draft-supplying agencies, but no true militia. Only the British militia and the Prussian landwehr represented the self-contained army of second line, and of these the former was never put to the test, while the latter, responding feebly to a political call to arms in 1850, was in consequence so entirely reorganized that it formed a mere rear rank to the line troops. This latter system, consecrated by the German successes of 1870, became the universal model for the continent of Europe, and organized and self-contained militias to-day are only to be found in states maintaining first line armies of "general service" professionals, or in states which maintain no first line troops whatever. In the first class are the auxiliary forces of the British Empire and the United States, in the second the Swiss, Norwegian, Dutch and Swedish forces. On the other hand, with the reduction of the term of service in countries where conscription prevails to a term as short as twelve months, these armies are in nature if not in name tending to become a superior type of national militia.

MILITIA OF ENGLAND

The title of "militia" disappeared from the list of the British forces in 1908, on the conversion of the existing self-contained militia into an army "special reserve" which is restricted to the rôle of providing drafts for the first line.[1] The "self-contained" second line army of the present day is the Territorial Army (*q.v.*) (*see* also ARMY and GREAT BRITAIN: *Army*).

The county organization of England, with which throughout the militia was closely associated, began with the advent of the Saxons. The prototype of the militia was the Fyrd. In this force as reorganized by Alfred liability of service was general on the part of every able-bodied male between the ages of 16 and 60. Although the title of "The Fyrd" survived until long after the Norman conquest, the force established by King Alfred was known as the general levy, which was bound to appear armed when ordered to aid in suppressing domestic riots as well as in defending the realm against invasion by foreign foes. Service was restricted to the counties, except in case of invasion, when it was extended to the whole kingdom. The Norman Conquest was immediately followed by the introduction of the feudal levy in addition to the general levy, the distinction between these forces being that while obligation to serve in the latter rested upon every male within certain limits of age, service in the feudal levy depended upon tenure of land under the king as feudal lord. The general levy was not in any case liable for service overseas, but the king for a long time employed his feudal tenants in continental wars until they too, successfully resisted the demand. Personal service formed the basis of both levies, but service by deputy, or payment in lieu of personal service were allowed from very early times. The feudal levy was discontinued during the Commonwealth and abolished at the Restoration; but liability to serve in the general levy has never been extinguished, but remains in the statutory and practical form of liability to serve both in the general and local militia. Even at the abolition of these forces the statutory liability to service in them was not done away with. Inspections of arms and the assembly and training of the men raised under this national system were secured from time to time by means of "assizes of arms," "views of armour," "commissions of array," and "commissions of musters," dating from early in the 12th century down to the 16th century. These constitutional powers were frequently abused by "electing" or impressing men to serve out of the kingdom, but this was checked in the year 1327 by an Act of Parliament, which strictly regulated the scope and limits of military service within the kingdom at the charge of the parishes or counties, but provided for service abroad at the charge of the Crown. "Commissions of musters" were a development of preceding measures for raising men and material for military service, under which the commissioners registered and mustered persons liable to serve, sorted them into bands and trained and exercised them at the charge of the county. These bands became known as *train* or *trained bands*, and were mustered annually. With them were associated lieutenants of counties, first appointed in 1549 by Edward VI., subsequently in Queen Mary's reign called lords lieutenant, and after the Restoration appointed as statutory officers for the militia. There does not appear to have been any clearly defined regimental organization in existence until these bands or companies were called into active service, but the Acts of the Commonwealth supplied this defect, and initiated a permanent regimental system. One of the earliest attempts to reform the force since the time of King Alfred was made by Charles I. in 1629, when Orders in Council were issued instructing lords lieutenant to put the militia on a better footing. Cromwell subsequently issued similar orders couched in strong terms, though under the Commonwealth the duties of lords lieutenant were not recognized, the militia being raised by commissioners. The great services rendered by the militia in the "crowning mercy" of Worcester are a historic exception to the general decadence of second line troops in the 17th and 18th centuries (*see* GREAT REBELLION and WORCESTER, BATTLE OF, 1651). At the Restoration an act was passed declaring that the control of the militia was the prerogative of the king. By the same statute the militia of each county was placed under the lieutenant, who was vested with the appointment of officers, but with a reservation to the Crown in the way of commissioning and dismissal. The cost of the annual training—for fourteen days—fell upon the local authority. Offences against discipline were dealt with by the civil magistrates, but with a power to the officers of fining and of imprisoning in default. Upon this footing the militia of England remained for nearly a century, with the general approval of the community, as an instrument for defence and the preservation of internal order. While the supreme command was distinctly vested in the Crown, every practical security was thus taken against its use by the Crown for any object not constitutional or legitimate. It was regarded as, and was, in fact, the army of the state as distinguished from the standing army, which was very much the army of the king personally. But the new "professional" conditions of warfare, and perhaps the practice of trying military offences by civil courts, contributed to the disrepute into which the militia fell and the inefficiency it displayed, with the exception of the trained bands of London, until it was reorganized in 1757. Under the act of 1662 all train bands were discontinued in the counties, but those of London, with their auxiliaries, remained until 1794, when they were reorganized as the City of London Militia. In 1688 an act was passed raising the militia for one year, and for some time it was an annually sanctioned force as the regular army is to-day. In 1690, on the occasion of the threatened French invasion, the militia was embodied; and again in 1715 and 1745 during the troubles caused by the Old and Young Pretenders. In a pamphlet of 1712 the English militia was estimated at 7,450 horse and 84,391 foot soldiers.

MILITIA OF IRELAND AND SCOTLAND

Ireland and Scotland did not furnish any regular militia until 1715 and 1797 respectively, although in Scotland militia existed

[1]Various dominions and colonies of the British Empire have militias, for which *see* UNITED KINGDOM: *Army*. For the Swiss Militia System, which is in many respects the archetype of modern militias, *see* SWITZERLAND; and for the organized militia of the United States *see* UNITED STATES and NATIONAL GUARD.

long before 1797, *e.g.* in Perthshire in 1684; and in addition corps of fencibles were raised and embodied. The Irish militia when first raised in 1715 was restricted to Protestants between the ages of 16 and 60, who were bound to appear or provide substitutes. The force was not made subject to military law, but various military offences were punishable by fine or imprisonment. In 1793 a new act was passed providing for raising a force of militia by ballot among men between the ages of 18 and 45, to serve for four years. An amendment in 1797 abolished religious restrictions for the supplementary militia, and another in 1802 for the general militia. The Scottish militia was at first raised by ballot among men between the ages of 19 and 30. In 1802 former acts were replaced by an act providing for the organization of the militia on a basis similar to that on which the militia of England was organized by the Consolidation Act passed in that year.

CONDITIONS DOWN TO THE WORLD WAR

Reorganization of 1757.—To return to England, the immediate cause of the organic reform carried out in 1757 was the disclosure of the inefficiency of the militia during the Rebellion of 1745. A liability on the part of the county or parish was now substituted for a liability on the part of individual property-owners. Each county was required to furnish a quota apportioned among the various parishes; men were to be chosen by lot to serve for three years (this being the first provision of a fixed term of service) or to provide, or pay £10 for the provision of, a substitute, and the ages of liability were from 18 to 45. The force was to be annually trained and exercised for a limited period, and in case of invasion or danger thereof, or in case of rebellion, the Crown could order it or any portion of it to be embodied; but only on condition of informing parliament (which was if not sitting to be summoned for the purpose). During the embodiment or annual training it was subject to the Mutiny Act, except that no punishment during training was to extend to "life or limb," to prevent an unconstitutional use of the militia by the Crown, the estimate for its training was framed each year, not by an executive minister of the sovereign, but by the House of Commons itself. Upon the initiative of a committee of the House, an act was passed providing for the pay and clothing of the militia for the year. The king directly appointed the permanent staff and was given a veto on the appointment and promotion of the officers, who were to have a property qualification.

Under this act 30,000 militiamen were raised by ballot and embodied from 1759 to 1763. This force was exclusively "Protestant," and remained so until 1802. The service of the militia as thus arranged remained nearly in the same state until 1870. Pitt's reform, however, was followed by numerous amendments, new enactments, and other changes, of which the most important are summarized below:—

1796. Supplementary militia formed, consisting of 63,878 men.
1798. (Irish Rebellion.) English militia volunteered for service in Ireland.
1799. Irish militia volunteered to serve in Great Britain.
15,000 militiamen volunteered to regular army.
1805. Militia affiliated to line for purposes of recruiting for regulars.
1806. Training Act to raise by ballot 200,000 men to be trained for one whole year, and then to discharge them from training for two years.
1808. Difficulties having arisen under above Act, local militia (which is in effect the old general levy) established in addition to general militia then embodied.
1811. English militia now made liable to serve in any part of the United Kingdom under certain restrictions, which were subsequently (in 1859) removed.
1812. In this year there were 250 regiments of local militia, with an establishment of 240,388 men and 214,418 actually enrolled.
1813. During ten years, from 1803 to 1813, nearly 100,000 militiamen joined the regular army.
Act passed to enable militia to serve abroad as militia with their own officers. Three strong battalions joined the British army in France.
1816. Local militia and Ballot Act suspended.
General militia disembodied.
1820–21–25. Militia called out for training.
1831. Militiamen raised by ballot in accordance with Order in Council, 27th of December 1830. This was the last occasion on which the ballot was put in force.

In the later stages of the great French war the tendency of the government was to use the general militia rather as a reservoir producing drafts (in the end whole units) for service abroad, and the local militia as the real defensive force. After the peace of 1815 the militia was allowed practically to fall into abeyance, and although the permanent staff was maintained, it had no duties to perform. It was not until 1852, after an unsuccessful attempt to resuscitate the local militia, that the general militia of England was reorganized under a system of voluntary enlistment with the ballot in reserve, Scotland and Ireland being included in 1854. Larger powers respecting the militia were conferred upon the Crown, and during the Crimean War the queen was authorized to embody the militia whenever a state of war existed with any foreign power. In that war the militia was embodied and did garrison duty not only in the United Kingdom but in the Mediterranean garrisons, thus enabling the authorities to send most of the available regular troops to the scene of hostilities. It further contributed many officers and some 30,000 men to the line. During the Indian Mutiny it filled scarcely less useful functions when again called out.

In 1871 an important constitutional change was made. It was part of the new army system inaugurated in that year that the control of the militia should be removed from the lord-lieutenant of the county and vested wholly in the Crown. It now virtually ceased to exist as a distinct body, and in 1881 it became a part of the regular forces with a limitation as to the time and area and other conditions of service. Militia battalions were united with the line battalions to form "territorial" regiments. The officers, who were commissioned by the Crown, were in 1877 made subject at all times to military law. Non-commissioned officers and men were only so subject when embodied or out for training. The period of engagement was for six years, re-engagements for periods of four years up to the age of 45 being permitted. Bounties were paid to militiamen at various rates upon enlistment, conclusion of training, re-engagement, enlistment into reserve or special service section, and other special circumstances. The annual training varied with the different branches of the service. The usual term for infantry was 27 days, 56 days being the legal maximum. The militia dépôts occupied as a rule the same barracks, and officers and men wore (with slight distinctions) the same uniform as the regulars.

The militia reserve consisted of men selected from the ranks of the militia for special enlistment for service in the regular army when called upon in emergencies, in the following proportions to the establishments of the various corps: Artillery, one-third; engineers and infantry, one-fourth; medical staff corps, one-half. The term "militia" reserve was therefore a complete misnomer, and the force so called was purely an army reserve. The special service section of the militia was formed by royal warrant in 1898, and consisted of (1) militia units and (2) individual militiamen. A militia unit was considered as available for special service if not less than 75% of the officers and men present at training made a voluntary offer to engage for special service in any part of the world. Liability for service was limited to 12 months. The result of this special section was not up to 1900 satisfactory.

During and after the South African War, while militia recruiting for the regulars showed a constant increase compared with preceding years, the strength of the militia itself decreased year after year. Its militia character had been diminishing ever since the creation of the "militia reserve" and the close affiliation of the force to the regular army. For good or evil, then, it had become in the first place a draft-producing agency, and on the reorganization of the forces of the Crown into two lines by Mr. Haldane the old "constitutional force" was frankly reorganized as a reserve for the line, enlistment and training conditions remaining somewhat similar to those in vogue in the militia, but the liability for service abroad becoming the first and most important condition in the "special reservist's" enlistment.

THE SPECIAL RESERVE

Test of the War.—The new Special Reserve was soon to be tested highly. For the World War had hardly begun in 1914 before the casualties and the consequent demand for drafts immeasurably

exceeded all calculations. While the Territorial Force and the New Armies were maintained from their own reserve sources of man-power, the requirements of the regular army were such that in the later stages of the war many of its battalions were officered entirely by officers trained in the Special Reserve. Some 67,307 officers and 1,763,253 other ranks were sent overseas as drafts to the infantry alone. The Special Reserve performed a threefold task, for besides supplying drafts it was relieving the Territorial Force of the duty of guarding the coast and provided part of the nucleus of trained soldiers on whom the New Armies were built. In addition, six infantry battalions and thirteen R.E. companies were sent out as units.

After the war, as a concession to feeling, the time-honoured title of "The Militia" was revived, and the War Office took the step of allotting one battalion to each regular regiment and invited county authorities to recommend officers for command. But the retrenchment of expenditure caused the postponement of any action, and the militia remains a mere title in the Army List, with a few officers nominally on its strength and the solemn annual announcement that "no militia training will be carried out this year." The increasing mechanization of the army is, however, tending to reduce the need for and the suitability of such a force, and its place has to some extent been taken by the formation of a Supplementary Reserve consisting mainly of technical personnel.

(B. H. L. H.)

UNITED STATES

The militia of the United States of America consists of all able-bodied male citizens (including those who have indicated their intention to become citizens) of more than 18 and, except as provided by law, of not more than 45 years of age. It comprises the National Guard, the Naval Militia and the Unorganized Militia. The National Guard consists of regularly enlisted militia between the ages of 18 and 45, and commissioned officers between the ages of 21 and 64 years. The National Guard developed from the militia, and is the largest and best prepared component of the military establishment. It is to be used as a front line force in time of emergency.

In 1774 the Massachusetts Colonial Assembly appointed a Committee of Safety which organized the militia in the locality of Boston. The Second Continental Congress (1775) provided for the organization of the militia of the several colonies, part of which agreed to hold themselves in readiness at a minute's notice, thereby becoming the so-called "Minute Men." Shortly after the battle of Lexington, the Congress of Massachusetts resolved that 50,000 troops were necessary and advised the several colonies to raise their proportion of this force, 13,600 being the quota to be raised in Massachusetts.

The Continental Congress, in so far as organization and administration of the militia was concerned, was almost entirely advisory. Enlistments were for approximately three months and desertions were extremely numerous. Of the 395,864 troops enrolled during the Revolutionary War, 164,087 were militia. Troops were untrained, and the officers inexperienced.

The first Federal Militia Law was enacted in 1792 and provided for the enrollment for military duty of able-bodied, white, male citizens between 18 and 45 years of age. No compensation was offered but each militiaman was expected to provide himself with a good musket. No active Federal control was contemplated and no Federal financial aid provided before 1808. For over 100 years after the Revolution, there was practically no development of the militia. There was no co-operation between the regular army and State troops until about 1880. In 1880, $200,000 was voted by Congress for the militia. This continued until 1887 when it was increased to $400,000 yearly. From 1900 to 1906, $1,000,000 was voted, and at present appropriations are about $31,000,000.

In the Spanish War, the militia consisted of about 1,600 companies informally grouped, in some instances, into battalions, regiments and brigades.

The origin of the present National Guard dates from the Dick Bill of 1903, whereby the militia was officially designated the "Organized Militia of the United States." The bill provided for: organization, armament and discipline to be the same as in the regular army; it authorized the secretary of war to issue at Federal expense ammunition and supplies provided for the regular army; it provided for regular inspections by regular army officers and regular returns by State adjutants general; it provided for participation of the militia in joint manoeuvres with the regular army and for pay, subsistence and transportation during such activities. State encampments for training were provided for, regular army officers were sent to the States as instructors, and other important improvements in organization were provided. The Division of Military Affairs in the War Department, with a regular army officer as chief, was inaugurated. The divisional plan of organization was adopted in 1913 and further Federal aid and co-operation were embodied in the National Defence Act of June 3, 1916.

On Aug. 5, 1917, all of the National Guard to which Federal recognition had been extended became part of the army of the United States. These troops consisted of 12,115 officers and 336,954 enlisted men and were organized into 16 divisions which were sent to various camps throughout the country for further training and development for use during the World War.

Reorganization of 1920.—By the Act of June 4, 1920, the National Guard was reorganized, and provision made for the preservation of names, records and flags of former National Guard organizations that had served in the World War, and for the establishment of the Militia Bureau of the War Department. This law further provided for enlistment under Federal oath, defined the pay, provided for equipment and training, and for the employment of the National Guard by draft into the service of the United States in national emergencies.

The authorized strength of the National Guard was fixed at 200 enlisted men for each senator and representative in Congress and a number to be determined by the president for each territory and the District of Columbia, this number to be increased each year after 1920 in the proportion of not less than 50% until the total peace strength of not less than 800 enlisted men for each senator and representative in Congress should have been reached. This now provides for a force of about 435,800.

In 1922 the National Guard was to be limited to 250,000, but current appropriations are sufficient for the maintenance of only 186,000, which comprise 18 infantry divisions, four cavalry divisions, certain coast defence corps and army troops, G.H.Q. and auxiliary units. In general, two divisions of infantry have been allocated to each of the nine corps areas of the United States. The enlisted personnel is obtained by recruiting agencies under State control. Original enlistments are for three years, subsequent enlistments being for one year.

The National Guard when not in Federal service is under command of the governor of each State. While not in the service of the United States, it is governed by National Guard regulations issued by the War Department in forms similar to army regulations. The Militia Bureau, under the direction of the secretary of war, is charged with the general administration of National Guard affairs. It is inspected by regular army officers to determine Federal recognition and consequent Federal financial aid. Annual armoury and field inspections are required. State funds amounting to about $11,000,000 provide for the State administration of the National Guard and supplement the pay of officers and men which is provided by the Federal Government. In general, the United States appropriates about $3.00 where the States appropriate about $1.00. The cost of each enlisted man in the National Guard is approximately $230.00 a year.

Officers and men in the National Guard receive one day's pay on a regular army basis for each drill period attended by 50% of the enlisted and 60% of the officer personnel and for each day of practical training in camp. Officers of the National Guard are eligible for detail as students at the general and special service schools of the army.

National Guard troops may be employed (1) as State troops under State control; (2) by the Federal Government under call into the Government service under constitutional provisions to execute the laws of the Union, suppress insurrection and repel invasion; (3) by draft into the Federal service as part of the

army of the United States. A "call" into the service of the United States is issued by the president in certain specifically defined emergencies. It may be issued when troops are required for some specific purpose, or it may be a warning order preliminary to a procedure known as a "draft." A "draft" is a procedure adopted by the president to take into the military service of the nation as a component of the army for service during the war or in an emergency a part or all of the National Guard when Congress shall specifically authorize for any particular emergency the use of armed land forces in excess of the regular army. As a result of this act (draft), the National Guard is divested of its militia character and becomes a Federal force without allegiance to State authorities. (W. N. Ha.)

MILK is the secretion of the mammary glands (mammae) of the large class, the Mammalia, of vertebrate animals that suckle their young. Those animals the milk of which is commonly consumed by man are the cow, the goat and the sheep.

The average composition of milk, according to Richmond is shown in the following table.

Water	87·34
Fat (Milk fat or butter fat)	3·75
Lactose	4·70
Caseinogen	3·00
Lactalbumin	0·40
Salts	0·75
Other Constituents	0·06

While the lactose and mineral salts are in true solution (*see* SOLUTIONS) the proteins, caseinogen and lactalbumin, are present in colloidal solution, with which fat is intimately mixed in the form of an emulsion or suspension of globules.

Milk is a complete food, containing as it does protein, fat, carbohydrates, mineral constituents, and water. Though deficient or lacking in certain metallic elements believed essential for normal adult health, the milk of any species is an adequate diet for the very young of that species in all respects, including its contents of vitamines (*q.v.*). On the other hand, it may not be equally satisfactory for the young of another species. Thus cow's milk is not always an absolute source of vitamine C for human infants. Normally cow's milk if produced under proper conditions is an adequate source of vitamines A and B, and a reasonably good source of C and D. Its content of vitamine E is probably low.

Variation in Composition.—The specific effects of different circumstances on the yield and chemical composition of milk are frequently dealt with in the reports on the experimental work carried out by the various agricultural colleges. According to Mackintosh the naturally occurring conditions which influence the yield and quality of milk can be summarized as follows:—1. Breed of Cow. 2. Individuality of Cow. 3. Period of Lactation. 4. Interval between milkings. 5. Efficiency of the milker. 6. Age of the Cow. 7. Climate and weather conditions. 8. Health of the Cow. 9. Kind and quality of food.

Under the Food and Drugs Act milk (other than skimmed, separated or condensed milk) must contain not less than 3 per cent. of milk fat and 8·5 per cent. "solids not fat," until the contrary is proved. Skimmed or separated milk should contain not less than 8·7 per cent. total solids.

The addition of preservatives or of colouring matter is illegal.

THE BRITISH MILK TRADE

Owing to its nature, fluid milk is one of the few products which are practically free from foreign competition. Approximately 80% of the dairy farms in England and Wales are producing milk for sale in the liquid state, which necessitates good market organization, as milk is the most perishable, bulky and easily contaminated of all food stuffs. Such organization depends largely upon centres of consumption by reason of the high cost of transport and necessary speed of delivery.

After the low prices of 1922 the National Farmers' Union and the National Federation of Dairymen combined to form a committee, which now regulates the price, and this price at first only applicable to London now influences the whole country.

After some opposition the majority of milk distributors agreed to purchase all their supplies through the pool. The Agency already embraces over 1,200 individual farmers, 14 Farmer's co-operative creameries, and handles over 50,000 gallons of milk per day, or 70% of all the milk supplies of the Clyde valley.

Recently the Scottish Milk Pool has extended its activities to Edinburgh and Aberdeen. Little changes have been caused by the inception of the pool in the methods of distribution, but gradual economies will be introduced, so as to lower transport and distribution costs.

Milk Classification.—Various "clean milk" movements have resulted, in England, in an optional system of grading milk with a sufficiently high degree of bacterial purity. The following standards are laid down under licence granted by or under the authority of the Ministry of Health:—

Raw Milk

<table>
<tr><th rowspan="2">Designation</th><th rowspan="2">Herds</th><th colspan="2">Bacterial content</th><th rowspan="2">Other conditions</th></tr>
<tr><th>Maximum number of bacilli per cubic centimetre</th><th>Coliform bacillus</th></tr>
<tr><td>Certified</td><td>Tuberculin tested and physically examined at regular intervals</td><td>30,000</td><td>Absent in $\frac{1}{10}$ cubic centimetre</td><td>Bottled on the farm, name of farm, day of production and word "Certified" on each bottle cap</td></tr>
<tr><td>Grade A Tuberculin tested</td><td>Tuberculin tested and physically examined at regular intervals</td><td rowspan="2">200,000</td><td rowspan="2">Absent in $\frac{1}{100}$ cubic centimetre</td><td rowspan="2">See Note*</td></tr>
<tr><td>Grade A</td><td>Physically examined at regular intervals</td></tr>
</table>

*Delivered to consumers in (a) the bottles or the sealed containers as received from the farm; (b) suitable containers of not less than two gallons capacity; (c) bottles with the name of the dealer by whom the milk was bottled, the address of the licensed bottling establishment, the day of production and the words "Grade A Tuberculin Tested" or "Grade A" on each bottle cap.

Pasteurized Milk

Designation	
Grade A pasteurized	Grade A milk that after pasteurization, as required by the Minister of Health, contains not more than 30,000 bacilli per cubic centimetre and no coliform bacillus in $\frac{1}{10}$ cc. All other conditions as required for Grade A milk
Pasteurized	Any milk that after pasteurization, as required by the Minister of Health, contains not more than 100,000 bacilli per cubic centimetre. No requirement for bottling

The regulations for the production of graded milks in Scotland is similar to the above, except that the milk must contain not less than 3·5 per cent of butter fat.

CONSUMPTION OF MILK

Statistics indicate that of the 1,117 million gallons of milk produced (exclusive of that fed to calves, etc.), 888 millions were consumed in the liquid state. This figure ignores the surplus which would be used for manufacturing. On this basis it has been estimated that the consumption per person in England and Wales is approximately 0·44 pts. per day.

For comparison, the consumption of milk per capita per day in the following countries is given:—Switzerland 1·83 pints, Sweden 1·48 pints, U.S.A., 1·00 pints, France 0·33 pints, and Berlin 0·30 pints.

Milk Products.—Butter and cheese production is largely confined to the West of England. (*See* DAIRY FARMING.) Large quantities are imported, butter from Denmark, New Zealand, and Australia. New Zealand and Canada are the chief countries from which cheese supplies are drawn. Cream for sale finds a limited market, and recent legislation entirely prohibits the addition of preservatives to cream.

Ice Cream.—Accurate figures on the manufacture of ice cream are difficult to obtain. The consumption is steadily increasing and the sales in 1923 were quite 5 times greater than those in 1919.

Good ice cream is very nutritious and easily digested. Unlike the United States and Canada, England has no definite legal standard as to composition.

The constituents used are many including fresh milk, condensed or dried milk, butter, cream, eggs, sugar, flavouring chocolate, nuts and fruit, with gelatine, corn-flour and rennet as stabilisers.

The process through which the mix, or unfrozen ice cream, passes are as follows:—Weighing and mixing of ingredients, pasteurising, homogenizing, and standardising to smooth the mixture and form a perfect emulsion, cooling, ageing for 12–72 hours to improve the flavour and then finally freezing and hardening.

Condensed and Dried Milk.—Condensed milk is cow's milk, skimmed or full cream from which a large proportion of water has been evaporated. The varieties known to the trade are sweetened condensed milk, to which cane sugar has been added, unsweetened condensed or evaporated milk, bulk condensed milk, and concentrated milk, such designations referring to the degree of concentration. Unsweetened varieties are sterilized during the manufacturing process. In this country the composition, and concentration is limited by the Condensed Milk Regulations (1923), which require that all condensed milk imported or sold for human consumption be contained in a tin or receptacle labelled as prescribed in the regulations. All condensed milk shall contain not less than:—

	Milk fat %	Milk solids (including fat) %
1. Full cream (unsweetened)	9·0	31·0
2. Full cream (sweetened)	9·0	31·0
3. Skimmed (unsweetened)	..	20·0
4. Skimmed (sweetened)	..	26·0

England is the principal market for condensed milk, but considerable quantities are re-exported. The Netherlands, Denmark, and the United States are the chief sources of supply, to a lesser extent Switzerland and Canada. A small amount is manufactured in this country.

Cow's milk, whole, or with part, or all of the cream removed, and evaporated to dryness, is variously named dry milk, desiccated milk, dehydrated milk, pulverized milk, milk powder, powdered milk, or milk flour. Sometimes it contains sucrose, and sometimes alkali or a buffer salt is added to render the product easily soluble. Powdered milk is well dried. Troubles due to bacteria and enzyme action are seldom met with, but deterioration due to oxidation of the milk fat may take place. For this reason milk powder from skimmed milk is most extensively manufactured.

The Public Health (Dried Milk) Regulations 1923 prescribe for the labelling and description of dried milk and milk powder. There are four classes of dried milk (1) dried full cream milk; (2) dried three-quarter cream milk; (3) dried half-cream milk; and (4) dried quarter-cream milk. Such milk shall contain not less than the following percentage of milk fat and milk solids:—

	Milk fat %	Milk solids (including fat) %
Milk	3·6	12·4
Three-quarter-cream milk	2·7	11·6
Half-cream milk	1·8	10·8
Quarter-cream milk	0·9	9·9

New Zealand is the chief source of supplies, but considerable quantities are obtained from the Netherlands, Canada, Australia, and the United States.

Dried Casein.—Casein is prepared for food, and industrial purposes. The usual method is by curdling separated milk, either by rennet or by acid; the precipitated casein is then washed and dried. Two distinct types are produced, one for food and medicinal purposes, the other for use in the manufacture of paints, putties, plastic masses, artificial ivory, for waterproofing manufacture, and as a dressing for paper and cloth.

The imports of Casein into Great Britain are largely from New Zealand, France, and Argentina. Considerable progress in the manufacture and export of casein has taken place in New Zealand during the last few years. (O. J. R.; A. Hy.)

UNITED STATES

The total annual production of milk in the United States has increased steadily for a number of years. This is due more to increased production per cow than to increase in number of cows. The number of milch cows on farms, 1920–28, as estimated on Jan. 1 of each year by the U.S. Department of Agriculture and including all milch cows and heifers two years old and over, follows:—

Year	Number	Year	Number
1920	21,427,000	1925	22,481,000
1921	21,408,000	1926	22,188,000
1922	21,788,000	1927	21,818,000
1923	22,063,000	1928	21,948,000
1924	22,255,000		

The increase in number of cows on farms from 1920 to 1928 was 6·41%. On Jan. 1, 1928, there were 185 milch cows on farms per 1,000 population, as against 201 in 1920. Estimates by the U.S. Department of Agriculture of milk production since 1920 indicate the progress of the dairy industry:—

Year	Production of milk in pounds	Year	Production of milk in pounds
1920	89,657,000,000	1924	114,666,000,000
1921	98,862,000,000	1925	116,505,000,000
1922	102,562,000,000	1926	120,766,000,000
1923	109,736,000,000		

Utilization of Milk.—The following table gives the quantities and proportions of milk in the United States used in each product for the calendar year 1926:—

Production and Uses of Milk in the United States

	Milk used per unit of product	Quantity of product manufactured	Whole milk used	Per cent of total milk
	lb.	lb.	lb.	
Creamery butter	21	1,451,766,000	30,487,086,000	25·245
Farm butter	21	615,000,000	12,915,000,000	10·694
Cheese (all kinds)	10	427,416,000	4,274,160,000	3·539
Condensed and evaporated milk	2·5	1,733,504,000	4,333,760,000	3·589
Powdered milk	8	10,768,000	86,144,000	·071
Powdered cream	19	331,000	6,289,000	·005
Malted milk	2·2	20,673,000	45,481,000	·038
Sterilized milk (canned)	1	1,286,000	1,286,000	·001
Milk chocolate	..	..	171,543,000	·142
Ice cream	13·75*	324,665,000†	4,464,144,000	3·698
Total whole milk used in manufacturing	..	..	56,784,893,000	47·020
Milk: For household purposes	..	55·3 gal. per caput	56,417,000,000	46·716
Fed to calves	..	200 lb. per calf	3,941,600,000	3·264
Wasted (estimated)	..	..	3,622,994,000	3·000
Grand total	..	..	120,766,487,000	100·000

*Per gallon. †Gallons.

The per caput consumption of milk, butter, cheese, condensed and evaporated milk and ice cream in the United States since 1917 shows remarkable increases.

Year	Milk	Butter	Cheese	Condensed and evaporated milk	Ice cream
	gal.	lb.	lb.	lb.	gal.
1917	42·4	14·6	2·89	10·49	2·07
1918	43·0	14·0	3·00	12·50	2·14
1919	43·0	14·8	3·50	12·30	2·49
1920	43·0	14·7	3·50	10·17	2·46
1921	49·0	16·1	3·50	11·40	2·28
1922	50·0	16·5	3·70	12·69	2·43
1923	53·0	17·0	3·90	13·25	2·68
1924	54·75	17·38	4·20	14·00	2·50
1925	54·75	17·39	4·26	14·87	2·80
1926	55·30	17·82	4·36	14·32	2·77

City Milk Supply.—The smaller American cities, having populations from a few hundred to 5,000, are usually supplied entirely by farmers who live near the cities, and by people who live in the suburbs and own one or more cows. Cities with a population of 5,000 to 10,000 are supplied by farmers from near the cities and also by milk distributors who purchase milk from more distant farmers and distribute it throughout the city. The larger cities receive their milk supply by train or truck from the country districts, sometimes from a distance of 200 or more miles. The supply of cream may be furnished in part by dairy districts 500 to 1,000 m. distant. The farmers who supply milk for such large cities as New York and Chicago, receive a price based on the butter-fat content of the milk less a charge for transportation according to the zone from which it is shipped. The zones are 10 m. in width and shippers in the same zone pay the same transportation costs per 100 lb. of milk. Milk receiving and cooling stations are located along the railroads, to which the milk is delivered direct by the farmers or "milk haulers" who collect from the farmers. Milk is hauled by passenger trains or by special trains which take precedence on the railroad over most of the other traffic. When the milk arrives at the dêpots it is speedily taken to the plants of the milk distributors, pasteurized, cooled and bottled ready for the milk wagons or trucks to deliver it to the consumers the following day.

Trend of Milk Prices.—The trend of the price of market milk has been upward for the last 30 years. This increase in price is, of course, due in part to a rise in the general price level of all commodities. The yearly average wholesale price of market milk per 100 lb. in Chicago, Ill., in 1900 was $1.35; in 1910, $1.83; in 1928, $2.49, an increase of 84·4% from 1900 to 1928. The retail price of milk for household use varies with the region and also with the season. The winter price is higher than the summer price on account of the additional cost of feed and as an inducement to producers to increase the supply and thus prevent a shortage.

Co-operative bargaining associations of producers have been able to increase the producer's price somewhat, but in many cities the retail price is more than double the buying price at country stations. When the price paid the producers is from 6 to 9 cents per quart, the retail price per quart delivered to consumers in large cities is usually from 12 to 20 cents.

The prices paid milk producers who are members of co-operative-selling organizations, are generally established monthly at a meeting of their committee, which meets with the dealers to discuss the market conditions. The price of 92 score butter and the value of milk for manufacture of cheese are considered with other factors in establishing the fluid milk price. Although the principal business of co-operative butter and cheese associations is to market butter and cheese, some of them are in a position to ship sweet cream or milk to the city market whenever it is advantageous to do so. Frequently cheese factories are under contract to furnish milk distributors in cities with milk when it is needed. Some co-operative creameries, where the cream is of good quality, ship many cars of sweet cream to large cities for use as fluid cream. One co-operative creamery association, during 1927, shipped 417 cars of sweet cream from the Middle West to Eastern cities. A recent development in the distribution of market milk and cream consists of the chain stores which retail milk and cream, generally at a slightly lower price than is asked for the milk delivered at the door of the patrons. Chain stores also have become an important factor in the retail distribution of butter and cheese, often buying direct from the manufacturers and selling direct to the consumer with a very small margin of profit. (*See* also FOOD PRESERVATION.) (T. R. PI.)

MILKING MACHINE: *see* DAIRY MACHINERY.

MILK-TREE, the name applied to two South American trees. In Brazil this is *Mimusops elata,* which produces a latex that "exudes in abundance when the bark is cut; it has about the consistence of thick cream" (A. R. Wallace, *Travels on the Amazon and Rio Negro*), and is used as milk and as glue. The timber of this tree is valuable and the fruit is edible. It belongs to the sapodilla family (Sapotaceae). The milk-tree of Venezuela is *Brosimum Galactodendron,* a member of the mulberry family (*Moraceae*). (*See* COW-TREE.)

MILKWEED, the name given to plants of the botanical genus *Asclepias,* family Asclepiadaceae (*q.v.*), comprising about 85 species, natives mostly of the New World, some 45 of which are found in North America. All are characterized by having a milky juice, and silky-downy seeds. Well known species of the eastern United States and Canada are the common milkweed (*A. syriaca*), the swamp milkweed (*A. incarnata*) and the poke milkweed (*A. exaltata*). Noteworthy species of the western United States are the showy milkweed (*A. speciosa*) and the narrow-leaved milkweed (*A. mexicana*). *See* BUTTERFLY-WEED.

MILKWORT, in botany, the common name for plants of the genus *Polygala* (family Polygalaceae), a large genus of some 500 species, widely dispersed in temperate and tropical regions and represented by about 50 species in North America and a few species in Great Britain. The common species, *P. vulgaris,* is a small wiry perennial found on heaths and in meadows throughout the British Isles. The stems are 2 to 10 in. long and bear narrow rather tough leaves and small, $\frac{1}{6}$ to $\frac{1}{3}$ in. long, white, pink, blue, lilac or purple flowers. The flowers are peculiar in form and arrangement of parts; they have five free sepals the two inner of which (*b*) are large petaloid and winglike, forming the most conspicuous part of the flower; the petals are united below with the sheath of the eight stamens forming a tube split at the base behind; their form recalls that of the pea family. The name *Polygala* is from the Greek πολύς, much, and γάλα, milk, the plant being supposed to increase the yield of milk in cows. Some species with showy flowers are known in cultivation as greenhouse or hardy annual or perennial, herbs or shrubs. The root of *P. Senega,* snake-root, a North American species is officinal. The fringed milk wort or flowering wintergreen (*P. paucifolia*), of the north-eastern United States and adjacent Canada, is a delicate woodland plant with handsome purple flowers. Sea milkwort is the common name for *Glaux maritima,* a small succulent herb found on northern ocean shores, and occurring on the Atlantic and Pacific coasts and locally in the interior of North America and also in the British Isles; it belongs to the primrose family (Primulaceae).

MILKWORT (POLYGALA VULGARIS)
The flowers have two coloured sepals, which are red, white or blue like the flowers

MILKY WAY: *see* GALAXY AND STAR.

MILL, HUGH ROBERT (1861–), British geographer and meteorologist, was born at Thurso on May 28, 1861, and was educated at Edinburgh university In 1884 he was appointed chemist and physicist to the Scottish marine station. In 1892 he became librarian to the Royal Geographical Society, and was honorable secretary of the Royal Meteorological Society from 1902–06, becoming its president in 1907. He served on many committees connected with meteorology and allied subjects, including the International Council for the study of the sea (1901–09), and the board of trade committee on the water power of the British Isles (1918). In 1901 he became director of the British Rainfall Organization, and editor of the *British Rainfall* and *Symons's Meteorological Magazine,* and when the organization was converted into a trust he became chairman of trustees (1909–19). From 1906–19 he was rainfall expert to the Metropolitan Water Board. In 1927 he became president of the Royal Geographical Society.

His publications include: *The Realm of Nature* (1892, latest ed. 1913); *The English Lakes* (1895); *Hints on the Choice of Geographical Books* (1897); *New Lands* (1900); *The Siege of the South Pole* (1905); a historical introduction to Sir Ernest Shackleton's *Heart of the Antarctic* (1909); *The Life of Sir Ernest Shackleton* (1923); he also edited *International Geography* (1911).

MILL, JAMES (1773–1836), historian and philosopher, was born on April 6, 1773, at Northwater Bridge, in the parish of Logie-Pert, Forfarshire, the son of James Mill, a shoemaker. His mother, Isabel Fenton, of a good family which had suffered from connection with the Stuart rising of 1745, sent him first to the parish school and to the Montrose academy, and then to the university of Edinburgh, where he distinguished himself as a Greek scholar. In October 1798 he was licensed as a preacher, but occupied himself with occasional teaching and with historical and philosophical studies. In 1802 he went to London in company with Sir John Stuart, then M.P. for Kincardineshire, and devoted himself to journalism. In 1804 he wrote a pamphlet on the corn trade, arguing against a bounty on the exportation of grain. After his marriage (1805) with Harriet Burrow, he took a house in Pentonville, where his eldest son, John Stuart Mill (*q.v.*), was born in 1806. About the end of this year he began his *History of India,* which he took 12 years to complete, instead of three or four, as he had expected.

In 1808 he became acquainted with Jeremy Bentham, and was for many years his chief companion and ally. He adopted Bentham's principles in their entirety, and did more to propagate them and to oppose the beginnings of Romanticism than anyone else. He was a regular contributor (1806–18) to the *Anti-Jacobin Review,* the *British Review,* the *Electric Review,* and the *Edinburgh Review* (1808–13). In 1811 he co-operated with William Allen (1770–1843), quaker and chemist, in a periodical called the *Philanthropist.* He contributed largely to every number—his principal topics being Education, Freedom of the Press, and Prison Discipline (under which he expounded Bentham's "Panopticon"). He took part in the discussions which led to the foundation of London university in 1825. In 1814 he wrote various articles, containing an exposition of utilitarianism, for the supplement to the fifth edition of the *Encyclopædia Britannica.*

In 1818 the *History of India* was published, and, in spite of the fact that it contained drastic criticisms of British rule in India, Mill was appointed an official in the India House. He gradually rose till he was appointed, in 1830, head of the office. His *Elements of Political Economy* appeared in 1821 (3rd and revised ed. 1826).

From 1824 to 1826 Mill contributed to the *Westminster Review,* started as the organ of his party, articles attacking the *Edinburgh* and *Quarterly Reviews* and ecclesiastical establishments. In 1829 appeared the *Analysis of the Human Mind.* From 1831 to 1833 Mill was largely occupied, as the spokesman of the court of directors, in the defence of the East India Company, during the controversy attending the renewal of its charter. His last published book was the *Fragment on Mackintosh* (1835). He died June 23, 1836.

Mill's greatest literary monument is the *History of India.* The materials for the history of the conquest of India were put into shape for the first time; political theory was brought to bear on the delineation of the Hindu civilization, and the conduct of the actors in the successive stages of the conquest and administration of India was subjected to a severe criticism. The work itself, and the author's official connection with India for the last 17 years of his life, effected a complete change in the whole system of governing that country.

Mill played a great part in English politics, and was, more than any other man, the founder of what was called "philosophic radicalism." His writings on government and his personal influence among the Liberal politicians of his time determined the change of view from the French Revolution theories of the rights of man and the absolute equality of men to the claiming of securities for good government through a wide extension of the franchise. Under this banner it was that the Reform Bill was fought and won. His *Elements of Political Economy,* which was intended only as a textbook of the subject, shows all the author's precision and lucidity. Its interest is mainly historical, as an accurate summary of the views of the philosophic radicals, based mainly on Ricardo. Mill maintained: (1) that the chief problem of practical reformers is to limit the increase of population, on the assumption that capital does not naturally increase at the same rate as population (ii. § 2, art. 3); (2) that the value of a thing depends entirely on the quantity of labour put into it; and (3) that what is now known as the "unearned increment" of land is a proper object for taxation. The clear enunciation of the second of these propositions is important in view of the emphasis laid on it by Marx and his followers and the deductions they made from it.

In his *Analysis of the Mind* Mill developed the psychological side of the Benthamite philosophy. It was a more systematic attempt than that already made by Hartley to explain all mental phenomena by the association of ideas. "Not only does he explain all phenomena of consciousness as having arisen through association, but he also—in a somewhat artificial fashion—reduces all associations to the association of such ideas as have frequently occurred together (which has since been called association by contiguity). . . . As Bentham had attempted to base the whole of ethics on the single principle that pleasure is preferable to pain, so James Mill attempts to construct the whole of psychology on the single principle that that which has been once experienced can be recalled when experiences which occurred with it, either in space or time, are repeated" (Höffding, *Hist. of Mod. Phil.* ii. 371). The implication of the Benthamite doctrine as interpreted by Mill, which took too little account of all emotions save one, and of the unconscious and involuntary elements in life, was fiercely fought by Samuel Taylor Coleridge.

Bibliography.—Leslie Stephen, *The English Utilitarians,* vol. ii. (1900), and article in *Dict. Nat. Biog.;* A. Bain, *James Mill* (1882); G. S. Bower, *Hartley and James Mill* (1881); James McCosh, *Scottish Philosophy* (1885); J. S. Mill, *Autobiography* (1873); Th. Ribot, *La Psychologie anglaise* (1870; Eng. trans., 1873); J. Morley in *Fortnightly Review,* xxxvii. (1882); Graham Wallas, *The Life of Francis Place* (1898).

MILL, JOHN STUART (1806–1873), English philosopher and economist, son of James Mill (*q.v.*), was born on May 20, 1806 in his father's house in Pentonville, London. He was educated exclusively by his father, who was a strict disciplinarian, and at the age of three was taught the Greek alphabet and long lists of Greek words with their English equivalents. By his eighth year he had read Aesop's *Fables,* Xenophon's *Anabasis,* and the whole of Herodotus, and was acquainted with Lucian, Diogenes Laërtius, Isocrates and six dialogues of Plato. (*See* his *Autobiography.*) He had also read a great deal of history in English—Robertson's histories, Hume, Gibbon, Robert Watson's *Philip II.* and *Philip III.,* Hooke's *Roman History,* part of a translation of Rollin's *Ancient History,* Langhorne's *Plutarch,* Burnet's *History of My Own Times,* 30 volumes of the *Annual Register,* Millar's *Historical View of the English Government,* Mosheim's *Ecclesiastical History,* M'Crie's *Knox,* and two histories of the Quakers. A contemporary record of Mill's studies from eight to thirteen is published in Bain's sketch of his life. It shows that the *Autobiography* rather understates the amount of work done. At the age of eight he began Latin, Euclid, and algebra, and began to

teach the younger children of the family. His main reading was still history, but he went through all the Latin and Greek authors commonly read in the schools and universities. He was never an exact scholar; it was for the subject matter that he was required to read, and by the age of ten he could read Plato and Demosthenes with ease. His father's *History of India* was published in 1818; immediately thereafter, about the age of twelve, John began a thorough study of the scholastic logic, at the same time reading Aristotle's logical treatises in the original. In the following year he was introduced to political economy and studied Adam Smith and Ricardo with his father.

Not unnaturally the training which the younger Mill received has aroused amazement and criticism. The really important part of the training was the close association with the strenuous character and vigorous intellect of his father; from his earliest days he spent much time in his father's study and habitually accompanied him on his walks in North London. It was an inevitable result of such an education that Mill acquired many of his father's speculative opinions, and his father's way of defending them. But he did not receive the impress passively and mechanically. "One of the grand objects of education," according to the elder Mill, "should be to generate a constant and anxious concern about evidence." The duty of collecting and weighing evidence for himself was at every turn impressed upon the boy; he was taught to accept no opinion on authority. He was deliberately educated to think for himself, and never to accept any proposition on authority, but to reason for himself. His childhood was not unhappy, but there is no doubt that it was a strain on his constitution, and that he suffered from the lack of natural unforced development. He was over-educated.

From May 1820 till July 1821 Mill was in France in the family of Sir Samuel Bentham, brother of Jeremy Bentham. Copious extracts from a diary kept by him at this time are given by Bain; they show how methodically he read and wrote, studied chemistry and botany, tackled advanced mathematical problems, made notes on the scenery and the people and customs of the country. He also gained a thorough acquaintance with the French language. On his return in 1821 he added to his work the study of psychology, and that of Roman law, which he read with John Austin, his father having half decided on the bar as the best profession open to him. In 1822, however, when he had just completed his seventeenth year, this intention was abandoned, and he entered the examiner's office of the India House, nominally as a clerk, but from the first he was more than that, and after a short apprenticeship he was promoted, in 1828, to assistant-examiner. For twenty years, from 1836 (when his father died) to 1856, Mill had charge of the Company's relations with the native states, and in 1856 he became chief of the office. Few statesmen of his generation had a wider experience of the responsible application of the principles of government.

About the time of his entering the India House Mill read Dumont's exposition of Bentham's doctrines in the *Traité de Législation*, which made a lasting impression upon him. When he laid down the last volume, he says, he had become a different being. It gave unity to the detached and fragmentary parts of his knowledge and beliefs. The impression was confirmed by the study of the English psychologists, also of Condillac and Helvetius, and in 1822–23 he established among a few friends the "Utilitarian" Society, taking the word, as he tells us, from Galt's *Annals of the Parish*. Two newspapers were open to him—the *Traveller*, edited by a friend of Bentham's, and the *Morning Chronicle*, edited by his father's friend Black. One of his first efforts was a solid argument for freedom of discussion, in a series of letters to the *Chronicle* on the prosecution of Richard Carlile. He seized every chance for exposing departures from sound principle in parliament and courts of justice. Another outlet was opened up for him (April 1824) by the starting of the *Westminster Review*, which was the organ of the philosophic radicals. In 1825, too, he edited Bentham's *Rationale of Judicial Evidence*. He discussed eagerly with the many men of distinction who came to his father's house, and engaged in set discussions at a reading society formed at Grote's house in 1825, and in set debates at a Speculative Society formed in the same year.

The *Autobiography* tells how in 1826 Mill's enthusiasm was checked by a misgiving as to the value of the ends which he had set before him. At the Speculative Debating Society, where he first measured his strength in public conflict, he found himself looked upon with curiosity as a precocious phenomenon, a "made man," an intellectual machine set to grind certain tunes. He now saw that regard for the public good was too vague an object for the satisfaction of a man's affections. It is a proof of the dominating force of his father's character that it cost the younger Mill such an effort to shake off his stern creed about poetry and personal emotion. Like Plato, the elder Mill would have put poets under ban as enemies of truth, and he subordinated private to public affections, Landor's maxims of "few acquaintances, fewer friends, no familiarities" had his cordial approval. These doctrines the younger Mill now felt himself forced in reason to abandon. Too much in awe of his father to make him a confidant, he wrestled in gloomy solitude. He emerged from the struggle with a more catholic view of human happiness, a delight in poetry for its own sake, a more placable attitude in controversy, a hatred of sectarianism, an ambition, no less noble and disinterested, but moderated to practical possibilities. Gradually the debates in the Speculative Society attracted men whose society was invigorating and inspiring, among others Maurice and John Sterling. He ceased to attend the society in 1829, but he carried away from it the conviction that a true system of political philosophy was "something much more complex and many-sided than he had previously had any idea of, and that its office was to supply, not a set of model institutions but principles from which the institutions suitable to any given circumstances might be deduced."

His letters in the *Examiner* in the autumn of 1830 after a visit to Paris, where he made the acquaintance of the younger liberals, may be taken as marking his return to hopeful aspiring activity. His enthusiasm for humanity had been thoroughly reawakened, and had taken shape as an aspiration to supply an unimpeachable method of search for conclusions in moral and social science. But he could not at once shake off his early training. He had been bred by his father in a great veneration for the syllogistic logic as an antidote against confused thinking. He attributed to his early discipline in this logic an impatience of vague language which in all likelihood was really fostered in him by his study of the Platonic dialogues and of Bentham, for he always had in himself more of Plato's fertile ingenuity in canvassing the meaning of vague terms than the schoolman's rigid consistency in the use of them. But he was determined that the new logic should stand in no antagonism to the old. In his *Westminster* review of Whately's *Logic* in 1828 he defended the syllogistic logic against highfliers such as the Scottish philosophers who talk of "superseding" it by "a supposed system of inductive logic." His inductive logic must "supplement and not supersede." But for several years he searched in vain for the means of concatenation.

Meantime, he had ceased (1828) to write for the *Westminster*, but during the years 1832 and 1833 he contributed many essays to *Tait's Magazine*, the *Jurist*, and the *Monthly Repository*. In 1835 Sir William Molesworth founded the *London Review* with Mill as editor; it was amalgamated with the *Westminster* (as the *London and Westminster Review*) in 1836, and Mill continued editor (latterly proprietor also) till 1840. Some of his essays written for these journals were reprinted in his first two volumes of *Dissertations and Discussions* (1859). The essays on Bentham and Coleridge constituted the first manifesto of the new spirit which Mill sought to breathe into English Radicalism. In 1837, on reading Whewell's *Inductive Sciences* and re-reading Herschel, Mill at last saw his way clear both to formulating the methods of scientific investigation and joining on the new logic as a supplement to the old. The *Logic* was published in 1843. In 1844 appeared his *Essays on Some Unsettled Questions in Political Economy*. Four out of the five are solutions of perplexing technical problems—the distribution of the gains of international commerce, the influence of consumption on production, the definition of productive and unproductive labour, the precise relations between profits and wages. Though Mill appears here purely as the

disciple of Ricardo, striving after more precise statement, and reaching forward to further consequences, he appears as an original and independent thinker.

That originality and independence became more conspicuous when he reached his second stage as a political economist, struggling forward towards the standpoint from which his systematic work was written.

While his great systematic works were in progress, Mill turned aside for a few months from his *Political Economy* during the winter of the Irish famine (1846–47) to advocate the creation of peasant-proprietorships as a remedy for distress and disorder in Ireland. The *Political Economy* was published in 1848. Mill now made a more thorough study of Socialist writers, and began to look upon some more equal distribution of the produce of labour as a practicability of the remote future, and to dwell upon the prospect of such changes in human character as might render a stable society possible without the institution of private property. Mill was convinced that the social question was as important as the political question. He desired the extension of the franchise, but he never saw it as the panacea for all ills. He declined to accept property, devised originally to secure peace in a primitive society, as necessarily sacred in its existing developments in a quite different stage of society. He separated questions of production and distribution, and he examined with an open mind Socialist solutions. He could not rest satisfied with a distribution which condemned the labouring classes to a cramped and wretched existence, and in many instances to starvation. He did not come to a socialist solution, but he had the great merit of having considered afresh the foundations of society.

This he has called his third stage as a political economist, and he says that he was helped towards it by the lady, Mrs. Taylor (Harriet Hardy), who became his wife in 1851. It is generally supposed that he writes with a lover's extravagance about this lady's powers when he compares her with Shelley and Carlyle. But he expressly says that he owed none of his technical doctrine to her, that she influenced only his ideals of life for the individual and for society; the only work perhaps which was directly inspired by her is the essay on the enfranchisement of women (*Dissertations*, vol. ii.). It is obvious that his real emancipation began when he threw off his father's authority, and entered on married life, against the wishes of his family. This new inner life was strengthened and enlarged by Mrs. Taylor.

During the seven years of his married life Mill published less than in any other period of his career, but four of his most closely reasoned and characteristic works, the *Liberty*, the *Utilitarianism*, the *Thoughts on Parliamentary Reform*, and the *Subjection of Women*, besides his posthumously published essays on *Nature* and on the *Utility of Religion*, were thought out and partly written in collaboration with his wife. In 1856 he became head of the examiner's office in the India House, and for two years, till the dissolution of the Company in 1858, his official work, never a light task, kept him fully occupied. It fell to him as head of the office to write the defence of the Company's government of India when the transfer of its powers was proposed. Mill opposed the transfer, and the documents in which he defended the Company's administration are models of trenchant and dignified pleading.

On the dissolution of the Company Mill was offered a seat in the new council, but declined, and retired with a pension of £1,500. His retirement from official work was followed almost immediately by his wife's death at Avignon. Mill spent most of the rest of his life at a villa at St. Véran, near Avignon, returning to his Blackheath house only for a short period in each year. He sought relief in active literary occupation, in politics, sociology and psychology. He published, with a touching dedication to his wife, the treatise on *Liberty*. He then turned to politics, and published, in view of the impending Reform Bill, a pamphlet on parliamentary reform. In the autumn of the same year he turned to psychology, reviewing Bain's works in the *Edinburgh Review*. In his *Representative Government* (1860) he systematized opinions already put forward in many casual articles and essays. His *Utilitarianism* (published in *Fraser's* in 1861) was a closely-reasoned systematic attempt to answer objections to his ethical theory and remove misconceptions of it. He was especially anxious to make it clear that he included in "utility" the pleasures of the imagination and the gratification of the higher emotions, and to show how powerfully the good of mankind as a motive appealed to the imagination. His next treatise, *The Subjection of Women*, was not published till 1869. He was one of the founders, with Mrs. P. A. Taylor, Miss Emily Davies and others, of the first women's suffrage society, which developed into the National Union of Women's Suffrage Societies, and his writings are the classical theoretical statement of the case for women's suffrage. He presented to Parliament the first petition on the subject. (*See* further Blackburn, *Women's Suffrage Record*.) His *Examination of Hamilton's Philosophy*, published in 1865, had engaged a large share of his time for three years before.

While mainly occupied in those years with philosophical studies, Mill did not remit his interest in current politics. He supported the North in the American crisis of 1862, using all his strength to explain what has since been universally recognized as the issue really at stake in the struggle, the abolition of slavery. Huxley, Tyndall, Cairnes, Mark Pattison, F. Harrison, Sir Frederick Pollock and Lockyer were among the contributors.

In 1865 he stood as parliamentary candidate for Westminster, on conditions strictly in accordance with his principles. He would not canvass, nor pay agents to canvass for him, nor would he engage to attend to the local business of the constituency. He was with difficulty persuaded even to address a meeting of the electors, but was elected. He took an active part in the debates on Disraeli's Reform Bill (moving, on April 12, 1866, an amendment to omit the word "man" and insert "person"), and helped to extort from the government several useful modifications of the Bill for the Prevention of Corrupt Practices. The reform of land tenure in Ireland, the representation of women, the reduction of the national debt, the reform of London government, the abrogation of the Declaration of Paris, were among the topics on which he spoke with marked effect. He took occasion more than once to enforce what he had often advocated in writing, England's duty to intervene in foreign politics in support of the cause of freedom. As a speaker Mill was somewhat hesitating, pausing occasionally as if to recover the thread of his argument, but he showed great readiness in extemporaneous debate.

Mill's subscription to the election expenses of Bradlaugh, and his attack on the conduct of Governor Eyre in Jamaica were perhaps the main causes of his defeat in the general election of 1868. But his studied advocacy of unfamiliar projects of reform had made him unpopular with "moderate Liberals." He retired with a sense of relief to his cottage and his literary life at Avignon. His little cottage was filled with books and newspapers; the beautiful country round it furnished him with a variety of walks; he read, wrote, discussed, walked, botanized. He was extremely fond of music, and was himself a fair pianist. His step-daughter, Miss Taylor (d. January 1907), was his constant companion after his wife's death. Mill was an enthusiastic botanist all his life long, and a frequent contributor of notes and short papers to the *Phytologist*. One of the things that he looked forward to during his last journey to Avignon was seeing the spring flowers and completing a flora of the locality. His delight in scenery frequently appears in letters written to his friends during his summer and autumn tours.

Yet he did not relax his laborious habits nor his ardent outlook on human affairs. The essays in the fourth volume of his *Dissertations*—on endowments, on land, on labour, on metaphysical and psychological questions—were written for the *Fortnightly Review* at intervals after his short parliamentary career. One of his first tasks was to send his treatise on the *Subjection of Women* (written 1861, published 1869, many editions) through the press. The essay on *Theism* was written soon after. The last public work in which he engaged was the starting of the Land Tenure Reform Association. The interception by the state of the unearned increment, and the promotion of co-operative agriculture, were the most striking features in his programme. He wrote in the *Examiner* and made a public speech in favour of the association a few months before his death. The secret of the ardour with which he took up this question probably was his

conviction that a great struggle was impending in Europe between labour and capital. He regarded his project as a timely compromise.

Mill died at Avignon on May 8, 1873. He was a man of extreme simplicity in his method of life. His services in ethics, politics and philosophy lay not so much in his actual achievement as in his personality and the liberal and inquiring spirit in which he handled the great questions of his time. A statue in bronze was placed on the Thames Embankment, and there is a good portrait by Watts (a copy of which, by Watts himself, was hung in the National Gallery).

The influence which Mill's works exercised upon contemporary English thought can scarcely be over-estimated. In philosophy his chief work was to systematize and expound the utilitarianism of his father and Bentham. (*See* UTILITARIANISM.) He may, in fact, be regarded as the final exponent of that empirical school of philosophy which owed its impulse to John Locke, and is generally spoken of as being typically English. Its fundamental characteristic is the emphasis laid upon human reason, *i.e.*, upon the duty incumbent upon all thinkers to investigate for themselves rather than to accept the authority of others. Knowledge must be based upon experience. In reasserting and amplifying the empirical conclusions of his predecessors, especially in the sphere of ethics, Mill's chief function was the introduction of the humanist element. This was due, no doubt, to his revulsion from the sternness of his upbringing and the period of stress through which he passed in early manhood, but also to the sympathetic and emotional qualities which manifested themselves in his early manhood. We have seen, for example, that he was led to investigate the subject of logic because he found in attempting to advance his humanitarian schemes in politics an absence of that fundamental agreement which he recognized as the basis of scientific advance. Both his logical and his metaphysical studies were thus undertaken as the pre-requisites of a practical theory of human development. Though he believed that the lower classes were not yet ripe for Socialism, with the principles of which he (unlike James Mill and Bentham) was in general agreement, his whole life was devoted to the amelioration of the conditions of the working classes. This fact, no doubt, should be taken into account in any detailed criticism of the philosophic work; it was taken up not as an end but as ancillary to a social and ethical system Reference to the articles on LOGIC, METAPHYSICS, etc., will show that subsequent criticism, however much it has owed by way of stimulus to Mill's strenuous rationalism, has been able to point to much that is inconsistent, inadequate and even superficial in his writings. Two main intellectual movements from widely different standpoints combined to diminish his influence: the idealism of the German school and the application of the evolutionary theory to ethics. In the sphere of psychology, likewise—*e.g.*, in connection with Mill's doctrine of Association of Ideas (*q v.*) and the phrase "Mental Chemistry," by which he sought to meet the problems which Associationism left unsolved—modern criticism and the experimental methods of the psychophysiological school have set up wholly new criteria, with a new terminology and different fields of investigation. (*See* PSYCHOLOGY)

A similar fate has befallen Mill's economic theories. The title of his work, *Principles of Political Economy, with some of their Applications to Social Philosophy,* though open to criticism, indicated a less narrow and formal conception of the field of the science than had been common amongst his predecessors. It is an admirably lucid, and even elegant, exposition of the Ricardian economics, the Malthusian theory being of course incorporated with these; but, notwithstanding the introduction of many minor novelties, it is in its scientific substance little or nothing more.

With respect to economic method he shifted his position, yet to the end occupied uncertain ground. In the fifth of his early essays he asserted that the method a priori is the only mode of investigation in the social sciences, and that the method a posteriori "is altogether inefficacious in those sciences as a means of arriving at any considerable body of valuable truth." When he wrote his *Logic* he had learned from Comte that the a posteriori method—in the form which he chose to call "inverse deduction"—was the only mode of arriving at truth in general sociology; and his admission of this at once renders the essay obsolete. But, unwilling to relinquish the a priori method of his youth, he tries to establish a distinction of two sorts of economic inquiry, one of which, though not the other, can be handled by that method. Sometimes he speaks of political economy as a department "carved out of the general body of the science of society"; whilst on the other hand the title of his systematic work implies a doubt whether political economy is a part of "social philosophy" at all, and not rather a study preparatory and auxiliary to it. Thus, on the logical as well as the dogmatic side, he halts between two opinions. Notwithstanding his misgivings and even disclaimers, he yet remained as to method a member of the old school, and never passed into the new "historical" school.

In political philosophy his greatest work was done as an advocate of liberty. In the treatise *On Liberty* he shows that political liberty alone is insufficient, that social tyranny may be more grinding than legal tyranny. And he showed consistently that any despotism, however benevolent, must in fact cramp and destroy the development of any people. He was torn all his life between his passion for individual liberty and initiative and his sense of the benefits of social control.

BIBLIOGRAPHY.—*Works: System of Logic* (2 vols., 1843; 9th ed., 1875; "People's" ed., 1884); *Essays on some Unsettled Questions of Political Economy* (1844, ed. 1874); *Principles of Political Economy* (2 vols., 1848; many ed., especially ed. by W. J. Ashley, 1909); *On Liberty* (1859; ed. Courtney, 1892, W. B. Columbine, 1903; with introd. Pringle-Pattison, 1910); *Thoughts on Parliamentary Reform* (1859); *Dissertations and Discussions* (i., ii., 1859; iii., 1867; iv. 1876); *Considerations on Representative Government* (1861; 3rd ed. 1865); *Utilitarianism* (1863); *Examination of Sir W. Hamilton's Philosophy* (1865); *Aug. Comte and Positivism* (1865, ed. 1908); *Inaugural Address at the University of St. Andrews* (1867); *England and Ireland* (1868); *Subjection of Women* (1869; ed. with introd. by Stanton Coit, 1906); *Chapters and Speeches on the Irish Land Question* (1870). The *Autobiography* appeared in 1873 (ed. 1908), and *Three Essays on Religion* (1874). Many of these have been translated into German, and there is a German edition by Th. Gomperz (12 vols., 1873–80). A convenient edition in the New Universal Library appeared between 1905 and 1910.

Biographical and Critical.—Many of Mill's letters are published in Mrs. Grote's life of her husband, in Duncan's *Life of Herbert Spencer,* in the *Memories* of Caroline Fox, and in Kingsley's letters. There are also editions of the correspondence with Gustave d'Eichtal and Comte (specially that of Lévy-Bruhl, 1899). By far the most illuminating collection is that of Hugh Elliott, *Letters of John Stuart Mill* (2 vols., 1910), which contains letters to John Sterling, Carlyle, E. Lytton Bulwer (Lord Lytton), John Austin, Alex. Bain, and many leading French and German writers and politicians. These letters are essential to an understanding of Mill's life and thought. Besides the *Autobiography* and many references in the writings of Mill's friends (*e.g.* Alex. Bain's *Autobiography,* 1904), *see* further A. Bain, *John Stuart Mill, a Personal Criticism* (1882); Fox Bourne, *Life of J. S. Mill* (1873); John (Viscount) Morley, *Miscellanies* (1877), ii. 239–327; J. E. Cairnes, *J. S. Mill* (1873), on economic theories, W. L. Courtney, *Metaphysics of J. S. Mill* (1879) and *Life* (1889); Douglas, *John Stuart Mill, a Study of his Philosophy* (1895), and *Ethics of J. S. Mill* (1897); Albee, *Hist. of Eng. Utilitarianism* (1902); Sir Leslie Stephen, *The English Utilitarians* (1900); J. MacCunn, *Six Radical Thinkers* (1907); Fred. Harrison, *Tennyson, Ruskin, Mill* (1899); John Watson, *Comte, Mill and Spencer* (1895); T. Whittaker, *Comte and Mill* (1905); Charles Douglas, *J. S. Mill, a Study of his Philosophy* (1895); J. Rickaby, *Free Will and Four English Philosophers* (1906); J. M. Robertson, *Modern Humanists* (1891); D. G. Ritchie, *Principles of State Interference* (1891); W. Graham, *English Political Philosophy from Hobbes to Maine* (1899). There are also a number of valuable French and German criticisms, *e.g.*, Taine, *Positivisme anglais, étude sur Stuart Mill* (Paris, 1864); F. A. Lange, *Mills Ansichten über die soziale Frage* (Duisburg, 1866); Littré, *A. Comte et Stuart Mill* (3rd ed., Paris, 1877); Cauret, *Philosophie de Stuart Mill* (Paris, 1885); Gomperz, *John S. Mill, ein Nachruf* (Vienna, 1889); S. Sanger, *J. S. Mill, sein Leben und Lebenswerk* (Stuttgart, 1901); S. Becher, *Erkenntnistheoretische Untersuchungen zu Stuart Mills Theorie der Kausalität* (1906); E. M. Kantzer, *La Religion de J. S. Mill* (1906); F. Degenfeld-Schonburg, *Die Lohntheorien von Adam Smith, John Stuart Mill, etc.* (1914); E. Wentscher, *Das Problem des Empirismus, dargest. an J. S. Mill* (1922); B. Alexander, *J. St. Mill und der Empirismus* (1927). *See* also histories of modern philosophy for later criticisms and developments of Mill's ideas.

See further LOGIC (Historical Sketch); PSYCHOLOGY; ASSOCIATION OF IDEAS.

MILL, the term given to the apparatus used in the grinding of corn into flour, and hence applied to similar mechanical devices for grinding or pulping other substances; *e.g.*, coffee-mill, powder-mill. "Mill" was first used of the building containing the apparatus, frequently with a word attached descriptive of the motive power; *e.g.*, wind-mill, water-mill, etc. It was not the early word used of the actual grinding mechanism. The old hand-mill was known as a "quern" (*see* FLOUR). The word mill is also applied to many mechanical devices by which raw material is transformed into a condition ready for use or into a stage preparatory to other processes; *e.g.*, saw-mill, rolling-mill, etc., or still more widely to buildings containing machinery used in manufactures; *e.g.*, cotton-mill. In mining it is applied to various machines used in breaking and crushing the ore (*see* ORE-DRESSING).

In the engineering industries milling machines constitute a very important class of machine tools, the characteristic of which is that rotary cutters are employed for shaping the metal (*see* TOOLS). In coins the "milling" is the serrated edge, called "creneling" by John Evelyn (*Discourse on Medals,* 1697, p. 225), which is formed on them to prevent clipping and filing. Coins made by the old process of hammering were apt to have irregular edges which invited mutilation; but the introduction of the screw-press, which came to be known as a mill (*cf.* W. Lowndes, *Amendm. Silver Coinage,* 1695, p. 93), permitted the production of a regular edge with serrations which in consequence were termed milling. This machine also enabled legends to be impressed round the edges of coins, such as the *Decus et tutamen* suggested by Evelyn (*see* W. J. Hocking, *Catalogue of the Coins, etc., in the Museum of the Royal Mint,* 1906). It was invented about the middle of the 16th century, and has generally been attributed to Guyot Brucher (d. 1556), who was succeeded at the Paris mint by his brother Antoine. Introduced into England by one Eloye Mestrel in 1561, it was used for 12 years, and was then abandoned owing to the opposition of the mint officials to Mestrel, who was executed for counterfeiting and striking money outside the precincts of the Tower of London; but it was again introduced by one Peter Blondeau in 1662, when it permanently superseded hammering. In the United States of America the term "milling" or "milled" is applied to the raised edge on the face of the coin; this is known in the British mint as "marking" (*see* MINT).

MILLAIS, SIR JOHN EVERETT (1829–1896), English painter, was born at Southampton on June 8, 1829, the son of John William Millais, who belonged to an old Norman family settled in Jersey for many generations, and Emily Mary, *née* Evamy, the widow of a Mr. Hodgkinson. After his birth the family returned to Jersey. In 1835 they removed to Dinan in Brittany. In 1838 he came to London, and on the strong recommendation of Sir Martin Archer Shee, P.R.A., his future was decided. He was sent to Sass's school, and entered the Academy schools in 1840. He won a silver medal from the Society of Arts in 1839, and carried off all the prizes at the Royal Academy. He was at this time painting small pictures for a dealer named Thomas, and defraying a great part of the household expenses in Gower Street, where his family lived. In 1846 he exhibited "Pizarro seizing the Inca of Peru" at the Royal Academy. In 1847 he competed unsuccessfully for the decoration of the Houses of Parliament, sending a very large picture of "The Widow's Mite."

In 1848 Millais and W. Holman Hunt, dissatisfied with the theory and practice of British art, initiated what is known as the Pre-Raphaelite movement, and were joined by Dante Gabriel Rossetti, and afterwards by five others, altogether forming the Pre-Raphaelite Brotherhood. Rossetti was then engaged, under the technical guidance of Hunt, upon his picture of "The Girlhood of Mary Virgin," which, with Hunt's "Light of the World" and Millais's "Christ in the House of His Parents," forms what has been called the trilogy of Pre-Raphaelite art. According to Millais, the Pre-Raphaelites had but one idea—"to present on canvas what they saw in Nature." Millais's first picture on his new principles was a banquet scene from Keats's "Isabella" (1849), and contains all the characteristics of Pre-Raphaelite work, including minute imitation of nature down to the smallest detail. The tale was told with dramatic force, and the expression of the heads was excellent. His next important picture, "Christ in the House of His Parents," or "The Carpenter's Shop" (1850), representing a supposed incident in the childhood of our Lord treated in a realistic manner, drew down upon him a storm of abuse. The rest of his more strictly Pre-Raphaelite pictures—"The Return of the Dove to the Ark," "The Woodsman's Daughter" and the "Mariana" of 1851, "The Huguenot" and "Ophelia" of 1852, "The Proscribed Royalist" and "The Order of Release" of 1853—met with less opposition, and established his reputation with the public. Indeed, this may be said to have been accomplished by "The Huguenot" and "Ophelia." The public were also greatly influenced by the championship of Ruskin, who, in letters to *The Times,* and in a pamphlet called "Pre-Raphaelitism," enthusiastically espoused the cause of the Brotherhood. Millais became acquainted with Ruskin, and in 1853 went to Scotland with him and Mrs. Ruskin, the latter of whom sat for the woman in "The Order of Release." In 1855 Millais exhibited "The Rescue," a scene from a fire. This was also the year of his marriage with Mrs. Ruskin (Euphemia Chalmers, daughter of Mr. George Gray of Bowerswell, Perth), who had obtained a decree of the nullity of her previous marriage. The principal pictures of 1856 were "Autumn Leaves" and "Peace Concluded"; of 1857 "Sir Isumbras at the Ford," and "The Escape of a Heretic"; of 1859, "Apple-blossoms" and "Vale of Rest." The "Black Brunswicker" of 1860 was in motive very like the "Huguenot," but it was a great deal broader in execution, and may be said to mark the end of the period of transition from his minute Pre-Raphaelite manner to the freedom of his mature style.

From 1860 to 1869 Millais was much employed in illustration, especially of Trollope's novels. He contributed to Moxon's illustrated edition of *Tennyson's Poems,* and made occasional drawings for *Once a Week,* the *Illustrated London News, Good Words,* and other periodicals and books. In 1863 he was elected a Royal Academician. The most important pictures of this and the next few years were "The Eve of St. Agnes," "Romans leaving Britain" (1865), "Jephthah" (1867), "Rosalind and Celia" (1868), "A Flood," and "The Boyhood of Raleigh" (1870). In many of his pictures of this period, such as "The Boyhood of Raleigh," his children were his models. In 1871 he exhibited the first and most popular of his pure landscapes, called "Chill October." Other landscapes from Perthshire, where he generally spent the autumn, included "Scotch Firs" and "Winter Fuel" (painted in 1874), "Over the Hills and Far Away," and "The Fringe of the Moor" (1875) and "The Sound of Many Waters" (1876).

WORKS OF LATER YEARS

It was to the painting of nature and the world around him that he devoted himself principally for the last 25 years of his life, abandoning imaginative or didactic themes. To this period belong a number of pictures of children, like "Cherry Ripe," "Little Miss Muffet," and "Bubbles." Amongst his more serious pictures were "The Princes in the Tower" (1878), "The Princess Elizabeth" (1870), two pictures from Scott—"Effie Deans" and "The Master of Ravenswood"—"A Yeoman of the Guard" (1877), and "The North-West Passage" (1874), representing an old mariner (painted from Edward John Trelawney, the friend of Byron) listening to some tale of Arctic exploration in a room overlooking the sea and strewn with charts. Amongst the works of his later years were his three portraits of Gladstone (1879, 1885 and 1890), and those of John Bright, of Lord Tennyson, and of Lord Beaconsfield, the last of which was left unfinished at his death. He also painted the marquess of Salisbury, Lord Rosebery, the dukes of Devonshire and Argyll, Cardinal Newman, Thomas Carlyle, Sir James Paget, Sir Henry Irving, George Grote, Lord Chief Justice Russell, J. C. Hook, R.A., and himself (Uffizi Gallery, Florence). He drew Charles Dickens after his death. Amongst his portraits of women were those of Mrs. Bischoffsheim, the duchess of Westminster, Lady Campbell and Mrs. Jopling.

In 1879 Millais left Cromwell Place for a house at Palace Gate, Kensington, which he built, and where he died. In 1885 he was created a baronet. Among his last works are: "St. Stephen," "A Disciple," "Speak! Speak!" (which was bought out of the Chantrey Bequest), and "The Forerunner"—his last exhibited subject-picture. His finely-characterized portraits of Mr. John Hare, the actor, and Sir Richard Quain belong also to his last years. On the death of Lord Leighton he was elected to the presidential chair of the Royal Academy. He died on Aug. 13, 1896, and was buried in St. Paul's Cathedral. The Winter Exhibition of the Royal Academy in 1898 was devoted to his works. The National Gallery of British Art possesses many of his finest works. He is also represented in the National Gallery, in the National Portrait Gallery, the Victoria and Albert museum, and many other public galleries including those of Manchester, Liverpool and Birmingham.

BIBLIOGRAPHY.—G. Millais, *Life and Letters* (1899); Ruskin's *Modern Painters, Notes on Royal Academy Exhibitions, Pre-Raphaelitism, etc.; Catalogues* of Grosvenor Gallery (summer of 1886); and of Royal Academy (winter of 1898); M. H. Spielmann, *Millais and his Works* (1896); A. L. Baldry, *Sir J. E. Millais, his Art and Influence* (1899); J. E. Reid, *Sir J. E. Millais* (1909). (C. MON.; X.)

MILLAR, ANDREW (1707–1768), British publisher, started business as a bookseller and publisher in the Strand, London, about 1729. His own judgment in literary matters was small, but he collected an excellent staff of literary advisers, and paid what at the time were large prices for good material. "I respect Millar, sir," said Dr. Johnson in 1755, "he has raised the price of literature." He paid Thomson £105 for *The Seasons,* and Fielding £700 for *Tom Jones* and £1,000 for *Amelia.* He was one of the syndicate of booksellers who financed Johnson's *Dictionary.* He also published the histories of Robertson and Hume. He died at Kew Green, London, on June 8, 1768.

MILLAU, a town of southern France, capital of an arrondissement in the department of Aveyron, on the Tarn at its confluence with the Dourbie, 74 m. N. of Béziers on the Southern railway. Pop. (1926) 14,033. In the middle ages Millau was the seat of a viscounty held by the counts of Barcelona and afterwards by the counts of Armagnac. It became a leading stronghold of Calvinism and revolted against Louis XIII. (1620); after its submission, Richelieu caused its fortifications to be dismantled. The edict of Nantes hastened the decline of the town, which did not recover till after the Revolution. Millau lies in a valley 1,200 ft. above the sea surrounded by the spurs of the Levezou, Causse Noir and Larzac ranges. One of its squares is bordered on two sides by wooden galleries on stone columns. The Romanesque church of Notre Dame was restored in the 16th century; there is a fine Gothic belfry on the old *hôtel de ville.* Millau is seat of a sub-prefect, and possesses a tribunal of commerce, a board of trade-arbitrators and a chamber of commerce. Glove making and leather-work are carried on. The chief articles of trade are skins, wool, timber, furniture and Roquefort cheese.

MILLAY, EDNA ST. VINCENT (1892–), American poet, was born in Rockland, Me., on Feb. 22, 1892. She graduated from Vassar in 1917 and was married in 1923 to Eugen Jan Boissevain. She was awarded the Pulitzer prize in 1923 for her volume, *The Harp-Weaver.* In 1925 she was commissioned by the directors of the Metropolitan Opera Company to write the book for an opera, the music of which was to be composed by Deems Taylor; the result of their collaborations, *The King's Henchman,* first presented in 1927, was a greater success than any previous American opera. Her works include *Renascence and Other Poems* (1917); *A Few Figs from Thistles* (1920); *Second April* (1921); *Distressing Dialogues* (1924, under the pseudonym Nancy Boyd); *Three Plays* (1926), which reprints her earlier publications, *Two Slatterns and a King* (1921), *Aria da Capo* (1920) and *The Lamp and the Bell* (1921); and *The Buck in the Snow* (1928). *See* J. H. Preston, "Edna St. Vincent Millay" in *Virginia Quarterly* (vol. 3, 1927).

MILLBOARD: *see* CARDBOARD.

MILLBURY, a town of Worcester county, Massachusetts, U.S.A., on the Blackstone river, and on the Boston and Albany and the New Haven railways. The population was 5,653 in 1920 (22% foreign-born white), and was 6,957 in 1930 Federal census. It is a manufacturing town, making chiefly cotton, woollen and linen goods, thread, felt and edge tools. Millbury was set off from Sutton and incorporated as a separate town in 1813.

MILLE, PIERRE (1864–), French man of letters, was born at Choisy-le-Roi in 1864, and educated at the Collège Rollin. He has taken part in many expeditions for the exploration of West Africa, the Congo, Indo-China and British India. During the Greco-Turkish War (1897) he acted as war correspondent for the *Journal des Débats,* and he served the *Temps* in the same capacity during the World War. His best works are *Barnavaux et quelques Femmes* (1908), *Caillou et Tili,* and *le Monarque.* The central figures in these tales have in common their power to see life only through the imagination.

MILLEDGEVILLE, a city of central Georgia, U.S.A., the county seat of Baldwin county; on the Oconee river, 32 m. N.E. of Macon. It is served by the Central of Georgia and the Georgia railways. The population was 4,619 in 1920, 5,534 in 1930. It is the seat of the Georgia State college for Women (1889), the State penitentiary and reformatory, and the State hospitals for white and for coloured insane. Milledgeville was founded in 1803 and chartered as a city in 1836. It was named after John Milledge (1757–1818), then governor of Georgia. From 1804 until 1868 it was the State capital, and a centre of wealth and culture. The governor's mansion, built in 1838, is now the residence of the president of the State college. On Nov. 23, 1864, Gen. Sherman entered the city. To save the State documents from the enemy, Governor Joseph E. Brown used the services of the convicts in the penitentiary, granting them pardons in return.

MILLENNIUM, literally a period of a thousand years, (a pseudo-Latin word formed on the analogy of *biennium, triennium,* from Lat. *mille,* a thousand, and *annus,* year). The term is specially used of the period of 1,000 years during which Christ, as has been believed, would return to govern the earth in person. Hence it is used to describe a vague time in the future when all flaws in human existence will have vanished, and perfect goodness and happiness will prevail.

Faith in the nearness of Christ's second advent and the establishing of his reign of glory on the earth was undoubtedly a strong point in the primitive Christian Church. In the anticipations of the future prevalent amongst the early Christians (*c.* 50–150) it is necessary to distinguish a fixed and a fluctuating element. The former includes (1) the notion that a last terrible battle with the enemies of God was impending; (2) the faith in the speedy return of Christ; (3) the conviction that Christ will judge all men, and (4) will set up a kingdom of glory on earth. To the latter belong views of the Antichrist, of the heathen world-power, of the place, extent, and duration of the earthly kingdom of Christ, etc. These remained in a state of solution; they were modified from day to day, partly because of the changing circumstances of the present by which forecasts of the future were regulated, partly because the indications—real or supposed—of the ancient prophets always admitted of new combinations and constructions. But even here certain positions were agreed on in large sections of Christendom. Amongst these was the expectation that the future kingdom of Christ on earth should have a fixed duration—according to the most prevalent opinion, a duration of 1,000 years. From this fact the whole ancient Christian eschatology was known in later times as "chiliasm"—a name which is not strictly accurate, since the doctrine of the millennium was only one feature in its scheme of the future.

This idea that the Messianic kingdom of the future on earth should have a definite duration has—like the whole eschatology of the primitive Church—its roots in the Jewish apocalyptic literature, where it appears at a comparatively late period. At first it was assumed that the Messianic kingdom in Palestine would last for ever (so the prophets; *cf.* Jer. xxiv. 6; Ezek. xxxvii. 25; Joel iv. 20; Dan. vi. 27; Sibyll. iii. 49 *seq.,* 766; Psalt. Salom. xvii. 4; Enoch lxii. 14), and this seems always to have been the most widely accepted view (John xii. 34). But from a comparison of prophetic passages of the Old Testament learned apocalyptic writers came to the conclusion that a dis-

tinction must be drawn between the earthly appearance of the Messiah and the appearance of God Himself amongst His people and in the Gentile world for the final judgment.

Nowhere in the discourses of Jesus is there a hint of a limited duration of the Messianic kingdom. The apostolic epistles are equally free from any trace of chiliasm (neither 1 Cor., xv. 23 *seq.* nor 1 Thess., iv. 16 *seq.* points in this direction). In Revelation however, it occurs in the following shape (ch. xx.). After Christ has appeared from heaven in the guise of a warrior, and vanquished the anti-Christian world-power, the wisdom of the world and the devil, those who have remained steadfast in the time of the last catastrophe, and have given up their lives for their faith, shall be raised up, and shall reign with Christ on this earth as a royal priesthood for 1,000 years. At the end of this time Satan is to be let loose again for a short season; he will prepare a new onslaught, but God will miraculously destroy him and his hosts. Then will follow the general resurrection of the dead, the last judgment, and the creation of new heavens and a new earth. That *all* believers will have a share in the first resurrection and in the Messianic kingdom is an idea of which the author of Revelation knows nothing. The earthly kingdom of Christ is reserved for those who have endured the most terrible tribulation, who have withstood the supreme effort of the world-power—that is, for those who are actually members of the church of the last days. The Jewish expectation is thus considerably curtailed, as it is also shorn of its sensual attractions. "Blessed and holy is he that hath part in the first resurrection; on such the second death hath no power; but they shall be priests of God and of Christ, and shall reign with Him a thousand years." Other ancient Christian authors were not so cautious. Accepting the Jewish apocalypses as sacred books of venerable antiquity, they read them eagerly, and transferred their contents bodily to Christianity. Nay more, the Gentile Christians took possession of them, and just in proportion as they were neglected by the Jews—who, after the war of Bar-Cochba, became indifferent to the Messianic hope and hardened themselves once more in devotion to the law—they were naturalized in the Christian communities. The result was that these books became "Christian" documents; it is entirely to Christian, not to Jewish, tradition that we owe their preservation. The Jewish expectations are adopted for example, by Papias, by the writer of the epistle of Barnabas, and also by Justin. That a philosopher like Justin, with a bias towards an Hellenic construction of the Christian religion, should nevertheless have accepted its chiliastic elements is the strongest proof that these enthusiastic expectations were inseparably bound up with the Christian faith down to the middle of the 2nd century.

After the middle of the 2nd century these expectations were gradually thrust into the background. They would never have died out, however, had not circumstances altered, and a new mental attitude been taken up. The spirit of philosophical and theological speculation and of ethical reflection, which began to spread through the Churches, did not know what to make of the old hopes of the future. To a new generation they seemed paltry, earthly and fantastic, and far-seeing men had good reason to regard them as a source of political danger. But more than this, these wild dreams about the glorious kingdom of Christ began to disturb the organization which the Churches had seen fit to introduce. In the interests of self-preservation against the world, the State and the heretics, the Christian communities had formed themselves into compact societies with a definite creed and constitution, and they felt that their existence was threatened by the white heat of religious subjectivity. So early as the year 170, a Church party in Asia Minor—the so-called Alogi—rejected the whole body of the apocalyptic writings and denounced the book of Revelation as a book of fables. All the more powerful was the reaction. In the so-called Montanistic controversy (*c.* 160–220) one of the principal issues involved was the continuance of the chiliastic expectations in the Churches. The Montanists of Asia Minor defended them in their integrity, with one slight modification: they announced that Pepuza, the city of Montanus, would be the site of the New Jerusalem and the millennial kingdom. After the Montanistic controversy chiliastic views were more and more discredited in the Greek Church; they were, in fact, stigmatized as "Jewish" and therefore "heretical." Dionysius, bishop of Alexandria, succeeded in healing the schism and asserting the allegorical interpretation of the prophets as the only legitimate exegesis. During this controversy Dionysius became convinced that the victory of mystical theology over "Jewish" chiliasm would never be secure so long as the book of Revelation passed for an apostolic writing and kept its place among the homologoumena of the canon. He accordingly raised the question of its apostolic origin; and by reviving old difficulties, with ingenious new arguments, he carried his point. The Greek Church kept Revelation out of its canon, and consequently chiliasm remained in its grave. It was considered a sufficient safeguard against the spiritualizing eschatology of Origen and his school to have rescued the main doctrines of the creed and the *regula fidei* (the visible advent of Christ; eternal misery and hell-fire for the wicked). Anything going beyond this was held to be Jewish. In the Semitic churches of the East (the Syrian, Arabian and Ethiopian), and in that of Armenia, the apocalyptic literature was preserved much longer than in the Greek Church. They were very conservative of ancient traditions in general, and hence chiliasm survived amongst them to a later date than in Alexandria or Constantinople.

But the Western Church was also more conservative than the Greek. Her theologians had, to begin with, little turn for mystical speculation; their tendency was rather to reduce the gospel to a system of morals. Now for the moralists chiliasm had a special significance as the one distinguishing feature of the gospel, and the only thing that gave a specifically Christian character to their system. This, however, holds good of the Western theologians only after the middle of the 3rd century. The earlier fathers, Irenaeus, Hippolytus, Tertullian, believed in chiliasm simply because it was a part of the tradition of the Church and because Marcion and the Gnostics would have nothing to do with this conception. It is the same all through the 3rd and 4th centuries with those Latin theologians who escaped the influence of Greek speculation. Commodian, Victorinus Pettavensis, Lactantius and Sulpicius Severus were all pronounced millenarians, holding by the very details of the primitive Christian expectations. As to the canonicity and the apostolic authorship of the Johannine Apocalypse no doubts were ever entertained in the West; indeed an Apocalypse of Peter was still retained in the canon in the 3rd century. That of Ezra, in its Latin translation, must have been all but a canonical book—the numbers of extant manuscripts of the so-called 4 Ezra being incredibly great, while several of them are found in copies of the Latin Bible at the beginning of the 16th century. These facts show how vigorously the early hopes of the future maintained themselves in the West. In the hands of moralistic theologians, like Lactantius, they certainly assume a somewhat grotesque form, but the fact that these men clung to them is the clearest evidence that in the West millennarianism was still a point of "orthodoxy" in the 4th century.

This state of matters, however, gradually disappeared after the end of the 4th century. The change was brought about by two causes—first, Greek theology, which reached the West chiefly through Jerome, Rufinus and Ambrose, and, second, the new idea of the Church wrought out by Augustine on the basis of the altered political situation of the Church. Augustine was the first who ventured to teach that the Catholic Church, in its empirical form, was the kingdom of Christ, that the millennial kingdom had commenced with the appearing of Christ, and was therefore an accomplished fact. By this doctrine of Augustine's, the old millennarianism, though not completely extirpated, was at least banished from the official theology. It still lived on, however, in the lower strata of Christian society; and in certain undercurrents of tradition it was transmitted from century to century. At various periods in the history of the middle ages we encounter sudden outbreaks of millennarianism, sometimes as the tenet of a small sect, sometimes as a far-reaching movement. And, since it had been suppressed, not, as in the East, by mystical speculation, its mightiest antagonist, but by the political

church of the hierarchy, we find that wherever chiliasm appears in the middle ages it makes common cause with all enemies of the secularized Church. It strengthened the hands of Church democracy; it formed an alliance with the pure souls who held up to the Church the ideal of apostolic poverty; it united itself for a time even with mysticism in a common opposition to the supremacy of the Church; nay, it lent the strength of its convictions to the support of States and princes in their efforts to break the political power of the Church. It is sufficient to recall the well-known names of Joachim of Floris, of all the numerous Franciscan spiritualists, of the leading sectaries from the 13th to the 15th century who assailed the papacy and the secularism of the Church—above all, the name of Occam. In these men the millennarianism of the ancient Church came to life again; and in the revolutionary movements of the 15th and 16th centuries—especially in the Anabaptist movements—it appears with all its old uncompromising energy. If the Church, and not the State, was regarded as Babylon, and the pope declared to be the Antichrist, these were legitimate inferences from the ancient traditions and the actual position of the Church.

The German and Swiss reformers also believed that the end of the world was near, but they had different aims in view from those of the Anabaptists. It was not from poverty and apocalypticism that they hoped for a reformation of the Church. In contrast to the fanatics, after a brief hesitation they threw millennarianism overboard, and along with it all other "opiniones Judaicae." They took up the same ground in this respect which the Roman Catholic Church had occupied since the time of Augustine. How millennarianism nevertheless found its way, with the help of apocalyptic mysticism and Anabaptist influences into the Churches of the Reformation, chiefly among the Reformed sects, but afterwards also in the Lutheran Church, how it became incorporated with Pietism, how in more recent times an exceedingly mild type of "academic" chiliasm has been developed from a belief in the verbal inspiration of the Bible, how finally new sects are still springing up here and there with apocalyptic and chiliastic expectations—these are matters which cannot be fully entered upon here.

Bibliography.—Corrodi, *Kritische Geschichte des Chiliasmus* (1781); Bousset, *Religion des Judentums* (1926), and works there quoted; Lohmeyer, *Die Offenbarung des Johannes* (1926). *See* also the Histories of Christian Doctrine and *cf.* Eschatology. (A. Ha.)

MILLER, JOAQUIN (Cincinnatus Heine) (1841–1913), American poet, was born in Indiana, Nov. 10, 1841, and was educated for the law. After some experiences of mining and journalism in Idaho and Oregon, he settled down in 1866 as judge in Grant county, Oregon, and during his four years' tenure of this post he began to write verse. In 1870 he travelled in Europe, and in 1871 he published his first volume of poetry, *Songs of the Sierras,* on which his reputation mainly rests. His *Songs of the Sunlands* (1873) followed in the same vein, and after other volumes had appeared, his *Collected Poems* were published in 1882. He also wrote plays, *The Danites in the Sierras* having some success as a sensational melodrama. On his return from Europe he became a journalist in Washington, but in 1887 returned to California. His pen-name, "Joaquin Miller," by which he is known, was assumed by him when he published his first book, in consequence of his having written an article in defence of Joaquin Murietta, the Mexican brigand. He died at Oakland (Cal.), February 17, 1913. In compliance with his last wishes his body was cremated and the ashes taken up into the Sierras and cast to the winds.

Revised editions of his *Complete Poetical Works* appeared at San Francisco in 1902. Critical estimates and personal reminiscences of him may be found in *The Sunset Magazine,* vol. 30, pp. 765–770 and in *The Overland Monthly,* vol. 63, pp. 109–19; vol. 75, p. 93–96. *See* also H. Wagner, *Joaquin Miller and his Other Self* (1929).

MILLER, JOE (Joseph or Josias) (1684–1738), English actor, first appears in the cast of Sir Robert Howard's *Committee* at Drury Lane in 1709 as Teague. Trinculo in *The Tempest,* the First Grave-digger in *Hamlet* and Marplot in *The Busybody,* were among his many favourite parts. He died on Aug. 16, 1738. After his death, John Mottley (1692–1750) brought out a book called *Joe Miller's Jests, or Wit's Vade Mecum* (1739), a collection of contemporary and ancient coarse witticisms, only three of which are told of Miller. Any time-worn jest has, somewhat unjustly, come to be called "a Joe Miller."

MILLER, OSKAR VON (1855–), German engineer, was born in Munich on May 7, 1855. After studying electrical technology he became director of the German Edison Company from which developed the Allgemeine Elektrizitäts Gesellschaft (the A.E.G., or General Electric Co.). He was director of the electrical exhibition (Frankfurt-on-Main, 1891), when the first high tension alternating current power-transmission apparatus was installed. The transmission was accomplished over a distance of 180 km. (from Lauffen on the Neckar to Frankfurt) and with only 25% loss. These experiments were of the highest importance in the development of modern electric-technology. He promoted the development of Bavarian water power as well as a systematic electric supply for that country, and was the founder and organizer of the German museum for natural and technical science in Munich.

MILLER, WILLIAM (1782–1849), leader of the Second Adventists in America, was born on Feb. 5, 1782, at Pittsfield, Mass. He bore a good reputation as a farmer and citizen, served as a captain in the War of 1812, and was a diligent student and reader, although he had only a common school education. About 1818, after two years of minute study of the Bible, he became a Second Adventist. In 1831 he began to lecture, arguing that the "two thousand three hundred days" of Daniel viii. 14 meant 2,300 years, and that these years began with Ezra's going up to Jerusalem in 457 B.C., and therefore came to an end in 1843, and urging his hearers to make ready for the final coming of Christ in that year. To his many followers, after the year 1843 had passed, he proclaimed that 1844 was the year, that his error was due to following Hebrew instead of Roman chronology, and that Oct. 22 was to be the day. There was renewed excitement among Miller's followers; many of them left their business, and in white muslin robes, on house tops and hills, awaited the epiphany. In spite of disappointment, many still believed with him that the time was near. He returned to Low Hampton and died there on Dec. 20, 1849. The Adventists or Millerites, were formed into a single body in a convention called by him in April 1845, but have since separated into four sects: Seventh Day Adventists (110,998), Advent Christians (29,410), Churches of God in Jesus Christ (1,686) and the Life and Advent Union (535). Their total membership in the United States in 1926 was about 146,177. Miller published in 1833 a pamphlet which was the basis of his lectures; these also were published in 1842 as *Evidence from Scripture and History of the Second Coming of Christ about the Year 1843.*

There are biographies by Sylvester Bliss (1853) and James White (1875).

MILLER, WILLIAM (1795–1861), British soldier, who took a prominent part in the South American Wars of Liberation, was born on Dec. 2, 1795 at Wingham, Kent, entered the British artillery service in 1811, and till 1814 served with Wellington's army in the Peninsula. He afterwards served in North America, then travelled for two years in Europe, and went to South America. The war which culminated in the expulsion of the Spaniards was just breaking out, and he took command in the Chilean artillery. As a major he commanded the marines on Cochrane's vessel, the "O'Higgins." In 1821 he landed in Peru, to assist General San Martin, and as general of brigade, rendered conspicuous services at Junin (Aug. 6, 1824), and at Ayacucho (Dec. 9, 1824). He subsequently filled various high military and political offices in Peru. In 1839 he was involved in the fall of Santa Cruz, and went into exile. For some years he filled the post of British Consul-General of the Pacific Coast. He died on board H.M.S. "Naiad" at Callao, on Oct. 31, 1861.

See the *Memoirs* published by his brother John Miller (1827).

MILLER, WILLIAM (1796–1882), Scottish line-engraver, was born in Edinburgh on May 28, 1796. After studying in London under George Cook, a pupil of Basire's, he returned to Edinburgh. He executed plates after Thomson of Duddingston, Mac-

culloch, D. O Hill, Sir George Harvey, and other Scottish landscapists, but his chief works were his transcripts from Turner. He engraved Turner's "The Grand Canal, Venice"; "The Rhine, Osterprey and Feltzen"; "The Bell Rock"; "The Tower of London"; and "The Shepherd." The art of William Miller was warmly appreciated by Turner himself, and Ruskin pronounced him to be on the whole the most successful translator into line of the paintings of the greatest English landscapist. In his later years Miller abandoned engraving for landscape-painting. He resumed his burin, however, to produce two final series of vignettes from drawings by Birket Foster illustrative of Hood's *Poems*, published by Moxon in 1871. Miller died on Jan. 20, 1882.

MILLERAND, ALEXANDRE (1859–), French Socialist and politician, was born in Paris on Feb. 10, 1859. He was educated for the bar, and made his reputation by his defence, with Georges Laguerre, of Ernest Roche and Duc-Quercy, the instigators of the strike at Decazeville in 1883; he then took Laguerre's place on Clemenceau's paper, *La Justice*. He was elected to the chamber of deputies for the department of the Seine in 1885 as a Radical Socialist. He was associated with Clemenceau and Camille Pelletan as an arbitrator in the Carmaux strike (1892). He had long had the ear of the chamber in matters of social legislation, and after the Panama scandals had discredited so many politicians his influence grew. He was chief of the Socialist left, which then mustered sixty members, and edited until 1896 their organ in the press, *La Petite République*. His programme included the collective ownership of the means of production and the international association of labour, but when in June 1899 he entered Waldeck-Rousseau's cabinet of "republican defence" as minister of commerce he limited himself to practical reforms, devoting his attention to the improvement of the mercantile marine, to the development of trade, of technical education, of the postal system, and to the amelioration of the conditions of labour.

Labour questions were entrusted to a separate department, the Direction du Travail, and the pension and insurance office was also raised to the status of a "direction." The introduction of trades-union representatives on the Supreme Labour Council, the organization of local labour councils and the instructions to factory inspectors to put themselves in communication with the councils of the trades-unions, were valuable concessions to labour, and he further secured the rigorous application of earlier laws devised for the protection of the working-classes. His name was especially associated with a project for the establishment of old age pensions, which became law in 1905. He became in 1898 editor of *La Lanterne*. His influence with the extreme Socialists had already declined, for it was said that his departure from the true Marxist tradition had disintegrated the party.

Millerand, now only a private member, threw himself into his work as a barrister, and appeared in many important civil cases. In the chamber he was a fierce opponent of the Combes ministry, which succeeded that of Waldeck-Rousseau; for he objected to its narrow and fanatical anti-clericalism. In July 1909 he became minister of public works in Briand's first cabinet, his principal achievement at this time being the re-organisation of the state railways. Together with Briand he took strong measures to suppress the railway strike of October 1910. In January 1912 he was appointed minister of war under Poincaré. His promotion surprised no one, for he had always taken a keen interest in questions of military organisation; and when the menace of Germany increased, he devoted himself to strengthening the national defences. He re-organised the higher command, and by the Act of May 29, 1912, he gave a definite status to military aeronautics for the first time. In January 1913 a personal incident brought about his retirement. On Aug. 25, 1914, he was invited by Viviani to take the place of Messimy as minister of war; and during the terrible situation which then prevailed he had constantly to take the initiative, for example, in attempting to remedy as far as possible the shortage of munitions. He was accused, however, of being too slow in providing the necessary heavy artillery, and he resigned with the other members of the Viviani cabinet at the end of October 1915. In 1918 he was elected a member of the Académie des sciences morales et politiques.

A few months after the conclusion of hostilities, on March 21, 1919, Millerand was appointed commissioner general for Alsace-Lorraine. The problem of reuniting with the mother-country two provinces which had been torn from her in 1871 was a most serious one. For 50 years they had been under an administration widely different from that of France. A period of transition, therefore, was essential, alike from the point of view of political expediency, administration, economics and finance. The first French officials sent to Strasbourg had not been equal to their task; and for this reason it was essential to appoint a statesman of eminent authority with power to act, who would keep in constant touch with the government. This post was filled by Millerand with complete success. In an important speech delivered in Paris on Nov. 15, 1919, on the eve of the elections, he outlined the policy of the coalition which, under the name of the *bloc national*, was returned to power.

On the resignation of Clemenceau, Jan. 18, 1920, Millerand was chosen to form a cabinet, and became both prime minister and minister for foreign affairs. His main activities were in regard to the application of the Treaty of Versailles; and in order to force Germany to fulfil her obligations, he ordered the provisional occupation of Frankfort. He was present at the inter-allied conferences at San Remo and Spa, in April and July 1920, and in August of the same year he met Lloyd George at Hythe. The situation in regard to Poland, who had been attacked by the Bolsheviks, now became grave, and Millerand therefore sent to Warsaw a contingent of French officers under General Weygand. With this assistance the Poles gained a complete victory over the Bolsheviks. Millerand about this time officially recognised the anti-Bolshevik government of General Wrangel, who was soon after completely defeated. In France itself, in May 1920, he frustrated various attempts, especially by the railwaymen, to organise revolutionary strikes.

In September 1920 Deschanel, president of the republic, was forced by ill-health to resign. Millerand was elected as his successor, and out of 892 votes cast, no fewer than 695 were given in his favour. During his candidature, he made it known that if he were elected, he intended to exert a more powerful influence on the policy of the government than his predecessors had done. He refused to admit that his office of president forced him to comply with a tradition of which he disapproved, by remaining absolutely neutral in politics. He made it clear that he intended to watch closely the foreign policy of the government, and made no secret of his wish to strengthen the power of the president by a revision of the constitution which would modify the conditions of his election; and he put his ideas into practice, by frequently intervening in diplomatic negotiations. During the inter-allied conference at Cannes in January 1922 he despatched a telegram expressing dissatisfaction at the conduct of affairs, which caused Briand to return to Paris, and, in fact, brought about his resignation. Working on the same lines, he summoned to the *Elysée* the prefects, or chief administrative officers of each department from all over France. In a powerful speech at Evreux in the spring of 1923 he declared that he would not agree to the re-introduction of the *scrutin d'arrondissement*, and showed marked favour to the adherents of the *bloc national*, who had been in the majority in the Chamber since the elections of November 1919, and against whom the Radicals and Socialists were then carrying on a campaign of public meetings.

Millerand's conception of the rôle of president of the Republic brought him into collision with the Radical and Socialist majority, which, under the name of the *cartel des gauches*, was successful in the elections of May 11, 1924. He was violently attacked by the Radical Socialist press, which accused him of having exceeded his powers by intervening in the party struggle, and called for his resignation. Herriot, the leader of the *cartel des gauches*, when asked by Millerand to succeed Poincaré as premier, announced that he would do so only on Millerand's resignation. The latter replied that he had been elected for seven years, and that the alteration of the party in power could in no way affect his consti-

tutional position nor abrogate his rights. But he made it clear that he had not the slightest intention of obstructing the new government, and that its leader could count on his impartiality.

Herriot, however, remained immovable; and Millerand therefore invited the senator François-Marsal, who had been his minister of finance in 1920, to form a cabinet. François-Marsal declared in the Chamber that the attacks on Millerand were contrary to the constitution, and that it was in order to uphold the latter that he had agreed to take office. His government, however, was immediately defeated; and Millerand tendered his resignation, protesting meanwhile against the illegality of the action taken against him. The attitude of the party in power dissatisfied the Senate, which, as a result, voted with the opposition and elected Doumergue as Millerand's successor, instead of Painlevé, the candidate of the *cartel des gauches.*

In January 1927, at the senatorial elections in the department of the Seine, Millerand was defeated. Several months later he stood for a by-election in the department of the Orne, in Normandy. He was elected and resumed his place in the Senate.

MILLERITE, a mineral consisting of nickel sulphide, NiS. Crystals belong to the rhombohedral system and have the form of slender needles arranged in divergent groups or of delicate fibres loosely matted together ("hair-pyrites"). The colour is brass-yellow and the lustre metallic. Typical specimens of millerite, so named, in 1845, in honour of W. H. Miller, are found in the coal-measures in the neighbourhood of Merthyr Tydvil, where the delicate needles and fibres occur with crystals of quartz and pearl-spar in the fissures of septarian nodules of clay-ironstone.

MILLER'S THUMB, a small fish, abundant in all rivers and lakes of northern and central Europe with clear water and gravelly bottom, up to 7,000 feet. It has a broad, flat head, rounded and scaleless body, large pectoral and narrow ventral fins, with two dorsal fins; the gill-cover is armed with a spine. The numerous species of the genus are confined to the north temperate zone, the majority being marine and called "bullheads." The miller's thumb is confined to fresh water; one other freshwater species is found in Europe, others occur in the fresh waters of northern Asia and North America. The miller's thumb (*Cottus gobio*) is common in all suitable localities in Great Britain, but rare in Ireland. Its usual length is from 3 to 5 inches. Its prey consists of small aquatic animals, upon which it pounces from some refuge. The female deposits her eggs in a cavity under a stone, whilst the male watches and defends them until the young are hatched. The common American bullhead is the *sculpin* (a name sometimes applied to all the New World members of the genus), *C. octodecim-spinosus,* which is marine.

MILLET, FRANCIS DAVIS (1846–1912), American artist, was born at Mattapoisett (Mass.), on Nov. 3, 1846. He was a drummer boy with the Union forces in the Civil War, graduated from Harvard college in 1869, and in 1871 entered the Royal Academy of Fine Arts, Antwerp. In 1873 he was made secretary of the Massachusetts commission to the Vienna exposition. During the Russo-Turkish War of 1877-78 he was correspondent of the London *Daily News* and *Graphic,* and of the New York *Herald.* On his return he was made a member from the United States of the International art jury at the Paris exposition of 1878. He was director of decorations at the Columbian exposition, Chicago, 1893, and in 1898 he went to Manila as war correspondent for *The Times* and for *Harper's Weekly.* In 1880 he became a member of the Society of American artists, and in 1885 was elected to full membership in the National academy of design, New York, and was for one term its vice-president. He was a trustee of the Metropolitan Museum of Art, secretary of the American academy of Rome and vice-chairman of the Fine Arts committee. He was also a member of the American water colour society and of the Institute of painters in oil colours, London. His work as a decorative artist may be seen at Trinity church, Boston; the Bank of Pittsburgh; and the capitol at St. Paul (Minn.). His pictures are in many public collections: among them are "A Cosy Corner," in the Metropolitan Museum of Art, New York; "At the Inn," in the Union League club, New York; and "Between Two Fires," in the Tate Gallery, London. He also wrote essays and short stories, and an English version of Tolstoi's *Sebastopol* (1887); and among his publications are *The Danube* (1891), *Capillary Crime and other Stories* (1892), and *Expedition to the Philippines* (1899). He was drowned in the "Titanic" disaster, April 15, 1912.

MILLET (or MILÉ), **JEAN FRANÇOIS** (*c.* 1642–1679), commonly called FRANCISQUE, was born at Antwerp about 1642, and is generally classed amongst the painters of Flanders on account of the accident of his birth. But his father was a Frenchman, a turner in ivory of Dijon, who took service with the prince of Condé and probably returned after a time to his native country. He remained long enough in Antwerp to apprentice his son to an obscure member of a painter family called Laurent, pupil of Gabriel Franck. With Laurent, Francisque left Antwerp for Paris, and there settled in 1660 after marrying his master's daughter. He was received a member of the Academy of Painting at Paris in 1673, and after gaining consideration as an imitator of the Poussins he died in 1679, bequeathing his art and some of his talents to one of his sons. His paintings of Italian and Arcadian scenery were graceful and effective, although, as he had not travelled, his impressions of them were gained at secondhand. Twelve of his most important landscapes in the Tuileries were destroyed by fire; and though many of his pieces may still be found catalogued in Continental and English collections, a great number remain unknown and unacknowledged.

MILLET, JEAN FRANÇOIS (1814–1875), French painter, who came of a peasant family, was born on Oct. 4, 1814 in the hamlet of Gruchy, near Gréville (La Manche). His boyhood was passed working in his father's fields, but the sight of the engravings in an old illustrated Bible set him drawing. Two drawings were shown to a painter at Cherbourg named Mouchel, who at once accepted him as a pupil; but shortly after (1835) Millet's father died, and the eldest son, with heroic devotion, took his place at home, nor did he return to his art until encouraged by his own family. After a short time spent at Cherbourg under a master named Langlois he started for Paris. The council-general of the department had granted him a sum of 600 francs, and the town council promised an annual pension of 400, but in spite of friendly help and introductions Millet experienced great difficulties. The system of the École des Beaux Arts was hateful to him, but after much hesitation, he decided to enter an official studio—that of Delaroche. The master recognized his ability, and arranged for his free admission to the studio, but he tried in vain to make him take the approved direction, and lessons ended with "Eh, bien, allez à votre guise, vous êtes si nouveau pour moi que je ne veux rien vous dire." At last Millet withdrew, and with his friend Marolle started in a little studio in the Rue de l'Est. He continued to study hard whilst he provided bread by painting portraits at 10 or 15 francs apiece and producing small "pastiches" of Watteau and Boucher. In 1840 Millet went back to Gréville, where he painted "Sailors Mending a Sail" and a few other pictures of Cherbourg life.

His first success was obtained in 1844, when his "Milkwoman" and "Lesson in Riding" (pastel) attracted notice at the Salon, and friendly artists presented themselves at his lodgings only to learn that his wife had just died, and that he himself had disappeared. Millet was at Cherbourg; there he remarried, but having amassed a few hundred francs he went back to Paris and presented his "St. Jerome" at the Salon of 1845. This picture was rejected and exists no longer, for Millet, short of canvas, painted over it "Oedipus Unbound," a work which during the following year was the object of violent criticism. He was, however, no longer alone; Diaz, Eugène Tourneux, Rousseau, and other men of note supported him by their confidence and friendship, and his second wife, Catherine Lemaire, bore poverty with dignity and gave courage to her husband. To this date belong Millet's "Golden Age," "Bird Nesters," "Young Girl and Lamb," and "Bathers"; to the "Bathers" (Louvre) succeeded "The Mother Asking Alms," "The Workman's Monday," and "The Winnower."

This last work, exhibited in 1848, was highly praised, but remained unsold until Ledru Rollin, informed of the painter's dis-

tress, gave him 500 francs for it. Rollin also gave Millet a commission which enabled him to leave Paris for Barbizon, on the skirts of the forest of Fontainebleau. There he settled in a three-roomed cottage for the rest of his life—twenty-seven years, in which he wrought out the perfect story of that peasant life of which he alone has given a "complete impression." Jules Breton has coloured the days of toil with sentiment; others, like Courbet, whose eccentric "Funeral at Ornans" attracted more notice at the Salon of 1850 than Millet's "Sowers and Binders," have treated similar subjects as a vehicle for protest against social misery; Millet alone, a peasant and a miserable one himself, saw true, neither softening nor exaggerating what he saw. To a friend he expressed his resolve to break with mythological subjects. In 1852 he produced "Girls Sewing," "Man Spreading Manure"; 1853, "The Reapers"; 1854, "Church at Gréville"; 1855—the year of the International Exhibition, at which he received a medal of second class—"Peasant Grafting a Tree"; 1857, "The Gleaners"; 1859, "The Angelus," "The Woodcutter and Death"; 1860, "Sheep Shearing"; 1861, "Woman Shearing Sheep," "Woman Feeding Child"; 1862, "Potato Planters," "Winter and the Crows"; 1863, "Man with Hoe," "Woman Carding"; 1864, "Shepherds and Flock," "Peasants Bring Home a Calf Born in the Fields"; 1869, "Knitting Lesson"; 1870, "Buttermaking"; 1871, "November—recollection of Gruchy."

Something of the imposing unity of his work was, no doubt, due to an extraordinary power of memory, which enabled Millet to paint without a model; he could recall with precision the attitudes or gestures which he proposed to represent. Thus he could count on presenting free from afterthoughts the vivid impressions which he had first received. Those impressions were always of a serious and often of a noble order, to which the character of his execution responded so perfectly that even a "Washerwoman at her Tub" will show the grand action of a Medea. The drawing of this subject is reproduced in *Souvenirs de Barbizon*, a pamphlet in which M. Piédagnel has recorded a visit paid to Millet in 1864. His circumstances were then less evil, after struggles as severe as those endured in Paris. A contract by which he bound himself in 1860 to give up all his work for three years had placed him in possession of 1,000 francs a month. His fame extended, and at the exhibition of 1867 he received a medal of the first class, and the ribbon of the Legion of Honour. He died on Jan. 20, 1875. He was buried by his friend Rousseau's side in the churchyard of Chailly.

(E. F. S. D.; X.)

See the article BARBIZON; also A. Sensier, *Vie et oeuvre de J. F. Millet* (1874); Piédagnel, *Souvenirs de Barbizon*, etc. (1876); Gensel, *Millet und Rousseau* (1902); Julia Cartwright, *Jean François Millet* (1910); Etienne Moreau-Nélaton, *Millet Raconté par lui-même* (1921).

MILLET, a name applied to a number of very different species of cereals and grasses belonging to distinct genera and even subfamilies of the Gramineae (grasses). They are grown in Europe and the United States as forage and in Asia and Africa as food crops. The four genera, *Chaetochloa* (*Setaria*), *Echinochloa*, *Panicum*, and *Pennisetum*, belonging to the tribe Paniceae, include most of the millets, though *Eleusine coracana* (ragi or finger millet grown in India) falls in the tribe Chlorideae. A key, following Frear and Robbins, is given below to the principal millets of economic importance and to some of the closely related weed grasses.

Inflorescence paniculate; no involucre below the individual spikelets.
- Inflorescence a raceme of short spikes; empty glumes awned or awn-pointed, *Echinochloa* (Barnyard millets and wild barnyard grass).
  - Awns long; spikelets white, *E. crusgalli* (common barnyard grass).
  - Awns short; spikelets brown, *E. frumentacea* (Japanese barnyard millet).
- Inflorescence a drooping panicle; empty glumes not awned, *Panicum miliaceum* (proso or broom-corn millet).

Inflorescence spicate; involucre of bristles below each spikelet.
- Grain enclosed in lemma and palet (the hull) at maturity; spike loose, *Chaetochloa* (foxtail millet and foxtail grass).
  - Panicle usually 1 centimetre thick or less; bristles commonly green; spikelets about 2 millimetres long, *C. viridis* (green foxtail).
  - Panicle usually 1 to 3 centimetres thick; bristles usually purple; spikelets, 2·5 to 3 millimetres long, *C. italica* (foxtail millets).
- Grain globose, forcing open the hull as it matures, and falling free when threshed; spike dense, *Pennisetum glaucum* (pearl millet).

Common millet (also called Indian millet, proso, hog-millet, broom-corn millet) is *Panicum miliaceum*. Its origin is unknown, but it is probably a native of Egypt and Arabia. It has been cultivated in Egypt, Asia and southern Europe since prehistoric times. It is a small erect annual, reaching a height of 3–3½ ft. and possesses bristly, much branched nodding panicles. Cross-pollination regularly occurs. The grain is about 3 mm. long by 2 mm. broad, the kernel being firmly surrounded by the shining, hard, flowering glume and palea. (*See* GRASSES.) Three varieties are often recognised: Vars. *effusum*, *contractum* and *compactum*. The plant ripens as far north as southern Germany; in fact, wherever the vine can be grown for wine production. The grain, which is very nutritious, is used in the form of groats and makes excellent bread when mixed with wheat flour. It is also largely used for feeding poultry.

BY COURTESY OF THE DEPT. OF AGRICULTURE

TURKISTAN OR ITALIAN MILLET, (SETARIA ITALICA), WHICH IS CULTIVATED AS A CEREAL IN ASIA

Chaetochloa italica or *Setaria italica* includes many varieties known as foxtail millets, Turkistan millet, German millet, Hungarian millet or grass, etc., is a native of Asia and is extensively grown in India. The grains are smaller than those of the common millet but it is exceedingly prolific, the total yield being many times that of wheat. The grains are used locally for human food and imported into Great Britain for poultry feeding.

Pearl millet (*Pennisetum glaucum* or *P. typhoideum*) is extensively cultivated in tropical Asia, Egypt and India. Its origin is unknown but it has come probably from tropical Africa.

Echinochloa (*Panicum*) *crusgalli* is the barnyard grass or millet of the United States and *E. frumentacea* (*Panicum frumentaceum*) may be a variety of *E. crusgalli;* it is the Japanese barnyard millet or Deccan grass. *E. maximum* is the Guinea grass, a native of tropical Africa; it grows 8 ft. high and yields a nutritious grain. Other gigantic species form the field crops on the banks of the Amazon.

E. (*P.*) *decompositum* is the Australian millet the grains of which are used by the natives. *Paspalum scrobiculatum* is the Kodo millet cultivated in India, while *Milium effusum* is the millet grass. (*See* also DURRA and SORGHUM.)

For further details *see* C. R. Ball, "Pearl Millet," *U.S. Dept. Agric. Farmers' Bull. 168I* (1903); G. Watt, *Dictionary of the Economic Products of India* (London, 1908); M. A. Carleton, *The Small Grains* (New York and London, 1916); W. Robbins, *Botany of Crop Plants* (Philadelphia, 1924). (V. H. B.)

MILLIKAN, ROBERT ANDREWS (1868–), American physicist, was born at Morrison, Ill., March 22, 1868, and received his education at Oberlin College (A.B., 1891; A.M., 1893) where he was instructor in physics 1891–93. He then proceeded to Columbia University (Ph.D., 1895), and the universities of Berlin and Göttingen (1895–96). In 1896 he was appointed assistant in physics at the University of Chicago, with which institution he continued to be associated for the next 25 years in the department of physics, being professor from 1910 to 1921. In 1921 he became director of the Norman Bridge laboratory of physics and chairman of the executive council of the California

Institute of Technology at Pasadena, California. He was vice-chairman of the National Research Council, Washington, D.C., in 1917, and chief of the science and research division of the Signal Corps, U.S.A., with the rank of lieutenant-colonel. In 1922 he was the first exchange lecturer to Belgium on the C.R.B. Foundation.

The best known of his researches were the "oil drop" experiments, undertaken with the view of making measurements of fundamental electrical quantity. They proved conclusively that all electrons are alike, and yielded the most accurate determination of the electron thus far made. He also undertook researches into photoelectric effect. Later research of his has tended definitely to bridge the gap between light and X-ray phenomena and to yield new information on the radiating properties of light atoms. He has recently brought new precision to the study of cosmic rays. He was awarded the Nobel Prize in physics in 1923 for his work in isolating and measuring the electron, and in making the first exact photoelectric determination of the light-quant. He received the Edison Medal for especially meritorious work in the field of electricity, and the Hughes Medal of the Royal Society in recognition of his determination of the electronic charge and other physical constants. He is also the recipient of the Faraday medal and the Matteuci medal. (*See* also PHYSICS and ELECTRICITY, ATMOSPHERIC: *Cosmos Radiation.*)

Millikan was the author of the following, among other works:—*Mechanics, Molecular Physics and Heat* (1901); *Electricity, Sound and Light* (1908); *The Electron* (1917); *Practical Physics* (1920); *Science and Life* (1923); *Science and the New Civilization* (1930), in addition to numerous contributions to technical periodicals.

MILLING: *see* FLOUR AND FLOUR MANUFACTURE.

MILLING-CUTTERS are revolving tools which cut all shapes in metal by continuous action and not by the reciprocating movement used in planing, shaping or slotting. (*See* MACHINE TOOLS.)

MILLING MACHINES are a highly important class of machine tool which will perform almost all the operations necessary in metal-cutting, by means of revolving cutters past which the work is fed. Milling was first done in the lathe, the cutter being rotated between the centres, while the slide traversed the piece of metal across and beneath it. There are still many milling machines, termed Lincoln millers, in which the resemblance to the lathe is evident, and which were developed at an early period to mill parts of small arms and sewing machines, when the interchangeable system of manufacture began.

The great advantage of the milling machine is that cutters can be made for all sorts of shapes, to mill corresponding profiles, which they will do on tens of thousands of pieces alike. Hand production by files is thus eliminated and great accuracy ensured. Cutters can also be multiplied, several being used on one spindle, so that a complicated surface or a number of duplicate pieces may be milled at one pass. Machines with multiple spindles, each carrying a cutter or a set will surface off very complex shapes of castings, *e.g.*, castings for parts of engines and machinery, etc., thereby saving a lot of piecemeal cutting which would otherwise be necessary to finish the outlines. There is a system termed *profile milling*, by means of which a cutter will produce curves and flats, the work being coerced during the traverse by a copy of like shape. The constantly-changing curves of cams are also milled by a similar device. Screw-threads and worms are cut by a milling cutter of suitable shape, revolved and fed laterally whilst the screw rotates.

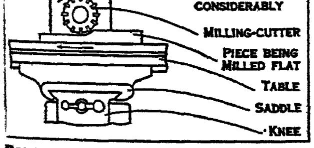
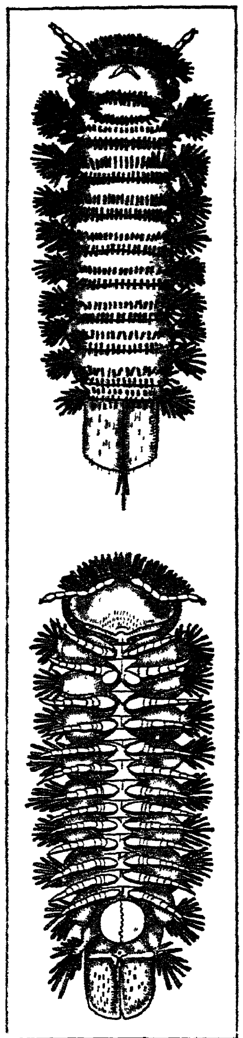


DIAGRAM SHOWING THE ELEMENTS OF A MILLING MACHINE

The Lincoln machine mentioned is built in small and in large sizes for what is termed *manufacturing*, that is the milling of large numbers of similar shapes for small arms, machine-guns, sewing machines, cycles, parts of cars, etc. Its constructional features are relatively simple, and the pieces of work are either gripped in a vice, or in a special clamping unit, termed a fixture, which automatically gives the correct attitude in relation to the cutter. Often several articles are clamped in line for the cutter to mill them in succession, so that at one traverse of the table three or four or more receive treatment.

When a varied range of milling has to be performed, this model is not sufficiently adaptable, and what is termed a plain or a universal machine is chosen. This has a column near the top of which a horizontal spindle is driven by belt or motor, and usually a change-speed gearing to obtain the various speeds. A triangular-shaped knee is adjustable up and down, slideways on the face of the column, and across the flat face at the top of the knee a saddle is adjustable. This saddle, in turn, carries the long sliding table for the objects to be milled. The operator has thus the choice of three adjustments with which he can bring all sorts of castings and forgings into correct position for milling, and then feed them by hand or automatically. Some cutters, termed end mills, cut mainly by their ends and effect surfacing and the milling of slots and grooves. By putting a pair of index centres, *i.e.*, a couple of heads with point centres between which work can be swung, on the table circular dividing may be effected. This action enables flats, squares, hexagons, etc., to be finished, or slots cut around a cylinder or disc. Gearwheel teeth are also made in the same manner. The difference between a plain and a universal miller is that the latter has a swivel-mounting for the table, so that it may be slewed at a suitable angle, and spiral grooves be cut, or the helically set teeth of milling-cutters or gears be produced, as well as screws and worms that may be required.

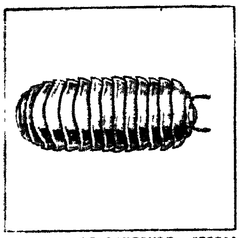

FROM VERHOEFF, "DIPLOPODA"
FIG. 1.—POLYXENUS LAGURUS, BACK AND FRONT VIEWS. SEE MILLIPEDE

Plano-millers.—Castings too large for the foregoing types of machines receive treatment on the *plano-millers*, big affairs like planing machines in general outline, but with one or more cutter-spindles on the cross-rail, and sometimes others attacking from the sides. The long table feeds the pieces under the cross-rail, or a gang of pieces is clamped to the table for milling at a single travel. Motor car cylinders are milled in batches on these machines, as well as many other portions of engines and machines. Or long frames or rods, such as printing machinery frames, locomotive connecting or coupling rods, etc., are passed under the cutters. Very large castings, such as cylinders, beds, turbine casings, condenser bodies, and big machine framings are too big for any plano-miller, but the milling is performed with a combined drilling, boring and milling machine or a portable milling machine is brought into position and attached to the object upon which it is intended to do the work.

Vertical-spindle milling machines handle a varied range of cutting by means of the end mills previously mentioned, or of cylindrical mills cutting on the periphery, for edges and sides. The profiling of contours which cannot be milled by the linear movements of the slides is effected by controlling the slides through the medium of a copy of the shape desired. Somewhat recent developments of the vertical-spindle designs are the *continuous* millers; a revolving circular table holds a set of work-holding fixtures so that each in turn passes the cutter. The attendant can remove the finished specimen from the fixture farthest from the cutter and put in a fresh one for milling, so that no stop need occur in the running. *Station* milling is another highly productive method; the rotary table feeds straight in towards the cutter; then it reverses, and makes a portion of a revolution,

bringing another piece into line for the feed. The operator is able to remove finished components and to re-load the fixture that is furthest away from the cutter. Still higher rate of production is practicable in the *drum continuous* machines which have a set of fixtures spaced around a big horizontally set cylinder, and cutters attacking from each end of the work.

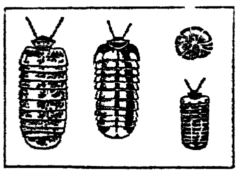
The principal difficulties in milling are connected with the results of vibration, which leaves a bad finish, and with the quantity of chips produced. The first difficulty is remedied chiefly by strong construction of the machine; the second by effective lubrication with a heavy volume of oil, which washes the chips rapidly away from the machine. (F. H.)



FROM H. DE SAUSSURE, "ESSAI D UNE FAUNE DES MYRIAPODES DU MEXIQUE"
FIG. 2.—GLOMERIDESMUS MEXICANUS

MILLIPEDE, an animal with a distinct head, one pair of feelers (antennae) and a segmented body not divided up into regions like that of most arthropods. Each typical segment of the body is provided with two pairs of walking legs (fig. 5). The millipedes form in the phylum Arthropoda the distinct class Diplopoda.

Millipedes have a world-wide distribution, and were among the earliest creatures to emerge from the water, for fossil Diplopoda are known in considerable numbers from the Devonian and some remains (*Archidesmus loganensis*) have been found in Scotland even in the Upper Silurian. By Carboniferous times millipedes were well established and are represented by a great array of specimens obtained in the United States, Great Britain and Bohemia. Early millipedes were remarkably like living forms. Some Carboniferous forms were probably amphibious (fig. 8).

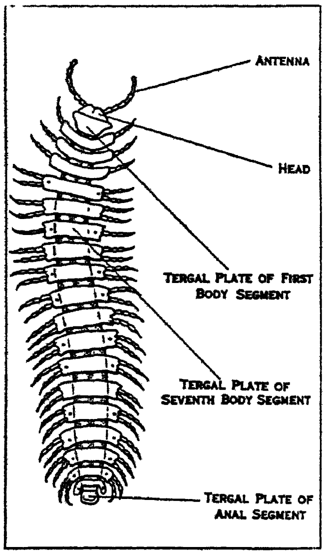


FROM BRONN, "KLASSEN UND ORDNUNGEN DES TIERREICHS"
FIG. 3.—GLOMERIS (THE PILL-MILLIPEDE)

The nesting habits of some millipedes are most interesting and somewhat complicated. In *Polydesmus* the female selects a suitable site on a fragment of wood or a similar object in a damp spot and builds a circular wall by the discharge of faeces, which are moulded by the anal valves; this process is carried on until the beehive-like nest is well advanced and then the eggs are deposited and the nest is roofed in. The female remains coiled around the nest for some time after the structure is complete (fig. 9).

Skin-changing is a serious danger to the life of a millipede because it leaves the animal in an unusually defenceless condition; for this reason the animal goes into retirement when the process is imminent, and in some cases, as in *Glomeris* and *Oxydesmus*, a special changing-cell like a nest is constructed.

For some unexplained reason millipedes occasionally move in large numbers, sometimes even in broad daylight. On one occasion in Alsace a train was stopped because the dead and crushed bodies of the migrating diplopods made the rails slippery.



FROM R. I. POCOCK, "ZOOLOGISCHE ERGEBNISSE" (E. J. BRILL)
FIG. 4.—PLATYRHACUS MIRANDUS, A SUMATRAN SPECIES OF POLYDESMIDAE, SHOWING THE FORM CHARACTERISTIC OF THE ORDER POLYDESMOIDEA

Some millipedes injure crops, but their masticatory organs are weak and they can only damage delicate tissues such as young roots or internal structures exposed by the attacks of other pests; others eat any decaying tissues.

Classification.—Millipedes were known to Aristotle but were little studied till the time of Linnaeus. The class may be subdivided, according to Attems, as follows:—

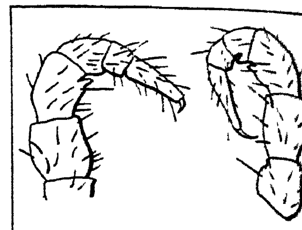
A. SUB-CLASS PSELAPHOGNATHA. Soft-bodied millipedes with rows and tufts of bristles. Example: *Polyxenus.*

B. SUB-CLASS CHILOGNATHA. Integument strengthened by deposition of salts of lime. Hairs, when present, occur singly, not in tufts. Sexually modified limbs in the male on the 7th segment or at the hind end of the body.

1. *Opisthandria.* Male has sexually modified limbs (one or two pairs) at the hinder end of the body.

Order *Limacomorpha.* Body with 22 segments. Body cannot roll into a ball. Example: *Glomeridesmus* (fig. 2).

Order *Oniscomorpha.* Body with 14–16 segments. Body will roll into a ball. Example: *Glomeris* (fig. 3).



FROM BRADE-BIRKS
FIG. 5.—BRACHYCHAETEUMA. WALKING LEGS

2. *Proterandria.* Sexually modified limbs on the 7th segment in the male.

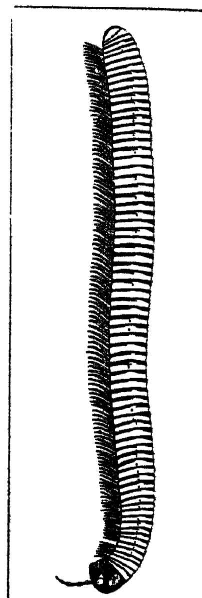
Superorder Eugnatha. Not more than seven pairs of walking legs in front of the sexually modified limbs of the 7th segment.

Order *Polydesmoidea.* 19 to 22 body segments. The first pair of limbs of the 7th segment modified in the male, the second pair is a normal pair of walking legs. Examples: *Polydesmus, Platyrhacus* (fig. 4).

Order *Nemato-phora.* 26 or more body segments. One or both pairs of limbs of the 7th segment modified in the male. Silk glands present. Example: *Brachychaeteuma.*

Order *Juliformia.* More than 40 cylindrical body segments. No walking legs on the 7th segment of male. No silk glands. Examples: *Iulus, Blaniulus, Spirostreptus* (fig. 6).

Superorder Colobognatha. 8 pairs of walking legs in front of the sexually modified legs of the male. Example: *Polyzonium* (Head in fig. 7).

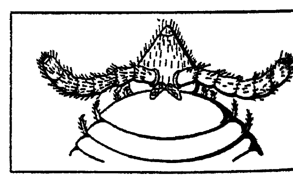


FROM BRONN, "KLASSEN UND ORDNUNGEN DES TIERREICHS"
FIG. 6.—A TYPICAL MEMBER OF THE ORDER JULIFORMIA

Structure.—The head bears one pair of antennae and the masticatory apparatus which consists of a pair of mandibles and a pair of fused appendages modified to form a single plate-like structure, the gnathochilarium.

In most millipedes paired simple eyes (ocelli) occur singly or grouped, but some are blind. Most millipedes are provided at the sides of the head with a sense-organ (organ of Tömösvary) of unknown function.

In the Pselaphognatha the integument remains soft but in other millipedes the cuticle is strengthened by the deposition of lime salts within its substance except in places where flexibility is necessary for movement. The roof and side-walls of the typical trunk segment are fused together to form a single pleurotergite almost encircling the body, the floor being formed by two small plates, the sternites, placed one in front of the other. Associated with each sternite is a pair of walking legs. More fusion, or less, accounts for differences in this arrangement in different millipedes. In many there is in addition one pair of protective "stink glands" opening on each pleurotergite. The digestive tube, heart, main nerve cord and breathing apparatus (tracheae) are in general like those of the centipede (*q.v.*). The reproductive system lies below the gut and opens in the third body segment.



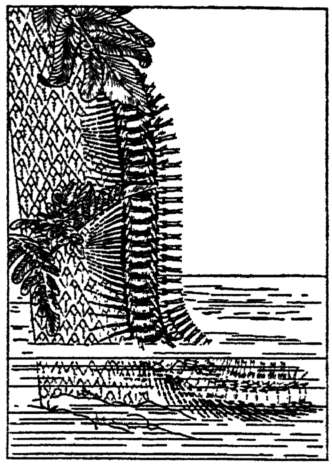
FROM VERHOEFF, "DIPLOPODA"
FIG. 7.—HEAD OF POLYZONIUM

The origin of the double segment in diplopods is obscure but an additional pair of masticatory appendages just behind the mandibles has been found in the embryo of *Spirostreptus.* The young are hatched from the egg with three pairs of walking-legs.

BIBLIOGRAPHY.—The literature in English and French is very scattered. The best modern accounts are in German: Carl Attems, "Diplopoda" in *Handbuch der Zoologie,* vol. iv. (1926); K. W. Verhoeff, "Diplopoda." which includes an account of fossil forms, in Bronn's *Klassen und Ordnungen des Tier-Reichs,* vol. v. (Leipzig, 1926–27); K. W. Verhoeff, *Die Diplopoden Deutschlands* (Leipzig 1910–14). On economic status, *see* S. G. Brade-Birks, Supplement to *Lancashire and Cheshire Naturalist* (Dec. 1923).

See also CENTIPEDE; MYRIAPODA; PAUROPODA; SYMPHYLA.

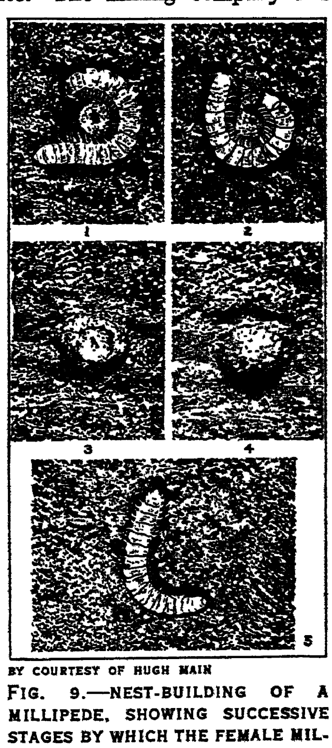
(S. G. B.-B.)



AFTER SCUDDER, MEM. BOSTON SOC. NAT. HIST.
FIG. 8.—ACANTHERPESTES MAJOR, AN AMPHIBIOUS MILLIPEDE OF COAL MEASURE TIMES

MILLOM, market town, urban district, Whitehaven parliamentary division, Cumberland, England, on the L.M.S. railway. Pop. (1921) 8,078. The church of Holy Trinity, early Norman and Decorated in date, is of interest for its pillars, alternately round and octagonal, and for a window in the north aisle. A massive roodstone stands in the churchyard. Millom castle, dating from the Conquest, was fortified (14th century) by Sir John Huddlestone, whose descendants held it until 1774. Though strongly built, the castle has been largely dismantled. In the neighbourhood of Millom there are blast furnaces and highly productive mines of red haematite. The mining company has expended upwards of £120,000 upon a sea-wall and embankment to protect the works from the sea.

MILLS, JOHN (d. 1736), English actor, was a member of the company at Drury Lane, London from 1695 almost uninterruptedly to his death, playing and creating hundreds of parts. He was at his best in tragedy. His wife was an actress, and their son William—"the younger Mills"—was also an actor of some merit.



BY COURTESY OF HUGH MAIN
FIG. 9.—NEST-BUILDING OF A MILLIPEDE, SHOWING SUCCESSIVE STAGES BY WHICH THE FEMALE MILLIPEDE POLYDESMUS MAKES THE NEST TO PROTECT ITS EGGS

MILLS, ROGER QUARLES (1832–1911), American legislator, was born in Todd county, Ky., on March 30, 1832. He went to Texas in 1839, studied law, and was admitted to the bar. He entered the Confederate army in 1861, took part as a private in the battle of Wilson's Creek, and as colonel at Arkansas Post, Chickamauga, Missionary Ridge and Atlanta. He served in the national House of Representatives as a Democrat in 1873–92, and in the Senate 1892–99. He made the tariff his special study, and was long recognized as a leading authority in Congress. As chairman of the ways and means committee he reported in April, 1888, the "Mills bill," which provided for a reduction of the duties on sugar, earthenware, glassware, plate glass, woollen goods and other articles, the substitution of *ad valorem* for specific duties in many cases, and the placing of lumber, hemp, wool, flax, borax, tin plates, salt and other articles on the free list. This bill was passed by the Democratic House on July 21, and was then so amended by a Republican Senate as to be unacceptable to the house. The tariff thus became the chief issue in the presidential campaign of 1888. During the free silver controversy he adhered to the Cleveland section of the Democratic Party, and failed to be re-elected when his term in the Senate expired in 1899. He then engaged in business and the practice of law in Corsicana, Tex., where he died on Sept. 2, 1911.

MILLSTONE: *see* FLOUR AND FLOUR MANUFACTURE.

MILLVALE, a manufacturing borough of Allegheny county, Pennsylvania, U.S.A., on the Allegheny river, opposite Pittsburgh. It is served by the Baltimore and Ohio and the Pennsylvania railways. Pop. (1920) 8,031 (15% foreign-born white); and was 8,166 in 1930.

MILLVILLE, a city of Cumberland county, New Jersey, U.S.A., on the Maurice river, 40 m. S. by E. of Philadelphia. It is served by the Pennsylvania railway system, trolley and motorbus lines and river barges. The population was 14,691 in 1920 (92% native white) and was 14,705 in 1930 by the Federal census. The principal industry (established in 1806) is the manufacture of glass, almost all kinds except for windows. Textile manufactures (dating from 1854) and the mining of sand are also important. The factory output in 1925 was valued at $8,098,127. The site of Millville is part of a large tract bought before 1790 by the Union company, which built a dam across the river, forming a beautiful pond 3 m. long and a mile wide (now called Union lake and included in a large public park), and established saw-mills there, from which lumber was floated down the river for half a century. The property changed hands in 1795, and in 1803 a town was laid out on the present site by Joseph Buck, with the plan (not then carried out) of moving the mills from the pond to the banks of the river. Millville was incorporated as a city in 1866, and in 1913 a commission form of government was adopted.

MILMAN, HENRY HART (1791–1868), English historian and ecclesiastic, third son of Sir Francis Milman, Bart., physician to George III., was born in London on Nov. 10, 1791. He was educated at Eton and at Brasenose college, Oxford. He gained the Newdigate prize with a poem on the *Apollo Belvidere* in 1812, was elected a fellow of Brasenose in 1814, and in 1816 won the English essay prize with his *Comparative Estimate of Sculpture and Painting.* In 1816 he was ordained, and two years later was presented to the living of St. Mary's, Reading. Milman's early work included tragedies, epic poems, hymns and translations from the classics. In 1821 he was elected professor of poetry at Oxford.

Turning to another field, Milman published in 1829 his *History of the Jews,* which is memorable as the first by an English clergyman which treated the Jews as an oriental tribe, recognized sheikhs and amirs in the Old Testament, sifted and classified documentary evidence, and evaded or minimized the miraculous. In consequence, his inevitable preferment was delayed. In 1835, however, Sir Robert Peel made him rector of St. Margaret's, Westminster, and canon of Westminster, and in 1849 he became dean of St. Paul's. By this time Milman was generally revered and beloved. His *History of Christianity to the Abolition of Paganism in the Roman Empire* (1840) had been ignored; but his reputation was fully established by the continuation of that work, his *History of Latin Christianity* (1855), which has passed through many editions. In 1838 he had edited Gibbon's *Decline and Fall of the Roman Empire,* and in the following year published his *Life of Gibbon.* Milman died on Sept. 24, 1868, and was buried in St. Paul's cathedral.

See A. C. Tait, *Sermon in Memory of H. H. Milman* (1868), and A. Milman, *H. H. Milman* (1900). *See* also the *Memoirs of R. Milman, bishop of Calcutta,* by his sister, Frances Maria Milman (1879).

MILNE, SIR GEORGE FRANCIS (1866–), British field marshal, born Nov. 5, 1866; joined the Royal Artillery in 1885. He served in the Nile Expedition of 1898, and the South African War (1899–1902). In 1913 he became commander of the artillery of the 4th Div., with which he went out to France in 1914. He was given, in July 1915, command of the 27th Div., which, three months later, he took to the Salonika theatre where, at the end of the year, he was placed in charge of an army corps. In May 1916 Milne was advanced to the command of the British

forces in Macedonia, and he occupied this responsible position under the orders of three successive French commanders-in-chief until the end of the struggle. He filled a difficult position with unfailing tact and sound judgment: after the final victory in 1918, he remained in charge of the British forces in the Near East and about the Black Sea until 1920, and on return to England was appointed to the Eastern command. In Feb. 1926 he succeeded Lord Cavan as Chief of the Imperial General Staff.

MILNE, JOHN (1850–1913), British seismologist and mining engineer, was born at Liverpool on Dec. 30, 1850, and educated at King's College, London and the Royal School of Mines. He worked as mining engineer in Newfoundland and Labrador, and in 1874 went as geologist with Dr. Beke's expedition to North-western Arabia. In 1875 he was appointed professor of geology and mining in the Imperial Engineering College at Tokyo, where he remained for 20 years. Milne was recognized as a leading first authority on seismology. He travelled widely in the East, and about 1880 established the seismic survey of Japan, with 968 stations. He invented various forms of seismograph. In 1894 he returned to England, and established a private observation station near Newport, I. of Wight. As secretary of the seismological committee of the British Association he was largely responsible for the establishment of seismological stations throughout the world. He died on July 30, 1913.

He published two standard works, *Earthquakes* (1883), and *Seismology* (1898), besides many books on scientific mining and crystallography, and papers in scientific journals.

MILNE-EDWARDS, HENRY (1800–1885), French zoologist, the son of an Englishman, was born in Bruges, Oct. 23, 1800, but spent most of his life in France. He graduated in medicine at Paris in 1823, but devoted himself to the study of the lower forms of animal life. In 1841 he was appointed professor of entomology at the muséum d'histoire naturelle, and 21 years later he succeeded Geoffrey Saint-Hilaire in the chair of zoology. He died in Paris on July 29, 1885.

Besides his papers in the *Annales des sciences naturelles*, with the editorship of which he was associated from 1834, he published: *Histoire naturelle de crustacés* (3 vols., 1837–41); *Histoire naturelle des coralliaires* (1858–60); and the excellent *Leçons sur la physiologie et l'anatomie comparée de l'homme et des animaux* (14 vols., 1857–81).

MILNER, ALFRED MILNER, VISCOUNT (1854–1925), British statesman and colonial administrator, was born at Bonn on March 23, 1854, the only son of Charles Milner, M.D., whose wife was a daughter of Major-General Ready, sometime governor of the Isle of Man. Alfred Milner was educated first at Tübingen, where his father was Reader in English of the university, then at King's College, London, and under Jowett as a scholar of Balliol College, Oxford, from 1872 to 1876. He graduated in 1877, with a first class in classics, having won the Hertford, Craven, Eldon and Derby scholarships, and was elected to a fellowship of New College. At Oxford he formed a close friendship with Arnold Toynbee, and was associated with his schemes of social work; and subsequently he wrote a tribute to his friend, *Arnold Toynbee: a Reminiscence* (1895). In 1881 he was called to the bar at the Inner Temple and joined the staff of the *Pall Mall Gazette* under John Morley, becoming assistant editor under W. T. Stead. In 1885 he was Liberal candidate for the Harrow division of Middlesex at the general election, but was defeated. He acted as private secretary to Mr. (afterwards Lord) Goschen, and in 1887, when Goschen became chancellor of the exchequer, was appointed his principal private secretary. It was by Goschen's influence that in 1889 he was made under-secretary of finance in Egypt. He remained in Egypt four years, his period of office coinciding with the first great reforms, after the danger of bankruptcy had been avoided. Milner returned to England in 1892, and was appointed chairman of the Board of Inland Revenue, being made C.B. in 1894 and K.C.B. in 1895. Shortly after his return to England he published his *England in Egypt*, which at once became the authoritative account of the work done since the British occupation.

Sir Alfred Milner remained at the Board of Inland Revenue until 1897. In April of that year Lord Rosmead resigned his posts of high commissioner for South Africa and governor of Cape Colony. The situation resulting from the Jameson raid (*see* TRANSVAAL and SOUTH AFRICA) was one of the greatest delicacy and difficulty, and Mr. Chamberlain, now colonial secretary, selected Milner as Lord Rosmead's successor. The appointment was avowedly made in order that an acceptable British statesman, in whom public confidence was reposed, might go to South Africa to consider all the circumstances, and to formulate a policy which should combine the upholding of British interests with the attempt to deal justly with the Transvaal and Orange Free State governments.

Sir Alfred Milner reached the Cape in May 1897, and after the difficulties with President Kruger over the Aliens' Law had been patched up he was free by August to make himself personally acquainted with the country. Between August 1897 and May 1898 he travelled through Cape Colony, the Bechuanaland Protectorate, Rhodesia and Basutoland, and also during this period learned both Dutch and the South African "Taal." He came to the conclusion that there could be no hope of peace and progress in South Africa while there remained the "permanent subjection of British to Dutch in one of the Republics." He also realized—as was shown by the triumphant re-election of Mr. Kruger to the presidency of the Transvaal in Feb. 1898—that the Pretoria government would never on its own initiative redress the grievances of the "Uitlanders." That Milner had good grounds for his view of the situation is shown in a letter written (March 11) by Mr. J. X. Merriman to President Steyn of the Free State: "The greatest danger," wrote Mr. Merriman, "lies in the attitude of President Kruger and his vain hope of building up a State on a foundation of a narrow unenlightened minority." Though this was recognized by the more far-seeing of the Bond leaders, they were ready to support Kruger, whether or not he granted reforms, and they sought to make Milner's position impossible. At the general election in Cape Colony the Bond obtained a majority, and in accordance with constitutional practice were invoked to form a ministry. In November he visited England, and the next February (1899) returned, assured of support, to find the situation more critical. On May 4 Milner penned a memorable despatch to the Colonial Office, in which he insisted that the remedy for the unrest in the Transvaal was to strike at the root of the evil—the political impotence of the injured. "It may seem a paradox," he wrote, "but it is true that the only way for protecting our subjects is to help them to cease to be our subjects." The policy of leaving things alone only led from bad to worse, and "the case for intervention is overwhelming." Milner felt that only the enfranchisement of the Uitlanders in the Transvaal would give stability to the South African situation. He realized keenly that the spectacle of thousands of British subjects in the Transvaal in the condition of "helots" (as he expressed it) was undermining the prestige of Great Britain throughout South Africa. This despatch was kept private for a time by the home government but its tenor was known to the leading politicians at the Cape, and at the instance of J. H. Hofmeyr a conference was held (May 31–June 5) at Bloemfontein between the high commissioner and the president of the Transvaal. Milner then made the enactment by the Transvaal of a franchise law which would at once give the Johannesburgers a share in the government of the country his main, and practically his only, demand. The conference ended without any agreement being reached, and war broke out in Oct. 1899.

In Feb. 1901 he was called upon to undertake the administration of the two Boer states, both now annexed to the British Empire, though the war was still in progress. He thereupon resigned the governorship of Cape Colony, while retaining the post of high commissioner. The work of reconstructing the civil administration in the Transvaal and Orange River Colony could only be carried on to a limited extent while operations continued in the field. Milner therefore returned to England for a holiday; on his arrival he was raised to the peerage with the title of Baron Milner of St. James's and Cape Town. Meanwhile the diplomacy of 1899 and the conduct of the war had caused a great change in the attitude of the Liberal party in England towards Lord Milner. A violent agitation for his recall, in which Sir Henry Campbell-Bannerman joined, was organized, but without success, and in

August he returned to South Africa, where he plunged into the herculean task of remodelling the administration. In the negotiations for peace he was associated with Lord Kitchener, and the terms of surrender, signed at Pretoria on May 31, 1902, were drafted by him. On July 15 he was made a viscount.

Immediately following the conclusion of peace Milner published (June 21) the Letters Patent establishing the system of crown colony government in the Transvaal and Orange River colonies, and exchanging his title of administrator to that of governor. The reconstructive work necessary after the ravages of the war was enormous. He provided a steady revenue by the levying of a tax of 10% on the annual net produce of the gold mines, and devoted special attention to the repatriation of the Boers, land settlement by British colonists, education, justice, the constabulary, and the development of railways. During a visit to Europe he was offered the post of secretary of State for the Colonies, but refused, returning to South Africa, where economic depression was becoming pronounced. He was back in Johannesburg in Dec. 1903, and had to consider the crisis in the gold-mining industry caused by the shortage of native labour. Reluctantly he agreed, with the assent of the home government, to the proposal of the mineowners to import Chinese coolies on a three years' contract.

In the latter part of 1904 and the early months of 1905 Lord Milner was engaged on the elaboration of a scheme to provide the Transvaal with a system of "representative" government, a half-way house between crown colony administration and that of self-government. Letters Patent providing for representative government were issued on March 31, 1905. Owing to the advent of a Liberal ministry in England, in Dec. 1905, this scheme remained inoperative. (*See* TRANSVAAL: *History*.) For some time he had suffered in health from the incessant strain of work, and he determined to retire. He left Pretoria on April 2, and sailed for Europe on the following day. Speaking at Johannesburg on the eve of his departure, he recommended to all concerned the promotion of the material prosperity of the country and the treatment of Dutch and British on an absolute equality. When he left, the economic crisis was still acute and criticism rife. But the foundations of revival had been laid.

Experience in South Africa had shown him that underlying the difficulties of the situation there was the wider problem of imperial unity. In his farewell speech at Johannesburg he concluded with a reference to the subject. "When we who call ourselves Imperialists talk of the British Empire we think of a group of states bound, not in an alliance—for alliances can be made and unmade—but in a permanent organic union. Of such a union the dominions of the sovereign as they exist to-day are only the raw material." This thesis he further developed in a magazine article written in view of the colonial conference held in London in 1907. He advocated the creation of a permanent deliberative imperial council, and favoured preferential trade relations between the United Kingdom and the other members of the empire; and in later years he took an active part in advocating the cause of tariff reform and colonial preference.

Milner occupied himself mainly, after his return from South Africa, with business interests in the City of London. He was active on behalf of causes which appealed to him from the imperial side, and he made several speeches on behalf of tariff reform and colonial preference. He was roused, however, by Lloyd George's budget of 1909, and he advised the House of Lords to reject the Finance Bill, and, as he said at Glasgow, to "damn the consequences." He made several speeches in the next 12 months in defence of the Lords' position; and when the Parliament Bill came up to the House of Lords in 1911, he was a leading spirit among the "Diehards" who advised resistance to the end.

Lloyd George, when he formed his first war ministry in December 1915, at once turned to Milner, the only British administrator who before 1914 had directed a war from the civil side, and constituted him one of his principal colleagues in his War Cabinet of four. From this time to the cessation of hostilities their relations were close, and, after Lloyd George, Milner took the largest share in the civilian conduct of the War. Milner's experience, scholarship, steadiness and somewhat bureaucratic habit of mind supplied an invaluable complement to his chief's daring, impatience of precedent, quickness of apprehension and intellectual agility. In February 1917 he attended, on behalf of the British Government, a conference of the Allies in St. Petersburg (Leningrad).

He devoted himself to his duties in the War Cabinet, seldom appearing in the House of Lords except to explain and defend the government's food policy. The acceptance by the government of the principle of imperial preference, and of the conservation of the raw materials of the Empire, owed much to his influence and support. He worked heartily for inter-Allied co-operation in the conduct of the War, and he was in France as the representative of the British cabinet at the time of the victorious German advance in March 1918; it was largely owing to his influence that General Foch was appointed generalissimo of the Allied forces in France on March 26. Lord Milner was made secretary for war on April 19, and presided over the Army Council during the succeeding months of the year which ended with victory.

After the general election, Lord Milner became colonial secretary. In that capacity he attended the Paris Peace Conference, and was a signatory to the Treaty of Versailles; and he subsequently helped to deal with a number of difficult questions arising under the treaty out of the disposal of the German colonies conquered in war. His financial authority was invoked to defend ministerial finance in the House of Lords; and when a serious revolutionary outbreak took place in Egypt in 1919, he was sent there in December, at the head of a special mission. The mission remained till March and subsequently conferred with Zaghlul Pasha, the Nationalist leader in London. In November they recommended the recognition of Egyptian independence. Great Britain was to guarantee the integrity of Egypt against aggression; she would have a privileged position in Egypt and would maintain a garrison in the canal zone. The capitulations were to be abolished, and the veto on legislation affecting foreigners would be vested in the high commissioner. Lord Milner resigned, February 1921, and was given the Order of the Garter. Before the end of the month he married Lady Edward Cecil, the widow of Lord Edward Cecil, formerly Miss Violet Maxse.

After this, though he took an active part in the work of the Rhodes Trust, and also published his views (*Questions of the Hour*, 1923), Milner only once showed any disposition to resume public work. When Baldwin, in the autumn of 1923, appealed to the country for a mandate to introduce protection, Milner accepted the chairmanship of a committee to advise the government as to the proposed tariff. As the electorate rejected protection, the committee proved abortive. Soon after returning from a visit to South Africa he was attacked by sleeping sickness and died on May 13, 1925, at Sturry Court, near Canterbury. There was found among his papers, and published shortly after his death, an impressive document containing his *Credo* (1925).

See also E. B. Iwan-Müller, *Lord Milner and South Africa* (1902); W. B. Worsfold, *Lord Milner's Work in South Africa* (1906); W. T. Stead, "Sir Alfred Milner," in *The Review of Reviews*, vol. xx. (1899); and the bibliography to SOUTH AFRICA. *The Nation and the Empire* (Collected Speeches 1913).

MILNGAVIE (locally pronounced Millguy), burgh, Dumbartonshire, Scotland, 6 m. N.N.W. of Glasgow by L.N.E.R. Pop. (1931), 5,056. Industries include bleach-fields, dye-works, and a paper-mill; but the town is largely a residential quarter for Glasgow. Close to the town are two large reservoirs, in which is stored the water from Loch Katrine. Mugdock Castle, 1¾ m. N. of Milngavie, is an old stronghold of the Grahams; in Baldernock parish, about 2 m. E., stands a megalith, called "the Auld Wives' Lift" (400 ft.), commanding a fine view.

MILO or **MILON,** of Crotona, Greek athlete, lived about the end of the 6th century B.C. He was six times crowned at the Olympic games and six times at the Pythian for wrestling, and was famous throughout the civilized world for his feats of strength—such as carrying an ox on his shoulders through the stadium at Olympia. In his native city he was much honoured, and he commanded the army which defeated the people of Sybaris in 511. The traditional account of his death is often used to point a moral:

he found a tree which some woodcutters had partially split with a wedge, and attempted to rend it asunder; but the wedge fell out, and the tree closed on his hand, imprisoning him till wolves came and devoured him. His name became proverbial for personal strength (Diod. Sic. xii. 9; Strabo vi. 263; Herodotus iii. 137).

MILO, TITUS ANNIUS, Roman politician, was the son of C. Papius Celsus, but was adopted by his mother's father, T. Annius Luscus. He joined the Pompeian party, and organized bands of mercenaries and gladiators to support the cause by public violence in opposition to P. Clodius, who gave similar support to the democratic cause. Milo was tribune of the plebs in 57 B.C. He took a prominent part in bringing about the recall of Cicero from exile, in spite of the opposition of Clodius. In 53, when Milo was candidate for the consulship and Clodius for the praetorship, the two leaders met by accident on the Appian Way at Bovillae and Clodius was murdered (January 52). Milo was impeached; his guilt was clear, and his enemies took every means of intimidating his supporters and his judges. Cicero was afraid to speak, and the extant *Pro Milone* is an expanded form of the unspoken defence. Milo went into exile at Massilia, and his property was sold by auction. He was the only man excepted from Caesar's general amnesty. He joined M. Caelius Rufus in 48 in his rising against Caesar, but was slain near Thurii in Lucania. His wife was Fausta, daughter of the dictator Sulla.

MILO OF GLOUCESTER, lord of Brecknock and earl of Hereford (d. 1143), was the son of Walter of Gloucester, who appears as sheriff of that county between 1104 and 1121, when he was succeeded by his son who later combined this office with that of local justiciar for Gloucestershire. After the death of Henry I. he declared for Stephen, at whose court he appears as constable in 1136. But in 1139, when the empress Matilda appeared in England, he declared for her, and placed the city of Gloucester at her disposal. He sacked the royalist city of Worcester and reduced the county of Hereford. In 1141, at Matilda's coronation, he was rewarded with the earldom of Hereford. He remained loyal to the empress after her defeat at Winchester.

See the *Continuation of Florence of Worcester* (ed. B. Thorpe, 1848–49); the Cartulary of Gloucester Abbey (Rolls series); and J. H. Round, *Geoffrey de Mandeville* (1892).

MILORADOVICH, MICHAEL ANDRIJEVICH, COUNT (1770–1825), Russian general, saw service under Suvarov in the wars against Turkey and Poland, and in the campaign of Italy and Switzerland (1799) earned much distinction as a commander of advanced troops. In 1805, having attained the rank of lieutenant-general, he served under Kutusov in the campaign of Austerlitz. In the Turkish War he distinguished himself at Guirgevo (1807). Promoted general of infantry in 1810, he commanded a corps at Borodino, and subsequently inflicted the defeat of Tarutino (or Winkovo) on Murat, king of Naples (Oct. 18, 1812). His corps was one of those most active in the pursuit of Napoleon's *Grande Armée,* and in 1813 he led the rear-guard of the Allies after their earlier defeats. He led a Russian-Prussian corps, at Leipzig and in the campaign of 1814. From 1818 to the time of his death he was military governor of St. Petersburg. He perished in the popular outbreak in the capital, on Dec. 26, 1825.

MILOŠ OBRENOVIĆ I. (1780–1860), prince of Serbia, founder of the Obrenović dynasty, was born in 1780 of poor Serbian peasants, and began life as a cattle-drover. Appointed voivode by Karageorge (*q.v.*) in 1807, Miloš distinguished himself both as military leader and administrator, and early became one of the leaders of the Russophil opposition to Karageorge, with whom he had a personal feud, believing him to have poisoned his half-brother. He was one of the few Serb leaders who remained behind when Karageorge and his followers fled in 1813 (*see* SERBIA) and obtained from the Turks the post of voivode of Rudnik, in central Serbia, in return for his co-operation in restoring order. His attitude, when a fresh Serbian revolt broke out against the cruelties of the returning Turks, was at first most equivocal; but at last he decided to join the rebels, and on Palm Sunday 1815 proclaimed the new revolt in the church of Takovo. By diplomatic astuteness and bribery, but chiefly by representing himself to the Turks as alone capable of restraining the extreme Serbian patriots, Miloš persuaded them to raise no active opposition to his election in 1817 as supreme prince of Serbia; shortly before he had almost certainly had his old chief and rival Karageorge murdered in his sleep. The Turkish régime was gradually relaxed, although the new position remained undefined, until the Hatti-sherif of 1830 recognized Miloš as hereditary prince, besides granting the Serbs other concessions.

While preserving the appearance of loyalty to the Porte, Miloš actually furthered his own ambitions. He did much for the organization of his country, but more for himself, and so tyrannical were the methods by which he enriched himself as to evoke a rebellion in 1824. His general enemies were assassinated; his officials forced to dust his boots; and he secured to himself the monopoly of the export of swine to Austria, Serbia's most lucrative trade. At last his exasperated people forced him in 1835 to grant a democratic constitution which in turn brought on him the disfavour both of the Porte and of Russia. Russia's intrigues with the Serb opposition at last forced Miloš to abdicate (1839). His sons Milan and Michael III. (*q.v.*) ruled Serbia; Miloš lived on his estates in Rumania, or in Vienna. He was recalled to the throne in 1859, on the deposition of Prince Alexander Karageorgević, but had only just time to show that his ideas remained unchanged. He died on Sept. 27, 1860, in Belgrade.

MILOVANOVIĆ, MILOVÁN (1863–1912), Serbian statesman and diplomatist, was born at Belgrade on March 2, 1863, and was educated there and in Paris, where he was the first Serb to take his degree as doctor of law and was awarded a gold medal for his thesis. On returning home he was appointed professor of international law at Belgrade university and soon acquired the position of one of Serbia's leading jurists. He was mainly responsible for drafting the new Serbian Constitution of 1888; and, becoming secretary of the central committee of the Radical party, he entered politics and held successively the portfolios of justice, commerce and finance during the closing decade of last century. In 1901 he went to Rome as minister, and retained his post after the revolution of 1903. In 1907 he represented Serbia at the Second Hague Conference, and was appointed a member of the international court of arbitration. In July 1908 he was made foreign minister in the Vetimirović cabinet, and thus had to guide Serbian policy through the difficult period of the Bosnian annexation crisis.

In 1911 he succeeded Păsić as premier. In foreign politics he showed signal moderation, and though a confirmed Russophil, initiated negotiations for a commercial treaty with Austria-Hungary and actively favoured good relations with Turkey. He was one of the chief founders of the Balkan League, the decisive step towards the creation of which was taken at a meeting between Milovanović and the Bulgarian premier, Gueschov, on Oct. 11, 1911. Secret negotiations continued throughout the winter and led to the conclusion of the Serbo-Bulgarian treaty of March 13, 1912 (*see* SERBIA). Discussions were still pending between the various Balkan capitals for a more precise and comprehensive project of alliance when, on July 1, 1912 at Belgrade, Dr. Milovanović died suddenly of heart failure. His removal at so critical a juncture was a grave blow to the cause of peace and moderation, and also deprived Serbia of her ablest statesman since the death of Prince Michael.

MILREIS. The Reis was the monetary unit of Portugal, and was naturally adopted in her South American colonies. With its depreciation in bygone days, it became too small to be convenient, and was replaced by the *milreis,* or thousand *reis.* When Brazil won her independence, she retained the *milreis* as her monetary unit, and as Portugal now calls the *milreis* the *escudo* (*q.v.*), the *milreis* is the monetary unit of Brazil.

A thousand *milreis* are known as a *conto.* It is written as 1,000-$000, while one *milreis* is written as 1$000. Subsidiary coins are of 500, 200, 100 and 50 *reis* in denomination.

Though nominally a gold coin, the *milreis* has always consisted of inconvertible currency notes. *See* BRAZIL.

MILTIADES, the name of two Athenian statesmen and generals of a family (the Philaidae) of Aeginetan origin, which claimed descent from Aeacus.

1. MILTIADES (6th century B.C.), the son of Cypselus, a prominent opponent of Peisistratus. He founded an Athenian colony in the Thracian Chersonese at the request of the Doloncians (Herod. vi. 36). He became "tyrant" of the Chersonese which he fortified by a wall across the isthmus from Cardia to Pactya. He was captured by the people of Lampsacus, but released on the intercession of Croesus of Lydia. He was succeeded by Stesagoras, son of his half-brother, Cimon.

2. MILTIADES (died *c.* 488 B.C.), the victor of Marathon (*q.v.*), was another son of Cimon. On the death of Stesagoras, he was sent to the Chersonese (? about 518–516) by Hippias—no doubt to support Hegesistratus at Sigeum (*see* PEISISTRATUS). He entrapped and imprisoned the chief men of the Chersonese, which was then in a turbulent condition, and married Hegesipyle, daughter of the Thracian prince Olorus (Herod. vi. 39). He led a contingent in the Scythian expedition of Darius Hystaspes, but Herodotus' story of the subsequent event is improbable (*see* SCYTHIA) and is probably derived from Alcmaeonid tradition, hostile to Miltiades. According to Herodotus, he advised the destruction of the Danube bridge, which would have cut off Darius' retreat, and was subsequently driven out by Scythian invaders, being restored by the Doloncians; he then fled to Athens on the arrival of the Persian expedition under Datis and Artophernes (492 B.C.), and was at once impeached for tyranny.

On the approach of the Persians Miltiades was made one of the ten Athenian generals, and it was on his advice that the polemarch Callimachus decided to give battle at Marathon (*q.v.*). Subsequently he obtained a fleet of 70 ships from the Athenians, with a commission, according to Cornelius Nepos, to regain control over the Aegean. Herodotus says that, having besieged Paros vainly for nearly a month, he made a secret visit to Timo, a priestess of Demeter in Paros, with a view to the betrayal of the island, and being compelled to flee wounded himself severely in attempting to leap a fence (but *see* Ephorus in *Fragm. hist. gr.* 107). In any case, the siege was raised for some reason, and the Alcmaeonidae had him impeached on some charge on his return. All that is known is that he died of his wound (489–488), without paying the fine, which was paid subsequently by his son Cimon (*q.v.*). He appears to have been a man of strong determination and great personal courage, of a type characteristic of the pre-Cleisthenic constitution. His absence in the Chersonese during the first years of the new democracy (508–493?) and his patrician lineage account naturally for the difference which existed between him and the popular leaders—Themistocles and Aristides.

See Herodotus, vi., and Cornelius Nepos, *Miltiades,* and histories of Greece. On the Parian expedition and the trial, R. W. Macan, *Herodotus iv.–vi.,* vol. 2, appendix xi.; on the foreign policy of Miltiades *see* THEMISTOCLES.

MILTON, JOHN (1608–1674), English poet, was born in Bread Street, Cheapside, London, on Dec. 9, 1608. His father, John Milton of Bread Street, scrivener, was himself an interesting man. He was the son of a staunch Roman Catholic, and turned Protestant at Oxford, for which he was disinherited. How he supported himself in London at first is obscure; perhaps his musical abilities helped him. He was about 37 when he became qualified early in 1600. He then set up at the Spread Eagle, Bread Street, and married Sarah Jeffrey; John Milton the younger was the second of their children who survived infancy.

Education.—When Milton was ten years old he had as tutor Thomas Young, afterwards master of Jesus college, Cambridge; he stayed till 1622, but before then Milton had already started to go to St. Paul's. Music was a natural part of his home environment, as his father was of some note in the musical world. Milton's chief friend at school was Charles Diodati, who left to go to Oxford in 1623. Milton stayed till 1624.

Milton had then all but completed his 16th year, and was as scholarly, as accomplished and as handsome a youth as St. Paul's school had sent forth. We learn from himself that his exercises "in English or other tongue, prosing or versing, but chiefly this latter," had begun to attract attention even in his boyhood. Of these poems the only specimens that now remain are two copies of Latin verses, preserved in a commonplace book of his (printed by the Camden Society in 1877), and his "Paraphrase on Psalm cxiv." and his "Paraphrase on Psalm cxxxvi." At the age of 16 Milton was entered as a student of Christ's college, Cambridge, in the grade of a "Lesser Pensioner," and he matriculated two months later, on April 9, 1625. At least three students who entered Christ's after Milton, but during his residence, deserve mention. One was Edward King, a youth of Irish birth and high Irish connections, who entered in 1626, at the age of fourteen; another was John Cleveland, afterwards known as royalist and satirist, who entered in 1627; and the third was Henry More, subsequently famous as the Cambridge Platonist, who entered in 1631, just before Milton left. Milton's own brother, Christopher, joined him in the college in February 1630/31, at the age of fifteen.

Milton's academic course lasted seven years and five months, bringing him from his 17th year to his twenty-fourth. In his second year he quarrelled with his tutor, Chappell. Johnson's suggestion that Milton may have been one of the last students to suffer corporal punishment deserves no credit; all we know is that he left college for a time and was transferred on his return to the tutorship of Nathaniel Tovey. For the first two or three years of his undergraduateship, he was generally unpopular among the younger men of his college. They had nicknamed him "the Lady" —a nickname which the students of the other colleges took up, converting it into "the Lady of Christ's"; and, though the allusion was chiefly to the peculiar grace of his personal appearance, it conveyed also a sneer at what the rougher men thought his unusual prudishness, the haughty fastidiousness of his tastes and morals. A change in this state of things had certainly occurred before January 1628/29, when, at the age of 20, he took his B.A. degree. By that time his intellectual pre-eminence had come to be acknowledged. In July 1632 Milton took his M.A. degree. Tradition still points out Milton's rooms at Christ's college. They are on the first floor on the first stair on the north side of the great court.

Early Writings.—Of Milton's skill at Cambridge, specimens remain in his *Prolusiones quaedam oratoriae.* They consist of seven rhetorical Latin essays, generally in a whimsical vein, delivered by him, either in the hall of Christ's college or in the public university schools. To Milton's Cambridge period belong four of his Latin "Familiar Epistles," and the greater number of his preserved Latin poems, including: (1) the seven pieces, written in 1626, which compose his *Elegiarum liber,* two of the most interesting of them addressed to his friend, Charles Diodati, and one to his former tutor, Young, in his exile at Hamburg; (2) the five short Gunpowder Plot epigrams, now appended to the *Elegies;* and (3) the first five pieces of the *Sylvarum liber,* the most important of which are the hexameter poem "In quintum novembris" (1626), and the piece entitled *Naturam non pati senium* (1628). Of the English poems of the Cambridge period the following is a dated list: "On the Death of a fair Infant" (1625–1626), the subject being the death of the first-born child of his sister Anne Phillips; "At a Vacation Exercise in the College" (1628); the magnificent Christmas ode, "On the Morning of Christ's Nativity" (1629); the fragment called "The Passion" and the "Song on May Morning," both probably belonging to 1630; the poem "On Shakespeare," certainly belonging to that year, printed in the Shakespeare folio of 1632; the two facetious pieces "On the University Carrier" (1630–1631); the "Epitaph on the Marchioness of Winchester" (1631); the sonnet "To the Nightingale," probably of the same year; the sonnet "On arriving at the Age of twenty-three," dating itself certainly in December 1631.

Just before Milton quitted Cambridge, his father, then verging on his 70th year, had practically retired from his Bread Street business, and had gone to spend his declining years at Horton, Buckinghamshire, not far from Windsor. Here Milton mainly resided for the next six years—from July 1632 to April 1638.

Although, when he had gone to Cambridge, it had been with the intention of becoming a clergyman, that intention had been abandoned. His reasons were that "tyranny had invaded the church," and that, finding he could not honestly subscribe the oaths and obligations required, he "thought it better to preserve

a blameless silence before the sacred office of speaking, begun with servitude and forswearing." In other words, he was disgusted with the system which Laud was establishing and maintaining in the Church of England. Eventually he decided to devote himself to scholarship and literature. There seems to have been some remonstrance from his father; in Milton's poem *Ad patrem* their agreement is recorded; Milton had his way. In perfect leisure, and in a pleasant rural retirement, with Windsor at the distance of an easy walk, and London only about 17 m. off, he went through, he tells us, a systematic course of reading in the Greek and Latin classics, varied by mathematics, music, and the kind of physical science we should now call cosmography.

It is an interesting fact that Milton's very first public appearance in the world of English authorship was in so honourable a place as the second folio edition of *Shakespeare* in 1632. His enthusiastic eulogy on Shakespeare, written in 1630, was one of three anonymous pieces prefixed to that second folio. Among the poems actually written by Milton at Horton the first, in all probability, after the Latin hexameters *Ad patrem*, were the exquisite companion pieces *L'Allegro* and *Il Penseroso*. There followed, in or about 1633, the fragment called *Arcades*. It was part of a pastoral masque performed by the young people of the noble family of Egerton, before the countess-dowager of Derby, at her mansion of Harefield, about 10 m. from Horton. That Milton contributed the words for the entertainment was, almost certainly, owing to his friendship with Henry Lawes, who supplied the music. Next in order among the compositions at Horton may be mentioned the three short pieces, "At a Solemn Music," "On Time," and "Upon the Circumcision"; after which comes *Comus*, the largest and most important of all Milton's minor poems. The name by which that beautiful drama is now universally known was not given to it by Milton himself. He entitled it, more simply and vaguely, "A Masque presented at Ludlow Castle, 1634, on Michaelmas night, before John Earl of Bridgewater, Lord President of Wales" (1637). Lawes supplied the music and was stage manager; he applied to Milton for the poetry; and on Sept. 29, 1634, the drama furnished by Milton was performed in Ludlow Castle before a great assemblage of the nobility and gentry of the Welsh principality, Lawes taking the part of "the attendant spirit," while the parts of "first brother," "second brother" and "the lady" were taken by the earl's three youngest children, Viscount Brackley, Mr. Thomas Egerton and Lady Alice Egerton.

From Sept. 1634 to the beginning of 1637 is a comparative blank in our records. Straggling incidents in this blank are a Greek translation of "Psalm cxiv.," a visit to Oxford in 1635 and the beginning in May 1636 of a troublesome lawsuit against his father by Sir Thomas Cotton, who accused him of misappropriation.

The lawsuit was still in progress when, on April 3, 1637, Milton's mother died, at the age of about sixty-five. The year 1637 was otherwise eventful. It was in that year that his *Comus*, after lying in manuscript for more than two years, was published by itself, in the form of a small quarto of 35 pages. The author's name was withheld, and the entire responsibility of the publication was assumed by Henry Lawes. Milton seems to have been in London when the little volume appeared. He was a good deal in London, at all events, during the months immediately following his mother's death. The plague, which had been on one of its periodical visits of ravage through England since early in the preceding year, was then especially severe in the Horton neighbourhood, while London was comparatively free. It was probably in London that Milton heard of the death of Edward King, who had sailed from Chester for a vacation visit to his relatives in Ireland, when, on Aug. 10, the ship in perfectly calm water struck on a rock and went down, he and nearly all the other passengers going down with her. There is no mention of this event in Milton's two Latin "Familiar Epistles" of September 1637, addressed to his friend Charles Diodati, and dated from London; but in Nov. 1637, and probably at Horton, he wrote his matchless pastoral monody of *Lycidas*. It was his contribution to a collection of obituary verses, Greek, Latin and English, inscribed to the memory of Edward King by his numerous friends, at Cambridge and elsewhere. The collection appeared early in 1638. The second part contained thirteen English poems, the last of which was Milton's monody, signed only with his initials "J. M."

His Tour Abroad.—Circumstances now favoured his plan for a foreign tour. The Cotton lawsuit was at an end, and Milton's younger brother Christopher had married and gone to live at Horton. Before the end of April 1638 Milton was on his way across the channel, taking one English man-servant with him. Through Paris, where Milton was introduced to the famous Hugo Grotius, then ambassador for Sweden at the French court, he moved on rapidly to Italy, by way of Nice. After visiting Genoa, Leghorn and Pisa, he arrived at Florence, in Aug. 1638. Enchanted by the city and its society, he remained there two months, frequenting the chief academies or literary clubs, and even taking part in their proceedings. It was in the neighbourhood of Florence that he "found and visited" the great Galileo, then old and blind, and still nominally a prisoner to the Inquisition for his astronomical heresy.

By way of Florence and Siena, he reached Rome some time in October, and spent about another two months there, not only going about among the ruins and antiquities and visiting the galleries, but mixing also, as he had done in Florence, with the learned society of the academies. The most picturesque incident of his stay in Rome was his presence at a great musical entertainment in the palace of Cardinal Francesco Barberini. Here he had not only the honour of a specially kind reception by the cardinal himself, but also, it would appear, the supreme pleasure of listening to the marvellous Leonora Baroni, the most renowned singer of her age.

Late in November he left Rome for Naples. He had hardly been in Naples a month, however, when there came news from England which urged his immediate return home.. "The sad news of civil war in England," he says, "called me back; for I considered it base that, while my fellow-countrymen were fighting at home for liberty, I should be travelling at my ease for intellectual culture" (*Defensio secunda*). In Dec. 1638, therefore, he set his face northwards again. His return journey, however, probably because he learnt that the news he had first received was exaggerated or premature, was broken into stages. He spent a second January and February (1638/39) in Rome, in some danger, he says, from the papal police, because the English Jesuits in Rome had taken offence at his habit of free speech on the subject of religion. From Rome he went to Florence, where he stayed two months, and in April 1639 he went on, by Bologna and Ferrara, to Venice. About a month was given to Venice; and thence, having shipped for England the books he had collected in Italy, he went, by Verona and Milan, over the Alps, to Geneva. Here he spent a week or two in June, having daily conversations with the great Protestant theologian Dr. Jean Diodati, the uncle of his friend Charles Diodati. From Geneva he returned to Paris, and so to England. He was home again in Aug. 1639, having been absent in all 15 or 16 months.

Milton's Continental tour, and especially the Italian portion of it, which he describes at some length in his *Defensio secunda*, remained one of the chief pleasures of his memory through all his subsequent life. Nor was it without fruits of a literary kind. Besides two of his Latin *Epistolae Familiares*, one to the Florentine grammarian Buommattei, and the other to Lucas Holstenius, there have to be assigned to Milton's 16 months on the Continent his three Latin epigrams *Ad Leonoram Romae canentem*, his Latin scazons *Ad Salsillum poetam romanum aegrotantem*, his fine Latin hexameters entitled *Mansus*, addressed to Giovanni Battista Manso, and his five Italian sonnets, with a canzone, in praise of a Bolognese lady.

His bosom friend and companion from boyhood, Charles Diodati, died in Blackfriars, London, in Aug. 1638, not four months after Milton had gone away on his tour. The intelligence did not reach Milton till some months afterwards, probably not till his second stay in Florence; and, though he must have learnt some of the particulars from his friend's uncle in Geneva, he did not know them fully till his return to England. How profoundly they affected him appears from his *Epitaphium Damonis*,

then written in memory of his dead friend. The importance of this poem in Milton's biography cannot be overrated. It is perhaps the noblest of all his Latin poems; and, though written in the artificial manner of a pastoral, it is unmistakably an outburst of the most passionate personal grief. In this respect *Lycidas*, artistically perfect though that poem is, cannot be compared with it; and it is only the fact that *Lycidas* is in English, while the *Epitaphium Damonis* is in Latin, that has led to the notion that Edward King of Christ's college was peculiarly and pre-eminently the friend of Milton in his youth and early manhood.

We should not have known, but for an incidental passage in the *Epitaphium Damonis* (160–178), that, at the time of his return from Italy, he had chosen a subject for a great poem from the Arthurian legend. This epic was to be in English, and he had resolved that all his poetry for the future should be in the same tongue.

London and Public Affairs.—Not long after Milton's return Christopher Milton and his wife went to reside at Reading, taking the old gentleman with them, while Milton himself preferred London. He had first taken lodgings in St. Bride's churchyard, at the foot of Fleet street; but, after a while, probably early in 1640, he removed to a "pretty garden house" of his own, at the end of an entry, in part of Aldersgate street. His sister, whose first husband, Edward Phillips, had died in 1631, had married a Mr. Thomas Agar, his successor in the Crown Office; and it was arranged that her two sons by her first husband should be educated by their uncle. John Phillips, the younger of them, only nine years old, had boarded with him in the St. Bride's churchyard lodgings; and, after the removal to Aldersgate street, the other brother, Edward Phillips, only a year older, became his boarder also. Gradually a few other boys, the sons of well-to-do personal friends, joined the two Phillipses whether as boarders or for daily lessons, so that the house in Aldersgate street became a small private school.

The Arthurian epic had been given up, and his mind was roving among many other subjects, and balancing their capabilities. How he wavered between Biblical subjects and heroic subjects from British history, and how many of each kind suggested themselves to him, one learns from a list in his own handwriting among the Milton mss. at Cambridge. It contains jottings of no fewer than 53 subjects from the Old Testament, eight from the Gospels, 33 from British and English history before the Conquest, and five from Scottish history. It is curious that all or most of them are headed or described as subjects for "tragedies," as if the epic form had now been abandoned for the dramatic. There are four separate drafts of a possible tragedy on the Greek model under the title of *Paradise Lost*, two of them merely enumerating the dramatis personae, but the last two indicating the plot and the division into acts. In 1641 he wrote in the *Reason of Church Government* that he was meditating a poem on high moral or religious subjects. But the fulfilment of these plans was indefinitely postponed. Milton became absorbed in the ecclesiastical controversies following on the king's attempt to force the episcopal system on the Scots.

Not until the Church question became paramount did Milton enter actively into public affairs. On this question there were three parties: the high church party, who wanted episcopacy retained; the middle party, who wanted it curtailed; and the "root-and-branch" party, who wanted it abolished. The manifesto of the high church party was issued by Joseph Hall, bishop of Exeter; it was answered in March 1640/41 by five Puritan clergymen, whose initials put together on the title-page formed the word "Smectymnuus." Thomas Young, Milton's old tutor, was largely responsible for the pamphlet, but Milton's own hand is also discernible in it, and he continued to aid the Smectymnuans in their subsequent rejoinders to Hall's defences of himself.

In May 1641 he put forth a defence of the Smectymnuan side in *Of Reformation touching Church Discipline in England and the Causes that hitherto have hindered it*. He reviewed English ecclesiastical history, with an appeal to his countrymen to resume that course of reformation which he considered to have been prematurely stopped in the preceding century, and to sweep away the last relics of papacy and prelacy. Among all the root-and-branch pamphlets of the time it stood out, and stands out still, as the most thorough-going and tremendous. It was followed by four others in rapid succession—*Of Prelatical Episcopacy and whether it may be deduced from the Apostolical Times* (June 1641), *Animadversions upon the Remonstrant's Defence against Smectymnuus* (July 1641), *The Reason of Church Government urged against Prelaty* (Feb. 1641/42), *Apology against a Pamphlet called a Modest Confutation of the Animadversions*, etc. (March and April 1641/42). The first of these was directed chiefly against the middle party, with especial reply to the arguments of Archbishop Ussher. The greatest of the four, and the most important of all Milton's anti-episcopal pamphlets after the first, is *The Reason of Church Government*. It is there that Milton takes his readers into his confidence, speaking at length of himself and his motives in becoming a controversialist. Poetry, he declares, was his real vocation; it was with reluctance that he had resolved to "leave a calm and pleasing solitariness, fed with cheerful and confident thoughts, to embark in a troubled sea of noises and hoarse disputes"; but duty had left him no option. The great poem or poems he had been meditating could wait; and meanwhile, though in prose-polemics he had the use only of his "left hand," that hand should be used with all its might in the cause of his country and of liberty.

Of Milton's life through the first months of the Civil War little is known. He remained in his house in Aldersgate street, teaching his nephews and other pupils; and the only scrap that came from his pen was the semi-jocose sonnet bearing the title "When the Assault was intended to the City." In the summer of 1643, however, there was a great change in the Aldersgate street household. About the end of May, as his nephew Edward Phillips remembered, Milton went away on a country journey, without saying whither or for what purpose; and, when he returned, about a month afterwards, it was with a young wife, and with some of her sisters and other relatives in her company. He had, in fact, been in the very headquarters of the king and the Royalist army in and round Oxford; and the bride he brought back with him was a Mary Powell, the eldest daughter of Richard Powell, of Forest Hill, near Oxford. She was 17 years and four months old, while Milton was in his 35th year. However the marriage came about, it was a most unfortunate event. The Powell family were strongly Royalist, and the girl herself seems to have been frivolous and entirely unsuited for the studious life in Aldersgate street. Hardly were the honeymoon festivities over, when, her sisters and other relatives having returned to Forest Hill, she pined for home again and begged to be allowed to go back on a visit. Milton consented, on the understanding that the visit was to be a brief one. This seems to have been in July 1643. Soon, however, the intimation from Forest Hill was that he need not look ever to have his wife in his house again. The resolution seems to have been mainly the girl's own; but, as the king's cause was then prospering in the field, Edward Phillips was probably right in his conjecture that the whole of the Powell family had repented of their sudden connection with so prominent a Parliamentarian and assailant of the Church of England as Milton. While his wife was away, his old father, who had been residing for three years with his younger and lawyer son at Reading, came to take up his quarters in Aldersgate street.

Milton's answer to the insult of his wife's desertion was most characteristic. *The Doctrine and Discipline of Divorce, Restored to the good of both Sexes from the Bondage of Canon Law and other Mistakes* was the title of a pamphlet put forth by him in August 1643, without his name, but with no effort at concealment, declaring the notion of a sacramental sanctity in the marriage relation to be a clerically invented superstition, and arguing that inherent incompatibility of character, or contrariety of mind, between two married persons is a perfectly just reason for divorce. There was no reference to his own case, except by implication; but the boldness of the speculation roused attention and sent a shock through London. It was a time when the authors of heresies of this sort, or of any sort, ran considerable risks. That there might be no obstacle to a more public prosecution, Milton put his

name to a second and much enlarged edition of the tract, in February 1644, dedicated openly to the parliament and the assembly. Then, for a month or two, during which the gossip about him and his monstrous doctrine was spreading more and more, he turned his attention to another subject. In June 1644 he published a treatise *Of Education.*

In July he returned to the divorce subject in a pamphlet addressed specially to the clergy and entitled *The Judgment of Martin Bucer concerning Divorce.* The outcry against him then reached its height. A sermon was preached against him before the houses of parliament, and efforts were made to bring him within parliamentary censure. The lead was taken by the Stationers' Company, who had a technical ground of complaint against him. His first divorce treatise, though published immediately after the "Printing Ordinance," requiring all publications to be licensed and registered in the books of the Stationers' Company, had been issued without license and without registration. Complaint to this effect was made against Milton, with some others liable to the same charge in a petition of the Stationers of the House of Commons in August 1644; and the matter came before committee both in that House and in the Lords.

It is to this circumstance that the world owes the most popular and eloquent, if not the greatest, of all Milton's prose writings, his famous *Areopagitica, a Speech of Mr. John Milton for the Liberty of Unlicensed Printing, to the Parliament of England.* It appeared on Nov. 25, 1644, deliberately unlicensed and unregistered, and was a remonstrance addressed to the parliament, calling for the repeal of their ordinance of June 1643 and attacking the whole system of licensing and censorship of the press. Though repeal did not follow, the pamphlet virtually accomplished its purpose. The licensing system had received its death-blow; and, though the Stationers returned to the charge in another complaint to the House of Lords, Milton's offence against the press ordinance was condoned. To this period there belong, in the shape of verse, only his sonnets ix. and x., the first to some anonymous lady, and the second "to the Lady Margaret Ley," with perhaps the Greek lines entitled *Philosophus ad regem quendam.* In March 1644/5 he published simultaneously his *Tetrachordon: Expositions upon the four chief places of Scripture which treat of Marriage,* and his *Colasterion, a Reply to a nameless Answer against the Doctrine and Discipline of Divorce.* In these he replied to his chief recent assailants, lay and clerical, with merciless severity.

So far as Milton was concerned personally, his interest in the divorce speculation came to an end in July or August 1645, when, by friendly interference, a reconciliation was effected between him and his wife. The ruin of the king's cause at Naseby had suggested to the Powells that it might be as well for their daughter to go back to her husband after their two years of separation.

By this time, having an increasing number of pupils, he had taken a house in Barbican, where he stayed till Sept. or Oct. 1647. Among his first occupations there must have been the revision of the proof sheets of the first edition of his collected poems. It appeared as a tiny volume, copies of which are now very rare, with the title, *Poems of Mr. John Milton, both English and Latin, composed at several times. Printed by his true Copies. The songs were set in Musick by Mr. Henry Lawes. . . .* The title-page gives the date 1645, but Jan. 2, 1645/6, seems to have been the exact day of its publication. In English there were only the four sonnets now numbered xi.–xiv., the first two entitled "On the Detraction which followed upon my writing certain Treatises," the third "To Mr. Henry Lawes on his Airs," and the fourth "To the Religious Memory of Mrs. Catherine Thomson," together with the powerful anti-Presbyterian invective or "tailed sonnet" entitled "On the New Forcers of Conscience under the Long Parliament"; and in Latin there were only the ode *Ad Joannem Rousium,* the *Apologus de Rustico et Hero,* and one interesting "Familiar Epistle" (April 1647) addressed to his Florentine friend Carlo Dati.

The fall of Oxford in 1646 compelled the whole of the Powell family to seek refuge in London, and most of them found shelter in Milton's house. His first child, Anne, was born there on July 29, that year; on Jan. 1, 1646/7, his father-in-law Richard Powell died there, leaving his affairs in confusion; and in the following March his own father died there, at the age of 84, and was buried in the adjacent church of St. Giles, Cripplegate.

From Barbican Milton removed, in Sept. or Oct. 1647, to a smaller house in that part of High Holborn which adjoins Lincoln's Inn Fields. His Powell relatives had now left him, and he had reduced the number of his pupils, or perhaps kept only his two nephews. But, though thus more at leisure, he did not yet resume his projected poem, but occupied himself rather with three works of scholarship, which he had already for some time had on hand. One was the compilation in English of a complete history of England, or rather of Great Britain, from the earliest times; another was the preparation in Latin of a complete system of divinity, drawn directly from the Bible; and the third was the collection of materials for a new Latin dictionary. Milton had always a fondness for such labours of scholarship and compilation. Of a poetical kind there is nothing to record, during his residence in High Holborn, but an experiment in psalm-translation, in the shape of Ps. lxxx.–lxxxviii. done into service-metre in April 1648, and the sonnet to Fairfax, written in September of the same year.

Milton's Secretaryship.—Milton's sonnet "On the Lord General Fairfax, at the siege of Colchester," attested the exultation of the writer at the triumph of the parliamentary cause. When the king was beheaded (1649) the first Englishman of mark out of parliament to attach himself openly to the new republic was John Milton. This he did by the publication of his pamphlet entitled *Tenure of Kings and Magistrates, proving that it is lawful, and hath been held so in all ages, for any who have the power, to call to account a Tyrant or wicked King, and, after due conviction, to depose and put him to death, if the ordinary Magistrate have neglected or denied to do it.* It was out within a fortnight after the king's death, and was Milton's last performance in the house in High Holborn. In March 1649 Milton was offered, and accepted, the secretaryship for foreign tongues to the council of state of the new Commonwealth. The salary was to be £288 a year (worth about £1,500 a year now). To be near his new duties in attendance on the council, he removed at once to temporary lodgings at Charing Cross. Thus he must at once have made acquaintance with President Bradshaw, Fairfax, Cromwell himself, Sir Henry Vane, Whitelocke, Henry Marten, Haselrig, Sir Gilbert Pickering and the other chiefs of the council and the Commonwealth, if indeed he had not known some of them before. After a little while, for his greater convenience, official apartments were assigned him in Whitehall itself.

At the date of Milton's appointment to the secretaryship he was 40 years of age. His special duty was the drafting in Latin of letters sent to foreign states and princes, and the examination and translation of letters in reply. As Latin was the language employed in the written diplomatic documents, his post came to be known indifferently as the secretaryship for foreign tongues or the Latin secretaryship. In that post, however, his duties, more particularly at first, were very light in comparison with those of his official colleague, Walter Frost, the general secretary. Foreign powers held aloof from the English republic as much as they could; and Milton's presence was required only when some piece of foreign business turned up. Hence, from the first, his employment in very miscellaneous work. Especially, the council looked to him for everything in the nature of literary vigilance and literary help in the interests of the struggling Commonwealth. He was employed in the examination of suspected papers, and in interviews with their authors and printers; and he executed several great literary commissions expressly entrusted to him by the council. The first of these was his pamphlet entitled *Observations on the Articles of Peace* (between Ormonde and the Irish), published in May 1649. A passage of remarkable interest in it is one of eloquent eulogy on Cromwell. More important still was the *Eikonoklastes* (which may be translated "Image-Smasher"), published by Milton in Oct. 1649, by way of counterblast to the famous *Eikon Basilike* ("Royal Image"), which had been in circulation in thousands of copies since the king's death, and

had become a kind of Bible in all Royalist households, on the supposition that it had been written by the royal martyr himself. (*See* GAUDEN, JOHN.) In the end of 1649 there appeared abroad the *Defensio regia pro Carolo I.*, by Salmasius, the greatest scholar of Europe. Milton threw his whole strength into a reply, through the year 1650, interrupting himself only by a new and enlarged edition of his *Eikonoklastes*. His Latin *Pro populo anglicano defensio* (1651) ran at once over the British Islands and the Continent, and was received by scholars as an annihilation of Salmasius. Through the rest of 1651 the observation was that the two agencies which had co-operated most visibly in raising the reputation of the Commonwealth abroad were Milton's books and Cromwell's battles.

Through 1651 Milton also acted as licenser and superintending editor of the *Mercurius politicus*, a newspaper issued twice a week, of which Marchamont Nedham was the working editor and proprietor. Milton's hand is discernible in some of the leading articles.

About the end of 1651 Milton left his official rooms in Whitehall for a "garden house" he had taken on the edge of St. James's park in what was then called Petty France, Westminster, but is now York street. Milton had now more to do in the special work of his office, in consequence of the increase of correspondence with foreign powers. But he had for some time been in ailing health; and a dimness of eyesight which had been growing upon him gradually for ten years had been settling rapidly, since his labour over the answer to Salmasius, into total blindness. Before or about May 1652, when he was but in his 44th year, his blindness became total, and he could go about only with some one to lead him. Hence a rearrangement of his secretarial duties. Such of these duties as he could perform at home, or by occasional visits to the Council Office near, he continued to perform; but much of the routine work was done for him by an assistant, a well-known German, George Rudolph Weckherlin, succeeded later by Philip Meadows and, eventually, by Andrew Marvell. Precisely to this time of a lull in Milton's secretaryship on account of his ill-health and blindness we have to refer his two great companion sonnets "To the Lord General Cromwell" and "To Sir Henry Vane the Younger."

In 1652 died his only son, who had been born at Whitehall in the March of the preceding year. His wife died in 1653/4, just after she had given birth to his third daughter, Deborah. With the three children thus left him—Anne, but six years old, Mary, not four, and the infant Deborah—the blind widower lived on in his house in Petty France in such desolation as can be imagined. He had recovered sufficiently to resume his secretarial duties; and the total number of his dictated state letters for the single year 1652 is equal to that of all the state letters of his preceding term of secretaryship put together. To the same year there belong also three of his Latin "Familiar Epistles." In December 1652 there was published *Joannis Philippi Angli responsio ad apologiam anonymi cujusdam tenebrionis*, being a reply by Milton's younger nephew, John Phillips, but touched up by Milton himself, to one of several pamphlets that had appeared against Milton for his slaughter of Salmasius.

In Dec. 1653 Cromwell's formal sovereignty began under the name of the Protectorate, causing a split in the party. Milton adhered to Cromwell, and was his Latin secretary through the whole of the Protectorate. For a while, indeed, his Latin letters to foreign states in Cromwell's name were but few, the reason for which may have been that he was then engaged on an answer to the pamphlet from The Hague entitled *Regii sanguinis clamor ad coelum adversus parricidas anglicanos* (March 1652). It came out in May 1654, with the title *Joannis Miltoni Angli pro populo anglicano defensio secunda* (Second Defence of John Milton, Englishman, for the People of England). The author of *Regii sanguinis clamor* was Dr. Peter du Moulin the younger, then moving about in English society, close to Milton; but the reply is made to Alexander More, a professor at Middelburg, to whom the pamphlet was attributed. The *Defensio* contains passages of singular autobiographical and historical value, and includes laudatory sketches of such eminent Commonwealth's men as Bradshaw, Fairfax, Fleetwood, Lambert and Overton, together with a long panegyric on Cromwell himself and his career, which remains to this day unapproached for elaboration and grandeur by any estimate of Cromwell from any later pen.

From about the date of the publication of the *Defensio Secunda* to the beginning of 1655 the only specially literary relics of Milton's life are his translations of Ps. i.–viii. in different metres, done in Aug. 1654, his translation of Horace's *Ode*, i. 5, done probably about the same time, and two of his Latin "Familiar Epistles." The most active time of his secretaryship for Cromwell was from April 1655 onwards. Milton's office was then redefined; the ordinary Foreign Office work was taken off his hands and he was left to deal with special occasions. Hardly was the arrangement made when a signal occasion did occur. In May 1655 all England was horrified by the news of the massacre of the Vaudois Protestants (Waldenses) by the troops of Emanuele II., duke of Savoy and prince of Piedmont, in consequence of their disobedience to an edict requiring them either to leave their native valleys or to conform to the Catholic religion. Cromwell and his council took the matter up with all their energy; and the burst of indignant letters on the subject despatched in that month and the next to the duke of Savoy himself, Louis XIV. of France, Cardinal Mazarin, the Swiss cantons, the states-general of the United Provinces, and the kings of Sweden and Denmark, were all by Milton. His famous sonnet "On the Late Massacre in Piedmont" was his more private expression of feeling on the same occasion. Milton's last Latin pamphlets, the *Pro se Defensio*, and the *Scriptum domini protectoris*, appeared in August.

Through the rest of Cromwell's Protectorate, Milton's life was of comparatively calm tenor. He was in much better health than usual, bearing his blindness with courage and cheerfulness; he was steadily busy with important despatches to foreign powers on behalf of the Protector, then in the height of his great foreign policy; and his house in Petty France seems to have been, more than at any previous time since the beginning of his blindness, a meeting-place for friends and visitors, and a scene of pleasant hospitalities. The four sonnets now numbered xix.–xxii., one of them to young Lawrence, the son of the president of Cromwell's council, and two of the others to Cyriack Skinner, once his pupil, belong to this time of domestic quiet, as do also no fewer than ten of his Latin "Familiar Epistles." His marriage to Katherine Woodcock on Nov. 12, 1656 brought him a brief period of domestic happiness; but, after only 15 months, he was again a widower, by her death in childbirth in February 1657/8. The touching sonnet which closes the series of Milton's *Sonnets* is his tribute to the memory of his second marriage. Some of his greatest despatches for Cromwell, including letters, of the highest importance, to Louis XIV., Mazarin and Charles Gustavus of Sweden, belong to the year 1658. On the whole, there is no doubt of Milton's high opinion of Cromwell; but he felt some doubts about his later policy, which he expressed in the *Defensio Secunda*. Above all, he was disappointed with Cromwell's church policy. Milton was strongly for complete disestablishment, and Cromwell's conservation of the Established Church must have been Milton's deepest disappointment with Cromwell's rule.

Cromwell's death on Sept. 3, 1658 left the Protectorship to his son Richard. Milton and Marvell, now his assistant secretary, continued in their posts, and a number of the Foreign Office letters of the new Protectorate were of Milton's composition. In Oct. 1658 appeared a new edition of his *Defensio prima*, and, early in 1659, a new English pamphlet, entitled *Treatise of Civil Power in Ecclesiastical Causes showing that it is not lawful to compel in Matters of Religion*, in which he advocated the separation of Church and State. To Richard's Protectorate also belongs one of Milton's Latin "Familiar Epistles."

His last work for the Commonwealth was a desperate struggle to avert the restoration of the monarchy. In a *Letter to a Friend concerning the Ruptures of the Commonwealth*, written in Oct. 1659, he had propounded a scheme of a kind of dual government for reconciling the army chiefs with the Rump; through the following winter, marked only by two of his Latin "Familiar Epistles," his anxiety over the signs of the growing enthusiasm

throughout the country for the recall of Charles II. had risen to a passionate vehemence which found vent in a pamphlet entitled *The Ready and Easy Way to Establish a Free Commonwealth, and the Excellence thereof compared with the Inconveniences and Dangers of readmitting Kingship to this Nation.* An abridgment of this pamphlet was addressed by him to General Monk in a letter entitled "The Present Means and Brief Delineation of a Free Commonwealth" (March 1660). Milton's proposal was that the central governing apparatus of the British Islands for the future should consist of one indissoluble grand council or parliament, which should include all the political chiefs, while there should be a large number of provincial councils or assemblies sitting in the great towns for the management of local and county affairs.

Not even when the king's cause was practically assured would Milton be silent. In *Brief Notes upon a late Sermon* (April 1660) he made another protest against the recall of the Stuarts, and in the same month he sent forth a second edition of his *Ready and Easy Way*, containing additional passages of the most violent denunciation of the royal family, and of prophecy of the degradation and disaster they would bring back with them. This was the dying effort. Charles II. returned to London on May 29, and by then the chief republicans had scattered themselves, and Milton was hiding in an obscure part of the city.

After the Restoration.—How Milton escaped the scaffold at the Restoration is a mystery now, and was a mystery at the time. The Commons voted that he should be taken into custody by the serjeant-at-arms, for prosecution by the attorney-general on account of his *Eikonoklastes* and *Defensio prima*, and that all copies of those books should be called in and burnt by the hangman. There was a story that Milton had once protected Davenant and now owed his immunity to him; but it is more likely that he was protected by the influence of Marvell, by Arthur Annesley, afterwards earl of Anglesey, and by other friends who had influence at court. At all events, on Aug. 29, 1660, when the Indemnity Bill did come out complete, with the king's assent, Milton did not appear as one of the exceptions on any ground or in any of the grades. He was actually taken into custody, though the prosecution was quashed by the Indemnity Bill, and complained to the Commons of the fee charged for his release.

Milton did not return to Petty France. For the first months after he was free he lived as closely as possible in a house near what is now Red Lion square, Holborn. Thence he removed, apparently early in 1661, to a house in Jewin street, in his old Aldersgate street neighbourhood. In Jewin street Milton remained for two or three years, or from 1661 to 1664. This is the time of which he says:—

> . . . though fallen on evil days,
> On evil days though fallen, and evil tongues,
> In darkness, and with dangers compassed round,
> And solitude.

The "evil days" were those of the Restoration in its first or Clarendonian stage, with its revenges and reactions, its open proclamation and practice of anti-Puritanism in morals and in literature no less than in politics. His few friends were mostly Nonconformists of some denomination, who were themselves under similar obloquy. Besides his two nephews, the faithful Andrew Marvell, Cyriack Skinner and some others of his former admirers, we hear chiefly of a Dr. Nathan Paget and of several young men who would drop in upon him by turns, partly to act as his amanuenses, and partly for the benefit of lessons from him —one of them a Quaker youth, named Thomas Ellwood. His three daughters, on whom he ought now to have been able principally to depend, were his most serious domestic trouble. The poor motherless girls, the eldest in her 17th year in 1662, the second in her 15th and the youngest in her 11th, had grown up, in their father's blindness and too great self-absorption, ill-looked-after and but poorly educated; and the result now appeared. They "made nothing of neglecting him"; they rebelled against the drudgery of reading to him or otherwise attending on him; they "did combine together and counsel his maid-servant to cheat him in her marketings"; they actually "had made away some of his books, and would have sold the rest."

It was to remedy this state of things that Milton consented to a third marriage. On Feb. 24, 1662/3 he married Elizabeth Minshull, a relative of Dr. Paget. She proved an excellent wife, and the Jewin street household, though the daughters remained in it, must have been under better management from the time of her entry into it. Meanwhile, he had been building up his *Paradise Lost.* He had begun the poem in earnest, we are told, in 1658 at his house in Petty France. He had made but little way when there came the interruption of the Restoration; but the work had been resumed in Jewin street and prosecuted there steadily, by dictations of 20 or 30 lines at a time to whatever friendly or hired amanuensis chanced to be at hand. Considerable progress had been made in this way before his third marriage; and after that the work proceeded apace, his nephew, Edward Phillips, who was then out in the world on his own account, looking in when he could to revise the growing manuscript.

Not very long after the third marriage, probably in 1664, he removed to another house, with a garden, in "Artillery Walk, leading to Bunhill Fields." Here *Paradise Lost* was certainly finished before July 1665—Aubrey says in 1663—for when Milton and his family, to avoid the Great Plague of London, went into temporary country-quarters in a cottage in Chalfont St. Giles, Buckinghamshire (Milton's cottage here is still standing, and is open to visitors), the finished manuscript was taken with him. This we learn from Thomas Ellwood, who had taken the cottage for him, and was allowed to take a copy of the manuscript away with him for perusal, during Milton's stay at Chalfont (*Life of Thomas Ellwood,* 1714). On April 27, 1667 Milton concluded an agreement, still preserved in the British Museum, with Samuel Simmons, printer, of Aldersgate street, London, to dispose of the copyright for £5 down, the promise of another £5 after the sale of the first edition of 1,300 copies, and the further promise of two additional sums of £5 each after the sale of two more editions of the same size respectively. The poem was entered in the Stationers' Registers on Aug. 20 following, and shortly after that date it was out in London as a neatly printed small quarto, with the title *Paradise Lost: A Poem written in Ten Books: By John Milton.* The sale of an edition of 1,300 copies in 18 months proves that the poem found a wide circle of readers. "This man cuts us all out, and the ancients too," is the saying attributed to Dryden on the occasion; and it is the more remarkable because the one objection to the poem which at first, we are told, "stumbled many" must have "stumbled" Dryden most of all. Except in the drama, rhyme was then thought essential in anything professing to be a poem; blank verse was hardly regarded as verse at all; Dryden especially had been and was the champion of rhyme, contending for it even in the drama. That, notwithstanding this obvious blow struck by the poet at Dryden's pet literary theory, he should have welcomed the poem so enthusiastically and proclaimed its merits so emphatically, says much at once for his critical perception and for the generosity of his temper. According to Aubrey, Dryden requested Milton's leave to turn the poem into a rhymed drama, and was told he might "tag his verses if he pleased." The result is seen in Dryden's opera, *The State of Innocence and the Fall of Man* (1675). One consequence of Milton's renewed celebrity was that visitors of all ranks again sought him out for the honour of his society and conversation. His obscure house in Artillery Walk, Bunhill, we are told, became an attraction now, "much more than he did desire," for the learned notabilities of his time.

Last Years.—Accounts have come down to us of Milton's personal appearance and habits in his later life. They describe him as to be seen every other day led about in the streets in the vicinity of his Bunhill residence, a slender figure, of middle stature or a little less, generally dressed in a grey cloak or overcoat, and wearing sometimes a small silver-hilted sword, evidently in feeble health, but still looking younger than he was, with his lightish hair, and his fair, rather than aged or pale, complexion. He would sit in his garden at the door of his house, in warm weather, in the same kind of grey overcoat, "and so, as well as in his room, received the visits of people of distinguished parts, as well as quality." Within doors he was usually dressed in neat black.

He was a very early riser, and very regular in the distribution of his day, spending the first part, to his midday dinner, always in his own room, amid his books, with an amanuensis to read for him and write to his dictation. Music was always a chief part of his afternoon and evening relaxation, alike when he was by himself or when friends were with him. His manner with friends and visitors was extremely courteous and affable, with just a shade of stateliness. In free conversation, either at the midday dinner, when a friend or two happened, by rare accident, to be present, or more habitually in the evening and at the light supper which concluded it, he was the life and soul of the company, from his "flow of subject" and his "unaffected cheerfulness and civility," though with a marked tendency to the satirical and sarcastic in his criticisms of men and things. This tendency to the sarcastic was connected by some of those who observed it with a peculiarity of his voice or pronunciation. "He pronounced the letter *r* very hard," Aubrey tells us, adding Dryden's note on the subject: "*litera canina*, the dog-letter, a certain sign of a satirical wit." He was extremely temperate in the use of wine or any strong liquors, at meals and at all other times; and when supper was over, about nine o'clock, "he smoked his pipe and drank a glass of water, and went to bed." He suffered much from gout, the effects of which had become apparent in a stiffening of his hands and finger-joints, and the recurring attacks of which in its acute form were very painful. His favourite poets among the Greeks were Homer and the Tragedians, especially Euripides; among the Latins, Virgil and Ovid; among the English, Spenser and Shakespeare. Among his English contemporaries, he thought most highly of Cowley. He had ceased to attend any church, belonged to no religious communion, and had no religious observances in his family. His reasons for this were a matter for curious surmise among his friends, because of the profoundly religious character of his own mind; but he does not seem ever to have furnished the explanation. The matter became of less interest perhaps after 1669, when his three daughters ceased to reside with him, having been sent out "to learn some curious and ingenious sorts of manufacture that are proper for women to learn, particularly embroideries in gold or silver." After that the household in Bunhill consisted only of Milton, his wife, a single maid-servant, and the "man" or amanuensis who came in for the day.

In 1669 he published *Accedence commenced Grammar*, and in 1670 his *History of Britain . . . to the Norman Conquest*, and a Latin digest of Ramist logic, entitled *Artis logicae plenior institutio*. In 1671 there followed his *Paradise Regained* and *Samson Agonistes*, bound together in one small volume, and giving ample proof that his poetic genius had not exhausted itself in the preceding great epic. In 1673, Milton ventured on the dangerous experiment of one more political pamphlet, in which, under the title *Of True Religion*, he put forth, with a view to popular acceptance, as mild a version as possible of his former principles on the topics discussed. In the same year appeared the second edition of his *Poems . . . both English and Latin*, which included, with the exception of the Sonnets to Cromwell, Fairfax, Vane and the second address to Cyriack Skinner, all the minor poems.

In 1674 the second edition of *Paradise Lost*, in 12 books instead of 10, appeared, and his *Epistolae Familiares*, together with his Cambridge *Prolusiones*. On Nov. 8, 1674, Milton died, in his house in Bunhill, of "gout struck in," at the age of 65 years and 11 months. He was buried, the next Thursday, in the church of St. Giles, Cripplegate, beside his father; a considerable concourse attending the funeral.

Posthumous Publications.—Of masses of manuscript that had been left by Milton, some portions saw the light posthumously. Prevented in the last year of his life from publishing his Latin *State Letters* in the same volume with his Latin *Familiar Epistles*, he had committed the charge of the *State Letters*, prepared for the press, together with the completed manuscript of his Latin *Treatise of Christian Doctrine*, to a young Cambridge scholar, Daniel Skinner, who had been among the last of his amanuenses, and had, in fact, been employed by him especially in copying out and arranging those two important mss. Negotiations were on foot, after Milton's death, between this Daniel Skinner and the Amsterdam printer, Daniel Elzevir, for the publication of both mss., when the English government interfered, and the mss. were sent back by Elzevir, and thrown aside, as dangerous rubbish, in a cupboard in the State Paper Office. Meanwhile, in 1676, a London bookseller, named Pitt, who had somehow got into his possession a less perfect, but still tolerably complete, copy of the *State Letters*, had brought out a surreptitious edition of them, under the title *Literae pseudo-senatus anglicani, Cromwellii . . . nomine et jussu conscriptae a Joanne Miltono*. No other posthumous publications of Milton's appeared till 1681, when another bookseller put forth a slight tract entitled *Mr. John Milton's Character of the Long Parliament and Assembly of Divines*, in 1641, consisting of a page or two, of rather dubious authenticity, said to have been withheld from his *History of Britain* in the edition of 1670. In 1682 appeared *A Brief History of Moscovia, and of other less-known Countries lying Eastward of Russia as far as Cathay . . .* undoubtedly Milton's, and a specimen of those prose compilations with which he sometimes occupied his leisure. Of the fate of his collections for a new Latin *Dictionary*, which had swelled to three folio volumes of ms., all that is known is that, after having been used by Edward Phillips for his *Enchiridion* and *Speculum*, they came into the hands of a committee of Cambridge scholars, and were used for that Latin dictionary of 1693, called *The Cambridge Dictionary*, on which Ainsworth's *Dictionary* was based. In 1698 there was published in three folio volumes, under the editorship of John Toland, the first collective edition of Milton's prose works, professing to have been printed at Amsterdam, though really printed in London. A very interesting folio volume, published in 1743 by "John Nickolls, junior," under the title of *Original Letters and Papers of State addressed to Oliver Cromwell*, consists of a number of intimate Cromwellian documents that had somehow come into Milton's possession immediately after Cromwell's death, and were left by him confidentially to the Quaker Ellwood. Finally, a chance search in the London State Paper Office in 1823 having discovered the long-lost parcel containing the mss. of Milton's Latin *State Letters* and his Latin *Treatise of Christian Doctrine*, as these had been sent back from Amsterdam a hundred and fifty years before, the *Treatise of Christian Doctrine* was, by the command of George IV., edited and published in 1825 by the Rev. C. R. Sumner, under the title of *Joannis Miltoni Angli de doctrina christiana libri duo posthumi*. An English translation, by the editor, was published in the same year. Those state papers of Milton which had not been already printed were edited by W. D. Hamilton for the Camden Society, in 1859.

Milton as Writer.—Milton's literary life divides into three almost mechanically distinct periods: (1) the time of his youth and minor poems, (2) his middle twenty years of prose polemics, and (3) the time of his later Muse and greater poems.

Had Milton died in 1640, when he was in his thirty-second year, and had his literary remains been then collected, he would have been remembered as one of the best Latinists of his generation and one of the most exquisite of minor English poets. In the latter character, more particularly, he would have taken his place as one of that interesting group or series of English poets, coming in the next forty years after Spenser, who, because they all acknowledged a filial relationship to Spenser, may be called collectively the Spenserians. In this group Milton would have been entitled, by the small collection of pieces he had left, and which would have included his *Ode on the Nativity*, his *L'Allegro* and *Il Penseroso*, his *Comus* and his *Lycidas*, to recognition as indubitably the very highest and finest. There was in him that peculiar Spenserian something which might be regarded as the poetic faculty in its essence, with a closeness and perfection of verbal finish not to be found in the other Spenserians, or even in the master himself. But owning discipleship to Spenser as the author did, he was a Spenserian with a difference belonging to his own constitution—which prophesied the passage of English poetry out of the Spenserian into a kind that might be called the Miltonic. This Miltonic something, distinguishing the new

poet from other Spenserians, was more than mere perfection of literary finish. It consisted in an avowed consciousness already of the *os magna soniturum*, "the mouth formed for great utterances," that consciousness resting on a peculiar substratum of personal character that had occasioned a new theory of literature. "He who would not be frustrate of his hope to write well hereafter on laudable things ought himself to be a true poem" was Milton's own memorable expression afterwards of the principle that had taken possession of him from his earliest days; and this principle of moral manliness as the true foundation of high literary effort, of the inextricable identity of all literary productions in kind, and their coequality in worth, with the personality in which they have their origin, might have been detected, in more or less definite shape, in all or most of the minor poems. It is a specific form of that general Platonic doctrine of the invincibility of virtue which runs through his *Comus*.

That a youth and early manhood of such poetical promise should have been succeeded by twenty years of all but incessant prose polemics has been a matter of regret with many. But this is to ignore his political and social side. Milton was not only the greatest pamphleteer of his generation—head and shoulders above the rest—but there is no life of that time, not even Cromwell's, in which the history of the great Revolution in its successive phases, so far as the deep underlying ideas and speculations were concerned, may be more intimately and instructively studied than in Milton's. Then, on merely literary grounds, what an interest in those prose remains! From the entire series there might be a collection of specimens, unequalled anywhere else, of the capabilities of that older, grander and more elaborate English prose of which the Elizabethans and their immediate successors were not ashamed.

While it is wrong to regard Milton's middle twenty years of prose polemics as a degradation of his genius, who does not exult in the fact that such a life was rounded off by a final stage of compulsory calm, when the "singing robes" could be resumed, and *Paradise Lost, Paradise Regained* and *Samson Agonistes* could issue in succession from the blind man's chamber? Of these three poems, and what they reveal of Milton, no need here to speak at length. *Paradise Lost* is one of the few monumental works of the world, with nothing in modern epic literature comparable to it except the great poem of Dante. This is best perceived by those who penetrate beneath the beauties of the merely terrestrial portion of the story, and who recognize the coherence and the splendour of that vast symbolic phantasmagory by which, through the wars in heaven and the subsequent revenge of the expelled archangel, it paints forth the connection of the whole visible universe of human cognisance and history with the grander, pre-existing and still environing world of the eternal and inconceivable. To this great epic *Paradise Regained* is a sequel, and it ought to be read as such. The best critical judgment now pronounces *Paradise Regained* to be not only, within the possibilities of its briefer theme, a worthy sequel to *Paradise Lost,* but also one of the most artistically perfect poems in any language. Finally the poem in which Milton bade farewell to the Muse, and in which he reverted to the dramatic form, proves that to the very end his right hand had lost none of its power or cunning. *Samson Agonistes* is the most powerful drama in the English language after the severe Greek model, and it has the additional interest of being so contrived that, without any deviation from the strictly objective incidents of the Biblical story which it enshrines, it is yet the poet's own epitaph and his condensed autobiography.

Much light is thrown upon Milton's mind in his later life, and even upon the poems of that period, by his posthumous Latin *Treatise of Christian Doctrine.* It differs from all his other prose writings of any importance in being cool, abstract and didactic. Professing to be a system of divinity derived directly from the Bible, it is really an exposition of Milton's metaphysics and of his reasoned opinions on all questions of philosophy, ethics and politics. The general effect is to show that, though he is rightly regarded as the very genius of English Puritanism, its representative poet and idealist, yet he was not a Puritan of what may be called the first wave, or that wave of Calvinistic orthodoxy which broke in upon the absolutism of Charles and Laud, and set the English Revolution agoing. He belonged distinctly to that larger and more persistent wave of Puritanism which, passing on through Independency, and an endless variety of sects, many of them rationalistic and freethinking in the extreme, developed into what has ever since been known as English Liberalism. The treatise makes clear that, while Milton was a most fervid theist and a genuine Christian, believing in the Bible, and valuing the Bible over all the other books in the world, he was at the same time one of the most intrepid of English thinkers and theologians.

Bibliography.—Mss. of the poems of Milton's earlier period in his own handwriting are preserved in the library of Trinity college, Cambridge. These are not enumerated among the gifts made by Sir Henry Newton Puckering in 1691, but presumably belonged to him, and came to the library at his death in 1700, as they were found by Charles Mason, a fellow of the college, among papers and books which had been his. They were bound in a folio volume by the care of Thomas Clarke, afterwards Master of the Rolls, in 1736. Besides the poems, with many interlineations and corrections, the ms. contains suggestions, and in some cases fully developed plans, for works generally dramatic in form. This manuscript volume, invaluable as an index to Milton's methods of work, was reproduced in facsimile (Cambridge, 1899) by W. Aldis Wright.

The first complete edition of *The Poetical Works of Mr. John Milton . . .* was printed by Jacob Tonson in 1695. In 1732 Richard Bentley put forward a curious edition of *Paradise Lost* in which long passages were rejected and placed in the margin on the ground that they were interpolations made possible by Milton's blindness. The Latin and Italian poems, with a translation by William Cowper, were printed by W. Hayley in 1808. The most important of the numerous later editions of Milton's poetical works are by H. J. Todd (6 vols., 1801); J. Mitford ("Aldine edition," 3 vols., 1832); T. Keightley (2 vols., 1859), whose notes are most original and interesting; D. Masson ("Library" or "Cambridge" edition, 3 vols., 1874; of which a new edition appeared in 1890, with memoir, introduction, notes and an essay on Milton's English and versification); John Bradshaw (new "Aldine edition," 2 vols., 1892); also a careful reprint retaining the peculiarities of the earlier printed copies, by H. C. Beeching ("Oxford edition," 1904); and another, with variant readings, by W. Aldis Wright (Cambridge University Press, 1903). The prose works were first partially collected in 1697. They were edited by J. Toland (3 vols., 1698), by C. Symmons (7 vols., 1806), by Pickering (8 vols., 1851) with the poetical works, and by J. A. St. John for Bohn's "Libraries" (5 vols., 1848–53). There are numerous annotated editions of separate works.

The earliest life of Milton is contained in Wood ms. D. 4 in the Bodleian library, Oxford, and was printed in the *Eng. Hist. Review* for January 1902, also by E. S. Parsons in *Colorado College Studies*, No. X. (1903). The author, who sympathized with the poet's political views, is unknown, but the name of Milton's friend, Dr. Nathan Paget, is suggested. His account formed the basis of the life given by Anthony à Wood in *Fasti oxonienses* (1691). Wood was also indebted to John Aubrey, whose *Brief Lives* were not printed until later. The life by his nephew Edward Phillips was prefixed to the *Letters of State* printed in 1694, and reprinted by William Godwin in his *Lives of E. and J. Phillips* (1815). Samuel Johnson's famous *Life of Milton* (1779), which contains some valuable criticism, is written from a somewhat unfriendly standpoint. The records of Milton's official life, available in the State Papers, were first made use of by H. J. Todd in a third edition (1829) of his *Milton.* All the available information was gathered in Professor Masson's *Life of John Milton; narrated in Connexion with the Political, Ecclesiastical and Literary History of his Time* (6 vols., 1859–80, with index, 1894; new ed. of vol. i., 1881) which contains ample reference to original authorities. Shorter works are *Milton und seine Zeit* (2 pts., 1877, 1879), by Alfred Stern; *Milton* (1879), by Mark Pattison in the "English Men of Letters" series, and *Life of John Milton* (1890) by Dr. Richard Garnett in the "Great Writers" series, with a bibliography by J. P. Anderson. W. H. Huline, *Two early lives of Milton* (1924), contains lives by Toland and Fenton. A valuable contribution to Miltonic criticism was made in 1893 by Robert Bridges in an essay on *Milton's Prosody.* This was reprinted in 1901 (new ed. 1921). Amongst other critical essays should be mentioned essays by Macaulay (*Edinburgh Review,* 1825); Walter Bagehot (*Literary Studies,* vol. i., 1879); S. T. Coleridge (*Seven Lectures on Shakespeare and Milton,* 1856); Edward Dowden (*Transcripts and Studies,* 1888); Edmond Scherer (*Études sur la littérature contemporaine,* vol. vi., 1882); Augustine Birrell (*Obiter dicta,* second series 1887); Walter Raleigh (*Milton,* 1900); E. Allodoli, *Giovanni Milton e l'Italia* (Prato, 1907); N. G. Tarrant, *John Milton* (1908); R. O. Havens, *Influence of Milton in English Poetry* (1922); W. Harris, *John Milton* (2nd ed. 1923); J. Langdon, *Milton's Theory of Poetry and Fine Art* (1924); D. Saurat, *Milton, Man and Thinker* (1925); J. H. Hanford, *A Milton Handbook* (1926); M. A. Larson, *The Modernity of Milton* (1927). (D. Ma.; X.)

MILTON, a town of Norfolk county, Massachusetts, U.S.A., 7 m. S. of Boston, on the Neponset river, and served by the New

York, New Haven and Hartford railroad. The population was 9,382 in 1920, 22% foreign-born white, and was 16,434 in 1930 by the Federal census. It covers 13 sq.m., embracing the villages of Milton, East Milton and Mattapan, and is primarily a residential suburb of Boston. It has several factories, and two quarries of dark bluish-grey granite, used chiefly for monuments. One of the public parks is part of the estate of Thomas Hutchinson, the last royal governor. On Great Blue hill (635 ft.), where great fires were kindled to celebrate important news and signal beacons were burned during the Revolution, is the Blue Hills observatory, established by Albert Lawrence Rotch, who used kites for securing meteorological data and made important studies of clouds. Milton was formed in 1662 from a part of Dorchester called Uncataquissett, which had been settled in 1640. On Sept. 9, 1774, at the home of Daniel Vose, a meeting (adjourned from Dedham) passed the bold "Suffolk Resolves," urging forcible opposition to Great Britain, if necessary.

MILTON, a borough of Northumberland county, Pennsylvania, U.S.A., on the Susquehanna river and the Susquehanna trail, 67 m. N. of Harrisburg. It is served by the Pennsylvania and the Reading railways and motor-bus lines. Pop. (1920) 8,638 and in 1930, 8,552. It is in a beautiful and productive region, and has important manufactures, including tank cars, fabricated steel, pressed steel products, hosiery, shirts, broad silk, cedar chests and dairy products. The borough (originally "Mill Town") was founded in 1792 and incorporated in 1817. A large part of the town was destroyed by fire in 1880.

MILWAUKEE, the largest city of Wisconsin, U.S.A., and the 12th in size in the United States (1930), on Lake Michigan, 85 m. N. of Chicago; a port of entry and the county seat of Milwaukee county. It is on Federal highways 16, 18, 41 and 141; has municipal and commercial airports; and is served by the Chicago and North Western, the Chicago, Milwaukee, St. Paul and Pacific, the Chicago, North Shore and Milwaukee, the Grand Trunk, the Pere Marquette, and the Soo Line railways, numerous motor coach and truck lines, and 9 lake steamship lines. Pop. (1920) 457,147 (110,160 foreign born, of whom 39,771 were from Germany and 23,060 from Poland; in 1930 it was 578,249.

The city has an area of 35 sq.m.; an altitude of 580 ft., rising to a height of 75 to 125 ft. above the level of the lake. Three rivers cut it into natural divisions, known as the east, the west and the south sides. The Milwaukee river, entering from the north, is joined half a mile from its mouth by the Menominee, flowing from the west, and nearer the lake by the Kinnickinnic, from the south, and empties into Milwaukee bay, about 6 m. wide. The rivers are navigable for lake traffic into the heart of the city. A large part of the lake front is owned by the city, and developed in parks, airport, and harbour facilities. The Court of Honor (dedicated to those who have taken part in the wars of America) is a broad parked space extending for three blocks on Wisconsin avenue, past the public library and museum, several fine churches, and other important buildings. In the heart of the city is the vast municipal auditorium, comprising 8 halls (seating from 300 to 8,000) under one roof, and providing over 95,000 sq.ft. of exhibition space. The 40 hotels have 5,500 guest-rooms, and the office buildings, department stores, and other business structures are for the most part large and of modern type. The park system covers 1,000 ac. and includes provision for all the popular games and recreations. Additional playgrounds are maintained by the school board. Under the forestry division of the park department, the systematic planting of shade trees and shrubs in the city streets is carried on, and existing trees are pruned, sprayed, moved when necessary, and removed when dead or diseased. In the first ten years after the creation (1918) of this service, 25,000 new trees were planted.

Education and Charities.—The public school system includes 80 elementary and 8 general high schools, two technical high schools, a trade school for girls and one for boys (the latter providing a Mechanics Institute for men), and a part-time vocational school which has an attendance of 12,000. The parochial schools number 101. The public library and museum contain 680,000 volumes, and an excellent collection of historic relics and of material illustrating the natural sciences. The city maintains one of the largest zoological gardens in the country. There is a municipal art institute, and the Layton Art gallery has one of the best collections of paintings west of the Alleghenies. The Germans who played so large a part in building up the city are represented (among many other reminders) by numerous musical societies and *turnvereins*. Milwaukee is the seat of a State normal school (established 1880); Milwaukee-Downer college for women (formed in 1895 by the consolidation of Milwaukee college and Downer college, a Baptist institution established at Fox Lake in 1855); Marquette university (Roman Catholic; 1881) which has one of the largest dental schools in the country; the Milwaukee School of Engineering (1905); the Wisconsin Workshop for the Blind; the Wisconsin Industrial School for Girls (to be moved about 1930); and numerous private schools and charitable institutions under religious auspices. Just west of the city is a group of county institutions for the care of the aged, infirm, insane and dependent. On the south-west outskirts is a branch of the national home for disabled and tuberculous army veterans. The privately supported philanthropic agencies of the city raise their funds in a joint annual campaign. Eight daily papers are published in the city, including one German and two Polish. The general death rate and the infant mortality are low.

Government.—The city operates under a charter of 1874, providing for a municipal form of government, with a mayor and board of aldermen elected biennially. The budget system has been in use since 1913. The water supply is taken from Lake Michigan, at a point 5 m. from the harbour. The two pumping stations have a capacity of 219,000,000 gal. in 24 hours, about three times the daily average consumption in 1927. The entire cost of the water works ($16,000,000) has been paid out of earnings of the department. In 1925 a sewage disposal system was completed at a cost of $8,500,000. It is based on the activated sludge process, by which fertilizer material of commercial value is produced, covering about two-thirds of the operating expense. The city's assessed valuation of property for 1928 was $1,181,899,550. Exempt property was valued at $191,435,264, and public utilities at $128,440,000. A comprehensive city plan was prepared in 1917 but has not yet (1928) been formally adopted. Zoning ordinances were enacted in 1920 and 1924.

Commerce and Manufactures.—Milwaukee is the commercial metropolis of the State, and ranked 11th in 1925 among the cities of the United States in the value of its manufactured products. Its fine harbour, open throughout the year and accessible to the largest craft on the lakes, is the most important gateway to the North-west for traffic across Lake Michigan. The water-borne commerce amounted in 1927 to 8,233,198 tons, valued at $466,726,000, of which entire total 66% (in value) was car-ferry traffic, and the rest general vessel cargo, largely coal and grain. Milwaukee is one of the great grain ports of the Great Lakes and one of the largest distributing centres for coal in the country. Its commerce is domestic for the most part. Exports to foreign countries were valued in 1927 at $43,676,422, and imports at $6,813,084. The aggregate jobbing and wholesale business of the city for 1926 was estimated at $170,000,000. Bank debits in 1927 amounted to $3,699,524,000.

The manufactures of the city are many and varied. The large brewing industry for which it was famous was dissipated by the national legislation following the adoption of the 18th amendment to the Constitution; but even at its height the manufacture of beer was less important than many of its other industries. In the year ending June 30, 1918, just before the prohibitory legislation, the output of the breweries was 2,900,000 bbl., valued at $22,500,000, but this was probably less than 4% of the aggregate output of all the factories. The total factory product in 1927 was valued at $627,415,824. Chief among the manufactures are heavy machinery (cranes and hoists, steam shovels, excavators and dredges, steam and water turbines, hydraulic electric units, rock and ore crushers, mining, milling, refrigerating and agricultural machinery of all kinds), tinware and enamelled ware, leather, motorcycles and automobile frames, steel wheelbarrows, work shoes, silk stockings, toilet soaps, doll carriages, candy, leather

gloves, trunks and soft drinks Milwaukee shovels dug the Panama canal and the great open-pit iron mines of Minnesota. The largest ore-crusher in the world (in operation in Chile), weighing 500 tons, was made in Milwaukee; as was the huge hydro-electric unit installed at Niagara Falls.

History.—In 1673 Father Marquette and Louis Joliet, returning to the mission of St. Francis Xavier at De Pere from their trip down the Mississippi, skirted the west shore of Lake Michigan in their canoes. Milwaukee bay is distinctly marked on the map attributed to Marquette which was discovered in a convent in Montreal and is now in the Jesuit college in that city. La Salle and his party probably stopped here on their way south in 1679, and the name first appears ("Millioke") in the Jesuit Relations of that year. This and the numerous other variants were attempts to transliterate the Indian name (meaning "good lands") of the village which the white men found here. The first Englishman known to have visited the spot was the adventurous trader, Alexander Henry, in 1760. There is record of a French fur-trading post in 1763. In 1795 Jacques Vieau established a permanent post for the North-Western Fur Company, which he seems to have kept up until it was superseded in 1820 by one belonging to Astor's American Fur Company. Vieau built a dwelling and a warehouse and engaged in extensive trading operations. In 1818 there arrived a young Frenchman, Laurent Solomon Juneau (1793–1856), who married one of Vieau's daughters and eventually bought out his business. The settlement was on the direct line of travel from Ft. Dearborn (Chicago) and Green Bay, and as soon as the Indian titles were extinguished by the treaties of 1831 and 1833 with the Menominee, colonists began to come to the neighbourhood. In 1833 Morgan L. Martin (1805–87) of Green Bay explored the harbour, made a map of the place, and entered into an agreement with Juneau and Michael Dousman for its development. A saw-mill was built in 1834. The east side was platted in the summer of 1835, and the west side a little later (by Byron Kilbourn). The rival settlements, officially Milwaukee East Side and Milwaukee West Side, were popularly known as Juneautown and Kilbourntown. A third, called Walker's Point, was established on the south side by George H. Walker. The east side and the west side towns had bitter quarrels, especially over the building of bridges, for their streets, having been surveyed independently, did not come out at the same point on the river. They were separately incorporated as townships of Milwaukee county in 1837, but in 1839 united as wards of the same village, each one keeping complete financial and administrative autonomy of its own affairs. Walker's Point was annexed as a third ward in 1845, and in 1846 the three were incorporated as the city of Milwaukee, of which Solomon Juneau was elected the first mayor. The first vessel anchored in Milwaukee bay in 1779. A Chicago packet entered the river in 1823. The first newspaper, the *Milwaukee Advertiser,* began publication on July 14, 1836, and a public school was opened in that year. In 1839 George Smith and Alexander Mitchell established the Fire and Marine Insurance Bank, which for 40 years was one of the strongest banking houses west of the Alleghenies. Its notes passed at par through panics under which even Government issues depreciated, and it financed the "Milwaukee" and other western railways. The first brewery was built in 1840, by Owens and Pawlett. Connection was established with Chicago by telegraph in 1849; by railway in 1856. About 1840 began a stream of immigration from Germany, which was accelerated by the revolutionary movements of 1848 and continued for half a century. In 1900, out of a total population of 285,315—53,854 had been born in Germany, and 151,045 more had one or both parents of German birth, making a total of 72% who were either German by birth or of the "first generation." The population of the city has grown steadily from the beginning. By 1860 it had reached the total of 45,246, and the increase in succeeding decades was 58%, 62%, 77%, 40%, 31%, and 22% for 1910–20.

MILYUKOV, PAUL NIKOLAYEVICH (1859–), Russian politician and historian, was born near St. Petersburg (Leningrad) on Jan. 27, 1859. He studied history and humanities at the University of Moscow, and received the degree of master in history for a learned work on the *State Economics of Russia in the First Quarter of the 18th Century.* His liberal opinions brought him into conflict with the educational authorities, and he was dismissed in 1895 after one of the ever-recurrent university "riots." After the meetings of the zemstvos in 1905 he became the political editor of the *Retch,* and helped to found the constitutional democratic party (Kadets). Milyukov became the leader of that party, although he was not elected a member of the first or the second Duma. When the tsar dissolved the first Duma he helped to draft the "Viborg manifesto," in which members of the Duma declared themselves ready to follow the people in resisting arbitrary rule. Milyukov did not sign, however, as he was not a member of the Duma, and escaped the persecution which accompanied the Stolypin reaction. He was elected to the third and the fourth Duma, and was a leader of the opposition.

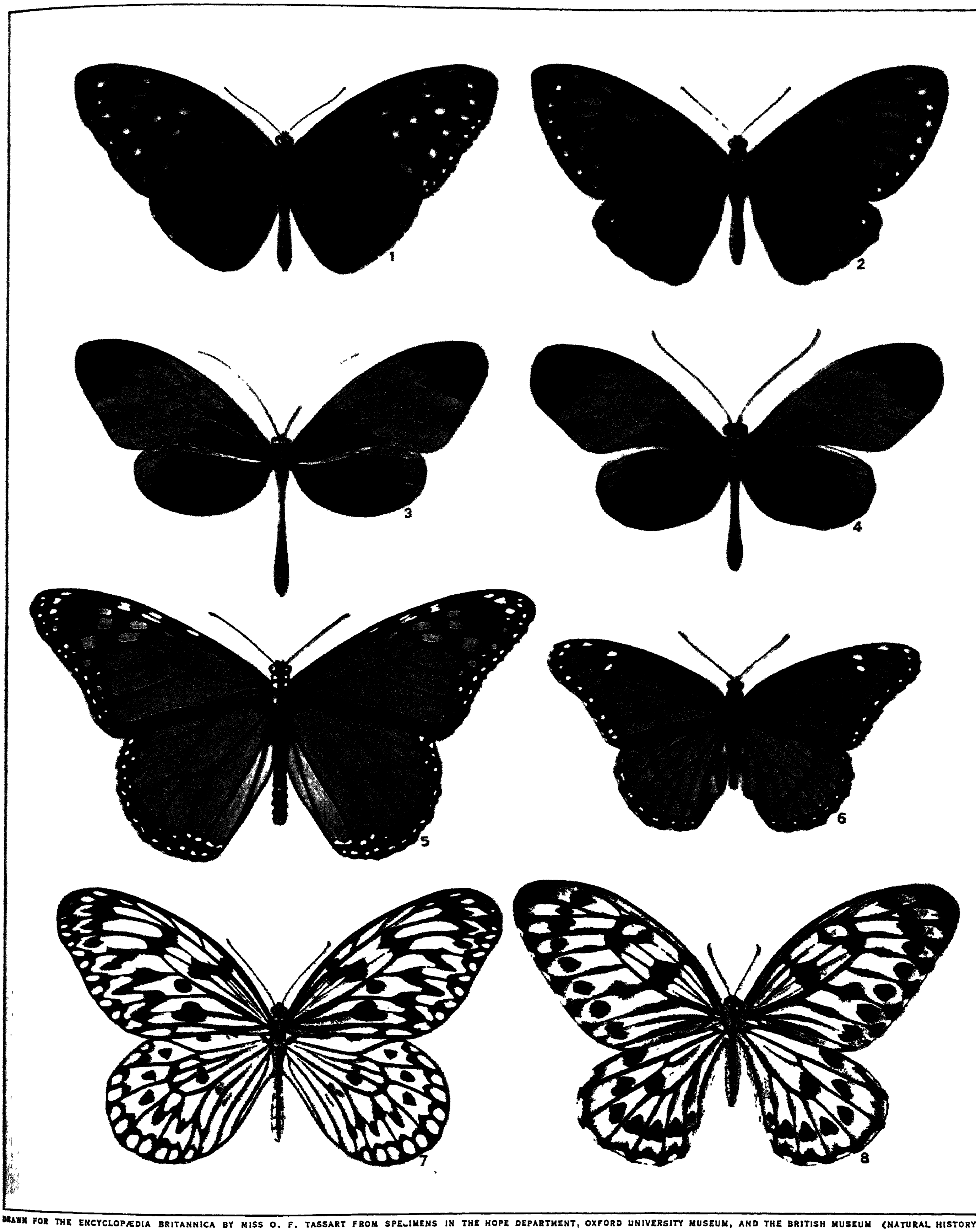
When the World War broke out he stood for a national union and for co-operation with the Entente, but the maladministration of the War Office drove him into an attitude of increasing hostility. Milyukov took office in Prince Lvov's provisional Government as minister of foreign affairs. When the Bolsheviks seized power he escaped to Kiev, then occupied by the Germans, and gave up the cause of the Allies as lost. After the Armistice Milyukov went to London and subsequently to Paris, where in 1921 he directed a journal (*Last News*) in which he advocated an alliance with patriotic Socialists.

His works include a *History of the Second Russian Revolution* (3 vols., 1921–23) and *Russia's Catastrophe* (2 vols., 1927).

MIME, an ancient Greek dramatic form in which the players portrayed events of everyday life, with the help of elaborate gestures; the name came to be applied also to the actors themselves. As literature, the mime developed in Sicily and southern Italy (5th century B.C.) through the prose of Sophron and Epicharmus, and later (3rd century B.C.) through the metric compositions of Herondas. The *mimus* found its way into Roman literature (1st century B.C.) through D. Labienus, Publius Syrus and others. For later growth and development *see* DRAMA; PANTOMIME.

MIMETITE, a mineral consisting of lead chloro-arsenate, $(PbCl)Pb_4(AsO_4)_3$, crystallizing in the hexagonal system and closely resembling pyromorphite (*q.v.*) in appearance and general characters. The arsenic is usually partly replaced by equivalent amounts of phosphorus, and there may thus be a gradual passage from mimetite to pyromorphite. The two species can, as a rule, only be distinguished by chemical analysis, and because of their close resemblance the less frequently occurring chloro-arsenate was named mimetite, or mimetesite, from Gr. μιμητής, imitator. Crystals of pyromorphite though usually optically uniaxial are sometimes biaxial, but in mimetite this anomalous character is almost always present; a cross-section of a hexagonal prism of mimetite shows a division into six optically biaxial sectors or a complex lamellated structure. In colour mimetite is usually yellow or brown, rarely white or colourless; the lustre is resinous to adamantine. The hardness is 3·5, and the specific gravity 7·0–7·25. Like pyromorphite, mimetite is found in the upper parts of veins of lead ore, where it has been formed by the oxidation of galena and mispickel. When found in large amount it is of importance as an ore of lead. The best crystallized specimens are those from Johanngeorgenstadt in Saxony, Wheal Unity in Cornwall, and Tsumeb in South-west Africa. It was formerly found in considerable amount at Dry Gill, Cumberland, as six-sided barrel-shaped crystals of a brownish-red or orange-yellow colour containing a considerable proportion of phosphoric acid; this variety has been called campylite (Gr. καμπύλος, curved), on account of the remarkable curvature of the faces of the crystals.

MIMICRY. The word Mimicry is applied by naturalists to certain advantageous resemblances between animals, and in some instances between plants. The resemblance of the common dead-nettle to the stinging nettle, with which it is commonly associated, is a good example of plant mimicry. These resemblances are independent of affinity, viz., they may exist between species of very different degrees of relationship, generally distant but sometimes near; they are such as appeal to the senses of enemies, especially to the sense of sight, not uncommonly to hearing, occasionally to



DRAWN FOR THE ENCYCLOPÆDIA BRITANNICA BY MISS O. F. TASSART FROM SPECIMENS IN THE HOPE DEPARTMENT, OXFORD UNIVERSITY MUSEUM, AND THE BRITISH MUSEUM (NATURAL HISTORY)

FOUR BUTTERFLIES AND THEIR MIMICS

Top row (left) The Danaid *Euploea midamus* and (right) its mimic *Papilio paradoxus* of Malaya

Second row (left) the Ithomiinae *Melinaea mothone* and (right) its Nymphalid mimic *Heliconius aristiona* both of Peru

Third row (left) the Danaid "Monarch" *Danaus plexippus* and (right) its mimic the Nymphalid "Viceroy" *Basilarchia archippus* both of North America

Fourth row (left) the Danaid *Hestia leuconoe* and (right) its mimic *Papilio idaeoides* both of the Philippines

smell and touch. They differ from the much larger class of Protective Resemblances in that these bring about concealment by a likeness to some object of no interest to enemies, whereas the true mimic resembles a conspicuous "model" feared or disliked by its enemies, and thus becomes conspicuous itself. Other differences have been suggested—that the mimic resembles an animal model and not the vegetable or mineral surroundings; that it resembles a moving and not a stationary object. These distinctions, although generally true, do not always hold. The resemblance of external parasites to the hair, feathers or skin of their host, and of many insects to the excrement of birds, snails or of other insects, and to empty snail-shells, is not mimicry but protective resemblance, which would also include those caterpillars whose curious swaying movements suggest a swinging fragment of twig, or butterflies and moths which float to the ground like a falling leaf or allow themselves to be driven like a leaf before the wind. Mimics are also commonly adapted to resemble their models in the position of rest as well as in flight.

Mimetic resemblances also differ from those which are an incidental result of similar functions, such as the general likeness in form between the racehorse and the greyhound or between the mole-like species with mole-like habits of life in the insectivores, rodents and marsupials; also from the incidental likeness between species which resemble the same part of their surroundings—sand, bark, leaves, etc. Mimetic resemblances differ from these in that they have been developed for the sake of the resemblance because of some advantage conferred in the struggle for existence. The term "mimicry," implying in its ordinary use conscious imitation, has been a source of confusion; it has now, however, a technical scientific meaning.

Other views as to the origin of these resemblances are:—that they are due (1) to the direct influence of the environment acting similarly on different species; (2) to a physiological response to constant mental experience such as colour sensation; (3) to sexual selection, modified by the presence of other types of colour. This last suggestion, due to Fritz Müller, is not supported by the fact that female butterflies are far more commonly mimetic than males.

The suggestion that these resemblances are a mere coincidence fails because of the evident geographical relationship. Mimics are found in the same localities as their models and when the latter are modified in various parts of their range the mimics change with them. There are however exceptions when the mimics are greater wanderers than their models, and in one remarkable example two butterflies in western China appear to be undoubted mimics of a model very common south of the Himalayas; here it is suggested that selection by migratory insectivorous birds may be influenced by their remembered experiences of the tropics.

Although mimetic resemblance is believed to exist in mammals, birds and fishes the number of examples is small and their interpretation often doubtful. Among reptiles poisonous snakes are mimicked by harmless species. Even the English grass-snake will often, when cornered, poise itself and strike like an adder. But for the study of the subject the insects are supreme, the small percentage of survival and swift succession of generations rendering natural selection peculiarly searching in its operation and rapid in its results.

DANAINE BUTTERFLIES

The figures on Plate I. illustrate facts consistent with the belief that mimicry is an advantageous resemblance and has been developed for its own sake—facts which are meaningless on any suggested interpretation except one based on selection. The butterflies most generally mimicked by species of other groups and by day-flying moths belong to a few dominant tropical sub-families, the Danainae and Acraeinae of the Old World, and, in the New, the Ithomiinae, allied to the first, and the Heliconinae allied to the second, together with very few Danainae and many Acraeinae. Now, however widely the types of pattern vary within each of these sub-families, they are still mimicked by butterflies of other groups and often by moths. The South American Acraeas have very different patterns from those of the African Acraeas, yet both are extensively mimicked. The most striking evidence is, however, supplied by the divergent colours and patterns of the Danaine models, of which a few examples are figured. The Oriental *Hestia* and its allies are large, black-and-white butterflies with thin papery wings. A characteristic example (*Hestia leuconoe*) from the Philippine islands and its swallowtail mimic (*Papilio idaeoides*) from the same locality are shown in the fourth row. In this and the following pair it must be borne in mind that the mimic is but a single example selected to represent many butterflies of different groups, and also day-flying moths, which mimic the same type of pattern in various parts of the Oriental region. In top row is the male of *Euploea midamus*, an example of a far more dominant and widespread Danaine type, that of the blue *Euploeas*, at its right is its swallowtail mimic (*Papilio paradoxus*). The originals of these two figures were both taken in the same part of the Malay peninsula. In Africa the Danaines are much less numerous but still supply the chief models for mimicry. The majority of the species belong to the genus *Amauris*, black butterflies with white or yellowish markings, very unlike the Oriental Danainae.

An entirely different type of Danaine pattern (third row, left) is borne by a series of nearly related species in the Oriental region, which must be regarded as the original home. This pattern is of especial interest for the present argument, because one species bearing it has migrated westward and become the chief model for mimicry in Africa, while two others have travelled eastward and become the ancestors of American species mimicked by indigenous American butterflies. In the third row is the best-known invader, *Danaus plexippus*, the monarch, the figured specimen, together with its mimic, the viceroy, having been caught near Chicago by the writer on Aug. 5, 1897. The mimic shown is a Nymphaline butterfly, *Basilarchia archippus*, closely related to the British white admiral and itself so recently descended from a North American white admiral that the two will interbreed and produce hybrid offspring. In all the earlier stages of its life-history the mimic remains a white admiral, the mimetic resemblance being restricted to the final colour and pattern. If, as some have supposed, mimetic likeness is the result of local influences, we should expect that the invader would have come to resemble the native rather than that the native should mimic the invader.

The above facts point directly to the conclusion that there is some advantage in mimicking Danaine butterflies, and, if space permitted, similar evidence could be brought forward to show that the widespread mimicry of the other great tropical groups is also advantageous. The proof becomes especially convincing in certain butterflies with many forms of female. Thus, three Uganda females of the African swallowtail *Papilio dardanus* mimic respectively three very different Danaine patterns, and the fourth an Acraeine; and in other parts of Africa where the Danaine patterns alter, and one of them or the Acraeine model is absent, we find that the corresponding female is similarly modified or wanting. In another African swallowtail, *Papilio cynorta*, the females mimic an Acraeine, changing geographically with the changes of the model. But in Abyssinia, where there is no appropriate model of this group, the female mimics a Danaine. All the local females of *P. dardanus* have often been bred, together with the non-mimetic males, from the eggs laid by a female of one form. From this it has been argued that they must have arisen suddenly from a female like the one found in Madagascar and Abyssinia and resembling the male. In recent years, however, numbers of intermediate females have been discovered and also bred in the Nairobi district. Furthermore the mimetic females which exist with the male-like females in Abyssinia, retain the "tails" on their hindwings which elsewhere have been lost by the fully formed mimics of the tailless Danaine and Acraeine models.

From these and many other examples it is evident that in butterflies the female is more commonly mimetic than the male. Furthermore when both sexes mimic, the female's likeness to a model is often the more complete. Apart from mimicry, female butterflies also appear in two or more forms far more commonly than males, and recent researches have shown that the females are more variable. It is therefore probable that the evolution of female mimicry has been facilitated by the quantity and variety of the material ready to be built up by natural selection.

Returning to a consideration of the advantages secured by mimicking the great tropical groups we find that their species possess conspicuous patterns made up of contrasted tints, the pattern of the under-surface of the wings being generally similar to that on the upper, so that when these butterflies fly with their characteristic flapping or sailing flight, or rest with wings closed, the colours and patterns, once learned, are easily recognized. Many of the species when disturbed emit an unpleasant odour which in some species is known to be secreted by special glands. When offered to insect-eating animals they are rejected except under the stress of hunger, and they have been seen to be attacked and rejected by enemies in the wild state. Their tissues are soft and flexible so that they can often recover from the injuries of experimental tasting. Just as these groups of butterflies are foremost in providing models for mimicry so are they conspicuous in the possession and in the advertisement of qualities which protect against attack. Mimicry of the advertisement suggests possession of the qualities. That young insect enemies do learn to associate the advertisement with the qualities has been proved by the interesting experiments of Lloyd Morgan. It must be remembered that the qualities are of the most varied kinds. Thus C. F. M. Swynnerton has shown that large African butterflies *Charaxes,* although palatable, are rejected because of their toughness, thus accounting for the mimetic likeness to them borne by smaller and less tough species of the genus; also for the resemblance of larger species to one another.

The two figures in the second row on Plate I. show that the species of the great tropical groups are not only mimicked by other butterflies but also that they mimic each other. Thus several African Acraeines mimic Danaines, while in both groups the species of one genus sometimes mimic those of another; the same is true of the Oriental Danaines. In tropical America the few Danaines and many of the Heliconines mimic species of the dominant group, the Ithomiines. This last mimetic association has been a fruitful source of confusion, for the superficial resemblance between the Ithomiines and an important section of the Heliconines is so strong that both groups were united under the Heliconidae by the older naturalists. And even when H. W. Bates recognized the wide difference between them he still left them as a single family divided into the Danaoid Heliconidae (the Ithomiinae) and the Acraeoid Heliconidae (the Heliconinae proper). Hence the models for mimicry, Ithomiine as well as Heliconine, are commonly called "Heliconidae." But in the meantime naturalists have recognized the true distinction, placing the two sections far apart, the Ithomiinae next to the Danainae, and the Heliconinae next to the Acraeinae. Now in the numerous mimetic associations between the two groups, the Ithomiinae, with hardly an exception, are the models and the Heliconinae the mimics. Thus the first figure in the second row represents the Ithomiine model, *Melinaea mothone,* and the second figure its beautiful Heliconine mimic *H. aristiona,* both from Peru. But as the latter is a Heliconine, it and other Heliconine mimics of Ithomiines are constantly referred to as models, thus reversing the true relationship, which is well shown by an exhibit, in the Oxford University museum, of the butterflies indiscriminately captured on two days in central British Guiana. There were taken on the first day 216 specimens of the chief Ithomiine model with *two* Heliconine mimics, belonging to different genera, on the second day six months later, of the model 220, and no mimic.

BATESIAN AND MÜLLERIAN MIMICRY

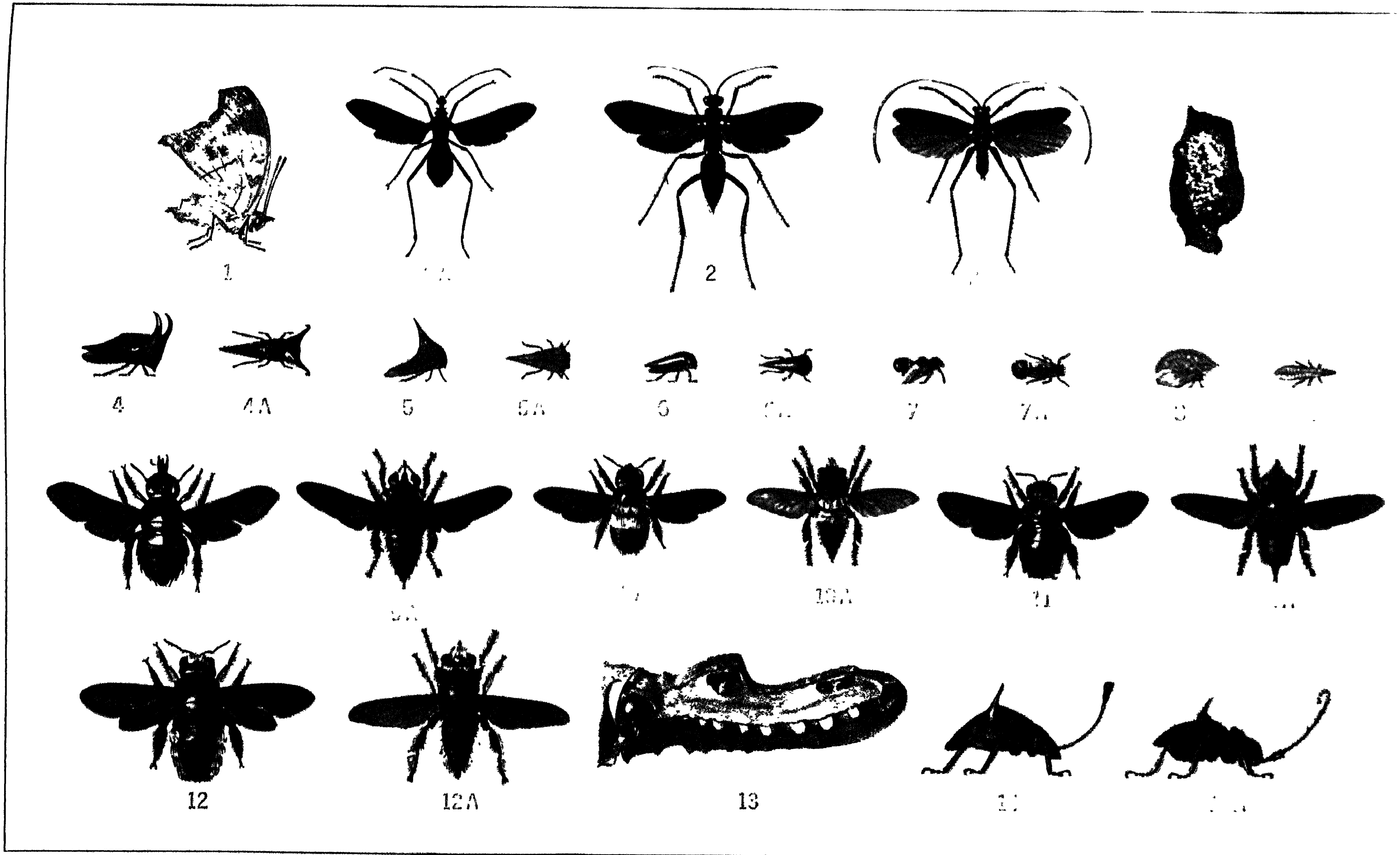
It is obvious that this resemblance between the butterflies of distasteful groups is, as Bates recognized, a different thing from the mimicry he sought to explain by his hypothesis—the likeness of a harmless or palatable species to a formidable or nauseous one which advertises its qualities by warning characters, especially colours, but often by movement, attitude or sound. The mimic gains advantage by the display of false warning characters. This is called "Batesian Mimicry" after its discoverer. The resemblance between the distasteful species themselves was later explained by Fritz Müller as an adaptation which economizes life by facilitating the education of enemies. If two distasteful species are alike they will share between them the lives which must be sacrificed before the enemies have learned to associate the warning characters with their special means of defence. If they are unlike, the lives must be contributed by each of them independently. These resemblances, which are a form of common or combined warning, are called "Müllerian mimicry." A Batesian mimic may be compared to an unscrupulous tradesman who copies the advertisement of a successful firm; Müllerian mimicry to a combination between firms to adopt a common advertisement and share the expense.

The qualities of Müllerian mimics differ widely in effectiveness and the species differ immensely in their relative numbers and in their capacities for variation. Hence models and mimics exist among them no less than in Batesian mimicry and in both there is the same evidence of the development of a mimetic from a different non-mimetic appearance still retained by allied species and often by the non-mimetic male. Those in second row are sufficient to show the likeness to the model which may be attained by a Müllerian mimic. But while Batesian mimicry is never an advantage and may be a disadvantage to its model, Müllerian mimicry is never a disadvantage but generally (theoretically always) an advantage. Although this criterion is in itself simple, it is extremely difficult, with our present imperfect knowledge of mimics and their enemies in life, to apply. The decision therefore rests on indirect evidence, which makes a different appeal to different minds, so that opinions differ widely as to the relative importance of the two kinds of mimicry.

It will be generally agreed that the resemblance of a Batesian mimic to its model is closely related to protective resemblance. In fact Bates originally included both resemblances under mimicry. A. R. Wallace and nearly all later writers on the subject have differed from him in this because, although the two classes are so near akin, the species in one are conspicuous, in the other well-concealed. They may, however, be conveniently grouped together under deceptive (or apatetic) resemblance. Both classes include palatable species, much sought after by the enemies of the group to which they belong. Any evidence supporting the conclusion that a mimic has been developed from a species with concealing colours would be evidence that it is a Batesian and not a Müllerian mimic. Such evidence may generally be obtained by comparison with its closest non-mimetic allies, and in butterflies often by comparing a mimetic female with its non-mimetic male, paying special attention to the under-surface, upon which concealing colours are specially developed. In the tropical American butterfly *Protogonius,* conspicuously mimetic on the upper surface and dead-leaf-like on the under, Kaye has recently observed that the latter appearance is so transparent that when the insect is sailing with expanded wings above the observer, he can only see the colours of the upper side.

If, on the other hand, the above comparisons lead to the conclusion that a mimic belongs to a group with warning colours, especially one which supplies models for mimicry,—we should, in the opinion of the present writer, be justified in considering it as Müllerian. Special evidence is offered by some mimics which retain warning characters independent of the mimetic appearance, and by others which, themselves resembling a central model, nevertheless act as models for still more outlying members of an association. Still stronger evidence may sometimes be found in reciprocal relationship between the species of two groups or between the groups themselves, *A* usually supplying models and *B* their mimics, but *B* also including models mimicked by species in *A*. In any case it is often difficult to draw the line between Batesian and Müllerian mimicry.

It is not always necessary, as has been generally assumed, that a mimetic pattern should be beneficial to the species. Certain butterflies which have developed such patterns in the presence of Danaine or Acraeine models are equally abundant, but non-mimetic, in other areas where the models are absent. It is clear that, in these species, the variations which promote the resemblance have been selected, but it is equally clear that the average number of survivors in each generation was not thereby increased. It is the proportion of survivors with and without the mimetic pattern that has been changed, not the total number of surviving



DRAWN FOR THE ENCYCLOPÆDIA BRITANNICA BY MISS O. F. TASSART FROM SPECIMENS IN THE HOPE DEPARTMENT, OXFORD UNIVERSITY MUSEUM, AND THE BRITISH MUSEUM (NATURAL HISTORY)

MIMETIC RESEMBLANCES AMONG INSECTS

1. A butterfly with a damaged wing which is evidence of bird attack; this common injury was seen to be caused by a bird
2. Brazilian fossorial wasp with (2a) its mimic bug and (2b) its long-horned grasshopper mimic
3. Cocoon of African moth covered with sham parasitic cocoons which were produced by a caterpillar

4 to 8. Tropical American membracid bugs shown from above and side, emphasizing the resemblance of the covering shield of the insect's body to (4) a hooked seed, (5) a thorn, (6) a smooth seed, (7) an ant, (8) a cocoon of a nauseous moth

9. Indian carpenter bee and (9a) its fly mimic
10. African carpenter bee and (10a) its fly mimic
11. Second African carpenter bee and (11a) its fly mimic
12. Third African carpenter bee and (12a) its fly mimic
13. Front of head of South American fulgorid, resembling the head of an alligator
14. Bornean nauseous beetle and (14a) its longhorn mimic, with a pencil of hairs imitating the spine of the model

individuals of the species. For this process, J. S. Huxley has suggested the term intra-specific selection.

One of the chief objections urged against the interpretation of mimicry as a resemblance perfected by selection is the belief that birds rarely attack butterflies. Some naturalists of great experience state that they have never witnessed such an attack. Nevertheless those who have paid special attention to this aspect of the subject have recorded numbers of instances from their own observation. Fig. 1 on Plate II. represents an injury seen by F. Muir to be inflicted by a bird upon a butterfly at Durban. The insect was at rest and the bird, attacking it from the rear, has shorn through both hind-wings symmetrically. Now this is a common type of injury and it is reasonable to suppose that it is generally if not always caused in the manner observed by Muir and others. Again Swynnerton in Rhodesia and Lamborn in Nyasaland have found the impress of a beak upon the wings which they have picked up after seeing them torn off by a bird. And such beak-marks are often found on specimens by those who look for them.

The remaining figures on Plate II. illustrate mimicry in other insects, especially the species resembling the most formidable of all models, the bees and wasps, among which, it must be added, Müllerian combinations are especially prevalent. Striking examples of the carpenter bees (Xylocopidae) and their fly mimics are represented in figures 9–12A, fig. 9 being a black Indian species (*Xylocopa tenuiscapa*) mimicked by the fly (*Hyperechia xylocopiformis*) shown in fig. 9A. The following three examples are African, fig. 10 the white-banded bee *X. inconstans* and 10A its fly mimic *H. bifasciata*; fig. 11, the reddish-brown banded *X. flavorufa*, with 11A *H. marshalli*, the model and mimic here represented having been taken within a few yards of each other at Mt. Mlanje, Nyasaland; fig. 12, the white-marked *X. nigrita*, with 12A, *H. consimilis*. It has been proved in recent years that the larvae of these flies burrow into the tunnels made by the larvae of their models and devour the occupants. It might appear at first sight that the object of the mimetic resemblance is to enable the flies to approach the nest and lay their eggs near or within the opening, but no such aid is necessary, for the mimics are more powerful fliers and more alert than their models. They are also more formidable and sometimes have been known to prey upon the bees themselves although generally upon other insects; but with all their other powers they have not the dreaded sting and are therefore protected by resembling the much commoner bees among which they live.

Wasps and bees are also mimicked by many other insects of varied groups. Fig. 2 represents a Brazilian sand-wasp (*Pepsis*) the model of 2A, a bug (*Spiniger*), and 2B a long-horned grasshopper (*Scaphura*). The movements in life of these two mimics—both members of unwasp-like groups—are known to promote the resemblance. The wasp's yellow-tipped antennae are seen to be short and thick as compared with those of its mimics but in both the section near the base is thickened and that beyond of hair-like fineness so as to be invisible except on close inspection. The end of the thick section is yellow in the grasshopper like the tip of the wasp's antennae. Similarly in certain beetles which mimic others with shorter knobbed antennae, a thickening at the corresponding distance from the base, or in some species the appearance of a thickening produced by a tuft of hairs, brings about a superficial likeness to the model. The close resemblance to a powerful curved spine on the wing-cases of the model, a distasteful Bornean beetle (an Endomychid), fig. 14, is similarly brought about by a curved pencil of hairs on its Longicorn mimic (*Zelota*) shown in 14A. Examples such as these afford strong evidence that the likeness has been achieved by the selection of any variation which led in the right direction, and as a result some feature in the mimic which seems to the eye to be similar to that of the model is often in its essential structure entirely different.

A good example of a mimetic resemblance attained in many ways is to be seen in the large tropical American association of diverse butterflies and day-flying moths which have developed transparent areas on their wings in mimicry of dominant Ithomiine models. Transparency has been attained by the following different methods in different mimetic species or groups of species:—(1) the scales of the wing may be so reduced in size that the light passes between them; (2) remaining the same size they may become much fewer; (3) they may stand up on edge; (4) remaining in the usual overlapping position they may become themselves transparent. Furthermore in the models themselves, the scales of the transparent parts have become minute vestiges, reduced to a much greater extent in one of the two genera to which the species belong. It may be added that the wings of many moths which mimic bees are, on emergence from the chrysalis, covered with loosely attached scales which blow off during the first flight. Such different methods of attaining the same end are to be expected if the development has been brought about by natural selection, for it is unreasonable to believe that similar variations would appear in very different species with very different natures.

The most convincing evidence of the development of mimicry and protective resemblance by natural selection is to be found in the Homoptera which, in addition to the cicadas, aphides, etc. also include the Membracidae, a family of small insects found nearly all over the world but most commonly in tropical America. These insects have, on the body-ring behind the head, a projection which grows backwards and expands into a shield covering every part except the head, wings and legs. The form of the concealed body is much like that of the allied greenfly and other aphids of our gardens. Five tropical American membracids are represented in figs. 4–8A. *Hemikyptha*, like a hooked seed, seen from above in 4A, from the side in fig. 4; the thornlike *Umbonia* in figs. 5, 5A; the smooth-seedlike *Hebetica* in 6, 6A; the ant-like *Heteronotus* in 7, 7A; finally *Oeda*, resembling the orange-coloured, freely exposed cocoon of a distasteful moth, in 8, 8A. Thus in the Membracidae the concealing or the mimetic appearance is developed on the covering shield, and not, as in so many other insects, on the body. Mimicry is only developed where it can be seen. The value of the ant-mimicry in figs. 7, 7A has been questioned because the Membracidae, like the allied froghoppers (Cercopidae), can escape by jumping, but this is only one of the numerous examples in which different methods are adopted by a species so that if the first fails there is still a chance of success by the second. It has also been objected that ants have many enemies and are therefore dangerous models. Haase is the only naturalist who has thought it necessary to assume that the special protection of models confers absolute immunity, even believing that it is efficient against the insect-enemies of insects. We know, however, that the species which are most distasteful to the higher insect-eating animals are especially liable to be attacked by parasitic and predaceous insects. Admitting the existence of numerous enemies, ants nevertheless possess qualities which render them the most successful insects in the world. Analogous reasoning would attempt to show that the form, colour and pattern of grass-feeding caterpillars are valueless because so many animals feed upon grass!

The mimicry of ants is a vast subject which cannot be treated even superficially here. They are models not only for insects of many diverse kinds but also, in movement as well as appearance, by numerous spiders. Certain species of the carnivorous mantises and also of long-horned grasshoppers mimic ants when small but in their later stages become flower- or leaf-like. Some idea of the advantage which may be conferred by resembling these models is suggested by a study of their guests. Since 1891 H. Donisthorpe has discovered in British ants' nests 150 species of insects, spiders and mites new to the country, including 70 new to science. Of these guests 28 species are mimics of ants and thus would be protected outside the nest or in a disturbed nest against enemies which fear the ants. In addition to these British ants are mimicked by 34 species living independently, and by 15 species possibly guests, possibly independent.

BOGEYS

A very different kind of mimicry is adopted by another tropical American homopterous insect, one of the large lantern flies (Fulgoridae). The front part of the head of this insect, *Laternaria lucifera*, projects forward as a hollow mask which resembles in remarkable detail the head of an alligator as may be seen from the side view represented in fig. 13. The true eye of the insect is

dary petioles, wh
hence to the ma
ds the stem, the b
of the leafstalk).
roop simultaneou
cease to respond
t-houses is *M. p*
alized in corresp
ardly distinguisha
. Species of the
ive-briar in the
MULUS, in bo
rising about 115 s
us, rarely shrubb
tainous parts of b
ost numerous in
n California. Th
xillary, generally

have served with Marmont in the Salamanca campaign. In the campaign of 1813 and 1814 he served under Wellington. After the restoration of Ferdinand he was exiled. His political opinions were democratic and radical, and as a yeoman he disliked the hidalgos (nobles). The revolution of 1820 brought him back, and he served the Liberal party in Galicia, Leon and Catalonia. On Nov. 1, 1823, he was compelled to capitulate to the French supporters of Ferdinand VII., but escaped to England by sea. In 1830 he took part in an unsuccessful rising against Ferdinand. On the death of the king he was recalled to Spain, and the government of the regent Christina gave him the command against the Carlists in 1835, though they feared his Radicalism. By this time, years, exposure and wounds had undermined his health. He was also opposed to Thomas Zumalacarregui (*q.v.*), an old officer of his in the War of Independence, and an even greater master of irregular mountain warfare. His health compelled him to resign in April 1835, and his later command in Catalonia was only memorable for the part he took in forcing the regent to grant a constitution in August 1836. He died at Barcelona on Dec. 24, 1836.

AUTHORITIES.—In 1825 Mina published *A Short Extract from the Life of General Mina,* in Spanish and English, in London. Mention is made of him in all histories of the affairs of Spain during the first third of the 19th century. His full Memoirs were published by his widow at Madrid in 1851–52.

MINANGKUBAU, the name for a mountainous district of central Sumatra and for the true Malay tribe inhabiting it, the *Orang Malayu,* from which sprang the civilized Malay race, whose migrations, starting in the 12th century, made them the dominant race in the Malay archipelago. The tribe is now Muslim, but the system of confederate villages governed by the assembled chiefs of the different clans in council still exists and the matrilineal system is observed in reckoning descent and relationship. Members of the royal clan seem to have had powers over property not unlike those of Polynesian chiefs (*see* MALAY).

See Marsden, *History of Sumatra* (1783); Winstedt, *Malaya* (1923).

MINARET, the tower usually attached to a Mohammedan mosque, from which the muezzin gives the call to prayer at the appointed hour. The origin of the form has been traced to the pharos or lighthouse at Alexandria. The Arabic word *manar* or minar signifies lighthouse. Early examples are those built by El Walid for the mosque at Damascus (707), and that of the mosque at Ibn Tulun at Cairo (879); the latter is remarkable for its heavy, square base and the external stair which leads up to the gallery from which the call to prayer is sung.

Four characteristic types of minarets were later developed. The first is the type of Cairo and Syria in which there are usually several galleries supported on stalactite work with the tower receding in stages at each gallery and the whole crowned with a bulbous dome. At times the lowest stage is square. Characteristic examples are those of the mosque of El Moyed, Cairo (1416); of Sultan Barkuk, Cairo (1405) and of Kait Bey, Outside the Walls, Cairo (1468); and the two later minarets of the mosque at Damascus (*c.* 1400). The second type, that of Morocco and Spain, consists simply of a large, richly decorated, square tower with a smaller square pavilion at the top, the platform over the lowest stage serving as the gallery for the call to prayer. This type is frequently built of brick, with rich relief patterns on all four sides. Noteworthy among them are the simple, low minaret at Kairouan (probably 9th century); that of the Koutoubia at Marrakech (1184); of Hassanat Rabat in Morocco (1184) and the famous Giralda at Seville (1195). The third type, characteristic of Persia, usually consists of a long, slender, tapered, cylindrical turret, most frequently placed in pairs flanking a great entrance arch, and usually carrying a single, high gallery and capped by a low dome. The whole is often cased in glazed Persian tile and glows with green, blue and yellow. Examples of the Persian type are the minaret of the tomb of Tamerlane at Samarkand (1405), those of the Shir-dar mosque at Samarkand (1601), and those of the imperial mosque at Ispahan (1613–27), the last noteworthy because of the delicate wooden gallery with open-work railing and slim posts that crowns the balcony from which the call to prayer is given. The fourth class comprises the slim, tapered, circular or polygonal minarets of Turkey which are probably based on Persian precedent, although frequently built of white marble and always without colour decoration. In most cases, however, instead of the single gallery of the Persian minaret, there are two, or even three, and the minarets are universally capped with slim, wooden cones. There are usually two minarets on the smaller mosques, and from two to six on the larger ones. The six minarets of the mosque of Sultan Achmed I. (1615), at Constantinople, are characteristic.

In India, early minarets were much affected by the native Hindu styles. Thus the famous Koutub Minar at Delhi (early 13th century), in its ridged masonry and rich solidity owes much to the Jaina style. Later examples show, on the other hand, strong Persian influence. The forms are, nevertheless, treated with that peculiar delicacy and restrained richness typical of Mogul work.

See H. Saladin, *Manuel d'Art Musulman,* vol. i. Architecture (1907). (T. F. H.)

MINAS (MINOÏDES) (*c.* 1790–1860), Greek scholar, was a native of Macedonia. During the Greek War of Independence he migrated to Paris, where he tried to enlist the sympathies of Europe on behalf of his countrymen and to promote the study of ancient and modern Greek. He discovered two important mss. in the monastery of Mt. Athos, part of a treatise now believed to be by Hippolytus (*q.v.*) and the greater portion of the Fables of Babrius.

MINAS GERAES (*i.e.,* "general mines"), popularly MINAS, an inland State of Brazil, covers an area of 221,861 sq. m. upon the great Brazilian plateau. Among the Brazilian States it is fifth in size and first in population—5,888,174 in 1920.

The surface of Minas Geraes is broken by mountain ranges and deeply eroded river-courses, the latter forming fertile valleys shut in by partly barren uplands, or campos. The principal mountain ranges are the Serra da Mantiqueira on its southern frontier and its north extension, the Serra do Espinhaço, which runs parallel to the Serra do Mar, or coast-range, and separates the inland or campo region from a lower forested zone between the two ranges. Most of the wooded district south of the Mantiqueira belongs to the States of São Paulo and Rio de Janeiro, but east of the Espinhaço it belongs to Minas Geraes and extends eastward to the Serra das Aymores, on the frontier of Espirito Santo. This zone has an abundant rainfall, dense forests and a fertile soil. It is drained by the Doce, Mucury, Jequitinhonha and Pardo. The southern part of this region is well populated, and is covered with coffee and sugar plantations. On the western frontier a northern extension of the great central chain of Goyaz forms the water-parting between the drainage basins of the São Francisco and Tocantins, and is known at different points as the Serra do Paranan, Serra de São Domingos and Serra das Divisões. South-east of this chain, between the headwaters of the Paraná and São Francisco, are the Serra da Canastra and Serra da Matta da Corde, an irregular chain of moderate elevation running north and south. The highest elevations in the State, so far as known, are Itatiaya (8,898 ft.) in the Serra da Mantiqueira, and Caraça (6,414 ft.), near Ouro Preto, in the Serra do Espinhaço.

Less than 100 m. from the city of Rio de Janeiro and 60 m. from the coast is the source of the Rio Grande, the larger of the two rivers that form the Paraná. North and parallel with its course is a low watershed, which separates its drainage basin both from that of the São Francisco and from that of the Parnahyba, the northern confluent of the Paraná. The latter rises on the western slopes of the Serra da Matta da Corde. The central and greater part of the State, is included in the drainage basin of the upper São Francisco. The climate of Minas Geraes is characterized by high sun temperatures and cool nights, the latter often dropping below the freezing point on the higher campos. The mean annual temperature is about 85° in the São Francisco valley, 77° on the campos of the south-east and 70° on the campos of the west. The year is divided into two seasons—wet and dry—the former lasting from November to May. This division is not so clearly marked in the south, especially in the "matta" (forest) regions,

prehistoric remains have been discovered on the common; while Woeful Dane Bottom, a neighbouring valley, was the scene of a Danish defeat (*c.* 918).

MIND: *see* PSYCHOLOGY.

MINDEN, a town of Germany, in the Prussian province of Westphalia, 44 m. by rail to the W.S.W. of Hanover, on the left bank of the Weser. Pop. (1925) 27,033. Minden (Mindun, Mindo), apparently a trading place of some importance in the time of Charlemagne, was made the seat of a bishop by that monarch, and subsequently joined the Hanseatic League. In the 13th century it was surrounded with walls. In 1648 the bishopric was converted into a secular principality under the elector of Brandenburg. From 1807 to 1814 Minden was included in the kingdom of Westphalia, and in the latter year it passed to Prussia. The fortifications were finally demolished in 1873. About 3 m. to the south of Minden is the so-called "Porta Westfalica," a narrow defile by which the Weser quits the mountains. The bishopric of Minden embraced an area of about 400 sq.m. and had about 70,000 inhabitants. The older parts of the town retain their narrow and crooked streets. The cathedral tower dating from the 11th century, illustrates the first step in the growth of the Gothic spire in Germany. The nave was erected at the end of the 13th century, and the choir in 1377–79. Among the chief edifices are the old church of St. Martin and the town hall, with a Gothic façade. Its industries include brewing, ship-building and the manufacture of tobacco, glass, soap, chocolate, leather, shoddy, cement and chemicals. There is also some activity in the building of small craft.

The Battle of Minden was fought Aug. 1, 1759, between the Anglo-Allied army commanded by duke Ferdinand of Brunswick and the French under Marshal Contades, the latter being defeated. The most brilliant episode of the battle was the entire defeat of the French cavalry by the British infantry, but Minden, though it is one of the brightest days in the history of the British army, has its dark side also, for the British cavalry commander Lord George Sackville (*see* SACKVILLE, VISCOUNT) refused to obey the order to advance, several times sent by Ferdinand, and thereby robbed the victory of decisive results. For an account of the battle, *see* SEVEN YEARS' WAR.

MINDEN, a city of north-western Louisiana, U.S.A., the capital of Webster parish; on Federal highway 80 and served by the Louisiana and Arkansas railway. Pop. (1920) 6,105 (41% negroes); and in 1930, 5,623 by Federal census. It has a large shipping trade in cotton and lumber, railway shops, and other manufacturing industries. Minden was founded in 1832 by Samuel Veeder and named after his home town in Germany.

MIND-READING: *see* TELEPATHY.

MIND STUFF THEORY, a term introduced by W. K. Clifford to denote the view that mind is composed of the same kind of ultimate elements as what appears to it as matter, and that these ultimate elements are of the nature of monads or spiritual entities. *See* W. K. Clifford, *Lectures and Essays* (1901); W. James, *Principles of Psychology* (1909).

MINEHEAD, a market town and seaside resort of Somersetshire, England, 188 m. W. by S. of London by the G.W. railway. Pop. of urban district (1931) 6,315. Minehead owed its origin and growth to its good harbour. Certain documents suggest that it had a corporate existence during the 15th century, but no record of the grant of a charter has been found. A charter of incorporation given by Elizabeth in 1558 vested the government in a portreeve, a steward and twelve burgesses, the continuance of the corporation being subject to the port and harbour being kept in repair. The charter lapsed in the reign of James I., and an attempt to obtain its renewal in the 18th century failed. The corporation was replaced by two constables chosen annually in the court leet of the manor until 1894, when an urban district council was appointed. The borough returned two members to parliament from 1558 until disfranchised by the Reform Act of 1832. A weekly market on Tuesdays and a fair (Sept. 29 to Oct. 2) were held from the 15th century. In 1465 a second annual fair on May 1 was granted by Edward IV., which is still held on the Wednesday in Whitsun week. The other fair has been discontinued, and the market day has been changed to Wednesday. During the 16th, 17th and 18th centuries Minehead had a considerable coastwise trade in wool, grain and wine, but began to decline owing to the migration of the woollen industry to the north of England, and to the decay of the herring fishery. A renewal of prosperity began when it acquired a reputation as a watering-place. The town has three parts: the Upper, built on a foreland known as North Hill; the Lower; and the Quay Town, with many old houses, stretching for about a mile beside the harbour. St. Michael's, the parish church, has a Perpendicular tower.

MINEO, town, province of Catania, Sicily, 34 m. S.W. of Catania by rail. Pop. (1921) 11,975. It occupies the site of the ancient *Menae,* founded by Ducetius in 459 B.C. Remains of ancient fortifications still exist. Four miles to the north is the Lacus Palicorum, a small lake in a crater, which still sends up carbonic acid gas. By it was the temple of the Palici, twin Sicel gods, the most holy place in Sicily, where an oath taken was especially binding, and an inviolable asylum for fugitive slaves.

MINER: *see* COAL AND COAL MINING, HEWER.

MINERAL DEPOSITS: *see* ORE DEPOSITS.

MINERALOGY, the science which describes and classifies the different kinds of mineral matter constituting the material of the earth's crust and of those extra-terrestrial bodies called meteorites. The study of minerals is thus a branch of natural history, but one in which certain of the exact sciences find an application. The determination of the composition and constitution of minerals is a chemical problem; their optical and other physical properties are determined according to the principles of physics; the study of their crystalline form and structure belongs to crystallography; their modes of occurrence, origins, associations and changes come within the province of geology and petrology; while a consideration of the localities at which they are found requires some acquaintance with geography. Finally, there is the economic side, dealing with the mining and application of useful minerals, the extraction of metals from their ores, and the uses of minerals for building, decoration and jewellery.

Many minerals have attracted the attention of mankind from the earliest times. The stone and bronze implements of prehistoric man and many of his personal ornaments and charms were directly or indirectly of mineral origin. The oldest existing treatise on minerals is by Theophrastus περί τῶν λίθων—*On Stones, c.* 315 B.C (Eng. version by John Hill, 1746), of which only a portion remains. Minerals were then classed as metals, stones and earths. The last five books of Pliny's *Historia naturalis,* written about A.D. 77, treat of metals, ores, stones and gems. Some of the Arabian philosophers devoted themselves to the study of minerals, and about 1262 Albertus Magnus wrote his *De mineralibus.* In the 16th century Georgius Agricola published several large volumes, dealing more especially with the mining and metallurgy of metalliferous minerals, in which more exact descriptions were given of the external characters; he mentioned several minerals by names (*e.g.* blende, fluor, quartz) which are now in common use. About the same period there appeared the systematic treatise on minerals of K. Gesner (1565), and that on precious stones by Anselm Boethius de Boodt (1609). The remarkable researches of Erasmus Bartholinus on Iceland-spar were published in 1669, and J. F. Henckel's *Pyritologia* in 1725. Later came the *Systema naturae* of C. Linnaeus (1735). Although the importance of chemical properties was recognized by the Swedish chemists—J. G. Wallerius (1747) and A. F. Cronstedt (1758)—the external characters of minerals formed the basis of the mixed systems of classification of A. G. Werner (1774) and of other authors, and even as late as the *Natural History System of Mineralogy* of F. Mohs (1820).

It was not until the end of the 18th and beginning of the 19th century, when the foundations of crystallography were laid by Romé de l'Isle and R. J. Haüy, and chemistry had assumed its modern phase, that any real advance was made in scientific mineralogy. It was then recognized that chemical composition and crystalline form were characters of the first importance, and that external (natural history) characters were often more or

less accidental. During this period numerous mineral substances were analysed by Scheele, Berzelius and others, and many new mineral-species and chemical elements discovered. After W. H. Wollaston's invention of the reflecting goniometer in 1809, exact measurements of the crystalline forms of many minerals were made. The principles of isomorphism and dimorphism enunciated by E. Mitscherlich in 1819 and 1821 respectively cleared up many difficulties encountered in the definition of mineral-species. About the same time also the discovery by E. L. Malus of the polarization of light gave an impetus to the optical examination, by Sir David Brewster and others, of natural crystals. Later, the investigation of rocks in thin section under the microscope led to the exact determination, particularly by A. Des Cloizeaux (1867), of the optical constants of rock-forming minerals.

For a detailed account of the history of mineralogy (including crystallography), *see* F. von Kobell, *Geschichte der Mineralogie von 1650–1860* (München, 1864); P. Groth, *Entwicklungsgeschichte der mineralogischen Wissenschaften* (Berlin, 1926).

I.—CHARACTERS OF MINERALS

Essential mineral characters are those relating to chemical composition, crystalline form, crystallo-physical properties and specific gravity; these are identical, or vary only within certain defined limits, in all specimens of the same mineral-species. Non-essential characters—such as colour, lustre, hardness, form and structure of aggregates—depend largely on the presence of impurities, or on the state of aggregation of imperfectly formed crystalline individuals. In an absolutely pure and perfectly developed crystal all the characters may be said to be essential, but such crystals are of exceptional occurrence in nature. (See, *e.g.*, Quartz and Calcite.)

In the following enumeration of the more salient characters of minerals it is to be noted that many of the terms used for non-essential characters are purely descriptive and have no exact definition; on the other hand, essential characters can be expressed numerically and are therefore perfectly definite.

1. MORPHOLOGICAL CHARACTERS

a. **Crystalline Form.**—This most important character of minerals can, of course, be determined only when the material available is in the form of crystals (*i.e.*, crystallized), which is not always the case. Massive aggregates of crystalline material are of much more frequent occurrence; when small fragments or thin sections of such material are transparent the crystalline symmetry may be determined, within certain limits, by the help of the optical characters (*see* below). External crystalline form must not, however, be considered alone apart from all other characters, for crystals of substances quite different chemically, *e.g.* silver iodide, zinc oxide and zinc sulphide, are sometimes almost identical in crystalline form.

All the six systems of crystals and most of the thirty-two symmetry-classes are represented amongst minerals (*see* Crystallography). Crystals of the same mineral-species may differ very widely in general form or habit; *e.g.*, crystals of calcite (*q.v.*) may be rhombohedral, prismatic, scalenohedral or tabular in habit. Besides habit there are frequently also characteristic kinds of groupings of crystals: thus parallel, divergent or radiating (*e.g.* scolecite), rosette-shaped (*e.g.* haematite—*Eisenrosen*), reticulated (*e.g.* rutile), or matted. The faces of natural crystals may be smooth, rough, striated, curved or drusy, *i.e.*, studded with small crystal faces and angles.

b. **State of Aggregation: Structure.**—According to the particular state of aggregation of a number of imperfectly developed crystals, which have grown together, various kinds of structure may be presented even by the same mineral species. The descriptive terms applied to these structures are almost self-explanatory: thus the structure may be granular (*e.g.* marble), fibrous (asbestos), radio-fibrous or stellated (wavellite), columnar (beryl), laminar or lamellar (talc), bladed (kyanite), etc., according to the relative shape and sizes of the individual crystals composing the aggregate. When the constituent crystals are invisible to the unaided eye the material is described as compact; incoherent aggregates are powdery or earthy. Minerals which are really amorphous, *i.e.* without any crystalline structure, are comparatively few in number (*e.g.* opal); many which are apparently amorphous are really microcrystalline (*e.g.* turquoise). The term massive is often used loosely for a crystalline mineral not showing crystal-faces. Crystal-aggregates often assume more or less accidental and imitative external forms to which the following descriptive terms are applied: dendritic or arborescent (*e.g.* copper, pyrolusite), mossy (copper), leafy (gold), wiry or filiform (silver), capillary (millerite), coralloidal (aragonite), globular (aragonite, with concentric structure; wavellite, with radiated structure), mammillary or with breast-like protuberances (arsenic), nodular (malachite), warty (menilite), botryoidal (dolomite), reniform (menilite), amygdaloidal (agate), stalactitic (calcite, chalcedony).

2. PHYSICAL CHARACTERS

a. **Optical Characters.**—The action of crystallized matter on transmitted light is a character of the highest importance in mineralogy. Even when the substance is opaque in large masses, it may be sufficiently transparent when in small splinters or in thin sections for the determination of the optical characters. The refractive indices, strength of the double refraction, optic axial angle, extinction angles on certain faces, are constant for each mineral-species (*see* Crystallography).

In their diaphaneity, or degree of transparency, minerals differ very widely even in the same species. Some, such as metals and most metallic sulphides are always opaque; while others may vary in different specimens from perfect transparency to perfect opacity (in the latter case, however, minute fragments will, as a rule, still be transparent). A good example of this is afforded by the varieties of quartz; rock-crystal is water-clear, chalcedony is translucent, and jasper opaque.

The colour of minerals is the character which first arrests attention; but being a character which may vary almost indefinitely in one and the same kind of mineral, it affords a typical example of a non-essential character. Thus, fluor-spar and quartz, when in well-formed and chemically pure crystals, are quite colourless and transparent; but it would be easy to collect a series of each of these minerals in which almost every shade of colour is represented. The difference is due solely to the accidental presence of traces of colouring matters so small in amount that their exact nature is difficult or impossible to determine. The value of diamond, corundum and other gem-stones depends largely on these accidental differences in colour. Such substances, which are essentially colourless and owe their colour to the presence of colouring matter as an impurity, are said to be "allochromatic"; any colour they may possess is non-essential. In some other substances, known as "idiochromatic," the colour is a definite and essential character.

An important character of transparent crystals is that of unequal absorption in different directions; so that light will, as a rule, be differently coloured according to the direction in which it has travelled through the crystal; this is known as dichroism or pleochroism (*see* Crystallography). Certain minerals (*e.g.* zircon and those containing cerium) when examined with a spectroscope by transmitted light show characteristic absorption spectra.

The colours of minerals may also be due to the interference of rays of white light at the surfaces of thin crevices or minute inclusions, either tabular or fibrous in form, in the mineral; for example, the play of colours of opal; the change of colours of labradorite; the bands of rainbow colours (Newton's rings) seen along cleavage cracks and irregular internal fractures (*e.g.* in quartz); the iridescent tarnish due to a superficial film of a decomposition product (*e.g.* "peacock copper ore").

The true colour of a mineral is best revealed by its "streak," *i.e.* the colour of its powder. This is obtained by scratching the mineral, or by crushing a fragment of it on a sheet of white paper, or rubbing it upon unglazed porcelain. The streak of allochromatic minerals is white, while that of idiochromatic minerals is coloured and is often of determinative value. Ores of iron may, for example, generally be distinguished by their streaks.

Another character depending on light is that of lustre, which is

often very characteristic in certain minerals, though it may be considerably modified by the state of aggregation. For example, the usual adamantine lustre of diamond is not exhibited by the compact aggregate known as carbonado; while earthy masses of any mineral will be devoid of lustre. Descriptive terms applied to the kinds of lustre are: metallic (*e.g.* pyrite), adamantine (diamond), vitreous (quartz), resinous (pyromorphite), greasy (elaeolite), waxy (chalcedony), pearly (talc, heulandite and other minerals with a perfect cleavage), silky (satin-spar), etc. The degrees of intensity of lustre: splendent, shining, glistening, glimmering and dull, depend usually on the smoothness of the crystal-faces.

The phenomena of phosphorescence (*q.v.*), fluorescence (*q.v.*) and radioactivity (*q.v.*) are strikingly exhibited by some minerals (*see* FLUOR-SPAR, DIAMOND, ETC.).

On the optical determination of minerals *see* E. S. Larsen, "The Microscopical Determination of Nonopaque Minerals" (*Bull.* U.S. Geol. Survey, No. 679, Washington, 1921).

b. **Microscopical Examination of Opaque Minerals.**—A method for the investigation of opaque minerals borrowed from metallography (*q.v.*), in which polished sections are examined under the microscope in reflected light, is specially useful for the study of metallic ores and consequently finds an economic application in the valuation of ore deposits. By this means several mineral species of which the ore is composed can be distinguished and their relations to one another determined; *e.g.*, the order of their deposition, and whether they are of primary or secondary origin. The process of grinding and polishing the sections presents certain difficulties owing to the extreme differences of hardness of the several minerals that may be present. The prepared section is illuminated vertically by means of a right-angle prism placed in the tube of the microscope above the objective. Details of structure can be brought out by etching the section with various chemical reagents. The several characters (colour, hardness, relief) of the minerals, together with their behaviour towards reagents, help in their determination. But in many cases ordinary simple tests made on fragments detached from the polished surface are more reliable. Electrical tests can be made with quite simple apparatus; for example, the electrical conductivity can be determined with a dry cell and voltmeter using needles as terminals on the polished surface. Certain optical determinations can also be made in reflected polarized light.

One result of this study of opaque minerals is to draw attention to the extremely intimate association and intergrowth of many of the ore-minerals; this is shown in some photo-micrographs. What to all appearances by ordinary methods is a homogeneous mineral may be found by the new method to be really heterogeneous; and, in fact, several supposed mineral species have been proved to be mixtures, and well-developed crystals have in certain cases been found to contain enclosures of other minerals. The method is thus of use for ascertaining the degree of purity of material collected for exact chemical analysis when the formula of a species is to be established. The long-debated question as to how silver exists in argentiferous galena (lead-ore) has been studied by this method.

The technique of the subject (called mineralography, mineragraphy or chalcography) is dealt with in the text-books; J. Murdoch, *Microscopical Determination of Opaque Minerals* (N.Y., 1916); W. M. Davy and C. M. Farnham, *Microscopic Examination of the Ore Minerals* (N.Y., 1920); H. Schneiderhöhn, *Anleitung zur mikroskopischen Bestimmung und Untersuchung von Erzen . . .* (Berlin, 1922); R. W. van der Veen, *Mineragraphy and Ore-deposition* (The Hague, 1925).

c. **Magnetic, Electrical and Thermal Characters.**—These as far as related to crystalline form, are discussed under crystallography (*q.v.*). Magnetite ("lode-stone") is the only mineral which is strongly magnetic with polarity; a few others, such as pyrrhotite and native platinum, possess this character to a much less degree. Many minerals are, however, attracted by the pole of a strong electromagnet, while a few (diamagnetic) are repelled.

Most minerals with a metallic lustre are good conductors of heat and electricity; others are bad conductors. For example, graphite is a good conductor, while diamond is bad. Non-conductors of electricity become electrified by friction, some positively (*e.g.* quartz and topaz), others negatively (*e.g.* sulphur and amber). The length of time during which different gem-stones retain their charge of frictional electricity was made use of by R. J. Haüy as a determinative character. For the pyro-electrical and thermo-electrical characters of crystals *see* CRYSTALLOGRAPHY. Some minerals—for example, salt, sylvite and blende—are highly diathermanous, *i.e.* transparent for heat-rays.

The specific heat and melting point of minerals are essential characters capable of exact measurement and numerical expression, but they are not often made use of. The following scale of fusibility was proposed by F. von Kobell:—

1. Stibnite	(525°C.)	5. Orthoclase	(1175°C.)
2. Natrolite	(965°C.)	6. Bronzite	(1300°C.)
3. Almandine	(1265°C.)	7. Quartz	(1430°C.)
4. Actinolite	(1296°C.)		

The melting points given above in parentheses were determined by J. Joly. Stibnite readily fuses to a globule in a candle-flame, while quartz is infusible before the ordinary blowpipe.

d. **Characters Depending on Cohesion.**—Some minerals (*e.g.* a sheet of mica) are highly elastic, springing back to their original shape after being bent. Others (*e.g.* talc) may be readily bent, but do not return to their original form when released; these are said to be pliable or flexible. Sectile minerals (*e.g.* chlorargyrite) may be cut with a knife without being fractured; related characters are malleability (*e.g.* argentite) and ductility (*e.g.* silver). The tenacity, or degree of frangibility of different minerals varies widely: they may be brittle, tough, soft or friable. The fractured surface produced when a mineral is broken is called the "fracture," and the kind of fracture is often of determinative value; descriptive terms are: conchoidal (*e.g.* quartz, which may often be recognized by its glassy conchoidal fracture), sub-conchoidal, uneven, even, splintery (*e.g.* jade), hackly (*e.g.* copper).

In many cases when a crystallized mineral is broken it separates in certain definite directions along plane surfaces. This property of "cleavage" (*see* CRYSTALLOGRAPHY) is an important essential character of minerals, and one which is often of considerable assistance in their recognition. For example, calcite, with its three directions of perfect cleavage parallel to the faces of a rhombohedron, may always be readily distinguished from aragonite or quartz.

"Hardness," or the resistance which a substance offers to being scratched by a harder body, is an important character of minerals, and being a test readily applied it is frequently made use of. It must, however, be remembered that the hardness of an incoherent or earthy aggregate of small crystals will be very different from that of a single crystal. A comparative "scale of hardness" was devised by F. Mohs in 1820 for the purpose of giving a numerical statement of the hardness of minerals.

Mohs's Scale of Hardness

1. Talc.	6. Orthoclase.
2. Gypsum.	7. Quartz.
3. Calcite.	8. Topaz.
4. Fluor-spar.	9. Corundum.
5. Apatite.	10. Diamond.

These minerals, arbitrarily selected for standards, are successively harder from talc the softest, to diamond the hardest of all minerals: a piece of talc is readily scratched by gypsum, and so on throughout the scale. A mineral which is capable of scratching calcite and can itself be as easily scratched by fluor-spar is said to have a hardness of $3\frac{1}{2}$. Some care is required to avoid error in the determination of hardness: it is best to select a smooth crystal-face, cleavage-surface or fracture on which to rub a sharp corner of the scratching mineral; the powder should be wiped off and the surface examined with a lens to see if a scratch has really been produced or only powder rubbed off the corner of the mineral with which the scratching was attempted. With a little practice a fair idea of the hardness of a mineral may be obtained with the use of a knife or file, which will scratch all minerals with a hardness of 6 or less. Thus pyrite (H.=$6\frac{1}{2}$) and chalcopyrite (H.=$3\frac{1}{2}$), apatite (H.=5) and beryl (H.=$7\frac{1}{2}$), or gem-stones and their paste imitations may be readily distinguished by this test. Talc and gypsum can be readily scratched with the finger-nail.

Planes of parting, etching figures, pressure- and percussion-figures are sometimes characters of importance in describing and

distinguishing minerals. (*See* CRYSTALLOGRAPHY.)

e. **Specific Gravity.**—The density or specific gravity of minerals is an essential character of considerable determinative value. In minerals of constant composition it has a definite value, but in isomorphous groups it varies with the composition: it also, of course, varies with the purity of the material. It is a character which has the advantage of numerical expression.

The exact determination of the specific gravity of minerals is therefore a matter of some importance. Three methods are in common use, viz. hydrostatic weighing, the pyknometer, and the use of heavy liquids. The first two methods are only applicable when a weighable amount of pure material can be selected. This is generally laborious. For exact determinations the pyknometer method is usually to be recommended, using for material the pure fragments which have been selected for quantitative chemical analysis. With a single pure crystal of a faceted gem-stone the method of hydrostatic weighing is usually applicable, providing the stone is not too small. The most ready method, however, is that afforded by the use of a heavy liquid, and the most convenient liquid for this purpose is methylene iodide. This liquid has a specific gravity of 3·33. Benzene is added until the fragment just remains suspended, neither floating nor sinking; the specific gravity of the fragment will then be the same as that of the liquid, and the latter may be determined by hydrostatic weighing or, more conveniently, by means of indicators. Small recognizable crystals of the following minerals may be kept at hand as a set of indicators: gypsum (sp. gr. 2·32), colemanite (2·42), orthoclase (2·56), quartz (2·65), calcite (2·72), aragonite (2·93), rubellite (3·02), apatite (3·20), dioptase (3·32), etc. With a series of tubes containing mixtures of methylene iodide and benzene of different densities and suitable indicators, specific gravities may be rapidly and accurately determined. For minerals of specific gravity greater than 3·33 heavier liquids have been suggested; the best being thallium silver nitrate ($TlAg(NO_3)_2$), which melts at 75° C. to a clear liquid with a density of 4·8.

f. **Touch, Taste and Smell.**—In their action on the senses of touch, taste and smell a few minerals possess distinctive characters. Talc is unctuous or soapy to the touch; tripolite and trachyte are respectively meagre and harsh. Some porous minerals (*e.g.* clays and hydrophane) adhere to the tongue. Gem-stones may often be distinguished from their glass imitation by the fact that they feel colder, since they are better conductors of heat. Bitumen and clays, when moistened, have a characteristic smell; pyrite and some other sulphides when rubbed emit a sulphurous odour. Minerals which are soluble in water have taste.

g. **Radioactivity.**—The strong radioactivity (*q.v.*) of uranium minerals affords a ready means of recognizing these valuable ores; the mineral may be wrapped up with a photographic plate, which is afterwards developed, but a simpler and quicker test is that with a simple gold-leaf electroscope. A piece of the mineral to be tested is placed on the cap of the electroscope, which is then charged with electricity; if the mineral contains uranium (and hence radium), the gold leaves will soon come together.

Determinations of the ratio of the amount of uranium to the amounts of the various products of its decay (radium, helium, lead, etc.) present in various radioactive minerals give (knowing the rate of the decay) some idea of the period of time during which these products have been accumulating. In this way estimates have been made of the age in years of these minerals and even of the age of the earth; but, of course, many unknown factors must have been omitted from such calculations. Lead of radioactive origin, or isotopic lead—the final product of uranium decay—is found to vary slightly in its atomic weight (*q.v.*) according to the uranium mineral from which it is extracted.

To radioactivity are ascribed the well-known "pleochroic halos" —tiny spots or borders of deeper colour surrounding microscopic inclusions—long ago observed in certain rock-forming minerals (cordierite, andalusite, mica, etc.) when micro-sections of rock are examined in polarized light. The long and continued emission of X-rays from zircon or other mineral grains has caused a change in colour of the surrounding mineral for distances varying from 0·002 to 0·4 millimetre. A study of these has again given some information as to the age of the minerals. Much experimental work on the coloration of minerals has been done within recent years by exposing the minerals to the action of radiations of various kinds. For example, some diamonds acquire a green colour and fluor-spar becomes blue when placed in contact with radium bromide.

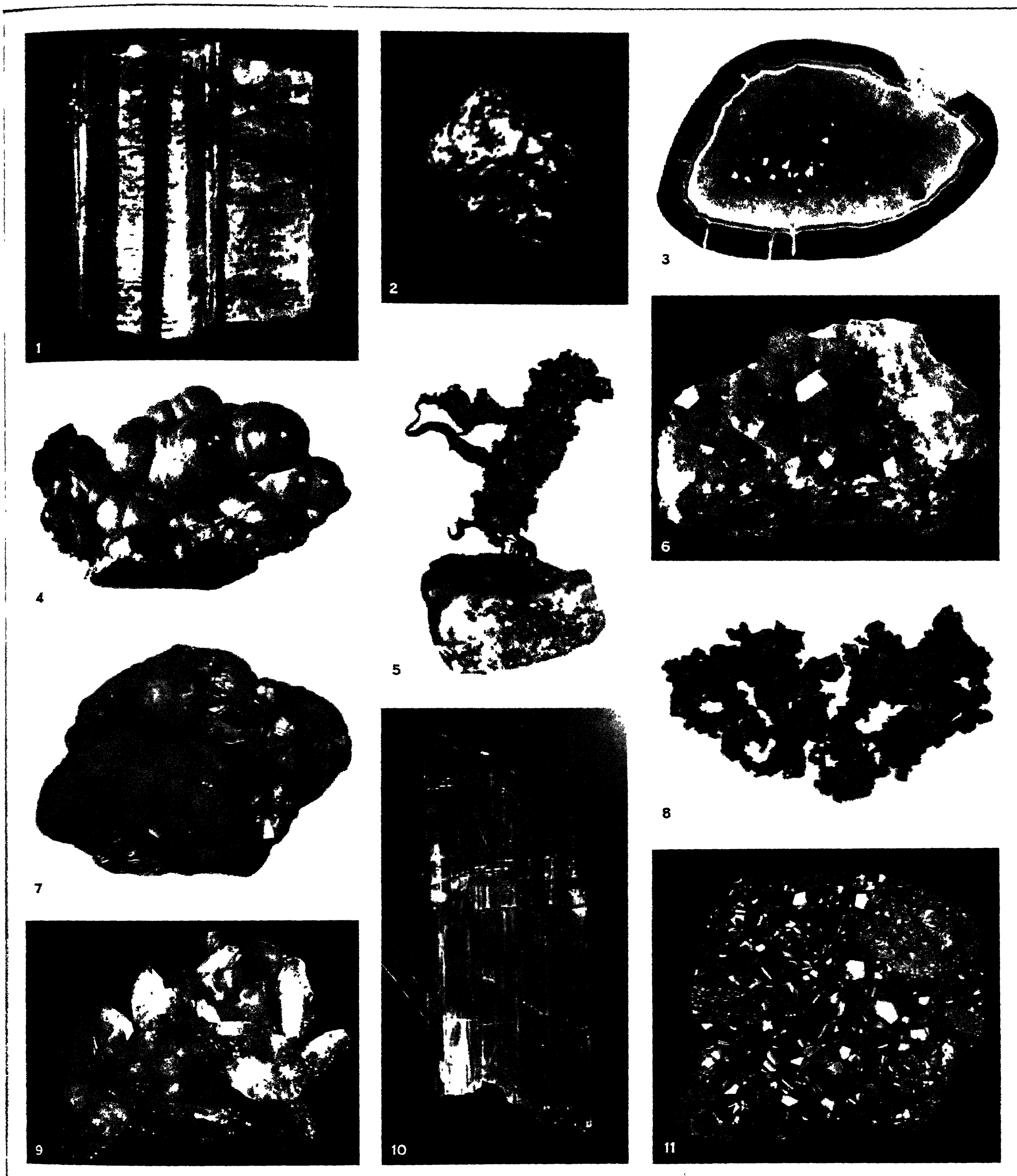
3. CHEMICAL CHARACTERS

Chemical composition is the most important character of minerals, and on it all modern systems of classification are based. A mineral-species cannot, however, be defined by chemical composition alone, since many instances are known in which the same chemical element or compound is dimorphous or polymorphous (*see* CRYSTALLOGRAPHY). In such cases a knowledge of some other essential character, preferably the crystalline form, is necessary, before the mineral can be determined.

All the known chemical elements have been found in minerals; and of many of them minerals are the only source. On the other hand, nitrogen, which is frequently present in organic substances, is rare in minerals; carbon has a wide distribution in mineral carbonates. It is estimated that the minerals of the earth's crust consist of about 47% by weight of oxygen, 27 of silicon and 8 of aluminium; silicates, and especially alumino-silicates, therefore predominate.

The chemical composition of minerals is determined by the ordinary methods of analytical chemistry. Since, however, minerals of different kinds usually occur intimately associated, it is often a matter of some difficulty to select a sufficiency of pure material for analysis. Thus the exact composition and the empirical formulae of several minerals, particularly amongst the silicates, still remain doubtful. Whenever possible, the chemical analysis should be made on small pure crystals which have been previously determined crystallographically. For the qualitative chemical examination of minerals, when only a small amount of material is available, the methods of blowpipe analysis and micro-chemical analysis are often convenient.

The principle of isomorphism (*see* CRYSTALLOGRAPHY) is of the highest importance in mineralogy, and on it the classification of minerals largely depends. In some minerals (*e.g.* quartz) isomorphous or vicarious replacement is not known to occur; but in the majority of minerals one or other of the predominating elements (generally the base, rarely that of the acid radical) may be isomorphously replaced by equivalent amounts of other chemically related elements. In some isomorphous groups of minerals replacement takes place to only a limited extent, and the element which is partly replaced always predominates; while in other groups the replacement may be indefinite in extent, and between the ends of the series the different members may vary indefinitely in composition, with no sharp demarcation between species. Thus in the group of rhombohedral carbonates the different species are usually sharply defined. In well-formed crystals of calcite the calcium is replaced by only small amounts of magnesium, iron, lead, etc.; in chalybite, however, iron is often more largely replaced by calcium, magnesium, manganese, etc., and the "brown spars" are not always readily distinguishable. In the dimorphous group of orthorhombic carbonates isomorphous replacement is less frequent, and the different species (aragonite, cerussite, etc.) are quite sharply defined. In other groups of minerals, particularly amongst the silicates, isomorphous replacement of the basic elements is so general that the several members of the series vary almost indefinitely in chemical composition, and will scarcely be the same for any two specimens, though it may be reduced to the same type of formula. For example, the formula of all varieties of garnet may be expressed generally as $R''_3R'''_2(SiO_4)_3$, where R''=Ca, Mg, Fe, Mn, and R'''=Al, Fe, Mn, Cr, Ti. Tourmaline affords another good example. In the plagioclase felspars (*see* PLAGIOCLASE) we have an example of the isomorphous mixing of two end-members, albite ($NaAlSi_3O_8$) and anorthite ($CaAl_2Si_2O_8$) in all proportions and with no sharp line between the several sub-species. In some other similar cases the end-members of the series are purely hypothetical: *e.g.*, in the scapolite group (mixtures of $Ca_4Al_6Si_6O_{25}$ and $Na_4Al_3Si_9O_{24}Cl$) and in the micas and chlorites. In such instances, where the formulae of the

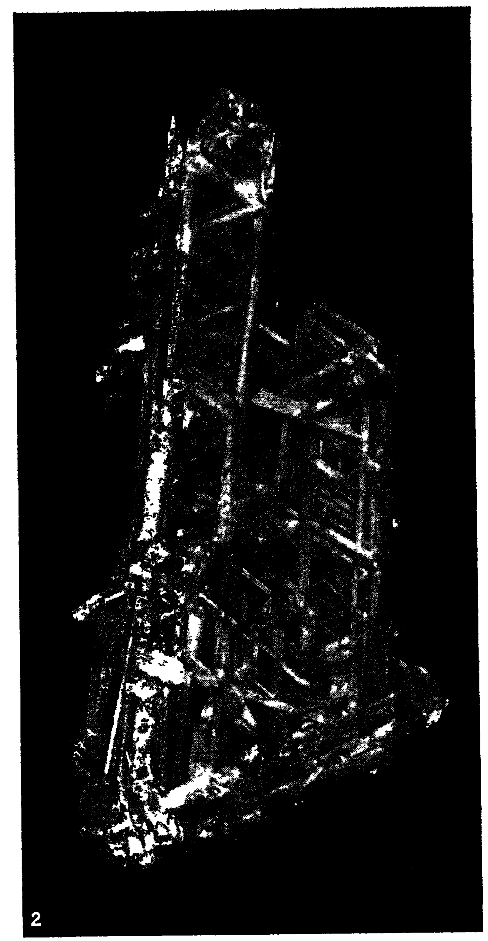


BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

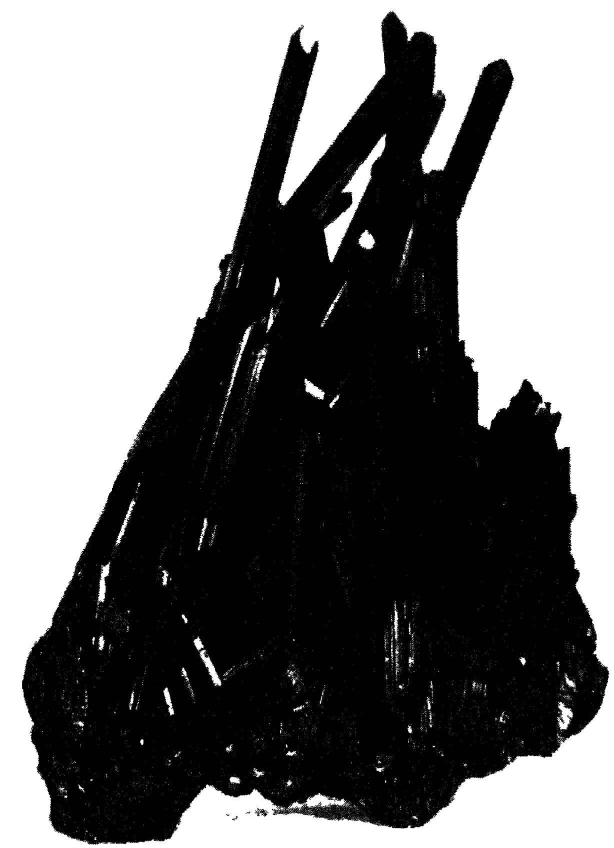
EXAMPLES OF IMPORTANT MINERALS

1. Beryl from Portland, Connecticut. This mineral consists of beryllium and aluminium in combination as a silicate
2. A gold nugget found at Rampart, Alaska
3. An agate geode lined with quartz crystals
4. Malachite, from south west Africa. Copper-ore of fine green colour
5. Silver from Kongsberg, Norway
6. Native sulphur, a non-metallic element occurring as yellow orthorhombic crystals. Specimen shown from Cianciana, Sicily
7. Goethite, a mineral composed of an iron hydroxide. Negaunee, Michigan
8. Native copper from Lake Superior, Michigan. A crystallized spray
9. Barytes, a mineral composed of barium sulphate. Cumberland, England
10. Serpentine asbestos from the Grand Canyon of Colorado. This mineral rubs down to a fine silky fibre which can be spun
11. Pyrite. A brass-yellow mineral with a brilliant metallic lustre

1



2



3

BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

CRYSTAL STRUCTURE

1. Calcite from Fontainebleau, France. This mineral consists of naturally occurring calcium carbonate crystallizing in the rhombohedral system. It is noted for the beauty and variety of its crystals. The crystals shown are remarkable in containing a large amount of enclosed sand
2. Cerussite from Broken Hill, New South Wales. A mineral consisting of lead carbonate and an important ore of lead. It crystallizes in the orthorhombic system and is frequently twinned
3. Stibnite from Japan. The mineral consists of antimony sulphide occurring as bladed or acicular orthorhombic crystals; an important ore of antimony

two end-members differ in type, "mass effect" may have some influence on the isomorphism.

In addition to isomorphous series, there are amongst minerals several instances of double salts, which contain the same constituents as the members of the isomorphous series: *e.g.*, dolomite (*q.v.*) and barytocalcite (*q.v.*).

The manner in which water enters into the composition of minerals is often difficult to determine. In some cases, *e.g.*, in the zeolites (*q.v.*), it is readily expelled at a low temperature, even at the ordinary temperature over sulphuric acid, and may be reabsorbed from a moist atmosphere or replaced by some other substances: it is then regarded as "water of crystallization." In other cases, when expelled only at a higher temperature, it is to be regarded as "water of constitution," forming either a basic salt (*e.g.* malachite, $Cu(OH)_2CO_3$) or an acid salt (*e.g.* dioptase, H_2CuSiO_4, and mica, *q.v.*). When present as hydroxyl it is often isomorphously replaced by fluorine (*e.g.*, topaz $[Al(F,OH)]_2SiO_4$).

As to the actual chemical constitution of minerals the little that is at present known is mainly speculative. Dimorphous minerals, which have the same empirical formula, may be expected to differ in constitution; and experiments have been made, for example on pyrite and marcasite, with the object of discovering a difference, but the conclusions of various investigators are not in agreement. More promising results have been obtained (by F. W. Clarke and others) by the action of various reagents on silicates, particularly on the more readily decomposed zeolites, and several substitution-derivatives have been prepared. The arrangement and relative positions of the constituent atoms have now been worked out for many minerals by X-ray methods of investigation.

Synthesis of Minerals.—The production of minerals by artificial means is a branch of chemical mineralogy which has been pursued with considerable success, especially by French chemists. Most minerals have been obtained artificially in a crystallized condition, and many related compounds, not as yet found in nature, have also been prepared. Crystals of artificially prepared minerals, though usually quite small in size, possess all the essential characters of natural crystals, differing from these only in origin. The following are the principles of some of the methods which have been used: simple sublimation (*e.g.* arsenolite); interaction of gases (*e.g.* haematite, from steam and ferric chloride; cassiterite, from steam and stannic chloride or fluoride); action of gases on liquids and solids; slow cooling of fused masses, either with or without the presence of *agents minéralisateurs* (*e.g.* minerals in furnace slags); from aqueous solution, sometimes at a high temperature and under pressure (*e.g.*, quartz); electrolysis; or even by subjecting dry amorphous material to enormous pressure. The chemical reactions by which various minerals have been obtained are often of considerable help in speculating as to their mode of origin in nature, though it must be borne in mind that the same mineral may have been formed, both naturally and artificially, by more methods than one. In this direction important results have been obtained experimentally by J. H. van't Hoff and his pupils on the formation of oceanic salt deposits, by J. H. L. Vogt with slags. A large amount of experimental work has been done in the geophysical laboratory of the Carnegie Institution at Washington. Many minerals and allied compounds have been prepared artificially in silicate and salt fusions. The conditions necessary for their formation and their ranges of stability—either when alone or when in the presence of other compounds—have been studied in detail. One important result obtained by experimenting over wide ranges of temperature has been to show that practically all compounds known as minerals exist in several polymorphous forms. Some few minerals used as gem-stones have been prepared artificially (*see* GEMS: *Artificial*).

II.—OCCURRENCE AND ORIGIN OF MINERALS

While some minerals are of rare and sporadic occurrence in rock-cavities and mineral-veins, others are widely distributed as important constituents of rocks. The same mineral-species may have several distinct modes of occurrence and origin, and be associated with different minerals in each case, for example quartz.

Minerals of Igneous Rocks.—The rock-forming minerals of primary origin in igneous rocks have crystallized out from the magma, or fused silicate-mass, which on consolidation gave rise to the rock-mass. Magmas sometimes contain a considerable amount of water and are then in a state of aqueo-igneous fusion, rather than of dry fusion; in such cases very coarsely crystalline rocks (pegmatites) often result, and under these conditions minerals of many kinds are formed as well-developed crystals. Those minerals which are present in large amount in igneous rocks are distinguished as essential constituents, since it is on these that the classification of igneous rocks is largely based: the most important are quartz, felspars, pyroxenes, amphiboles, micas and olivines. Other minerals occurring as primary constituents, but in small amounts, are distinguished as accessory. Sometimes these accessory constituents are concentrated by magmatic differentiation, and important ore-deposits sometimes result. Surface weathering and other processes result in the alteration of some or all of the primary minerals with the production of others, which are spoken of as secondary minerals: thus felspars are often partly or wholly altered to kaolin, olivine to serpentine, pyroxene and mica to epidote, chlorite, etc.

Minerals are also formed by the vapours given off by igneous magmas. The gases emitted by volcanoes and solfataras may deposit directly by sublimation, or by their chemical interaction, such minerals as sulphur, sal-ammoniac, haematite, which occur for instance, as incrustations on Vesuvian lava; the boric acid of the Tuscan lagoons has also originated in this way. The effects produced by the exhalations of deep-seated magmas are more complex in character, since the vapours, being more confined, have more opportunity of acting chemically not only on the surrounding rocks but also on the igneous rock-mass itself before its final consolidation. A good example of the "pneumatolytic" action produced by the vapours from a mass of granitic magma is afforded by veins of tin-ore, in which the ore (cassiterite) is associated with minerals containing boron and fluorine. In a similar way the exhalations of basic magmas have given rise to chlor-apatite with associated sphene and ilmenite.

Minerals of Metamorphic Rocks.—By the baking action of a deep-seated igneous mass on the surrounding rocks or on included rock-fragments, various new minerals are developed. By this process of thermal or contact-metamorphism well-crystallized examples of many minerals have often been formed; *e.g.* in calcareous rocks (limestones), especially those containing some magnesia and silica, idocrase, garnet, diopside, tremolite, wollastonite, etc., are developed; in argillaceous rocks (slates), chiastolite and staurolite are characteristic products; and in arenaceous rocks (sandstones), cordierite and sillimanite often result. The effects of pressure (dynamo-metamorphism) on rocks of various kinds, especially those of igneous origin, also result in the production of new minerals; *e.g.* pyroxene is transformed to amphibole, orthoclase to muscovite, plagioclase to zoisite, olivine to tremolite.

Minerals of Sedimentary Rocks.—By the weathering and disintegration of igneous and metamorphic rocks the various minerals set free and the products of decomposition of others supply the material of sedimentary rocks; thus sandstones consist largely of quartz, shales of kaolin and other clay minerals. Those minerals (*e.g.* gem-stones, cassiterite and gold) which resist the action of weathering processes are found as water-worn pebbles and grains in detrital deposits. Other sedimentary rocks consist of minerals deposited from solution either by chemical or organic agencies, from sea-water, lakes or springs; *e.g.* the calcite of limestones, deposits of bog-iron-ore (limonite), gypsum.

Minerals Segregated in Veins and Rock-cavities.—Water percolating through rock-masses takes up mineral matter in solution, and the solutions so formed may further react on the minerals composing the rocks. Such solutions will deposit some of their dissolved material in rock-cavities with the production of various minerals. For instance, the amygdaloidal cavities of basic volcanic rocks (*e.g.* basalt, melaphyre), are frequently partly or completely filled with agate or beautifully crystallized zeolites, calcite, etc. The crevices and joint-planes of limestone become in this way coated with crystals of calcite, and those of siliceous rocks with quartz, giving rise to the abundantly occurring quartz-

veins. In sedimentary rocks pyrite, flint and other minerals become segregated round a nucleus of organic matter. In the case of ore deposits, including metalliferous veins or lodes, however, the solutions are no doubt frequently of deep-seated origin and often connected with igneous and metamorphic processes. By the weathering of the metallic minerals of mineral-veins numerous other finely crystallized minerals result; for example, in the upper oxidized portion of veins of lead-ore (galena) crystals of anglesite, cerussite and pyromorphite are often met. (*See* ORE DEPOSITS.)

Alteration of Minerals: Pseudomorphs.—Crystals which have been formed under one set of conditions of temperature and pressure and in the presence of certain solutions, will in many cases be unstable under another set of conditions. The crystals may then be corroded or even completely redissolved, or the substance may undergo a chemical or physical change and give rise to the formation of minerals stable under the new conditions. An example of the secondary products due to the decomposition of a mineral is afforded by pyrite (FeS_2), of which two types of alteration may be distinguished. By oxidation in the presence of pure water it gives rise to ferrous sulphate (melanterite), free sulphur and sulphuric acid; the melanterite by further alteration gives various basic ferric sulphates (copiapite, etc.); and the sulphuric acid by acting on surrounding rocks (limestone, clay, etc.) gives rise to the formation of gypsum, aluminite and other sulphates. By the action of water containing oxygen and calcium carbonate in solution pyrite suffers another kind of alteration; the sulphur is carried away in solution as gypsum and the iron is left behind as a ferric hydroxide (limonite) which preserves the original form of the crystals. We have then a pseudomorph of limonite after pyrite.

Pseudomorphs are frequently met with in nature, and they are of considerable importance in studying the changes which minerals undergo. Several kinds of pseudomorphs are to be distinguished. When the alteration has involved no change in chemical composition of the material, but only in the internal crystalline structure and physical properties, the altered crystal is called a "paramorph." For example, crystals of aragonite are often altered to a confused granular aggregate of crystalline individuals of calcite, the change being accompanied by a decrease in specific gravity but without change in external form. An "epimorph" results from the encrustation of one mineral by another; the first may be afterwards partly or wholly dissolved out, leaving the second as a hollow shell (*e.g.* chalybite after fluor-spar).

III. NOMENCLATURE AND CLASSIFICATION OF MINERALS

A mineral-species, or simple mineral, is completely defined by the statement of its chemical composition and crystalline form. When we are dealing with a definite chemical compound the limitation of species is easy enough; thus corundum, cassiterite, galena, blende, etc. are quite sharply defined mineral species. But with isomorphous mixtures the division into species, or into subspecies and varieties, must be to a certain extent arbitrary, there being no sharp lines of demarcation in many isomorphous groups of minerals. Thus in the minerals garnet and tourmaline the chemical composition varies indefinitely between wide limits, but no corresponding difference can be traced in the crystalline form or in the external characters save colour and specific gravity. Some authors have therefore questioned the advisability of separating minerals into species each with distinctive names, and they have attempted to devise chemical names for the different kinds of minerals. Owing, however, to the frequency of polymorphism and isomorphism amongst mineral substances such a system presents many practical difficulties. Thus the three modifications of titanium dioxide are more simply and conveniently referred to as rutile, anatase and brookite, while to give a purely chemical designation to such a mineral as tourmaline would be quite impracticable.

The practice of giving distinct names to different kinds of minerals dates from very early times (*e.g.* diamond). The common termination *ite* (originally *itis* or *ites*) was adopted by the Greeks and Romans for the names of stones, the names themselves indicating some character, constituent, or use of the stone, or the locality at which it was found. For example, haematite, because of the blood-red colour. The custom of naming minerals after persons is of modern origin; *e.g.* prehnite, biotite, haüyne, zoisite. Unfortunately there is a lack in uniformity in the termination of mineral names, many long-established names being without the termination *ite*, *e.g.* beryl, blende, felspar, garnet, gypsum, quartz, zircon, etc. The termination *ine* is also often used, *e.g.* nepheline, olivine, serpentine, tourmaline, etc.; and many others were introduced by R. J. Haüy without much reason, *e.g.*, anatase, dioptase.

The number of known mineral species differs, of course, according to different authors; roughly there may be said to be about a thousand. The total number of mineral names (apart from chemical names), many of them being applied to trivial varieties or given in error, amount to about 6000.

Minerals may be classified in different ways to suit different purposes, *e.g.*, according to their uses, modes of occurrence, system of crystallization, etc. The earlier systematic classifications, being based solely on external characters, were on natural history principles and too artificial to be of any value. J. J. Berzelius, in 1815, was the first to propose a purely chemical system of classification; his primary divisions depended on the basic (electro-positive) element and the subdivisions on the acid (electro-negative) element. This method of classification, though still in use for metallic ores, is now quite arbitrary. The systematic classifications in use at the present day are modifications in detail of the crystallo-chemical system of G. Rose (1852). Here there are four main divisions, viz. elements; sulphides, arsenides, etc.; halogen compounds; and oxygen compounds: the last, and largest, division is subdivided into oxides and according to the acid (carbonates, silicates, sulphates and chromates, phosphates and arsenates, etc.); in each section isomorphous minerals are grouped together. The classifications adopted by different authors differ much in detail, especially in the large section of the silicates.

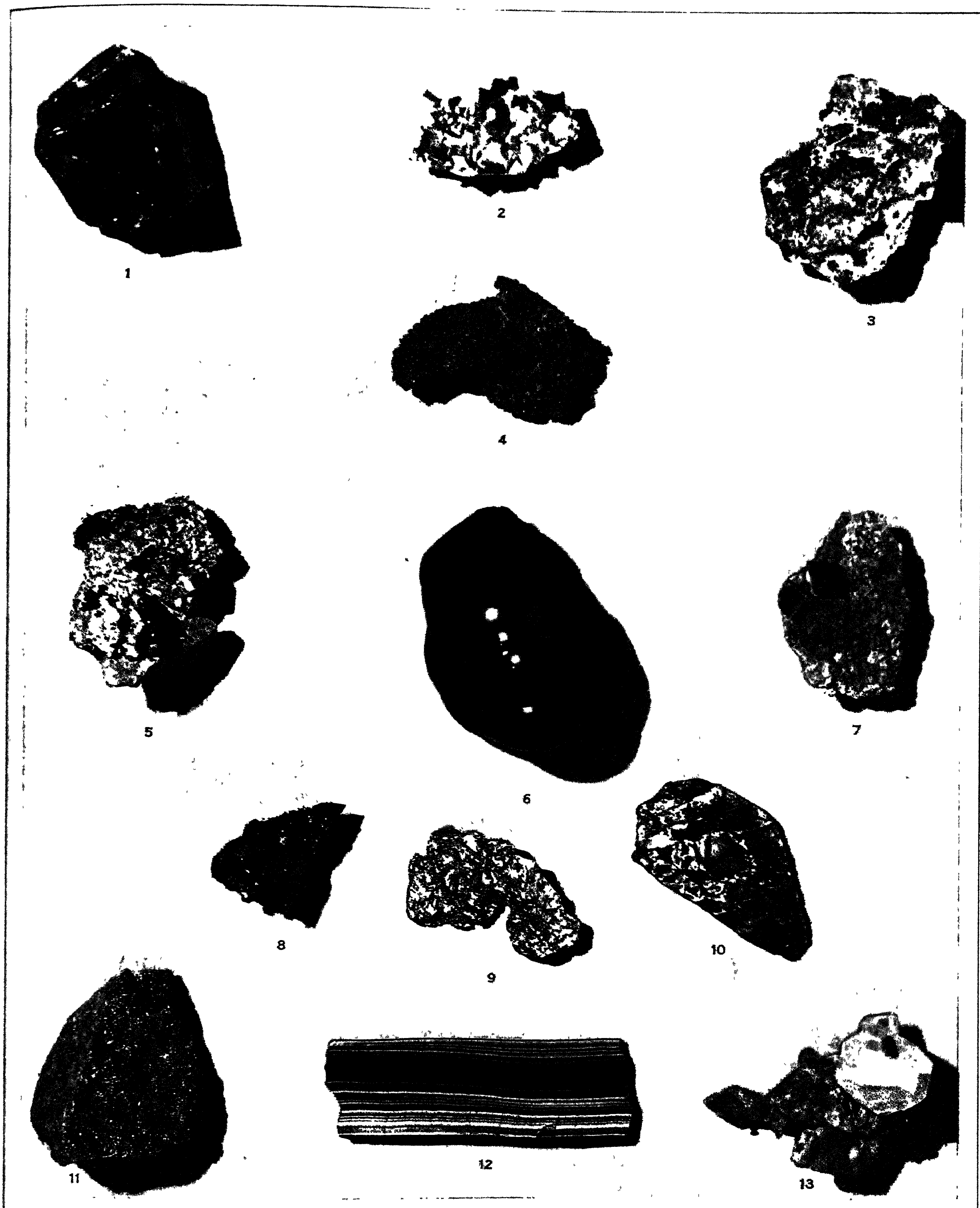
BIBLIOGRAPHY.—Elementary introductions to the study of minerals are: E. S. Dana, *Minerals and how to study them* (N.Y., 1895); L. J. Spencer, *The World's Minerals* (1911, N.Y. 1916). A larger work on popular lines is: R. Brauns, *The Mineral Kingdom*, Eng. trans. by L. J. Spencer (Stuttgart, 1908–12). Textbooks for students: H. A. Miers, *Mineralogy, an Introduction to the Scientific Study of Minerals* (1902); E. S. Dana, *Textbook of Mineralogy* (3rd ed., N.Y., 1922); and G. Tschermak, *Lehrbuch der Mineralogie* (9th ed., Vienna, 1923). The standard works of reference for descriptive mineralogy are: J. D. Dana, *System of Mineralogy* (6th ed., by E. S. Dana, N.Y., 1892, Appendices 1–3, 1899–1915); C. Hintze, *Handbuch der Mineralogie* (Leipzig, 1898, etc.).

For special branches of mineralogy reference may be made to the following: R. Brauns, *Chemische Mineralogie* (Leipzig, 1896); C. Doelter, *Handbuch der Mineralchemie* (4 vols., Dresden & Leipzig, 1911, etc.); H. Rosenbusch, *Mikroskopische Physiographie der Mineralien und Gesteine*, Band I., *Die petrographisch wichtigen Mineralien*, 5th ed., by O. Mügge (Stuttgart, 1925–27); J. P. Iddings, *Rock Minerals* (2nd edit., N.Y., 1911); G. P. Merrill, *Non-metallic Minerals, their Occurrence and Uses* (2nd edit., N.Y., 1910); T. Crook, *Economic Mineralogy* (1921); G. J. Brush, *Manual of Determinative Mineralogy* (16th ed., by S. L. Penfield, N.Y., 1907); M. Bauer, *Edelsteinkunde* (2nd ed., Leipzig, 1909), and Eng. trans. *Precious Stones*, by L. J. Spencer (1904).

There are many books on topographical mineralogy, for example: Greg and Lettsom, *Manual of the Mineralogy of Great Britain and Ireland* (1858).

The following scientific journals are devoted to mineralogy: *Neues Jahrbuch für Mineralogie*, etc. (Stuttgart, since 1807); *Tschermaks Mineralogische und petrographische Mitteilungen* (Vienna, since 1872); *The Mineralogical Magazine and Journal of the Mineralogical Society* (London, since 1876, including since 1920 *Mineralogical Abstracts*); *Zeitschrift für Krystallographie und Mineralogie* (Leipzig, since 1877); *Bulletin de la Société française de Minéralogie* (Paris, since 1878); *American Mineralogist* (Menasha, Wis., since 1916); *Fortschritte der Mineralogie, Kristallographie und Petrographie* (Berlin, since 1911).
(L. J. S.)

MINERAL PHOSPHATES. In mineralogy, those varieties of native calcium phosphate which are not distinctly crystallized, like apatite (*q.v.*), but occur in fibrous, compact or earthy masses, often nodular, and more or less impure, are included under the general term phosphorite. The name seems to have been given originally to the Spanish phosphorite, probably because it phos-



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

VALUABLE AND BEAUTIFUL MINERALS FROM MANY LANDS

1. Fluorite, or Fluor Spar, from Westmoreland, New Hampshire
2. Pyrite, "fool's gold," from Central City, Colorado
3. Cinnabar, native vermilion, from Felsobanya, Hungary
4. Copper, man's first useful metal, from Cornwall, England
5. Rhodonite, manganese ore, from Franklin Furnace, New Jersey
6. Hematite, iron ore, from Cumberland, England
7. Rhodochrosite, manganese ore, from Leadville, Colorado
8. Cassiterite, tin-stone, from St. Agnes, Cornwall, England
9. Gold nugget, from the Klondike, Northwestern Canada
10. Labradorite, with rainbow colours, from Labrador
11. Realgar, arsenic sulphide, from Manhattan, Nevada
12. Crocidolite, "tiger's eye," from Griqualand, South Africa
13. Sulphur, from Cianciana, Sicily

phoresced when heated. This mineral, known as Estremadura phosphate, occurs at Logrossan and Cáceres, where it forms an important deposit in slate. It may contain from 55 to 62% of calcium phosphate, with about 7% of magnesium phosphate. Dahllite is a Norwegian phosphorite, containing calcium carbonate, named in 1888 by W. C. Brögger and H. Bäckström after the Norwegian geologists T. and J. Dahll.

Phosphorite, when occurring in large deposits, is a mineral of much economic value for conversion into the superphosphate largely used as a fertilizing agent. Many of the impure substances thus utilized are not strictly phosphorite, but pass under such names as "rock-phosphate," or, when nodular, as "coprolite" (q.v.), even if not of true coprolitic origin. The ultimate source of these mineral phosphates may be referred to the apatite widely distributed in crystalline rocks. Being soluble in water containing carbonic acid or organic acids it may be removed in solution, and may thus furnish plants and animals with the phosphates required in their structures. On the decay of these structures the phosphates are returned to the inorganic world, thus completing the cycle.

There are three sources of phosphates which are of importance geologically. They occur (*a*) in crystalline igneous and metamorphic rocks as an original constituent, (*b*) in veins associated with igneous rocks, and (*c*) in sedimentary rocks either as organic fragments or in secondary concretionary forms.

The first mode of occurrence is of little significance practically, for the crystalline rocks generally contain too little phosphate to be valuable, though occasionally an igneous rock may contain enough apatite to form an inferior fertilizing agent, *e.g.*, the trachyte of Cabo de Gata in south-east Spain, which contains 12–15% of phosphoric acid. Many deposits of iron ores found in connection with igneous or metamorphic rocks, and the oolitic iron ores, such as those of the Jurassic system in England and Lorraine, contain from 1 to 2% of phosphorus, which passes into the slags in the basic process of steel-making, and forms a very important source of phosphatic manures ("basic slag").

Another group of phosphatic deposits connected with igneous rocks comprises the apatite veins of south Norway, Ottawa and other districts in Canada. These are of pneumatolytic origin (*see* PNEUMATOLYSIS), and have been formed by the action of vapours emanating from cooling bodies of basic eruptive rock. They once formed an important source of phosphate, but are now worked out.

The phosphatic rocks which occur among the sedimentary strata are the principal sources of phosphates for commerce and agriculture. They are found in formations of all ages from the Cambrian to those which are accumulating at the present day. Of the latter the best known is guano. (*See* MANURES and MANURING.)

Where guano-beds are exposed to rain their soluble constituents are removed and the insoluble matters left behind. The soluble phosphates washed out of the guano may become fixed by entering into combination with the elements of the rock beneath. Many of the oceanic islets are composed of coral limestone, which in this way becomes phosphatized; others are igneous, consisting of trachyte or basalt, and these rocks are also phosphatized on their surfaces but are not so valuable, inasmuch as the presence of iron or alumina in any quantity renders them unsuited for the preparation of artificial manures.

The leached guanos and phosphatized rocks, which are grouped with them for commercial purposes, have been obtained in great quantities in many islands of the Pacific Ocean (such as Baker, Howland, Jarvis and McKean Islands) between long. 150° to 180° W. and lat. 10° N. to 10° S. In the West Indies from Venezuela to the Bahamas and in the Caribbean Sea many islands yield supplies of leached guanos; the following are important in this respect: Sombrero, Navassa, Aves, Aruba, Curaçao. Christmas Island has been a great source of phosphates of this type; also Jaluit Island in the Maldive Archipelago, Banaba or Ocean Island, and Nauru or Pleasant Island. On Christmas Island the phosphate has been quarried to depths of 100 feet. To these leached guanos and phosphatized limestones the name sombrerite has been given. It has been estimated that 500,000 tons of phosphate were obtained in Aruba, 1,000,000 tons from Curaçao since the deposits were discovered in 1870, and Christmas Island in 1925 yielded 110,000 tons.

In the older formations the phosphates tend to become more and more mineralized by chemical processes. In whatever form they were originally deposited they often suffer complete or partial solution and are redeposited as concretionary lumps and nodules, often called *coprolites* (*q.v.*). The "Challenger" and other oceanographic expeditions have shown that on the bottom of the deep sea concretions of phosphate are now gathering around the dead bodies of fishes lying in the oozes; consequently the formation of the concretions may have been carried on simultaneously with the deposition of the strata in which they occur.

Important deposits of mineral phosphates are now worked on a large scale in the United States, the annual yield far surpassing that of any other part of the world. The most active operations are carried on in Florida, where the phosphate was first worked in 1887 in the form of pebbles in the gravels of Peace river. Then followed the discovery of "hard rock-phosphate," a massive mineral, often having cavities lined with nearly pure phosphorite. Other kinds not distinctly hard and consisting of less rich phosphatic limestone, are known as "soft phosphate"; those found as smooth pebbles of variable colour are called "land pebble-phosphate," whilst the pebbles of the river-beds and old river-valleys, usually of dark colour, are distinguished as "river pebble-phosphate." The land pebble is worked in central South Florida; the hard rock chiefly between Albion and Bay City. In South Carolina, where there are important deposits of phosphate, formerly more productive than at present, the "land rock" is worked near Charleston, and the "river rock" in the Coosaw river and other streams near Beaufort. The phosphate beds contain Eocene fossils derived from the underlying strata and many fragments of Pleistocene vertebrata such as mastodon, elephant, stag, horse, pig, etc. The phosphate occurs as lumps varying greatly in size, scattered through a sand or clay; they often contain phosphatized Eocene fossils (Mollusca, etc.). Sometimes the phosphate is found at the surface, but generally it is covered by alluvial sands and clays. Phosphate mining began in South Carolina in 1868, and for twenty years that state was the principal producer. Then the Florida deposits began to be worked. In 1892 the phosphates of Tennessee, derived from Ordovician limestones, came into the market. From North Carolina, Alabama and Pennsylvania, also, phosphates have been obtained but only in comparatively small quantities. In 1900 mining for phosphates was commenced in Arkansas. In 1908 Florida produced 1,673,651 tons of phosphate valued at 11 million dollars. All the other states together produce less phosphate than Florida, and among them Tennessee takes the first place with an output of 403,180 tons.

Algeria contains important deposits of phosphorite, especially near Tebessa and at Tocqueville in the province of Constantine. Near Jebel Kouif, on the frontier between Algeria and Tunis, there are phosphate workings, as also in Tunis, at Gafsa. The deposits belong to the Lower Eocene, where it rests unconformably upon the Cretaceous. The joint production of Tunis and Algeria in 1927 was not less than 3,748,000 tons. Phosphates occur also in Egypt, in the desert east of Keneh and in the Dakla oasis in the Libyan desert.

France is rich in mineral phosphates, the chief deposits being the departments of the Pas-de-Calais, Somme, Aisne, Oise and Meuse, in the north-east, and another group in the departments of Lot, Tarn-et-Garonne and Aveyron, in the south-west; phosphates occur also in the Pyrenees. The deposits near Caylus and in Quercy occupy fissures and pockets in Jurassic limestone, and have yielded a remarkable assemblage of the relics of Tertiary mammals and other fossils. Phosphates occur in Belgium, especially near Mons, and these, like those of north-east France, are principally in the Upper Chalk. Two varieties of phosphate rock are recognized in these districts, viz., the phosphatic chalk and the phosphate sand, the latter resulting from the decomposition of the former. Large and valuable deposits of the sand have been obtained in sinks and depressions on the surface of the chalk. The production is on the whole diminishing in Belgium (172,000

TABLE I. *Typical Mineral Waters*

	Indifferent	Earthy	Salt	Salt	Sulphur	Iron	Alkaline	Alkaline-Saline	Table water	Purging water
	Gastein 95°–118°	Leuk 123·8°	Kissingen	Sea-water	Aix-la-Chapelle 113°–140°	Schwalbach	Vichy 105·8°	Carlsbad 119°–138°	Seltzers	Hunyadi Janos
Solids										
Bicarbonate of soda .	..	..	..	..	0·6449	0·0206	4·883	1·92	1·2	..
„ „ potash	..	..	..	..	..	..	0·352	..	..	..
„ „ magnesia	0·0017	0·013	0·017	0·45	0·0506	0·2122	0·303	0·18	..	..
„ „ calcium	0·0195	0·012	1·06	2·38	0·157	0·2213	0·434	0·428	..	..
Sulphate of soda .	0·0208	0·050	..	..	0·2831	0·0079	0·292	2·37	..	15·9
„ „ potash .	0·0135	0·038	..	..	0·1527	0·0037	..	0·16	..	..
„ „ magnesia	..	0·308	0·588	2·96	..	..	..	..	0·46	16·0
„ „ calcium .	..	1·520	0·389	0·25	..	..	..	..	..	..
Sulphide of sodium .	..	..	..	..	0·0136	..	..	..	..	..
Chloride of sodium .	0·0428	..	5·52	25·21	2·616	..	0·534	1·03	2·2	1·3
„ „ potash .	..	..	0·286	..	..	..	..	..	..	..
„ „ magnesia .	..	..	0·303	3·39	..	..	..	..	..	..
Carbonate of iron .	0·0005	0·023	0·277	..	..	0·0837	..	0·003	0·01	..
Silicic acid . . .	0·0496	0·036	..	..	..	0·0320	..	..	..	..
Gases										
Carbonic acid . .	..	..	3·19	..	..	5·35	2·6	0·76	2·24	0·45
Hydrosulphuric acid	..	..	..	..	trace	..	..	..	..	..

tons in 1927), but in France by this time it has become nearly, or very nearly, extinct.

In the Lahn district of Nassau (Germany) there are phosphate beds in Devonian rocks. The deposits were rich but irregular and local, and were much worked from 1866 to 1884, but are no longer of economic importance. In northern Estremadura in Spain and Alemtejo in Portugal there are vein deposits of phosphate of lime. As much as 200,000 tons of phosphate have been raised in these provinces, but in 1927 Spain was not mentioned in the list of producers. Large deposits of phosphate occur in Russia, and those in the neighbourhood of Kertch have attracted some attention; it is said that the Cretaceous rocks between the rivers Dniester and Volga contain very large supplies of phosphate, though probably of low grade.

Phosphatic nodules and concretions, with phosphatized fossils and their casts, occur at various geological horizons in Great Britain. Bands of black nodules, highly phosphatic, are found at the top of the Bala limestone in North Wales; beds of concretions occur in the Jurassic series; and important deposits are known in the Cretaceous strata, especially in the Lower Greensand and at the base of the Gault. The Lower Greensand phosphates have been worked, under the name of "coprolites," at Potton in Bedfordshire and at Upware and Wicken in Cambridgeshire. The Cambridge Greensand, rich in phosphatic nodules, occurs at the base of the Chalk Marl. The chalk occasionally becomes phosphatized, as at Taplow (Bucks), Lewes (Sussex) and Ciply in Belgium. At the base of the Red Crag in East Anglia, and occasionally at the base of the other Pliocene Crags, there is a "nodule bed," consisting of phosphatic nodules, with rolled teeth and bones, which were formerly worked as "coprolites" for the preparation of artificial manure. Lord Rayleigh has found that phosphatized nodules and bones are rich in radioactive constituents, and has brought this into relation with their geological age.

BIBLIOGRAPHY.—For American phosphates see ***The Phosphates of America***, by Francis Wyatt (5th ed., 1894); the Annual Reports on ***Mineral Resources of the U.S.*** (U.S. Geol. Survey), including some valuable reports by C. W. Hayes, also those in Rothwell's ***Mineral Industry***; "Nature and Origin of Deposits of Phosphate of Lime," by R. A. F. Penrose, Jun., *Bull. U.S. Geol. Survey*, No. 46 (1888); ***Florida, South Carolina and Canadian Phosphates***, by C. C. Hoyer Miller (1892); and ***The Non-metallic Minerals***, by G. P. Merrill (1904). Many of the above include descriptions of mineral phosphates in other parts of the world. For a general discussion of the origin of the phosphates, *see* "The Natural History of Phosphate Deposits," by J. J. H. Teall, *Proc. Geol. Assoc.*, xvi. 369 (1900). Consult also ***Étude complète sur les phosphates***, by A. Deckers (Liége, 1894).

MINERAL RIGHTS DUTY: *see* INLAND REVENUE DUTIES.

MINERAL WATERS. The number of mineral waters in various parts of the world is so great that a comprehensive list cannot be given. In the accompanying tables are presented short notes of the chief with their dominating characters and indications for their use in medicine. In many instances detailed information can be readily obtained from the various official handbooks issued. As to the action of mineral waters in general (*see* BALNEOTHERAPEUTICS; BATHS) there is so large a social and commercial element in all spas that the medical side, viewed from a strictly scientific standpoint, is much obscured. Where the water contains a special substance (*e.g.*, arsenic, as in some French springs, lithium, radium or radium emanation) it is usually regarded as dominating the character of the water and the uses to which it should be put medically. *See* also AERATED WATERS and SOFT DRINKS.

TABLE II. *Indifferent Waters*

Locality	Height in ft.	Temp. °Fahr.	For what prescribed
Evian, Lake of Geneva	1,100	..	Nervous cases, dyspepsia, urinary affections.
Badenweiler, Baden .	1,425	..	For mild rheumatic treatment; a health resort.
Buxton, England .	980	82	Gout and rheumatism (nitrogen present).
Schlangenbad, Nassau	800	80–87	Nervous cases, female disorders, skin.
Sacedon, Spain . .	1,500	85	Rheumatism, gout, cutaneous affections.
Wildbad, Württemberg	1,320	90–101	Gout and rheumatism, neuralgia, thickenings.
Pfeffers, Switzerland .	2,115	99	Do. do. do.
Ragatz, do. . .	1,570	95	Do. do. do.
Panticosa, S. Pyrenees	5,110	85–95	Do. (nitrogen present); special action in phthisis.
Teplitz, Bohemia .	648	101–120	Gout, rheumatism, old injuries, joints or bones.
Gastein, Austria . .	3,315	95–118	Do. do.; soothes nervous system.

TABLE III. *Earthy Waters*

	Locality	Height in ft.	Temp. °Fahr.	Therapeutic action
Cold	Contrexéville, Vosges	1,050	..	Special action in calculous affections.
	Lippspringe, North Germany . .	..	..	Supposed to be useful in phthisis.
	Wildungen, do. .	..	..	Special use in urinary complaints; contains iron.
	Weissenberg, Switzerland . . .	2,600	..	Resorted to for pulmonary affections.
	Pougues, France .	600	..	Dyspepsia, diabetes, hepatic and urinary concretions.

TABLE III. *Earthy Waters*—continued

	Locality	Height in ft.	Temp. °Fahr.	Therapeutic action
	Baden, Switzerland	1,180	117–122	Rheumatism, gout, paralysis, scaly eruptions.
	Leuk, do.	4,400	93–123	Do., some female complaints.
	Bormio, North Italy	4,400	86–104	Do. do.; old sprains.
Warm	Lucca, Italy	..	108–122	Do. do. do.
	Bath, England	..	108–122	Do. do. do.
	Dax, south of France	1,400	139	Do. do.
	B. de Bigorres, Pyrenees	1,800	64–123	Do.; chlorosis, neuralgia.

TABLE IV. *Salt Springs*

	Locality	Temp. °Fahr.	Therapeutic action
Cold	Soden, near Frankfort	..	Dyspepsia, anaemia, scrofula, special for throat and phthisis.
	Homburg, do.	..	Dyspepsia, slighter hepatic affections, chlorosis, gout.
	Kissingen, Bavaria	..	In all essentials the same.
	Pyrmont, North Germany	..	Better known for its iron; has a good salt drinking spring.
	Kreuznach, near Bingen	..	A salt well without carbonic acid; used in scrofula and anaemia; bathing more important.
Warm	Wiesbaden, Nassau	155	Used in dyspepsia and gout; the bathing is most important.
	Baden-Baden	156	Still milder water; uses similar; gout.
	Bourbonne, Haute-Marne	114–149	Rheumatism, neuralgia, effects of malaria.
	Balaruc, South France	116·6	Do.; special for treatment of paralysis.
	Salins, Moutiers, Savoy (1,480ft.)	96	Scrofula, anaemia, loss of power, sexual disorders.
	Brides, Savoy (1,700 ft.)	95	Act on liver and digestive canal; used for obesity.
	Acqui, North Italy	169	Rheumatism; special treatment with the bath deposit.
	Abano, do.	185	Chiefly as baths; mud of bath used for poultice.
	Caldas de Mombuy, near Barcelona	153–158	Rheumatism, sciatica, old injuries.
	Cestona, Guipuzcoa, Spain	88–94	Rheumatism, indigestion, bronchitis.

Almost all the above named stations have several springs of various strengths: the cold may be said to vary from 14 to 5·8% of chloride of sodium; the warm are generally weaker, perhaps varying from 6·8 to 1·6. In several, minute traces of iodine or bromine are found.

TABLE V. *Stronger Salt Waters*

Locality	Chloride of Sodium in 1,000 parts of Water	Therapeutic application
Rheinfeld, Aargau, Switzerland	311	Scrofula, effects of inflammation, chronic exudations, some chronic exanthemas, rheumatism, uterine infiltrations.
Salzungen, North Germany	256	Do. do.
Ischl, Austria (1,440ft.)	256	Do. do.
Hall, Tyrol (1,700ft.)	255	Do. do.
Reichenhall, near Salzburg (1,800ft.)	224	Do. do.
Bex, Rhone Valley (1,400 ft.)	156	Do. do.
Castrocaro, Tuscany	36	Do. do.
Droitwich, near Worcester	233·6	Do. do.
Sea Water	30·4	Do. do.
Rehme, Westphalia (92° F)	24–85	Do.; special use in locomotor ataxia.
Nauheim, Wetterau (80°–103° F)	29	Do. do.

TABLE VI. *Iron Waters*

Locality	Height in ft.	Carb. of iron	Therapeutic use
Rippoldsau, Black Forest	1,886	0·12	For anaemic conditions; laxative.
Homburg, near Frankfort	..	0·10	Do. do.
Elster, Saxony	1,465	0·08	Do. do.
Liebenstein, North Germany	911	0·08	Do. do.
Schwalbach, Nassau	900	0·08	Do.; much of a ladies' bath.
Bocklet, near Kissingen	600	0·08	Do.
Griesbach, Black Forest	1,614	0·07	Do.; laxative; a ladies' bath.
Franzensbad, Bohemia	1,293	0·07	Do. do.
Pyrmont, Germany	..	0·07	Do.
Spa, Belgium	1,000	0·06	Do.
Petersthal, Black Forest	1,333	0·04	Do.; laxative.
St. Moritz, Engadine, Switzerland	5,464	0·03	Do.; sought for its air.
Forges-les-Eaux, France	..	0·06	Do.
La Malou, Hérault, France (temp. 88°)	..	0·08	Do.
Recoaro, North Italy	1,943	0·04	Do.
Tunbridge Wells	..	0·06	Do.; deficient in carbonic acid.
Muspratt Spring, Harrogate (chloride)	600	0·15	

TABLE VII. *Cold Sulphur Springs*

Locality	Sulphuretted Hydrogen dissolved in water	Sulphide of Sodium
Eilsen, Schaumburg-Lippe	42·3	..
Meinberg, Lippe-Detmold	23·1	0·008
Gurnigel, Switzerland (3,600ft.)	15·1	..
Leuk, do. (3,593ft.)	44·5	..
Challes, Savoy (900ft.)	..	0·478
Enghien, near Paris	..	0·106
Uriage, Isère, France (1,500ft.)	7·34	..
Harrogate, England	..	0·207
Strathpeffer, Scotland	..	0·026
Lisdoonvarna, Clare, Ireland	..	..

TABLE VIII. *Warm Sulphur Springs*

Locality	Height in ft.	Temp. °Fahr.	Hydrosulphuric acid absorbed in water	Sulphide of Sodium
Aix-la-Chapelle, Germany	534	131–140	0·3	0·01
Baden, near Vienna	..	95–115	2·5	0·052
Schinznach, Switzerland	1,060	80–92	37·8	..
Lavey, Rhone Valley	1,350	92–113	3·5	..
Hercules Bad, Banat	500	110	42·6	..
Aix-les-Bains, Savoy	765	108·5	27·2	..
Luchon, Pyrenees	2,000	135·5	..	0·07
Barèges, do	4,100	113	..	0·04
Amélie-les-Bains, Pyrenees	810	87–147	..	0·01
Cauterets, do.	3,254	71–134	..	0·02
Eaux Bonnes, do.	2,400	90·5	..	0·02
Archena, Murcia, Spain	..	126	..	..

TABLE IX. *Alkalic Waters* Class I. *Simple Alkalines*

Locality	Carb. Soda	Therapeutic uses
Vals, South France	7·1	Catarrh of stomach, gout, renal and biliary calculi, liver complaints, diabetes.
Bilin, Bohemia	4·2	Do. do. do.
Vichy, France (105° F)	5·1	Do. do. do.
Neuenahr, Rhineland (92°–97° F)	1·0	Mucous catarrh; diabetes specially.
La Malou, France (97° F)	..	Do.; sedative effect on nervous system.
Vidago, Portugal	..	Do.; gout, urinary affections.

Class II. *With Chloride of Sodium varying from 4·3 to 1 in amount*

Locality	Height in ft.	Temp. °Fahr.	Carb. Soda	Therapeutic uses
Luhatschowitz, Moravia	1,600	..	8·4	Springs rich both in carb. soda and chl. sodium.
Tönnistein, Rhine Valley	..	..	2·5	Light antacid tonic to stomach.
Ems, Nassau	..	85–115	2·0	Special in female complaints and mucous membrane.
Ischia, Italy	..	up to 170	2·0	Specially rheumatism and female complaints.
Royat, Auvergne	1,400	80–95	1·3	Do. and some skin affections.
Mont Dore, do.	3,300	100–114	..	Asthma, chronic laryngitis.
Bourboule, do.	2,800	107–125	..	Scrofula, rachitis, cutaneous affections.

Class III. *With Sulphate of Soda varying from 5·2 to 2 in amount, and Carbonate of Soda varying from 3·55 to 0·51 in amount*

Locality	Height in ft.	Therapeutic uses
Elster, Saxony	1,460	Action on abdominal organs, female complaints.
Marienbad, Bohemia	1,012	Do.; special use in obesity.
Franzensbad, do.	1,293	Do.; specially a ladies' bath.
Tarasp, Lower Engadine	4,000	Powerful action on abdominal viscera.
Carlsbad, Bohemia (121°–164° F)	1,200	Gout, liver affections, biliary and renal calculi, diabetes.

Table X. *American Mineral Waters*

	Designation and locality	Therapeutic application
Indifferent (Thermal)	Lebanon, Columbia co., N. Y. (73° F)	
	Healing, Bath co., Va. (88° F)	Scrofulous ulcers and ophthalmia, ozoena, chronic diarrhoea and dysentery, secondary and tertiary syphilis.
	Warm, Bath co., Va. (98° F)	Chronic and subacute rheumatism, gout, neuralgia, nephritic and calculous diseases.
	Hot, Bath co., Va. (110° F)	Chronic rheumatism, gout, diseases of liver, neuralgia, contractions of joints.
	Paso Robles, San Luis Obispo co., Cal. (122° F)	
	Hot, Garland co., Ark. (93-150° F)	Dartrous diseases of skin, functional diseases of uterus, chronic mercurial and lead poisoning.
Calcareous and Earthy	Gettysburg, Adams co., Penn.	Calculus, gravel, catarrh of stomach or bladder, dyspepsia.
	Sweet, Monroe co., W. Va. (74° F)	Gravel, dyspepsia (diuretic, diaphoretic).
	Berkeley, Morgan co., W. Va (74° F)	Neuralgia (restorative).
	Alleghany, Montgomery co., Va.	Purgative, diuretic.
	Bethesda, Waukesha co., Wis.	Diabetes mellitus, gravel, inflammation of bladder, dropsy, albuminuria (diuretic)
Sulphur	Lower Blue Lick, Nicholas co., Ky.	Aperient and alterative.
	Sharon, Schoharie co., N. Y.	Do. do.
	White Sulphur, Greenbrier co., Va.	Dartrous skin diseases, diseases of the bladder, jaundice, dyspepsia.
	Salt Sulphur, Monroe co., W. Va.	Do.; scrofula and syphilis.
Epsom Salt	Bedford, Bedford co., Penn.	Anaemia, gravel, calculus (strongly diuretic).

Table X. *American Mineral Waters*—continued

	Designation and locality	Therapeutic application
Common Salt	St. Catharine's, Ontario, Canada	Rheumatism, gout, scrofula, neuralgia.
	Caledonia, Ontario, Canada	Rheumatism, gout.
	Hathorne, Saratoga, N. Y.	Dyspepsia, jaundice, abdominal plethora.
	Ballston, Saratoga co., N. Y.	Do. do. do.
Iron	Oak-Orchard Acid, Genesee co., N. Y.	Ulcers, diseases of the skin, passive haemorrhages, atonic diarrhoea (has 10 grains of free sulphuric acid in the pint).
	Rawley, Rockingham co., Va.	Chlorosis and anaemia generally, tonic.
	Sweet Chalybeate, Alleghany co., Va.	Do. do. do.
	Rockbridge Alum, Rockbridge co., Va.	Scrofula, chronic diarrhoea.
	Cooper's Well, Hinds co., Miss.	Anaemia, chlorosis, chronic diarrhoea, dropsy.
Glauber Salt	Crab Orchard, Lincoln co., Ky.	
	Midland, Midland co., Mich.	
Alkaline	Bladen, Choctaw co., Ala. (carbonated alkaline)	
	Congress, Santa Clara co., Cal. (saline-alkaline)	
	St. Louis, Gratiot co., Mich. (simple alkaline)	Dyspepsia, neuralgia, chronic and subacute rheumatism.

Bibliography.—(1) German: E. Osann, *Darstellung der Heilquellen Europas* (3 vols., Berlin, 1839–43); J. Seegen, *Handbuch der Heilquellenlehre* (Vienna, 1862); B. M. Lersch, *Hydrochemie* (1870), and many other works; Helfft, *Handbuch d. Balneotherapie* (8th ed., Berlin, 1874); Valentiner, *Handbuch d. Balneotherapie* (Berlin, 1876); L. Lehmann, *Bäder u. Brunnen Lehre* (Bonn, 1877); J. Braun, *System, Lehrbuch d. Balneotherapie*, 4th ed., by Fromm (Berlin, 1880); O. Leichtenstern, *Balneotherapie* (Leipzig, 1880); *Deutscher Bäderkalender* (Berlin, 1927). (2) French: *Dictionnaire des eaux minérales*, etc., by MM. Durand-Fardel, etc. (2 vols., Paris, 1860); J. Lefort, *Traité de chemie hydrologique* (2nd ed., Paris, 1873); C. James, *Guide pratique aux eaux minérales* (Paris), many editions; Macé, *Guide aux villes d'eaux, etc.* (Paris, 1881); Joanne and Le Pileur, *Les Bains d'Europe* (Paris); L. Porcheron, *Guide pratique aux villes d'eaux, stations, climatiques, plages marines françaises* (Paris, 1923). (3) Swiss: Meyer Ahrens, *Heilquellen der Schweitz* (Zürich, 1867); Gsell Fels, *Die Bäder und Kurorte der Schweitz* (Zürich, 1880). (4) Italy: G. Jervis, *Guida alle acque minerali d'Italia* (Turin, 1876, etc.); E. F. Harless, *Die Heilquellen und Kurbäder Italiens* (1848). (5) Spanish: Rubio, *Tratado de las fuentes minerales de España* (Madrid, 1853); Don J. de Antelo y Sanchez has recently published a work on Spanish waters. (6) English: T. Short, *History of the Mineral Waters* (London, 1734); J. Rutty, *Methodical Synopsis of Mineral Waters* (London, 1757); Granville, *Spas of England* (1841); E. Lee, *Mineral Springs of England* (London, 1841); J. Macpherson, *Our Baths and Wells* (1871), and *Baths and Wells of Europe* (1873); H. Weber's Eng. ed. of Braun (London, 1875); *The Spas of Britain*, the official handbook of the British Spa Federation (Bath, 1924); E. Hawkins, *Medical Climatology of England and Wales* (London, 1923); T. D. Luke, *Spas and Health Resorts of the British Isles* (London, 1919); N. Wood, *Health Resorts of the British Islands* (2nd ed., London, 1919). A great portion of the literature is to be found in monographs on particular places. (7) American: J. Bell, *The Mineral and Thermal Springs of the United States and Canada* (1855); J. J. Moorman, *The Mineral Waters of the United States and Canada* (1867); C. F. Chandler, *Lecture on Water* (1871); G. E. Walton, *The Mineral Springs of the United States and Canada* (1875); I. Burney Yeo, *The Therapeutics of Mineral Springs* (1904); A. A. Chambers, "Comparison of American and European Mineral Waters," in *U.S. Geol. Surv. Prod. of Mineral Waters, 1916*, pp. 500–508 (1918); A. J. Ellis, "Publications on Mineral Waters," *ib.*, pp. 509–510; O. E. Meinzer, "Large Springs in the United States," *U.S. Geol. Surv. Water Supply Paper 557* (1927); and W. E. Fitch, *Mineral Waters of the United States and American Spas* (1927).

United States.—The term "mineral water" is employed to connote water of high mineral content as well as all water bottled and sold for table or medicinal use without appreciable alteration from its natural state. Some of these waters contain considerably less mineral matter than many of the public water supplies. A mineral content of less than 10 grains per gallon is considered low, 30 grains high, and over 100 grains very high. It is estimated that there are over 10,000 mineral springs in the United States. Mineral waters are employed for medicinal purposes, as table

waters in place of public water supplies, and for the manufacture of soft drinks, particularly carbonated beverages.

MINERAL WELLS, a city of Palo Pinto county, Texas, U.S.A., 45 m. W. of Fort Worth, near the Brazos river; on Federal highway 80, and served by the Gulf, Texas and Western and the Weatherford, Mineral Wells and North Western railways. Pop. (1920) 7,890, and in 1930, 5,986 by Federal census. It is primarily a health and pleasure resort. More than 150,000 visitors come annually to drink the waters and take the baths. The water is bottled for shipment in one of the largest plants of the kind in the world. The city was founded in 1880 and incorporated in 1885.

MINERS MILLS, an anthracite-mining borough of Luzerne county, Pennsylvania, U.S.A., 3 m. N.E. of Wilkes-Barre; served by the Central of New Jersey, the Delaware and Hudson, and the Lehigh Valley railways. Pop. (1920) 4,365 (29% foreign-born white). It was annexed to Wilkes-Barre in 1929.

MINERS PERMANENT RELIEF SOCIETIES: *see* FRIENDLY SOCIETIES.

MINERS' PHTHISIS. Almost any dust inhaled in sufficient quantity may cause chest trouble, but certain dusts are related to the occupational disease variously known as miners' phthisis, pneumonoconiosis, grinders' rot, potters' rot, stonecutters' rot, etc.

Phthisis-producing Dusts.—Dusts with this association are often referred to as phthisis-producing dusts, because pulmonary tuberculosis plays a more or less important part in this disease and is always associated with a fatal termination and usually with disablement. E. L. Collis has shown that the phthisis-producing dust of far the greatest importance in industry is dust of free silica (SiO_2) and the disease is often known as "Silicosis." For a dust to be phthisis-producing it must be comparatively insoluble and inert and the particles must be minute, say from five microns downwards, or about the size of the common pathogenic micro-organisms. Owing to their minute size these particles may be present in air in dangerous concentration without being visible to the eye or in any other way noticeable to the senses, so in a phthisis-producing industry it is expedient to sample the air for dust as one samples for gas in a "gassy" mine.

The Lungs and Dust.—The lungs have a very considerable power of ridding themselves of inhaled particles, and some dusts, like coal-dust, are much more readily got rid of than others while, in the case of a phthisis-producing dust, accumulation readily gets ahead of elimination, so quite small quantities of air-borne dust may be dangerous. It is owing to this cumulative factor that duration and continuity of exposure are of importance as well as concentration in the air. While the average incidence of miners' phthisis in the gold-mines of the Witwatersrand is under 3% per annum of the underground population, the incidence rises as high as 10% per annum among miners of 13 years' service and over.

A certain proportion of the fine dust inhaled runs the gauntlet of the upper respiratory passages and gets right down into their minute blind extremities, the alveoli. In silicosis as in pulmonary tuberculosis "lesion means arrest" and the dust particles are arrested by being taken up by certain cells often called dust cells. These are phagocytic endothelial cells and, when dust-laden, they aggregate forming masses or pseudo-tubercles on the alveolar walls, under the pleura and in the lymphatic channels which they obstruct. The pseudo-tubercles tend to degenerate and become replaced by fibrous tissue, thus forming the fibroid nodules characteristic of the early stage of silicosis.

Prevention.—It is the fine dust that matters and, in mines where a phthisis-producing rock is dealt with, the chief sources of fine dust are blasting and rock-cutting with machines. From the point of view of prevention, in industries where blasting is practised, the workers should not return to the working-place until after all dust and fume have been blown away. Ventilation with good currents of dust-free air is the great safeguard because, by treating the air-borne dust as a gas, it can be diluted down towards a safe level. With daily exposure over many years, perhaps about one milligramme of dust per cu. metre of air is a safe level. The fine dust is only a small proportion by weight of the total air-borne particles, but includes the majority of particles by enumeration. A sample of air-borne dust of 2 milligrammes per cu. metre as determined by the method in use on the Witwatersrand corresponds to about 350 particles of fine dust per cu.cm. of air (counted by Kitze koniometer). The other great safeguard is "working wet" as the chief source of the dust associated with machine drilling is "sludging" with air. When it is practicable to sludge with water only, machines raise much less dust. Water-sprays should be in continuous use and the roof, walls and floor of the working-place kept wet (*see* MINING).

A machine may be in good order for rock-cutting and in bad order for dust-control and should be inspected from the latter point of view as well as the former. A hand-drill is more difficult to keep in order for dust-control than is the larger machine and it is doubtful if it is possible to secure safe conditions if hand-drills are used dry when cutting phthisis-producing rock. In all phthisis-producing industries, apart from working wet, it is wise to think of the fine air-borne dust as a gas and make use of exhaust-hoods and abstractors; while sources of dust escaping to the air should, as far as possible, be located and enclosed.

There are two important factors in the severe forms of miners' phthisis:—

(1) The phthisis-producing dust.
(2) The tubercle bacillus.

The modern view of pulmonary tuberculosis as met with in the adult population of civilized countries is that it is contracted from an active case by inhalation. Under experimental conditions the presence of dust in the air, together with the tubercle bacillus, renders the susceptible animal much more liable to infection by inhalation. It is on account of this association that, in a phthisis-producing industry, one must strive not only to eliminate dust but also to eliminate the tubercle bacillus. The only practicable step towards the latter ideal is to detect and remove the "carrier," *i.e.*, the sufferer from open tuberculosis.

BIBLIOGRAPHY.—*Public Health* (1915, with bibl.); E. L. Collis, *Industrial Pneumonoconioses*, Milroy Lectures, 1915 (1919); *Annual Reports of Miners' Phthisis Board* and *Miners' Phthisis Medical Bureau*, Department of Mines and Industries, Union of South Africa; *Publications of United States Bureau of Mines*, B132, T.P. 372, etc.
(A. MA.)

MINERSVILLE, a borough of Schuylkill county, Pennsylvania, U.S.A., on the Schuylkill river, 4 m. W. of Pottsville. It is served by the Pennsylvania and the Reading railways. Pop. (1920) 7,845; and in 1930 it was 9,392. Anthracite mining is the chief industry, and there are several factories. The borough was settled about 1790 and incorporated in 1831.

MINERVA, an Italian goddess, subsequently identified with Athena; also MENERVA, from *mens*, mind. She presided over all handicrafts, including professions and arts. Besides her Etruscan cult in the capitol, she had at Rome, before 207 B.C., a temple on the Aventine, which was from the time of Livius Andronicus (q.v.) the meeting-place for guilds of craftsmen, including dramatic poets and actors. The dedication day of the temple was March 19, called *quinquatrus*, because it fell on the fifth day after the Ides. Properly this was a festival of Mars, but it came to be considered Minerva's day, apparently from the accident that her temple had been founded then. She herself was confused with Nerio, the cult-partner of Mars. All the schools had holidays at this time, and the pupils, on reassembling, brought a fee (*minerval*) to the teachers. At a later time the festival extended over five days. Her later cult is wholly modelled on that of Athena. There was another shrine of Minerva on the Caelian hill, where she was worshipped under the name of Capta, the "captive." This cult was brought to Rome on the capture of Falerii, 241 B.C. Here a festival called the lesser *quinquatrus* was celebrated on June 13 and 14, chiefly by the flute-players (Livy ix. 30; Ovid, *Fasti* vi. 651). *See* also PALLADIUM.

MINES, MINELAYING AND MINESWEEPING. A submarine mine is a weapon used for the attack and defence of harbours and anchorages or to deny the use of certain areas of water to ships. Briefly, it consists of a charge of explosive, contained in a water-tight case, intended by its explosion to put out of action a hostile vessel of any class it is designed to act against. Prior to 1870 the term "torpedo" was used for all explosive

charges fired in the water, but since that date the word "torpedo" has been restricted to the mobile torpedo (*see* TORPEDOES). Although the scientific development of submarine mining warfare is the work of the last sixty years, attempts to use drifting charges against ships and bridges are recorded as early as the 16th century. Mines were used by the Americans in 1777, and in 1780 Robert Fulton produced an explosive machine which he called a "torpedo," and which was experimented with, not very successfully, up to 1815. In 1854, the Russians used mechanical mines in the Baltic, but without any marked success.

The first application of electricity to the explosion of submerged charges was made by Sir Charles Pasley in the destruction of wrecks in the Thames and of the wreck of the "Royal George" at Spithead in 1839 and subsequent years. The first military use of electrically-fired mines was made in the American Civil War of 1861–65 when several vessels were sunk or damaged by mines or torpedoes. From this date onwards most European nations experimented with mines, and they were actually used during the Franco-German War of 1870, the Russo-Turkish War of 1878 and the Spanish-American War of 1898. The most interesting example of mine warfare prior to the World War was in the attack and defence of Port Arthur during the Russo-Japanese War of 1904–05. Both sides used mechanical mines only, and both suffered heavy losses from the mine warfare. Mines and torpedoes were first introduced into the English service about 1863, defence mines being placed in the charge of the Royal Engineers, while torpedoes were developed by the Royal Navy. In 1904 the responsibility for all mining work was placed on the Navy. As a rule mines are moored, but mines which drift with the tide or current are occasionally used for special purposes.

Any explosive can be used in submarine mines provided adequate means are provided to explode the charge. The detonators for electrically fired mines are fired by heating a small length of wire, termed a "bridge," round which is placed a priming which burns and detonates a small charge of fulminate of mercury, lead azide or similar explosive, which in turn detonates the main charge. The detonator for mechanically fired mines is exploded by the friction of the striker entering it. The charge is contained in a steel mine case which also contains the necessary electrical or mechanical arrangements for firing the mine. For buoyant mines the cases must have sufficient air space to provide the necessary buoyancy. The size of the mine case will therefore depend principally on the weight of charge and the buoyancy required, the latter varying according as the mine is to be laid in still water or in currents or tides, and according to the depth of water and consequent weight of mooring rope. The cases are moored to the sea bed by a heavy weight called a "sinker," the connection being made by a flexible steel wire rope or, in electrically controlled mines, by the electric cable itself. Various proposals have been made for including in a mine some apparatus which will compensate for the rise and fall of the tide and enable the mine to be kept at the pre-arranged depth all the time. Submarine mines may be divided into two main classes, "controlled" and "non-controlled."

Controlled Mines.—These are fired by electricity and are connected by electric cables to a shore station where means are provided for switching off the current, thus rendering the mines inert and harmless during the passage of friendly vessels. They are thus absolutely under the control of the operator on shore, their condition is always accurately known from the testing apparatus at the shore station and if any break adrift from their moorings the mines are harmless. It should be noted that *all* mines are supposed to be harmless if they break adrift. Controlled mines take longer to prepare and lay than non-controlled mines, as the electric cables have to be laid and jointed, and more skill and training is required to lay and maintain a minefield. They can be arranged on two systems according to the method to be employed to effect the exact moment to fire the charge. These methods are by *observation* or by *circuit closer*.

In the *observation* system, the exact position of the mines when laid is marked on a special chart, on which the track of any ship crossing the minefield can also be plotted. The operator in the shore station plots the track and when it is seen to be crossing the position of a mine he closes a switch and the mine is fired. The mines themselves are placed either on the sea bed or at depths well below the bottom of any friendly ships, and therefore such mines offer no obstruction to friendly traffic, though anchoring in the mine field must be prohibited for fear of damaging the cables. As the mines are not in contact with the ship at the moment of firing and as errors in observation must be allowed for, these mines must carry larger charges of explosive than mines fired by contact with a ship and they are usually fired in groups.

In the *circuit closer* system, each mine contains an apparatus which is actuated by any vessel or other heavy object bumping against the mine. When set in action the apparatus completes the electrical circuit through the detonators in the explosive charge and the mine fires if the main controlling switch on shore is closed. When it is not desired to fire, the main switch on shore is kept open and the circuit closer is restored to its open condition automatically after the mine has been bumped. Such mines are necessarily placed near the surface and though they can be rendered harmless they are liable to damage by vessels passing through the field and consequently are used in waters which it is intended to close entirely. Their principal advantage over observation mines is that as long as the main switch is closed they are effective in fog or mist, when observation mines and the guns of the defence system could not be effective. As they are fired in contact with the ship a comparatively small charge only is required and only a single mine is fired at a time.

Non-controlled Mines.—In these the means of firing are contained in the mine itself; they may be fired either electrically by means of a small local battery or mechanically by a spring, pistol or suspended weight. In all cases the impulse which actuates the firing gear is the bump given by a ship or other heavy object striking the mine. When non-controlled mines have once been laid they are dangerous to friend and foe alike. Safety arrangements are fitted to these mines to keep the firing apparatus out of action while the mine is being laid, to render the mine harmless in case it breaks away from its mooring and, in some cases, to render it inactive after a certain period of time. Mines that fail in these respects become as great a danger to friend as to foe. At the outbreak of war in 1914 the German Carbonit mine was unreliable in respect to its safety after breaking adrift while the British mines were, unfortunately, only fully efficient in the same respect. In the latter part of 1917 the new and improved British H2 mines came into use. This mine was similar in principle to the German Carbonit mine except for the method of taking up the predetermined depth.

The German method of depth-taking was for the mine, attached to the sinker, to drop to the sea bottom, where, after a short interval for the purpose of safety, the mine released itself from the sinker and rose to the depth for which it was set. In the British method, on release from the minelayer the mine remained on the surface while the sinker went down, unreeling the mooring wire until a small weight (hanging below the sinker a distance equal to the depth the mine was required to be below the surface) struck the bottom. The mooring rope then stopped unreeling and the sinker continuing to sink pulled the mine below the surface. An advantage of the British system was that heavy water pressure on the mine-case was obviated; but, on the other hand, it did not obtain the exceptional accuracy in depth-taking which was noticeable in the German method. The United States used a mine of a novel type. It carried the usual charge of 300lb. of tri-nitrotoluene, but from each mine there extended antennae for a distance of 35ft. which, if touched by a metal ship, exploded the mine. The result was that the danger zone was largely increased.

Moored mines can be laid in any depth up to 100 fathoms, or even more in tideless waters, and they can be regulated to lie at any depth below the surface. Deep mines are used against submerged submarines, and shallow ones against surface shipping. In a strong tide, with a long mooring-rope, the mine will bend over to the tide; so that mines, under strong tidal conditions, sometimes lie too deep to be harmful to surface ships. During the War in a position such as the Pentland Firth, mines were in fact

only a danger at slack water, a period of minutes only. Again, the difference in height between high and low water is an important matter. If, for instance, the tidal range was exceptionally large, as in the Bristol Channel or Bay of Fundy, all types of ships could pass over a minefield at high water in perfect safety, provided no mines had been seen at low water on the surface. By The Hague convention drifting mines should become inactive one hour after they are first dangerous. Some uses for these mines are (a) for attacking ships sheltering in a harbour by allowing the tide to drift the mines in; (b) for dropping in the wake of a ship or squadron when being chased.

The most recent forms of drifting mine are oscillating mines which maintain themselves at approximately a steady depth by mechanical means. The inventors claim for them the advantage that they cannot be swept up. Of oscillating mines a well known type is the Leon mine. The mine is slightly heavier than the water it displaces and therefore sinks slowly. On passing the prearranged depth a hydrostatic valve switches on electrical power which drives a propeller and causes the mine to rise until at a certain depth the power is switched off, and the mine commences to sink again.

MINELAYING

Mines are laid by vessels specially fitted to carry them. In surface vessels the mines rest on their sinkers which have wheels at the bottom running on rails laid on the decks in a fore and aft direction. Means are provided for hauling the mines along these rails until they enter the mine traps placed in ports cut in the stern of the ship. The traps hold the mine in position ready for letting go. When the trap is opened the mine sinker runs down a short curved piece of the rails and drops into the water. In minelaying submarines the mines are carried in tubes or shoots formed in the hull, from which they can be released one at a time.

British Minelaying Resources.—At the outbreak of hostilities in 1914 the British Navy possessed seven old cruisers (Latona class) fitted as minelayers. These had a speed of only 14 knots. Shortly afterwards four merchant ships were added; and in the second part of the War a considerable number of submarine minelayers and fast destroyers were used.

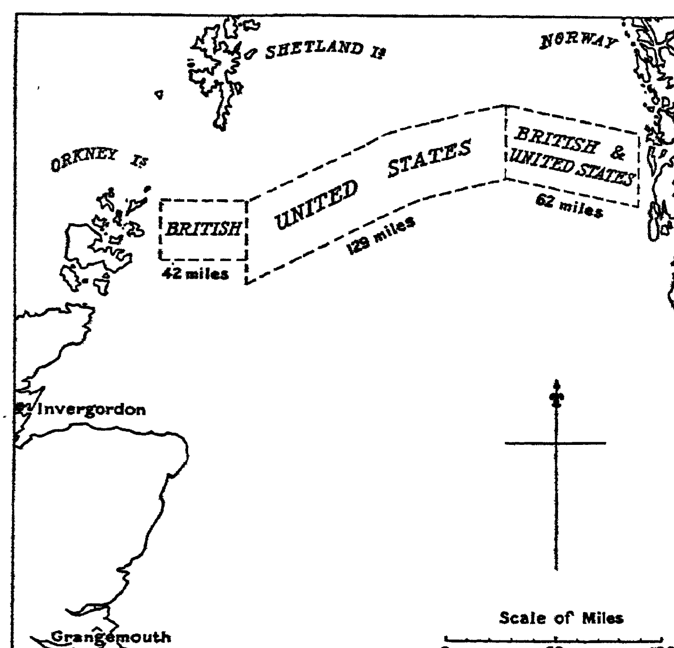
German Minelaying Resources.—At the outbreak of war the Germans had available 3 men-of-war and nine auxiliary vessels fitted as minelayers. Two of the men-of-war "Nautilus" and "Albatross," were 20 knot vessels and each carried 200 mines. During the War four more auxiliaries were fitted including the raiders "Möwe" and "Wolf." In 1915 the first of the submarine minelayers started work. In June 1915 a small type, termed U.C. boats, working from Zeebrugge, with Bruges as a mine-depot, commenced laying batches of 12 mines held in vertical shoots, at first between Dover and Harwich, and later over a wider area. During 1915, 54 cargoes (648 mines) were laid in this manner. The effect was a serious increase in British losses by mine, which comprised 5 supply ships, 1 hospital ship, 2 Trinity House vessels, 34 steamers, 19 fishing boats and 15 minesweepers, also 24 neutrals, a total of 100 vessels. The number of German submarine minelayers increased in 1916, and there were larger boats operating over a still wider area. These carried 18 mines. As further construction improved, the number of mines carried rose to 24, and in 1917, to 36. The larger boats worked from the Elbe, and the smaller from Flanders.

Elements of Mining Warfare.—Three factors are necessary for successful mining warfare—the strategic function, the operation of laying the mines and the technical efficiency of the mine itself. The first of these factors is woven into the main strategy of a naval war. The stronger fleet, in its anxiety to seek out and destroy its enemy, desires a clear sea; and, to obtain this, must insure that such a means of attrition as the mine is reduced to the utmost. On the other hand, the weaker fleet will use the mine profusely in an endeavour, by attrition, to reach an equality or superiority of force: and it will also use this weapon against merchant ships, particularly when they belong to a belligerent dependent on its carriage of foodstuff from overseas. This was the initial stage of naval strategy in the World War; and to some extent it explains the pre-war application of the Germans to mining and the comparative neglect of the subject by Great Britain. The second factor is the operation of laying the mines. To be successful, this must be governed by the element of surprise, and be expeditiously performed; it requires for its purpose a ship of high speed, or one which, by disguise or subterfuge, can carry out the work unmolested.

The third factor is purely one of technique. No type of mine that does not meet the following requirements is efficient. It must be safe until it is laid. When laid, it must take up and maintain its required depth, throughout all kinds of weather, for an appreciable length of time. It must be immune from mechanical failure when required to function. In the interest of both belligerents and neutrals, it must automatically render itself safe should it break from its moorings. Considerable importance attaches to the design of a minefield. A simple straight line of mines is easily and quickly laid, but presents little difficulty to the minesweepers once it is located. Lines of mines laid in zig-zags, particularly when spaces of water are left clear, present the greatest difficulty to removal. On the other hand, such patterns will necessarily cover a larger sheet of water, and will require very accurate plotting if, subsequently, the vicinity of the mined area is to be approached by the sea forces of the minelayer. An existing apparatus termed "taut wire measuring gear" proved a great aid to accuracy in positioning a minefield.

British Minelaying in the War.—On October 2, 1914, the first line of 1,264 mines was laid by the old cruisers in an area 10m. north of Ostend. This had the effect of forcing neutral shipping to pass through the Downs. Unfortunately, the British mines then in use proved so defective that for a time minelaying had to cease; and although in 1915, after some technical improvement, some 15 more minefields were laid, it was not until 1916 that attention was concentrated on providing a mine of the calibre of that used by the Germans.

One of the principal British minelaying operations of 1916 was a coast barrage, consisting of a double line of deep mines, running



THE PLAN OF THE GREAT NORTHERN MINE BARRAGE OF 71,126 MINES LAID IN 1918, BY BRITISH AND UNITED STATES MINELAYERS

for 40m. from the Belgian coast, at a distance of 12m. from the shore. It was supplemented by mine nets laid by the Dover drifters. The work took five weeks to complete; but only one submarine seems to have been accounted for by it. The end of the year saw the institution of a mining school at Portsmouth for research and development.

On the assumption that the Belgian coast barrage had been effective, a similar barrage was completed in Feb. 1917 across the Straits of Dover; but the mines dragged and had to be swept up.

It was, however, relaid by the end of July 1917. In Jan. 1917 it became essential to encircle the Heligoland Bight and thus to surround all exits from German ports; but the shortage of mines at the time caused the operation to be postponed, nor was the British mine considered suitable for it. However, towards the end of 1917 the "Abdiel" and five minelaying submarines had laid nearly 16,000 mines in the German Bight; and these accounted for a certain number of German destroyers and minesweepers. The mine used in the later stages of this operation was the new British H2. In due course the new H2 mine was delivered in sufficient quantity for the long-delayed defensive minefields to be begun by the British, and an extensive new barrage in the English Channel was then completed. Between Folkestone and Cape Gris Nez 9,500 mines were laid in 20 parallel lines, the shoals of the Varne and the Ridge dividing the area into three sections. This barrage effectively closed the Channel exit to the German submarines, nine of which were lost in attempts to pass it.

Minelaying by the United States.—The entry of the United States into the War admitted of a large augmentation in mines and in minelayers; and an attempt was made to close the northern exit from the North sea by a mine barrage between the Orkneys and the Norwegian coast (*see* plan). This operation was undertaken by both British and U.S. minelayers. The latter formed a base at Inverness, and supplied ten large minelayers with a total carrying capacity of over 5,500 mines.

The vast area covered by mines can best be appreciated by a reference to the plan, which gives an idea of the work carried out by the U.S. minelayers. Difficulties were encountered as the operation proceeded. A proportion of the American mines exploded prematurely; while a number of British mines took up a shallower depth than intended, and had to be swept up and relaid. The complete operation, however, was finished by June 1918. It must not be supposed that the whole water available for a submarine was effectively covered by this minefield; but the dangerous area was greatly increased and an effect on the *morale* of the Germans quickly produced. In July German submarines began to creep past in Norwegian waters; but the Norwegians closed this coastal lane to both belligerents by minefields of their own. Of the mines laid in the Northern Barrage 56,033 were American and 15,093 British. All the time the encircling of the Bight had been going steadily on, and some 21,000 mines were in place by the date of the Armistice. During the period of the War, approximately 172,000 mines were dropped in the North sea and Channel by the British and American minelayers, the very great majority of which were laid during the last 18 months of the War. The Italian Navy laid 12,293 mines during the War chiefly in the Adriatic.

German Practice.—In the early part of the War, the Germans used surface vessels for minelaying and the fields consisted of large groups of mines concentrated in areas where they were likely to damage naval vessels. For instance, on Aug. 5, 1914, the "Königin Louise" laid a line of about 150 mines off the east coast of England and on Dec. 16, 1914, under cover of the raid on Scarborough the "Kolberg" laid 180 mines near Scarborough Bay. After 1915 German minelaying in British home waters was carried out almost entirely by submarines. These usually confined their mines within an area of two or three sq. miles, laying them in groups of four or even less. The position chosen was most frequently near some focal point, buoy or lightship, or at the entrance to a naval base or commercial port. For instance, during the war, over 450 mines were laid by German submarines within a mile of the Shipwash Light vessel, a position necessarily passed by all traffic up and down the east coast war channel, by the convoys to and from Holland and by those destroyer flotillas based on Harwich. The Germans also allotted to each of these submarines a particular stretch of the British coast. The flotillas working from Flanders covered the coast from Flamborough Head south about to the Clyde, also the northern French coast; the high sea, or large boats, working from the Elbe, were responsible for the rest of the English and Scotch coasts, and the whole of Ireland. Each commander being restricted to work in his individual area, the danger of striking previously laid mines was minimised. The commanders, moreover, by this arrangement, got quickly into touch with the local movements of the traffic, the method and capacity of their opposing minesweepers and the coastal navigation within their beats. In most cases after some 10 to 14 days a commander would not hesitate to pass over a position where he had previously laid mines. He would be confident that his mines had been discovered and cleared if shipping had been seen in the area. Minelaying from surface vessels was confined to disguised raiders such as "Wolf" who laid small groups of mines in various parts of the world including the Cape, Bombay, Colombo and Australian coasts. Altogether 11,000 mines were laid by German minelayers in British home waters.

The first mining offensive against the Grand Fleet occurred in August 1915, when 380 mines were laid in the entrance to the Moray Firth, distributed over lines which totalled nearly 70 miles. A large portion of the fleet was at Invergordon at the time. The results were negligible, the losses being confined to minesweepers and one destroyer. A channel was found to be clear on the northern side of the Firth, which was at once used as an exit for the fleet. On the southern side, however, a channel was cleared, but an area of mines was purposely left to form a defensive barrier and so limit the water requiring patrol and minesweeping. On January 1, 1916 the area west of Scapa Flow was mined by the "Möwe" on her passage into the Atlantic. In this field 252 mines were laid, endangering an area of 40 sq.m., which resulted in the loss of H.M.S. "King Edward VII." before the presence of mines was realised. Once located, this area was treated in the same way as the Moray Firth.

On May 29, 1916, "U.75" laid her 18 mines close to Marwick Head, off the northwest coast of Orkney. The operation was part of the pre-Jutland submarine actions of the enemy. It is probable that these mines were intended to be laid off the western entrance of Scapa Flow to hinder the exit of the fleet and that a mistake was made in the position. The mines were set for a depth of seven metres. The tide was appreciable causing sufficient "dip" to insure that the mines at this depth should be innocuous even to a heavy-draught ship, except at low water, and with considerable motion on that ship. The period of slack water was extremely limited. The "Hampshire," proceeding in a sudden gale, and hugging the shore to obtain less sea, struck one of the mines at low slack water and sank. By this curious conjunction of all these factors, the career of Lord Kitchener was brought to a tragic close. Except for a determined offensive by the Flanders submarines against the Channel Ports, the mine was not extensively used in the latter part of 1916. It would appear that the Germans were then husbanding their resources for unrestricted submarine and mine warfare.

Synchronous mining of adjacent British ports was resorted to by the Germans, which raised many sudden problems in traffic control. The convoy system had now been introduced, and the sweeping of convoys into certain ports often became essential. Particular difficulties arose in regard to Liverpool owing to the shallowness of the channel and narrow entrance; mines swept up, and sunk without exploding, causing serious danger to heavy draught ships by their proximity to the ship when resting on the bottom. The south coast of Ireland was seriously and continuously mined, and even the bays on the west coast of Ireland did not escape.

Early in 1918, an appreciation of failure led the Germans to concentrate their efforts in minelaying in two directions only. The first was a grandiose scheme, which, commencing in January, was only concluded in late September. It consisted of batches of 36 mines, laid at regular intervals of 10m. apart on a semicircle 45m. from the Bell Rock, the result being a complete ring round the entrance to the Firth of Forth. This operation fulfilled a two-fold purpose. It menaced the exit and entry of Norwegian convoys, which were then working from Methil in the Firth of Forth; it also menaced every possible course taken by the Grand Fleet when leaving or entering its base at Rosyth. The scheme, however, was barren of results to the Germans, although methodically carried out in every detail. It was appreciated and countered after the third batch of these mines was discovered, the result being that each of the successive groups of mines was located and cleared immediately; and this was done without the Germans

realising that any of these groups had been removed. The other concentration took the form of a field of 400 mines, also laid gradually by submarines. It was directed against the Dutch convoys, and was laid close to the Dutch coast to cover the approaches to the Maas and Ijmuiden. This position was such that any attempts at clearance exposed the minesweepers to a flank attack from enemy vessels. There were some losses by mine, particularly to destroyers escorting the convoys; but the convoys sailed as before, and the losses, on the whole, were very trivial. The total number of German mines laid in all parts of the world was 43,636.

MINESWEEPING

Methods of Sweeping.—At the outbreak of War, the British system of minesweeping was for two vessels to tow a stout wire between them, the wire being kept at the required depth by means of water kites, one being attached to each side and towed astern of each vessel.

The sweep comes into contact with the mooring rope of the mine which is generally cut in the process of dragging particularly when serrated wire is used. When the mooring rope is cut the mine comes to the surface when it can be sunk by rifle-fire. In some cases, however, the sweep strikes a horn of the mine, and explodes it. This occasionally parts the sweep and consequent delay is caused while a new wire is passed. The most serious drawback is that if the sweep fails to break the mine wire, the mine is towed along, more often than not unknown to the sweepers. This latter trouble caused many of the early minefields in the War to be scattered far beyond the limits in which they were laid, and constituted a serious danger. The eventual safeguard was to heave the sweep slowly in, and to sight the whole wire and water-kites on the surface before slipping it, when a mine holding to the wire would be seen and reswept afterwards. The innovation of a serrated form of sweep wire eventually reduced the difficulty to a considerable extent. This simple method of minesweeping stood the test of the whole war, and its simplicity had the great advantage of reducing the training period which would have been necessary had a more complicated apparatus been used. Sweeping with this type of sweep can be carried out by any suitable pair of vessels. Trawlers and drifters are fitted with appliances for their ordinary fishing work which make them readily convertible into sweepers. They are also very good sea boats and as far as weather conditions are concerned, sweeping can be carried out by them as long as they can come together to pass the end of the sweep wire from one to the other. Where, however, mines have been laid at very shallow depths and there is little or no rise and fall of tide lighter draught vessels must be used as sweepers. When sweeping, marks are laid out to show the channel which has been cleared. That minesweeping is a most arduous and dangerous work is shown by the fact that throughout the World War an average of half of the crew of a trawler was lost when one was mined. For the first two months of the war, for every two mines swept up one trawler was lost. Improved methods and greater experience later minimised the losses, until an average of one loss for every 80 mines was achieved in 1918.

The French towed from a single vessel two sweeps, one on either side, each kept out by an otter similar to the usual otter used in trawling but regulated for depth by attachment to a large torpedo-shaped float, the depth at the other end being regulated by a water-kite. Along each wire was distributed a series of small mechanical and explosive wire-cutters. The "shooting" of these sweeps caused trouble unless the crews were adept, and the speed at which the apparatus could be towed was limited to six to seven knots. The spread of the British system was 400 to 500 yd. per pair according to the type of minesweeper, that of the French system not more than 200 yards. In the latter part of the war the Americans adopted the French method, which had by then been somewhat simplified.

The German system was akin to the British, excepting that, in order to cover the route of their fleet more quickly, they instituted a very light form of sweep which could be towed at 20 knots. Directly this apparatus met with an obstacle it was automatically slipped, thus giving notice of the obstruction, whereupon the slower type of sweepers were hastened to the spot to clear it. In practice this system constantly led the fast sweepers to report mines when they had only encountered wrecks or some other harmless obstruction, and little confidence was therefore placed in the reports of mines by this fast flotilla. Under ordinary cruising conditions, searches by sweepers were made whereby only a small percentage of the water was covered—sufficient, however, to allow a strong probability of the presence of mines being discovered in good time. The introduction of the "paravane," which protected the ship herself, very much reduced the mine danger; but it is an apparatus which, for assured efficiency, requires skilled handling. There are situations where its use is impracticable, and it has not replaced the necessity for the minesweeper.

Minesweeping During the War.—Before the outbreak of war in 1914 the British navy had, to some extent, realized the possibility of a mining offensive on the part of their enemies; and, largely due to the foresight of the late Admirals Lord Charles Beresford and Sir Doveton Sturdee, trawlers had been tested and had proved to be efficient minesweepers as early as 1907. A trawler reserve purely for minesweeping was instituted shortly afterwards. Thus, by August 8, 1914, 96 hired trawlers had put to sea to sweep up enemy mines, and within a fortnight another 100 trawlers had been requisitioned and were fitting out. The trawler minesweeper, however, did not entirely cover the requirements, as it was too slow to sweep the water ahead of a moving fleet; and this had been realised, and to some slight extent, catered for, by training a flotilla of eight old torpedo-gunboats. These ships were capable of towing the sweep at 12 knots, which was double the speed at which the majority of the trawlers could operate. This gunboat flotilla moved north from Dover on July 31, 1914, and, with sweeps out, actually covered the track over which the Grand Fleet passed. They were necessarily much overworked in the first six months of the war, as, whenever practicable, they swept the waters through which the fleet moved, and were also constantly required to search areas where mines were expected to be laid. The first batch of the special sweeping vessels, called sloops, was laid down in January 1915.

In British home waters the augmentation of the minesweeping force was less difficult than abroad. Light-draft excursion vessels (paddlers) were requisitioned in addition to the newly built craft already mentioned, and by April 1915, over 150 vessels were employed on minesweeping in home waters. In the Dardanelles 8 cross-channel steamers had augmented the trawler force, and a certain number of destroyers had been fitted for minesweeping.

Progress in 1916.—By the beginning of 1916, 14 sloops had joined the Grand Fleet, and 35 hired paddlers were in action. The success of this latter type led to 24 being laid down by the Admiralty, and also a new type of twin-screw sweeper, known as the "Hunt" class. The value of these ships lay in their sea-keeping qualities and shallow draught. The paravane (*q.v.*) also passed its test in 1916, and by the end of the year had been supplied to 180 of H.M. ships. A modified form of this apparatus was fitted in merchant vessels; and, by the end of the war, 2,740 merchant ships had been fitted.

The intensity of minelaying and expansion of areas in the first half of 1917 was difficult to meet with the minesweepers available; and the climax was reached in April, with a loss of one minesweeper per diem for the greater part of that month. Probably no other service had a more severe strain placed on its personnel during this month and those immediately following. Every available and suitable paddle steamer and motor fishing boat had to be requisitioned; and those incapable of towing a heavy sweep were fitted with a light one, and used for search. Aircraft and motor launches were also used for low-water searches for mines, in order to reduce losses of sweepers; and improvements in traffic organisation and still closer co-operation between adjacent areas were gradually effected. Further protective minefields were laid in certain suitable positions, but the opening of new areas was constantly necessary; and, by the end of 1917, the coastal waters of Great Britain and Ireland, over 1,000m. in extent, were being swept every day for mines. The war channel was also extended to the Firth of Forth, and merchant ships only released from a night

shelter when they could proceed in freshly swept water. One hundred new vessels of the "Hunt" class were laid down, and 300 new drifters put out to contract, so as gradually to replace and release trawlers for patrol and anti-submarine work.

The year closed with a total of 3,989 German moored mines swept up in home waters, at a cost of 170 Allied and neutral merchant ships sunk and 28 damaged. This total of mines for the year exceeded the combined totals for the previous years of the War. Nevertheless, the outlook was more hopeful. Although the intensity of minelaying had become so much greater, the losses had only been increased by nine ships over those of the previous year; and progressive success in the destruction of submarines and their personnel made it evident that the same intensity and efficiency of the minelayers could not be continued much longer. New construction and greatly improved material for minesweeping had already made their mark. The only fear was that the minesweep would be defeated by some innovation of the enemy. This fear, however, never materialised; although a delayed action (whether intentional or otherwise) for releasing the mine from its sinker some hours after it was laid was observed on several occasions.

Minesweeping After the Armistice.—When the hour of the Armistice struck, a minesweeping force was waiting at the gate of the Dardanelles; and, within 24 hours, 600 British and enemy mines had been removed to clear the way for the fleet to Constantinople. For one year after the War, mineclearing was continuous in every area where British or German mines had been laid. Under the difficult conditions which immediately followed the war, a special minesweeping force had to be enrolled. It consisted of some 600 officers and 15,000 men. Over 23,000 Allied mines and some 70 German mines were cleared from the sea by British minesweepers. No loss of a merchant ship by mine occurred during that period; and exactly one year to the day from the institution of this force the seas round Britain, her colonies and in the Mediterranean were reported clear. A fine performance in this respect was the clearing by the Americans of the mines laid between Orkney and the Norwegian coast. The Germans also commenced to clear the heavily mined areas in the Heligoland Bight, and later in the Baltic; but this work of clearance was not completed until 1923. Other nations concerned cleared their own coastal waters. (For military mines *see* FORTIFICATION and SIEGECRAFT.) (A. H. W.)

BIBLIOGRAPHY.—Rudyard Kipling, *The Fringes of the Fleet* (1915); W. MacNeile Dixon, *The Fleets Behind the Fleet* (1917); L. C. Cornford, *The Merchant Seaman in War* (1918); W. Wood, *Fishermen in War Time* (1918); D. W. Bone, *Merchantmen-at-Arms* (1919); M. F. Sueter, *Evolution of the Submarine Boat, Mine and Torpedo* (1907).

MINGHETTI, MARCO (1818–1886), Italian economist and statesman, was born at Bologna on Nov. 18, 1818. In 1846 he was appointed member of the State council summoned to prepare the constitution for the papal States. In the first constitutional cabinet, presided over by Cardinal Antonelli, Minghetti was minister of public works, but after the allocution by Pius IX. against the Italian war of independence he resigned, and joined the Piedmontese army as captain on the general staff. Returning to Rome in Sept. 1848, he refused to form a cabinet after the assassination of Pellegrino Rossi, and spent the next eight years in study and travel. He was in 1859 appointed by Cavour secretary-general of the Piedmontese Foreign Office. In the same year he was elected president of the assembly of the Romagna, after the rejection of pontifical rule by those provinces, and prepared their annexation to Piedmont.

Appointed Piedmontese minister of the interior, he resigned office shortly after Cavour's death, but was later made minister of finance by Farini, whom he succeeded as premier in 1863. With the help of Visconti-Venosta he concluded (Sept. 15, 1864) the "September Convention" with France, whereby Napoleon agreed to evacuate Rome, and Italy to transfer her capital from Turin to Florence. Minghetti was then driven from office. He took little part in public life until 1869, when he became minister of agriculture in the Menabrea Cabinet. Both in and out of office he exercised his influence against an Italo-French alliance and for an immediate advance upon Rome, and in 1870 was sent to London and Vienna by the Lanza-Sella Cabinet to organize a league of neutral powers. In 1873 he overthrew the Lanza-Sella Cabinet and was premier and minister of finance until the fall of the Right on March 18, 1876. During his premiership he inaugurated the *rapprochement* between Italy, Austria and Germany; and, as finance minister, restored equilibrium between expenditure and revenue for the first time since 1860. After the advent of the Left, Minghetti remained for some years in Opposition, but towards 1884 joined Depretis in creating the "Trasformismo," which consisted in bringing Conservative support to Liberal cabinets. Minghetti died at Rome on Dec. 10, 1886. His writings include: *Della economia pubblica e delle sue attinenze con la morale e col diritto* (Bologna, 1859), and *La Chiesa e lo Stato* (Milan, 1878).

MINGRELIA: *see* GEORGIAN S.S.R.

MINIATURE LANDSCAPE: *see* BON-SEKI; BON-KEI; BON-SAI; HAKO-NIWA.

MINIATURE PAINTING. The word "miniature" is derived from the Latin "minium," vermillion, the colour used for the borders of the pages and the initial letters of manuscripts, in which small pictorial scenes were introduced. These lines were later on known as rubrications, and the word "miniature" applied to the decorations themselves, rather than to the lines which surrounded them. Then, owing to the small size of the work, the word became connected with the French word "mignature" and so gradually applied to paintings in little, and in the present day to anything that is of unusually small size. The two more accurate phrases are "paintings in little" as Pepys calls them, or "limnings" as they were termed in 1675, and the miniature painter, even in Queen Anne and George I.'s time, was spoken of as the "limner." That word itself goes back to "enluminer," and that again is derived from the Latin "illuminare," to paint. (For Byzantine and Early Christian miniatures *see* ILLUMINATED MANUSCRIPTS.)

(G. C. W.)

MINIATURE PAINTING IN THE EAST

The beginnings of miniature painting in the Mohammedan East are obscure, in consequence of the various forces of destruction that have laid in ruins so many of the centres of Muslim culture, as well as the hostile attitude of the theologians towards all forms of representational art, and the fanaticism that sought to destroy the work of the artist. Two or three drawings on Arabic papyri of the 10th century, now in the collection of the archduke Rainer in Vienna, show that Coptic influence was operative from an early period in the Mohammedan era; but examples are not forthcoming as evidence of any further development in Egypt.

Persia.—In Mesopotamia, however, in the 13th century begins a series of miniature paintings, illustrating the Maqāmāt of Ḥarīrī and such animal stories as those of Kalīla and Dimna; a comparison with contemporary miniatures in the service books of the Jacobite and Nestorian Churches suggests that the painters were either themselves Christians or were carrying on the tradition of oriental Christian art, in the service of Muslim employers. Influences of another kind are observable in the illustrations of a ms. (dated A.H. 710=A.D. 1310–11) of the history of the world, by the famous minister of State, Rashīd ud-Dīn (d. A.D. 1318), made by his painters in Tabriz; the talented author appears to have provided not only Christian but also Chinese and Indian pictures for the guidance of his painters in their representations of the various historical incidents of successive ages. From this period onwards Persia continued to produce the finest examples of Mohammedan painting. Chinese influences were, it is true, prominent under the rule of the Mongol conquerors, and portraits of them occur (*e.g.*, in such a ms. as *Supplément persan* 1113 in the Bibliothèque Nationale); but native Persian genius began to re-assert itself in the reign of Tīmūr (1369–1404) and under his immediate successors, and freed itself from all such Chinese influences, except certain conventional forms of representation, such as clouds, etc. Several portraits of Tīmūr are extant, and his sons and grandsons, who divided his empire among themselves, were distinguished for an even more generous patronage of artists. But the art of painting in Persia is entirely anonymous until the reign of the last of the Timurid princes, Sultan

BY COURTESY OF (1) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM, (2, 3) THE SCHWAIGER COLLECTION, (4, 5, 6) THE METROPOLITAN MUSEUM OF ART, NEW YORK

INDIAN AND PERSIAN MINIATURES

1. Indian. Portrait of the Empress Nur Jahan Begam (1573–1645), wife of the Mogul Emperor Jahangir. Mogul painting (Delhi school), 17th century
2. Indian. Prince Murad, son of Shah Jahan, Mogul emperor of Delhi. Note the carefully painted out halo. Mogul painting, *c.* 1650
3. Indian. Ragini Todi, one of the musical modes, an illuminated tempera painting. Rajput (Jaipur school), 18th century
4. Persian. Laila and Majnun in love with each other at school, probably painted by Mirak. From Nizami, Khamsah, fol. 129a; ms. 8 of the Cochran Collection, *c.* 1525
5. Persian. "Seek thou for Jamshid's Cup in the wineglass, and for the water of life in the grape lees." From Jami, Diwan, fol. 263b; ms. 17 of the Cochran Collection, 15th century
6. Persian. "Bahram Gur on the Chase." From Nizami, Haft Paikar, fol. 10a; ms. 10 of the Cochran Collection, late 16th century

BY COURTESY OF (1, 2) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM, LONDON, (5, 7, 16, 17, 19, 20) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (18) THE LORD CHAMBERLAIN'S DEPARTMENT

MINIATURES OF THE 17TH TO THE 19TH CENTURY

1. Portrait of Sir Kenelm Digby (1603–65), signed and dated 1627, by Peter Oliver (1594–1647), English. From the collection of the Hon. Frederic Wallop
2. Portrait of Charles, fifth Lord North, first Lord Grey of Rolleston, painted *c.* 1650–65, by Samuel Cooper (1609–72), English. From the collection of the Hon. Frederic Wallop
3. Portrait of Voltaire, by Louis Cheron (1655–1735), French. From the Pierpont Morgan collection, New York
4. Portrait of Madame du Barry, by Richard Cosway (1742–1821), English. From the Pierpont Morgan collection, New York
5. Portrait on ivory of the Hon. Frances Courtenay, by Andrew Plimer (1763–1837), English
6. Portrait of the artist in fancy costume, by Nicholas Lancret (1690–1743), French. From the Pierpont Morgan collection
7. Portrait on ivory of Lord Robert Fitzgerald, by George Engleheart (1750–1829), English
8. Portrait on a snuff-box, of the children of Mme. de Coincy, by Jean Baptiste Jacques Augustin (1759–1832), French. From the Pierpont Morgan collection, New York
9. Portrait of Marie Antoinette, Queen of France (1755–93), by Antoine Sergent (1751–1817), French. From the Pierpont Morgan collection
10. Portrait of the artist, by Peter Adolf Hall (Pierre Adolphe) (1739–93), Swedish. From the collection of His Majesty the King of Sweden
11. Portrait of Mlle. Constance Mayer, by Pierre Paul Prud'hon (1758–1823), French. From the Pierpont Morgan collection, New York
12. The artist's daughter, by Jean Baptiste Greuze (1725–1805), French. From the Pierpont Morgan collection, New York
13. Portrait of Mlle. de Bethisy, daughter of the *dame du palais* to Marie-Leszczynska, queen consort of Louis XV. of France, by François Dumont, the elder (1751–1831), French. From the Pierpont Morgan collection, New York
14. Portrait of Mrs. Baldwin, signed and dated 1782, by John Smart (1741–1811), English. From a private collection in London
15. Portrait of the Marquise de Gauville, by Nicolas de Largillière (1656–1746), French. From the Pierpont Morgan collection, New York
16. Portrait of Mrs. James Lowndes, by Edward Green Malbone (1777–1807), American
17. Portrait on ivory of Alexander Murray, by James Peale (1749–1831), American
18. Portrait of Queen Charlotte (1744–1818), wife of George III., by Ozias Humphry (1742–1810), English. From the collection of His Majesty the King of England
19. Portrait on ivory of George Washington, by Robert Field (1749–1819), English
20. Portrait of Mrs. Stephen van Rensselaer third, water colour on ivory, by Robert Fulton (1765–1815), American

Ḥusayn Mīrzā, who reigned in Harat from 1468 to 1505. The most famous painter in the annals of Persian art, Bihzād, during the earlier part of his career worked under the patronage of this prince, and more than one portrait of his patron is attributed to him. Later, Bihzād enjoyed the favour of Shāh Ismā'īl, the founder of the Safavid dynasty in 1502, and for about a century a succession of painters of extraordinary talent were actively employed in the service of the earlier monarchs of this dynasty. Their work has survived mainly in manuscripts of Persian poetry, which they were called upon to illustrate, and masters, such as Mīrak, Muẓaffar 'Alī, Qāsim 'Alī and Sultan Muḥammad, carried on in a brilliant manner the traditions of the school of Bihzād. Shāh 'Abbās (1587–1629) followed the practice of his forefathers in employing a number of court-painters, who worked in the royal atelier, but though their names have been recorded, it is difficult to assign to them, with any degree of certainty, the pictures that have survived from this period. Only a very few paintings bear the signature of any of these court-painters, with the important exception of Rizā 'Abbāsī, who was a prolific artist, and not only had the habit of signing his pictures, but in many instances also wrote out long inscriptions giving the exact date and the circumstances under which the pictures were made; he was a master in the art of portraiture, and his miniatures have preserved a record of Shāh 'Abbās, his patron, and of a considerable number of his contemporaries. A portrait of the master himself, who died in April 1635, is extant, copied 40 years later by an enthusiastic admirer, named Mu'īn Muṣavvir, who called himself his pupil.

India.—From the end of the 16th century onwards, portraiture constituted one of the most prominent forms of artistic activity not only in Persia, but also in India. The emperor Akbar (1542–1605) kept up a large establishment of over 100 painters, and employed them to illustrate his manuscripts, especially the translations which he had made for his use of works of Sanskrit literature into Persian. The emperor himself often sat for his portrait, and also ordered the portraits of the grandees of his court to be taken. Of the painters themselves very little more than their names is known, but these frequently occur, written apparently by some one of Akbar's clerical staff, not by the artists themselves, under the paintings with which they were credited. Among them, 'Abdus Samad was especially noted for his skill in portraiture and he was entrusted with the training of some of the other court-painters. Jahāngīr (1605–1628) was as generous a patron of painters as his father had been, and innumerable portraits of him and of his courtiers are in existence; in his memoirs, the emperor makes mention of several of these artists, and bestows especial praise on Abu'l Ḥasan, as having painted a picture of his accession, and on Bishandās, as a painter of portraits; the latter was sent to Persia in the suite of an ambassador accredited to that court, in order that he might there paint the portraits of the shāh and the chief nobles. Shāh Jahān (1628–1659) carried on the tradition of his father and grandfather in patronizing art. The head of his staff of painters was named Muḥammad Faqīrullāh Khān, and he was assisted by Mīr Hāshim, famous as a portrait painter. But the rigid orthodoxy of his son, Aurangzeb (1659–1707), caused him to be hostile to all forms of representational art, and during the long reign of this monarch the art of painting in India suffered a decline from which it never entirely recovered, and though many pictures, portraits especially, were produced, they fall short of the fine achievements of the court painters of the first five emperors of the Mughal dynasty.

Turkey.—Similarly, orthodox sentiment stood in the way of painting receiving so open and generous a patronage in Turkey, as it had once enjoyed in India, though some of the Ottoman sultans took painters into their service; the earliest of these were Persians, and it was not until the middle of the 15th century that there is any record of a painter of genuine Turkish stock, named Ḥusāmzāda Ṣan'ullāh. Mohammed II. (1451–1481) took a special interest in the work of Italian painters and medallists, and Gentile Bellini worked for him in Constantinople for a little more than a year, and trained a Turkish pupil, named Shiblīzāda Ahmad. Sulaymān the Magnificent (1520–1566) also encouraged painters, one of whom, named Ḥaydar, made copies of miniatures by François Clouet; but lack of intelligent patronage checked the growth of a school of painters in Turkey, and their achievement has consequently been more meagre and less distinguished than that of Mohammedan painters in either Persia or India.

Bibliography.—P. W. Schulz, *Die persisch-islamische Miniaturmalerei* (1914=, bibl.); P. Brown, *Indian Painting under the Mughals* (1924); T. W. Arnold, *Painting in Islam* (1928); A. Grohmann and T. W. Arnold, *The Islamic Book* (1929). (T. W. A.)

EUROPEAN MINIATURE PAINTING

Portraits of living persons appear in illuminated manuscripts, especially of the 14th, 15th and 16th centuries and in many notable documents. They reached a high standard in France and the Netherlands. Hans Holbein the younger executed small portraits of very fine and dainty technique, such as are called in the present day miniatures; and though at this period there were other portrait painters who were responsible for somewhat similar work, such as Shute, Betts, Benninck and Teerlinc in England (*see* Salting collection, Victoria and Albert museum) Holbein is generally regarded as the earliest and greatest representative of the art. The technique of the European miniature painter was closely derived from that of the painter of illuminated manuscripts.

England.—The earliest known English miniature painter, Nicholas Hilliard (*c.* 1547–1619), in his work shows clear signs of such derivation, his colours are opaque, gold is used to heighten the effect, but the portraits have a flatness and absence of shadows entirely resembling the paintings of the illuminated manuscripts. His son's work is a little bolder than that of the father, and his miniatures somewhat richer in colour. Two painters named Isaac and Peter Oliver, father and son, succeeded Hilliard, Isaac (*c.* 1567–1617) being stated to have been a pupil of Hilliard, and Peter (1594–1647) his father's pupil. These two men were the earliest to give roundness and form to the faces that they painted, and they were responsible for larger portraits than Holbein or Hilliard had ever painted in miniature, some of them measuring as much as 10 in. by 9 inches.

The representations of all these four miniature painters are flat, everything is seen in one light, all in detail, and embroidery, lace or jewellery presented with almost microscopic minuteness.

The two Olivers were followed by two painters named Hoskins, again father and son, the elder, John (d. 1664) was the master of Samuel Cooper the greatest of English miniaturists. In the time of Hoskins, the influence of the old school of illuminators nearly passed away, the portrait was presented much more completely in the round, in distinguished fashion, painted with a full brush in easy rich masses, and the harmony of colours was deeper and grander. Hoskins was the first of the miniature painters to be able to represent in satisfactory fashion the appearance of flesh.

Hoskins was succeeded by Samuel Cooper, his nephew (1609–1672), who spent much of his early life in France and Holland, and whose work in miniature has been characterized as "life-size in little." His under-painting is often in sepia, but where flesh was concerned in vivid green with a transparent red lake over it. He painted faces supremely well, although erring a little on the ruddy side, and Walpole says of him that, "if a glass could expand Cooper's pictures to the size of Vandyck's, they would appear to have been painted for that proportion."

Up to this time, miniature portraits had been painted mainly upon the backs of playing cards, very occasionally upon thin skin, usually chicken-skin, stretched across such card, but Cooper experimented twice at least upon mutton bone. The use of ivory did not come in until long after his time. His portraits mark the supreme point in English miniature portrait painting.

He had a brother Alexander (d. 1660), whose works resemble those of Samuel Cooper, but are not as strong or as magnificent.

There were many other painters of his period; among them were David des Granges (1611–1675), whose work can be studied at Ham House and Windsor Castle, Richard Gibson (1615–1690), Mrs. Rosse, his daughter, who cleverly imitated the work of Samuel Cooper, and other painters, such as Flatman, who was also a poet, Nicholas Dixon, Sir B. Gerbier and Charles and Mary Beale. All these made use of opaque colours.

Just before 1768, there was a fashion for extremely small

miniatures, still, however, painted upon cardboard or occasionally upon vellum, and the work of such artists as Gervase Spencer (d. 1763), Hone and Scouler should be noted.

In the 18th century, we come to the earliest use of ivory as a suitable material on which to paint portrait miniatures. This provided miniature painters, especially those of France, with exactly the most suitable material upon which to use the newly discovered transparent colours. The establishment of the Royal Academy (1768) was largely responsible, in England, for the popularity of the miniature painting on ivory.

Richard Cosway (1742–1821) is usually regarded as the principal English exponent of the art, so much so that for a long time when little was known of other artists, miniatures on ivory specially well painted were invariably attributed to him. His works are brilliant and of considerable beauty, his dexterity being so great that the portrait, to use the words of a well known critic, looks as if it was blown on to the ivory, and was gently resting there. With all their beauty, however, Cosway's miniatures possess many faults in draughtsmanship, and these were exaggerated by one of his successors, Andrew Plimer (1763–1837) whose delightful portraits are often marked by forced chiaroscuro, experiments in strong colour and most inaccurate drawing. Plimer had a brother Nathaniel, who did better work than did his elder brother, and his miniatures are much smaller, and more difficult to acquire.

Perhaps the most popular man of this period was George Engleheart (1750–1829), who was responsible for nearly 4,000 miniatures, a careful account of which he kept in his ledgers. His work is bolder and stronger than that of Cosway. His paintings are usually signed by an initial, and often dated.

The most skilful draughtsman of the period was John Smart (1741–1811) whose work excelled all that of his contemporaries in its silky texture and elaborate finish, and in the extreme skill with the flesh, perchance sometimes too ruddy in colour, is painted. Amongst all the group, Smart alone seems to have had a profound knowledge of anatomy.

One of the most delightful miniature painters of the day was Ozias Humphry, whose work is broader than that of his contemporaries, and who was in many respects an original genius. Towards the end of his life, owing to failing eyesight, he had to devote his time to pastel painting. Nathaniel Hone and his son Horace Hone, Peter Paillou (1740–1800) and William Wood (1768–1809) are painters who stand out in somewhat marked fashion.

At the end of the 18th century, another group of artists come into view, such as Shelley, whose best portraits are groups of two or three persons, Hargreaves, a Liverpool painter, Mrs. Mee, who was responsible for a large number of portraits, Edridge, who drew also in pencil full length portraits, colouring the faces in miniature fashion, as did Cosway, Nixon, Collins, Crosse and others.

Lawrence and Raeburn, in the early part of their career, both painted miniatures, but works that can be definitely attributed to either of them are extremely rare, and can very seldom be identified. Hoppner is said to have painted one or two miniatures, one only is known bearing his signature.

Andrew Robertson started quite a new fashion in miniature portraits, desiring to make them more like small-sized paintings in oil, but his pigments were water-colours used with extreme skill and great knowledge. His paintings are particularly brilliant and also often executed with a very dark background, and full of dignity and force. The desire gradually came about in his time, and the time of those who followed him, to have much larger portraits than had hitherto been called miniatures, and at that period there was introduced the process of flattening out curved slices of ivory by hydraulic pressure. This enabled such men as Sir William Ross, Chalon, Newton and Thorburn to paint portraits of unusually large size, as large, and in some cases, larger than an octavo sheet of paper. In some instances, the ivory, by reason of climatic changes, has returned in a slight degree to its original curved shape, and hence these larger miniatures are often slightly cracked. Of this latest school, Chalon and Newton were the only two who worked in broad masses, the others, notably Ross, had an almost microscopically minute technique, and invariably worked under a magnifying glass.

All this school devoted too much attention to costume and accessories, and too little to the representation of the human face, presenting their works, moreover, in full direct light, with but little shadow, and comparatively formal and stiff in their positions.

Among modern miniaturists the work of Alyn Williams is of marked distinction and importance, and he has gathered about him a group of excellent modern miniature painters, but it would be invidious to name any others than Miss Brunton, whose work is so distinctive and almost miraculous in its combination of minute treatment and broad effect, that it stands out in sharp relief. Lately, an effort has been made to move away from the accepted microscopic minuteness to an effect of broader painting with excellent results, and even the modernist school has its exponents amongst the miniature painters of the present day, who aim at showing that the art is a living one, and that it progresses with the steady evolution that should characterize all artistic movements.

United States.—In the United States there have been many notable miniature painters. The earliest that can at present be identified was John Watson (*c.* 1715), who drew small portraits in pencil and in India ink. C. W. Peale was the most notable of the Philadelphia painters, and his works exhibit much charm. In Charleston (S.C.), Henry Bembridge did admirable work in about the middle of the century. Miniaturists who must be specially mentioned in connection with New York are J. S. Copley, Henry Pelham and Joseph Dunkerley, while John Ramage was also notable and for a while was known in connection with Boston also. Two Scotsmen, Archibald and Alexander Robertson, went out to America towards the end of the century, and did admirable work in miniature painting, as did also another Robertson, an Irishman named Walter. The best native talent in the United States belongs to a Rhode Island man, E. G. Malbone, and with him should be mentioned Benjamin Trott from Boston and Charles Fraser from Charleston; the latter continued to paint down to 1850. Perhaps the most famous of all was named Robert Field, who was responsible for some of the very finest miniatures ever painted in America. He is the subject of a notable book by H. Piers, *Robert Field* (1927) recently issued concerning him. Two New Englanders amongst the very last of the American miniature painters were Alban Clark of Massachusetts and R. M. Staigg of Newport, and in the early part of the 19th century, one ought not to forget to mention Henry Williams of Boston and Sarah Goodridge, and in New York, Dickinson, Wood, Inman and Cummings.

France.—In France, there has always been a very important series of miniature painters. Amongst the earliest portraits on vellum and paper were those painted by Clouet, father and son, Perreal and Fouquet, and following them is a long series of excellent painters who were, in almost every case, admirable draughtsmen and good colourists. Some of the finest portraits painted in France were, however, the work of a Swede named Pierre Adolphe Hall (1739–93), who, during the Pompadour period, was an exceedingly popular artist. A great painter was the Austrian, Heinrich Füger (1751–1818), who painted single portraits and groups on ivory in amazingly skilful fashion, charming graceful compositions in excellent colour.

Of French painters, amongst the best known are Dumont, Sicardi, and in later days Isabey and Augustin; the former died in 1855 and the latter in 1832. Probably no Frenchman painted portraits more skilfully than did Augustin, and those he produced of the great Napoleon are unequalled for beauty and brilliance.

Quite another school of miniature painters was represented by Fragonard, whose portraits are painted with a brush very full of colour in exceedingly broad manner, with a marked absence of the excessive minuteness of technique which is usually exhibited in a miniature painter's work. Other names that ought to be mentioned are those of Drouais, Nattier, Largilliere and Périn. The great Boucher also was responsible for a few miniatures.

Spain.—In Spain, Goya produced some excellent works, and there are also many other notable painters in Spain, who executed good miniatures.

Italy.—Rosalba Carriera (1675–1757), the famous Venetian

pastellist, was also a notable miniature painter.

TECHNIQUE

One is not able to speak with certainty respecting the vehicles that were used by the earlier painters (*see* G. C. Williamson, *The Art of the Miniature Painter*, 1926). Probably Holbein's portraits were executed with a distemper vehicle, either the white or the yolk of egg, or both combined, and it has been stated that by analysis absolute proof has been obtained of Holbein's use of albumen, and of his arrangement to neutralize the alkaline action of the albuminous liquid by means of weak acetic acid. Hilliard certainly ground his colours with gum arabic, and other gums similar to that were used by those who followed him. Sugar candy also was used, sometimes in lieu of the gum, and sometimes in connection with it, and honey has also been mentioned as one of the vehicles used by these painters. The use of glycerine as a vehicle did not come about until after 1800. Hilliard certainly painted upon parchment, especially upon what he calls abortive parchment, and with long, slender, highly pointed brushes, in some cases made from the hair of the English squirrel. The use of opaque colours by miniature painters continued during the 18th century, in some instances we know exactly what they were, because Bernard Lens painted his own portrait with his palette, dated 1724, and shows on it the actual colours set on the palette.

Respecting the colours used by the artists who painted on ivory, we have ample details, as many of them have left behind specimens of their colours and information concerning their technique and media.

Painting in oil upon copper, or very occasionally upon silver plates was an art that was peculiarly characteristic of the Netherlands and also of Italy. There was a long series of artists about whose art history we know very little, who in Holland produced numberless miniature paintings of this kind. They are seldom signed. The English and French miniature painters produced very few oil paintings on metal, in fact, hardly a single example can be attributed to any of them with certainty. In Italy, the art was more usually accepted, and there are several painters, particularly of the later Bolognese school, who are known to have practised this art, but small oil portraits on copper attributed to the great masters, such as Tintoretto in Italy, and Velasquez and El Greco in Spain, must be considered as having names attributed to them very much at haphazard. We have no evidence to support such a contention, but a considerable amount of evidence to set against it. There is a bare possibility that some of them may have experimented in such a medium, but they have left no record of such experiments, either amongst their papers or in contemporary records or by means of their own signatures.

Portraits in Enamel.—The art of portraits in enamel is an important section of the study of portrait miniatures. The very finest works of this kind were produced by Petitot (1607–1691) who worked under Louis XIV., and whose son succeeded him in the same profession. Among the chief exponents of this art who sometimes came and settled down in England, Boit and Zincke may be mentioned as examples. Enamel portraits required the greatest possible skill and a never-ending patience to produce them. A few moments too long exposure in the kiln might entirely ruin the work of a very long period. We do not even yet know how Petitot painted some of his very finest enamels, and what method he adopted for burning them. Some of his best are on gold instead of copper plates. The greatest English exponent of the art was Henry Bone, and there are many other members of the same family who were closely associated with him in producing fine portraits in enamel. Painters in enamel frequently also copied well known works that had been executed in oil, producing small-sized reproductions of great charm and beauty, with the added advantage of being imperishable and almost indestructible. (*See* PENCIL DRAWINGS; PAINTING; PORTRAITURE.) (G. C. W.)

BIBLIOGRAPHY.—J. L. Propert, *History of Miniature Art* (1887); G. C. Williamson, *Portrait Miniatures* (1897; 2nd ed., 1910); *Richard Cosway, R.A.* (1897; 2nd ed., 1905); *George Engleheart* (1902); *Andrew and Nathaniel Plimer* (1903); *How to Identify Portrait Miniatures* (1904); *History of Portrait Miniatures* (2 vol., 1904); *Life and Works of Ozias Humphry* (1918); *The Miniature Collector* (1921), also the privately printed *Catalogue of the Pierpont Morgan Collection* (4 vol., 1906–08); Dudley Heath, *Miniatures* (with bibl., 1905); J. J. Foster, *Samuel Cooper and English Miniature Painters of the 17th century* (1914–16).

See also the *Catalogue of Miniatures* of the Victoria and Albert museum (1908). R. W. Golding, *The Welbeck Abbey Miniatures* (1916); H. A. Kennedy, *Early English Portrait Miniatures in the Collection of the Duke of Buccleuch* (1917); the series, *Die Bildnisminiatur und ihre Meister* (edit. L. Grünstein, 12 vol. to date, 1925, etc.); H. B. Wehle, *American Miniatures, 1730–1850* (London, 1927).

MINIM (adapted from Lat. *minimus*, the smallest; a superlative formed from the Indo-Germanic root *min-*, small), the smallest possible part of a thing, a particle. In music the name "minim" (*nota minima*) was given by mediaeval musicians to a note whose value was half a semibreve. It was, as its name implies, the note of the shortest duration then in use. In modern music several notes of lesser value, as the "crotchet" and "quaver," have been added, and the minim is now about halfway in the scale of "values." According to Thomas Morley (*A Plaine and Easie Introduction to Practical Music*, 1597), its introduction into manuscript music is ascribed to Phillipus de Vitriaco, a musician of the 14th century. In medicine a minim is the smallest fluid measure.

MINIMI (or Minims), members of a Catholic monastic order founded in Italy in 1435 by St. Francis of Paula. The first rule of the order followed closely that of St. Francis of Assisi, but the second (1501) and third (1506) showed more independence. By the year of the death of St. Francis of Paula, 1507, the order had spread to France, Spain and Germany. In 1623 there were 359 convents and 6,430 members. After the French Revolution the number declined rapidly. In 1910 there were 19 convents, 15 of them in Italy, with about 330 friars.

MINIMUM WAGE. A wage-rate fixed either by collective agreement, or (more commonly) by legal enactment, or by some other means, as the lowest wage payable to workers either generally or in a particular craft or grade. The phrase is most frequently used in connection with the various minimum wage laws passed by numerous countries in recent years, and especially in Australia and Great Britain. But it has no necessary reference to a legal minimum; and the phrase is also used to describe wages arrived at by collective bargaining, or adopted as minima by employers without either bargaining or legal compulsion. These other uses, however, raise no special problem; and this article is concerned with the discussion of the *legal* minimum wage.

The idea of enforcing a legal minimum wage is closely bound up with the idea that society has certain obligations to safeguard the life-standard of its members. "Free" contract, without State interference, is in most countries still regarded as the normal method of determining the conditions of employment, but exceptions to this rule are more and more widely recognized. Just as one country after another has been driven, by the hard compulsion of facts, to build up a system of factory and similar legislation for the purpose of preventing inhuman and anti-social conditions of employment, so the evil of "sweated labour" is compelling them to legislate for the enforcement of wage-rates high enough to ensure for those covered by them employment at a "minimum standard of civilized life." Nowhere, indeed, has this purpose yet been wholly achieved; but the minimum wage laws now in force in various parts of the world represent a considerable advance.

While this has been the outstanding motive behind legislation for the enforcement of a minimum wage, it has in certain cases been intertwined with another—that of checking the development of strikes and industrial unrest. In Australia especially the laying down of enforceable minimum rates has been often combined with the prohibition of strikes and lock-outs and the enactment of compulsory arbitration. Where this is the case the rates of wages enforced by law are in effect maximum as well as minimum rates, whereas under systems of pure minimum wage legislation there is nothing to prevent the demanding or payment of higher rates. Thus, under the British Trade Boards Acts, only pure minimum rates are prescribed, and the workers, or their trade unions, are left perfectly free to claim, and, if they think fit, strike for, higher rates. On the other hand, the rates of wages fixed by the justices after the Black Death and in Elizabethan times began

as maximum rather than minimum rates, and only came later to be minima as well as maxima. At the time of their institution, the object was to prevent, not sweating or underpayment, but the rise of wages above a conventionally accepted standard.

The Elizabethan wage legislation, which fell gradually into disuse during the 17th and 18th centuries, was finally repealed in 1813, after the weavers and other classes of workers, whose wage-standards had been depressed by the Napoleonic wars and the Industrial Revolution, had vainly attempted to use it for the raising of wages by State aid. A minimum wage bill introduced by Samuel Whitbread in 1795, largely on behalf of the agricultural workers, was thrown out in face of the dominance of the ideas of free contract and the iron law of wages. Not for more than a century after Whitbread's failure was the British State to begin the direct legal regulation of wage-rates, though factory legislation made a timid beginning in 1819, and important truck acts, regulating the form in which wages might be paid, were passed early in the 19th century. In Great Britain, until the Trade Boards Act of 1909, the State contented itself with legislating against truck, and with the provision of purely voluntary machinery for conciliation and arbitration under such acts as the Conciliation Acts of 1867 and 1896.

Minimum Wage Acts.—The provision by law of machinery for prescribing legally enforceable minimum rates of wages began in 1896 in the Australian State of Victoria. Under the act of 1896, with later amendments, wages boards were set up in one trade after another, consisting of equal numbers of employers and workers, with an impartial chairman. These boards were given power to fix minimum rates enforceable on the employer; and provision was made for a court of industrial appeals. South Australia followed Victoria's lead, and established boards of a broadly similar type. Other Australian States, and later the Commonwealth of Australia, followed a different plan, already started by New Zealand in 1894, and introduced in varying forms the system of compulsory conciliation and arbitration, under which the rates fixed were binding on both parties, and not as minima on the employer alone.

The British Trade Boards Act of 1909 was based on the Victorian precedent, in that it set up boards for particular trades, with impartial chairmen (to whom it added certain impartial "appointed members"), and with power to fix binding minimum rates, but without any powers of compulsory arbitration. As this act and the still more important Trade Boards Act of 1918 are fully described in a separate article, they are not further dealt with here, save as illustrating the general principle of the legal minimum wage. Nor is there space in this article to deal with the widely varying experiments in minimum wage legislation which have been made in other countries. (*See* WAGES, and under the countries concerned.) It need only be said here that in both Europe and America the greater part of this legislation is confined to women workers, while many of the European acts deal only with home-workers. The French act of 1915, for example, is limited in both these ways.

The decision to institute some sort of minimum wage legislation in Great Britain followed on the Liberal election victory of 1906 and the return to parliament of a Labour Party which then for the first time became formidable enough to exert a real influence on the policy of the State. The ground for the act of 1909 was prepared by the exposures of the evil of "sweating" by the National Anti-Sweating League and other bodies, as well as by trade-union agitation. At the outset, two possible courses presented themselves. The State could have aimed at enforcing, over the whole range of industry and employment, a single minimum rate of wages (or perhaps different minima for men and women, boys and girls). But any such rate or rates would have necessarily been very low, as they could only have been based on the situation in the worst-placed industries. As in Victoria, the alternative was preferred of setting up a distinct board for each trade or industry, each with power to prescribe a rate or rates for the particular trade concerned. The boards were also given power, if they thought fit, to prescribe different minima for different localities; but they chose, as a rule, rather to fix minimum rates for a trade over the whole country, with the object of bringing the worse areas gradually up towards the level of the better.

The act of 1909 was only experimental, and covered only a few specially selected trades. The act of 1918 brought in many more (for details *see* TRADE BOARDS); but the regulation of wages by the State was still treated as an exceptional measure, and was extended only to trades in which, because the wages paid were abnormally low or no satisfactory machinery for collective bargaining existed, a special case of regulation was held to exist. In the great mass of British industries, including most of the great basic services, no legal minimum wage exists to-day. The Trade Boards Acts apply to about three million workers, out of a total employed population of 20 millions. The agricultural labourers, whose wages were first regulated by law by the Corn Production Act of 1917, have now a minimum wage fixed separately for each county under the Labour Government's Agricultural Wages Act of 1924. The miners, too, have a Minimum Wage Act passed in connection with the national mining strike of 1912; but, as will be seen, this is not a true minimum wage measure.

Though the trade-board method has been gradually extended to new trades—until further progress was stopped with the coming of the post-war slump in 1921—very many classes of low-paid workers are still outside the scope of any form of State wage-regulation. With many of these it would be possible to deal by the creation of more trade boards; but any such project is bound to encounter at least two difficulties. The Trade Boards Acts have been applied so far only to trades in which a large proportion of the total number of workers employed has been in receipt of exceptionally low wages. But many sections of low-paid workers are to be found in industries in which, taken as a whole, the rates of wages are relatively high. If the acts were applied to these cases, it would be necessary either to apply them to the whole trade or to the underpaid sections only; and in either case this would involve a new principle. The trade unions and employers would probably be alike opposed in many instances to the former method; while the latter would involve considerable difficulties of demarcation.

Moreover, even if the acts were extended as widely as possible to clearly defined trades, there would remain a large residue of workers, including many of the worst paid, employed in ill-defined or scattered occupations for which it would be difficult to establish any wage-fixing machinery on trade-board lines. It has been suggested that, in order to legislate for workers of this type, there should be set up some sort of general board, with power to prescribe minimum rates for any classes of workers for whom the establishment of a special board is difficult or inexpedient.

Coal Mines Minimum, 1912.—The Coal Mines Minimum Wage Act of 1912 stands in quite a different class from the legislation discussed above, and cannot properly be regarded as a minimum wage act at all. It was passed primarily in order to remedy a grievance peculiar to the mining industry—that of the man who, finding himself in an "abnormal place" in which coal-getting is especially difficult, is unable at piece-work prices to earn a reasonable wage. The act of 1912 provides for the payment to such a man of a minimum wage based on the wages actually in force in the district concerned. Thus, if the district wage fixed by collective bargaining falls, the legal minimum falls too. The act is designed, not to secure a particular rate of wages, but merely to protect individuals from earning, owing to conditions beyond their control, less than a standard established by the ordinary process of collective bargaining. It has, therefore, been of no effect in dealing with the severe fluctuations of miners' wages recently.

In general, the question of the legal minimum wage is bound up with the wider question of the State's duty to secure for all its citizens a reasonable standard of life. In Australia, where the conception has been furthest developed, the minimum wage has been gradually forced up in accordance with an expanding conception of the minimum standard of civilized living. The growing practice has then been to define in relation to human needs a "basic" wage, which is then established as a general minimum, rates in particular trades being fixed at varying levels above the

basic wage. In other countries, including Great Britain, legislation has been introduced only with great caution, and the boards entrusted with the task of fixing minimum rates have been guided largely by the immediate "ability to pay" of the trades concerned, with the result that they have had relatively little effect in raising the general standard of living. During the past few years, indeed, the tendency has been towards a narrow interpretation of their functions and powers. Under these circumstances, the often expressed fears that the fixing of minimum rates might "drive trade out of the country" have not been verified. In certain trades—notably tailoring—there has been some tendency to stimulate factory production and the use of machinery in place of home work and the small workshop. But on the whole the acts have had relatively little effect on the structure or organization of industry. They have, however, never been used in Great Britain with the purpose of bringing about any general rise in wages, and their utility has in practice been limited to the prevention of some of the grosser forms of "sweating." Within this limited sphere minimum wage legislation has undoubtedly produced good results, and would produce better if a more adequate system of inspection were provided. The number of inspectors is, however, still too small to ensure full enforcement of rates prescribed.

BIBLIOGRAPHY.—J. H. Richardson, *The Minimum Wage* (1927); M. E. Burns, *Wages and the State* (1926); D. Sells, *The British Trade Boards Acts* (1923); A. G. B. Fisher, *Wages and their Regulation* (1926); E. Aves, *Report on Wages Boards and Industrial Conciliation and Arbitration Acts in Australia and New Zealand* (1908).

(G. D. H. C.)

United States.—The fixing of wages of employees has not been favoured in the United States. Because of constitutional limitations on the powers of the legislatures and because of public opinion, legislation attempting to fix wages has followed tendencies different from those in other large industrial nations. Legislation fixing the wages of public employees and those engaged upon public works has been upheld as constitutional. Some acts, with regard to employees engaged on public works, fix a flat minimum rate while others provide that the rate shall be the "prevailing rate of wages" in the vicinity where the work is being done. With reference to private industrial enterprises the courts have recognized a difference between those affected with a public interest (as railroads) and other private industries. With reference to industries affected with a public interest there seems to be a tendency to recognize the power of the legislatures to fix wages at least in emergency cases. As to other private industries the courts do not look upon the fixing of wages of men, women and children in the same light. As to men in private industry the legislatures have not taken any action to fix wages, except by the compulsory arbitration law of Kansas which has been held unconstitutional. Minimum wage laws covering women and children in private employment have been passed and have received considerable attention since 1912. Massachusetts was the first State (1912) to enact one of these laws. The following year 8 States, California, Colorado, Minnesota, Nebraska, Oregon, Utah, Washington and Wisconsin passed laws. In 1915 Arkansas and Kansas acted. In 1917 the Arizona legislature passed a minimum wage act and the following year (1918) Congress passed a minimum wage act for the District of Columbia. In 1919, 3 laws were passed, North Dakota, Porto Rico and Texas, and since then, only South Dakota, 1923, has passed a law on the subject. Though 17 laws were passed only 15 are now on the statute books as Nebraska (1919) and Texas (1921) have repealed their acts.

With the exception of Massachusetts the States having minimum wage acts are not important industrial States. Most of the laws are general in their enumeration of industries covered by the act with a tendency to except domestic service and similar employment from the terms of the act. Most of the acts apply to male minors as well as females but some of the acts are limited to females only. The States may be divided into two groups according to the method of determining wage rates. Four acts, those of Arizona, Porto Rico, South Dakota and Utah, fix flat rates. Arkansas fixes a flat rate but gives power to a commission to change the rate. The other 12 acts provide a more flexible system. In these States an administrative body is created having power to establish minimum rates. In two of these, Massachusetts and Nebraska, the force of the rates depends upon public opinion. The administrative bodies created by the acts are of two kinds. Permanent and general bodies are intended to be permanent continuing bodies and generally are not restricted to the subject of minimum wages but have general powers as to the conditions of employment of women and minors. Advisory and special bodies have duties usually limited to the investigation of conditions and the making of recommendations. Advisory boards are provided for in most of the minimum wage acts. Various provisions exist concerning the personnel of these advisory boards but generally the employers, the employees and the public are represented. Many of the laws provide for the granting of special licences in the case of substandard workers who, because of age or physical or mental condition, cannot earn the standard wage.

The non-compulsory Massachusetts law was upheld as constitutional in the State courts. The Oregon Act of 1913 became the basis of an important test case. After being upheld in the State courts, the case was taken to the Supreme Court of the United States where it was argued Dec. 16–17, 1914, and reargued on Jan. 18, 1917. The court divided equally 4 to 4 on the question of constitutionality and the decision of the State court upholding the act was sustained April 9, 1917 (Mr. Justice Brandeis, who had originally appeared as attorney for the law, not voting). Partly because of the doubt as to the constitutionality of the acts the development became slow. After the passage of the District of Columbia Act in 1918, and with four changes in the personnel of the Supreme Court bench a new test case was taken to the Supreme Court of the United States. That court, by a five to three decision (Mr. Justice Brandeis not participating), held the act unconstitutional on April 9, 1923, in the case of *Adkins* v. *Children's Hospital*. This decision was followed in 1925 and 1927 by *per curiam* decisions holding the Arizona and Arkansas acts unconstitutional. Several of the States have accepted the Adkins case as controlling but have continued to enforce the acts with the voluntary co-operation of some employers and without prosecution for violation of the acts. The Adkins case seems to be limited to the application of the act to women and not necessarily as applied to children. The Massachusetts non-compulsory law is being enforced. Wisconsin in 1925 passed an act intended to save the constitutionality of that act by bringing it within the limitations laid down in the opinion in the Adkins case.

BIBLIOGRAPHY.—*Bureau of Labor Statistics, U.S. Department of Labor*, No. 285. "Minimum Wage Laws of the United States: Construction and Operation" (1921); *Women's Bureau, U.S. Department of Labor*, No. 61. "The Development of Minimum-Wage Laws in the United States, 1912 to 1927." (E. STE.)

MINING ACCIDENTS: *see* COAL AND COAL MINING; DANGEROUS TRADES; INDUSTRIAL ACCIDENTS.

MINING ENGINEER. This term may be broadly considered to include anyone who is engaged in the extraction of minerals from the earth. The work of the mining engineer includes prospecting (*q.v.*) for deposits and various minerals, the development of mining methods and works required for the exploitation of proven deposits, and the installation of the necessary equipment above and below ground.

The mining engineer should be of rugged physique, capable of undergoing serious hardships. He should have an active and imaginative mind and must be able easily to adapt himself to varying circumstances. Above all, he must be an able executive. Because of consolidations and the centralized operation of mining properties, the number of mining engineers required is decreasing. While the training and experience at present expected of the mining engineer is much broader than formerly, in many instances it is true that continual broadening of the field is forcing him to specialize in some certain phase of the mining industry. Thus, there is a sharp distinction between a coal mining engineer and a metal mining engineer. Opportunities for the general mining engineer are, perhaps, greatest in Asia, Africa and South America where much pioneer work yet (1929) remains to be done.

A mining engineer should have a knowledge of the kinds and methods of mining and the fundamental sciences that are the foundation of all technical education. He should also be familiar

with geology, mineralogy, chemistry and the principles of mechanical, electrical and civil engineering. He should have a general knowledge of mining law and metallurgy. (F. J. G. Du.)

MINING, METALLIFEROUS, the winning of metals and their ores from the ground. Metals, in their pure state and also mechanically and chemically combined with other substances, occur all over the earth's surface. These deposits of metals and metal ores vary in extent and metal content and in their depth under the surface of the ground, which gives rise to different methods of mining. The broad classification of these methods, which is used by the American Institute of Mining and Metallurgical Engineers, divides metalliferous mining into two main fields: open-cut mining and underground mining.

Classification of Mining Methods

- Open-cut, with or without Stripping.
  - Benches
  - Glory-holes and milling
  - Placer mining
    - Hand sluicing
    - Dredging
    - Hydraulicking
- Underground Methods.
  - Breast Stoping. (Tabular, flat-dipping deposits or beds.)
    - Continuous horizon
    - Casual pillars
    - Room-and-pillar
  - Underhand Stoping. (Veins and large masses.)
    - Glory-hole and milling with pillars
    - Open stope
      - with stulls
      - with square-set timbering
  - Overhand Stoping. (Steep dipping veins or masses.)
    - Open stope
      - with pillars
      - with stulls
      - with square-set timbering
    - Filled stope
      - Horizontal cut and fill (flat-back)
      - Inclined cut and fill (rill)
      - Square-set timbering
      - Resuing or stripping
    - Shrinkage stope
    - Sub-level stopes
  - Top-slicing. (Wide veins or masses.)
    - Continuous horizon
    - Panel slicing
    - Block slicing
    - Inclined slicing
  - Caving. (Large masses.)
    - Sub-level caving
    - Block-caving
      - Undercut from main level
      - Undercut from sub-levels
      - Block-caving into chutes
      - Block-caving with branch raises
- Combined Methods. (Large masses.)
  - Alternate shrinkage stope and pillar, pillars mined by top-slicing, sub-level caving or block-caving
  - Square-set timbering: pillars mined by slicing.

OPEN-CUT MINING

This term is applied to the working of metalliferous deposits which either outcrop at the surface of the ground or are covered by a shallow overburden or capping which must be removed before the ore can be mined. Since the cost of removing the overburden is charged to the cost of mining, a point is reached, as the cover increases in thickness, beyond which open-cut mining does not pay and some method of underground mining must be used. Large deposits of copper and iron ores are worked by open-cut mining, usually by the bench method. The depth of capping varies from a few feet up to 300 feet. Power-driven shovels work on benches loading the ore into cars running on a track placed near the edge of the bench. The material is loosened by blasting, and care should be taken that the pieces are small enough to be handled easily by the shovels. The height of bank is determined by the thickness of the deposit, the size of the shovels used, the physical character of the ore and climatic conditions. The higher the bank the more material the shovel can handle from one position, but the greater is the danger of a slide burying the shovel and of falling rock injuring the men. The material may stand at a high angle when dry, but slides may occur in wet weather. Thick deposits are worked in several benches. The slope of the bank varies at different mines, but for preliminary investigations may be taken as 45° from the horizontal, giving a general slope of from 38° to 40° for the entire side of the cut.

The shape of the ore body has an important bearing on the feasibility of open-cut mining. Due to the slope which the sides of the cut must take, a narrow ore body cannot be mined as

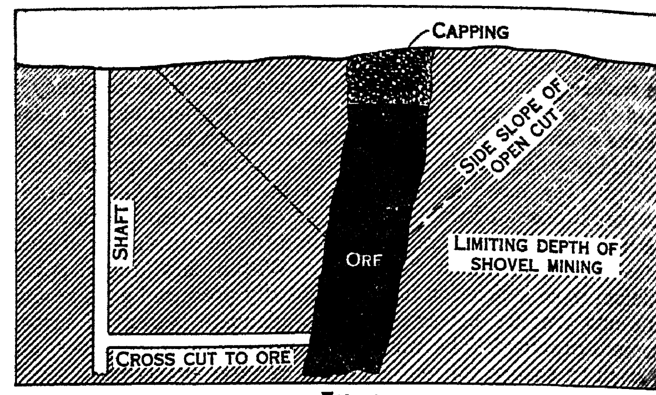


FIG. 1

economically by this method as a large flat lying deposit. If the deposit is irregular in outline it may be difficult to prevent diluting the ore with waste. Even under favourable conditions, it is seldom possible to mine the entire ore body without resorting to underground mining for some part of it. Fig. 1 illustrates how side slope limits the economical depth of open-cut mining. To carry shovel working to greater depth would require the removing of too much overburden, so for deeper working some method of underground mining must be used.

The electrically operated shovel fitted with caterpillar tread is superseding the steam shovel, especially in large scale work. The electric shovel eliminates the problems of water and fuel supply, which are of especial disadvantage in cold weather. Power-shovel work, due to the high cost of equipment, must be on a large scale, and consequently can be economically applied only to large ore deposits, in which case it gives a large output at a very low mining cost. Ample dump room must be available, if much capping is to be removed. No timbering is required; however, the surface of the ground is destroyed for further use, bad weather may seriously interfere with operations and a large outlay of capital is required.

Glory-hole Mining.—In this case a vertical connection or raise is driven to the surface from an underground haulage way. The top of this raise is broken out to form a funnel-shaped opening, which is widened and deepened by drilling and blasting around the inside. The broken ore slides down the funnel into the raise which serves as a chute, the ore being drawn off through gates into cars on the haulage level. This is a cheap method of mining, but it is dangerous especially if pieces of the wall tend to break off and the excavation is large. A series of holes may be mined until they intersect. The intervening ridges are then worked out. The entire operation of getting the ore into the chutes is called "milling."

PLACER MINING

Placer mining is a general term applied to deposits of minerals accumulated into workable quantities of economical importance through the natural processes of erosion and concentration. The heavy and not easily decomposed minerals in the parent rock are freed as the rock is broken down, and are sorted by the action of water and concentrated in the lower parts of stream beds. *Alluvial*, used largely in the British Empire, is applied to placers formed by the mechanical action of moving water, whether of streams, lakes or oceans. *Eluvial* is a term applied to placers found close to the parent rock, *see* fig. 2. Erosion has set free the gold which has worked down the slope due to the combined action of gravity and rains. Once a flowing stream is reached the gold may be carried a long distance before it is deposited. A placer deposit may be formed by one or more of a number of different minerals.

Placer deposits are found in present stream beds, in benches above present streams, in elevated channels of ancient streams now cutting across present drainage (as the White Channel placers of the Yukon), in gravels deeply buried (deep leads) beneath present streams or covered by lava flows. They have also been discovered at the mouths of streams flowing into lakes and as beach deposits formed by the breaking, transporting and sorting action of waves. Some beach deposits have been elevated above the present ocean level. Workable placers have also been formed by the action of wind, which carried away the lighter minerals leaving a residual concentrate of economic importance.

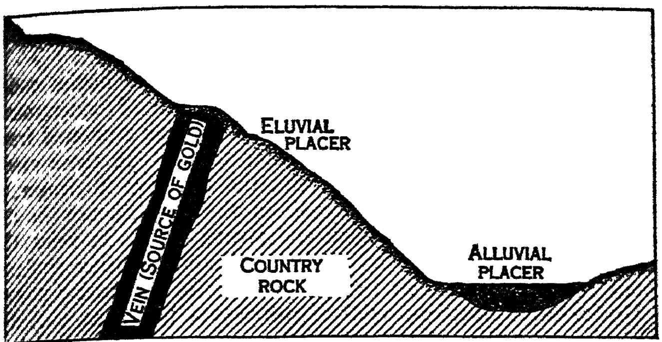


FIG. 2

The size of placer gold varies from nuggets of 2,000 oz. troy or more to such fine flakes that 2,000 of them are worth only 1 cent. Gold coated with silica, oxide of manganese or iron oxide will not be caught by mercury. Small pockets of auriferous gravel are worked by the pan or the rocker. A rocker is a small wooden trough or box mounted on two transverse rockers so the device can be given a side motion. By diligent work an experienced panner may handle 1 cu.yd. of gravel in 10 hours. Two men with a rocker can handle from 3 to 5 cu.yd. of gravel in 10 hr. under average conditions.

Sluicing and Hydraulicking.—A slightly sloping wooden trough (box sluice) or a ditch cut in hard gravel or rock (ground sluice) is used as a channel along which gold-bearing gravel is carried by a stream of water. Riffles, in the form of cobblestones, wooden blocks, wooden poles or steel rails are placed along the bottom of the sluice to aid in saving the gold. Sluices vary from 1 to 6 ft. in width and from 1 to 4 ft. in depth, their cross-section being proportional to the volume of material passing through them. Their length should be sufficient to allow the gravel to disintegrate and the gold to settle. This usually takes place in the first 100 to 300 feet. Additional length of sluice is required to save much of the finer gold (sluices are not sufficient savers of very fine gold) and to convey the gravel to the dump. The slope or grade of sluices is commonly specified as the drop in inches in a length of 12 feet. Sections are commonly 12 ft. long. A drop of 3 in., per box may be sufficient for small light gravel, but more common drops are 6 to 7 in. per box. A drop of 12 in. gives a current too swift to permit the settling of any but the coarsest gold.

Sluicing is the term applied to working placers where the gravel is carried to the head of the sluice by shovelling, in wheelbarrows, in small cars, by scrapers, by dragline excavators or by small steam shovels. Large placer deposits are worked by hydraulicking, the gravel being loosened from place and washed into the sluice by powerful jets of water from nozzles called hydraulic giants. To be effective the head of water on the giant should not be less than 200 ft., equivalent to a pressure of 86·8 lb. per square inch. In case more head room is required than natural conditions afford, additional lift of gravel may be had through the use of an hydraulic elevator, a steeply inclined pipe having a nozzle placed inside at the bottom. The gravel is washed into the elevator at a point just above the nozzle and is carried up by the force of the jet. Water for the hydraulic giant is measured in terms of the miner's inch, or a flow of 1·5 cu.ft. per minute. The volume of gravel loosened and washed through a sluice by a miner's inch of water used for 24 hr. varies with conditions of the gravel, the slope of the sluice and the pressure of the water. As a rough guide, under average conditions the duty of a miner's inch is from 3 to 6 cu.yd. of gravel per 24 hours.

Undercurrents are in some cases placed at an intermediate point or at the end of the main sluice to save fine gold. They are short sluices considerably wider than the main sluice, and are set on a steeper grade, generally at right-angles to the main sluice. A screen or grizzly in the main sluice lets the fine gravel, sand and gold pass through but retains the large rocks and sufficient water to move them in the main sluice. The discharge from the undercurrent is either returned to the main sluice through an auxiliary sluice of flatter grade or goes directly to the dump.

Drift Mining is the term applied to the working of placer deposits by underground methods of mining. It is classified under breast stoping. The paystreak is reached through a horizontal opening called a drift or adit (*q.v.*), or through a shallow vertical shaft. Small cars are commonly used for transporting the gravel, which is removed in some system of regular cuts or sluices across the paystreak. Posts and headboards are used to support the roof, but if the gravel is loosed a method of forepoling or tight timbering must be used. Frozen gravel must be thawed before it can be mined. Steam, hot water or cold water have been successfully used as thawing mediums, being forced into the gravel through pointed pipes. Drifting is more expensive than sluicing or hydraulicking and is used only for rich gravels. The thickness of pay gravel is generally between 2 and 8 feet.

UNDERGROUND METHODS

These include the various forms of stoping, top-slicing and caving.

BREAST STOPING

As a separate method of mining this is applied to thin ore deposits that are either horizontal or dip at a small angle with the horizontal. Stoping is the term applied to breaking the ore from place by drilling and blasting. The excavation in which the miners work is called a *stope*. Thickness of deposits worked by this method is not usually over 12 ft., although in modified form this system is applied to beds up to 70 ft. in thickness, as in the Wisconsin zinc district. In thin deposits the entire thickness of ore is mined at one time, thus advancing the working in a vertical face or breast. In thicker deposits the ore is mined in a series of benches. *Continuous horizon* implies a long working face which is attacked simultaneously at a number of points.

In the Missouri lead and zinc region the roof is supported by pillars of ore from 10 to 40 ft. in diameter, placed at irregular intervals. From 10 to 17% of the ore is left in the pillars, this amount depending upon the nature of the floor (hard or soft), the strength of the roof and total weight supported. The recovery of ore from the pillars is low, it being more economical to leave some of the ore than to use artificial means of support. To reduce the cost of mining, hand shovelling is replaced wherever feasible by some form of machine loading. Small power shovels are used in some large stopes. Concrete discs and concrete columns have proved a satisfactory means of support and in some places have supplanted wooden cribs filled with waste.

Room and Pillar.—This method applies to the systematic cutting of the deposit into regular lines of square or rectangular pillars, which later are removed as much as possible. At the Maywood iron mine, Yorkshire, England, a deposit of iron ore 7·5 ft. thick is cut into pillars 54 to 60 ft. by drives 15 ft. wide, leaving some 63% of the ore in pillars, which later are worked out in sections, using posts as temporary roof supports. Finally, the posts are pulled out and the roof settles down over.

UNDERHAND STOPING

As the name implies this is a method of working an ore body from the top down. Holes for blasting are drilled downward. Fig. 3 shows a composite section of underhand mining in a narrow vertical vein. In mining it is customary to concentrate the handling of ore and waste and the distribution of supplies on certain horizons called levels, which are commonly spaced 100 ft. apart vertically, though this distance may be greatly increased in some

mines. The ore mined between two consecutive levels is dropped through chutes to the level below for hauling to the shaft. On any level the passageways driven lengthwise of the vein are called drifts (a single drift may be called a level), and those driven across the vein from wall to wall are called cross-cuts. If the vein is inclined, the upper wall is the hanging wall and the lower wall is the footwall. Two levels are interconnected by verti-

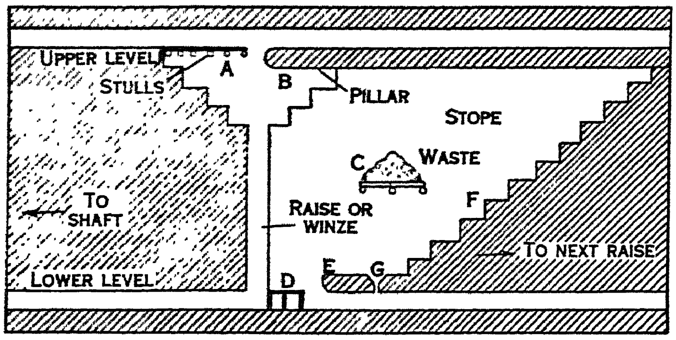


FIG. 3

cal or inclined openings called raises, if driven upward from a level, and winzes, if driven downward from a level. Thus the same connecting opening may be a raise or a winze depending upon which level is used as a reference point. The term back is applied both to the roof of an underground opening or to the entire body of ore between a level and the next one above. Since each main level must have a haulage system and a station must be made at the shaft, a large number of levels in a mine calls for a heavy development expense. To lessen this expense levels may be placed 1,000 ft. or more apart, if the vein is fairly constant in dip and has strong walls, as in some of the Rand mines. Raises are spaced from 100 to 200 or even 500 ft. apart horizontally.

An underhand stope, *see* fig. 3, is started by working outward from the top of a winze in a series of horizontal slices, which tect the lower level and to provide a means of loading cars, the lower level is either timbered, as shown at *D*, or a pillar of ore, *E*, is left, through which chutes, *G*, are cut at intervals of 25 to 50 feet. The face of the ore forms a rough slope rather than a series of steps as indicated at *F*. The angle of repose of broken ore is from 35° to 45°, the steeper angle being for hard ores. If possible, the slope should be such that the ore runs down under the influence of gravity, but in inclined veins it may be necessary to shovel the ore down the slope or to use mechanical scrapers.

Underhand stoping may be applied to large ore bodies under certain conditions. It generally takes the form of underground glory-holes (mill-holes), one series of holes being separated from another series by an intervening pillar of ore. In these cases, as in the working of a narrow vein, the men are in danger of rock falling from the back or walls of the stope, hence the desirability of having a firm back and strong walls. In veins, the maximum width worked by underhand stoping using stulls is about 20 ft., since longer timbers have little supporting power.

Underhand Stoping with Square-sets has been used for mining small bodies of ore. The term square-sets is applied to a flexible system of timber support. A complete set is composed of 12 pieces of timber, four each of posts, caps and girts. As additional sets are added each timber becomes common to four adjacent sets. Round timbers are also used in sets, but they require a different framing. Sets are held in place by short blocks placed at the corners and wedged tightly against the walls of the stope. By extending sets vertically and horizontally this skeleton framework may be shaped to fit a stope of very irregular outline. However, it is an expensive method of support and cannot withstand great pressure. If a few of the timbers are thrown out of line, the entire framework is likely to collapse. The ore is first stoped to make room for the top floor of sets, which are covered with lagging to hold back the sandy capping or back, then the excavation for the floor below is made. The second floor sets are supported from the top floor sets by using

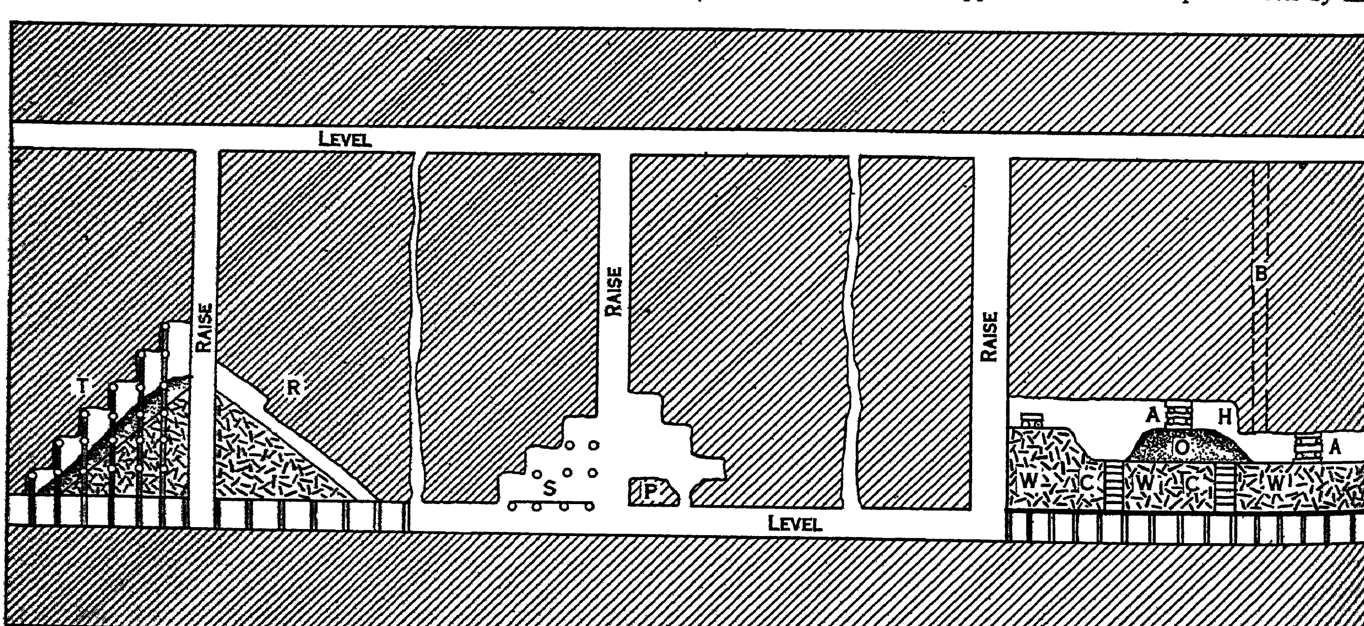


FIG. 4

leave the ore in step-like form. If the ore is rich, timbers called stulls are covered with plank (called lagging) to form the bottom of the level, as at *A*, but if the ore is lean, it is more economical to leave a pillar of ore as at *B*. Should the level be the lowest level in the mine, the ore must be hoisted to the top of the winze. The cost of mining is increased, so this procedure is used only for recovering small bodies of ore below a level. Raises and winzes are generally timbered to afford at least two closed compartments, one to be used as a chute for ore or waste and the other fitted with a ladder to serve as a manway. To pro- chains and planks nailed from a timber in the top set to another in the floor below. The second set timbers are then wedged in place and work on the third floor is started.

OVERHAND STOPING

Open Stopes.—In this system of mining, the stopes are advanced upward, the ore being removed in horizontal, vertical or inclined slices. The stopes are started from the bottom of a raise; either from the top of a protecting pillar of ore, as at *P*, fig. 4, or directly off the level, as at *S*, in which case the level

is protected by stulls or drift sets which are covered with lagging. Stulls used in narrow veins are commonly from 8 to 12 in. in diameter, though sizes up to 30 in., have been used in heavy ground. The upper ends of the stulls are held in place by wedges. Lagging may be plank or round poles. Scattered pillars of ore may be left to support the walls. Though the attempt is made later to recover this ore much of it may be lost. In wide veins so much ore would be required for pillars that square-set timbering is used.

As the stoping proceeds upward the miners must have some support on which to work. For veins having a dip of 40° or less, the men can work from the footwall, but on steeper dips stulls or square-sets are covered with lagging to afford temporary working platforms. Strong walls and firm ore require a minimum of support, and then the stope may be left open.

Filled Stopes.—In case the ore is likely to fall as soon as it is undercut and if the walls are weak a stronger support than can be given by timbering alone is required and filling the stope with waste is resorted to. The waste is secured from sorting the ore (the amount is seldom sufficient), from driving small drifts or inclined raises into the walls of the deposit, or outside the mine. In some cases the tailing from concentrating plants is used. This material may be dry or it may be mixed with water and washed into the mine through pipes in which case the water is drained from the filling and is pumped from the mine. This method is called *sand filling*. The *horizontal-cut-and-fill* or *flat-back* system of overhand mining is shown in fig. 4. At *H* the cut is being made horizontally to the right, the miners drilling holes from the top of the pile of broken ore at *O*. Chutes, *C*, are for drawing off the ore to the level below. These timbered chutes are built up to keep the top just above the waste filling, which is brought in through the upper level and dropped down the waste chute in the raise to be distributed through the stope in cars. As the mining progresses away from the main raise, additional waste raises, *B*, are driven at intervals to save hauling distance. Before a slice of ore is shot down, the waste filling is levelled and is covered with planks. The planks are removed when waste is to be dumped. After the slice *H* has been carried beyond the first waste raise, another slice may be started from the main raise. In this way several sets of miners may be working in a stope. In the Michigan copper mines where this system is followed, the ore is sorted in the stope. At the Champion mine about 53% of the material broken in the stopes is left for filling. The ore chutes are built of large pieces of waste arranged in circular form. Some support to the back may be afforded by cribs built on the waste or on the ore as at *A*, fig. 4, but no heavy weight can be supported in this way. For ore bodies of long horizontal extent, vertical pillars of ore are left at intervals, and additional support is afforded by horizontal pillars left just above and below.

Rill Stoping.—This method, also known as *inclined-cut-and-fill mining*, is a form of overhand stoping in which inclined slices are broken, as is shown at *R*, fig. 4. The method works well where the ore is hard and the walls are firm and regular. The slices or cuts are made either from the top down or the bottom up, the miners standing on the broken ore. After a slice has been shot down and the ore has drawn off at the level, waste is run in from the raise. The waste runs in under the influence of gravity and takes its own angle of repose. A layer of planks is laid on the waste, another slice of ore is shot down and drawn off, and the planks are removed for the next layer of waste filling. Both ore and waste require a minimum of handling. At *T*, fig. 4, stulls and posts are used as support. Here, the broken ore is shown lying on the plank-covered waste. Still stronger support is given by using square-sets. As the stope increases in height the lower point or toe moves away from the raise. The danger of falls of rocks from the back limits the length of the stopes, which in some cases may be only 50 to 60 feet. An ore chute is started from the level at the toe of the slope and is carried up, keeping pace with the waste filling. If two chutes are used, one for waste and the other for ore and a grizzly is placed over the ore chute, the larger pieces of waste may be sorted out. At the Pilares copper mine in Mexico no planks are used in the stope; water is used to wet the surface of the waste before the ore is shot down. After drawing off the ore, the fine material remaining is carefully scraped off the waste before additional filling is run in.

Filled Square Sets.—These offer a flexible method of mining heavy ground. By varying the number of sets opened on the bottom or sill floor of a stope and by limiting the vertical number of sets left unfilled, this system can be made to suit the nature of the ground being mined. If no great pressure is brought on the timbers, a sill floor of say 12 to 15 sets or even more may be opened. In bad ground, the sill floor may be only two or three sets. This area of horizontal cut is carried up to the level above, and then another similar cut is started next to the filled sets, and the operations are repeated. Thus a large block of heavy ground may be safely mined in a series of small vertical slices. In very heavy ground, the filling must be carried as close as possible to the working face. Chutes and manways are made by lining square sets tightly on the inside with vertically placed plank or lagging. Waste is confined within sets by placing lagging horizontally on the inside of the posts and spacing the plank a few inches apart unless the filling is very fine.

Resuing or Stripping.—This term is applied to the mining of rich narrow veins or of veins in which rich ore lies in a streak of less width than the vein. The object of resuing is to mine the ore clean and free from waste, and thus save diluting the ore with waste and sending a larger tonnage of lower grade ore to the mill or smelter. In fig. 5 *A* is the rich streak and *V* is the lean part of the vein. A level *L* is opened and the stoping is carried upward. The level is driven largely in the worthless rock, which is first removed and then the rich streak is shot down, canvas or hides being commonly used to catch the ore since the richest part is generally the finest. The ore should separate easily from the wall of the vein; if it adheres tightly to the wall some waste will be mixed with the ore.

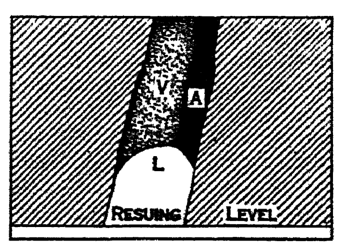
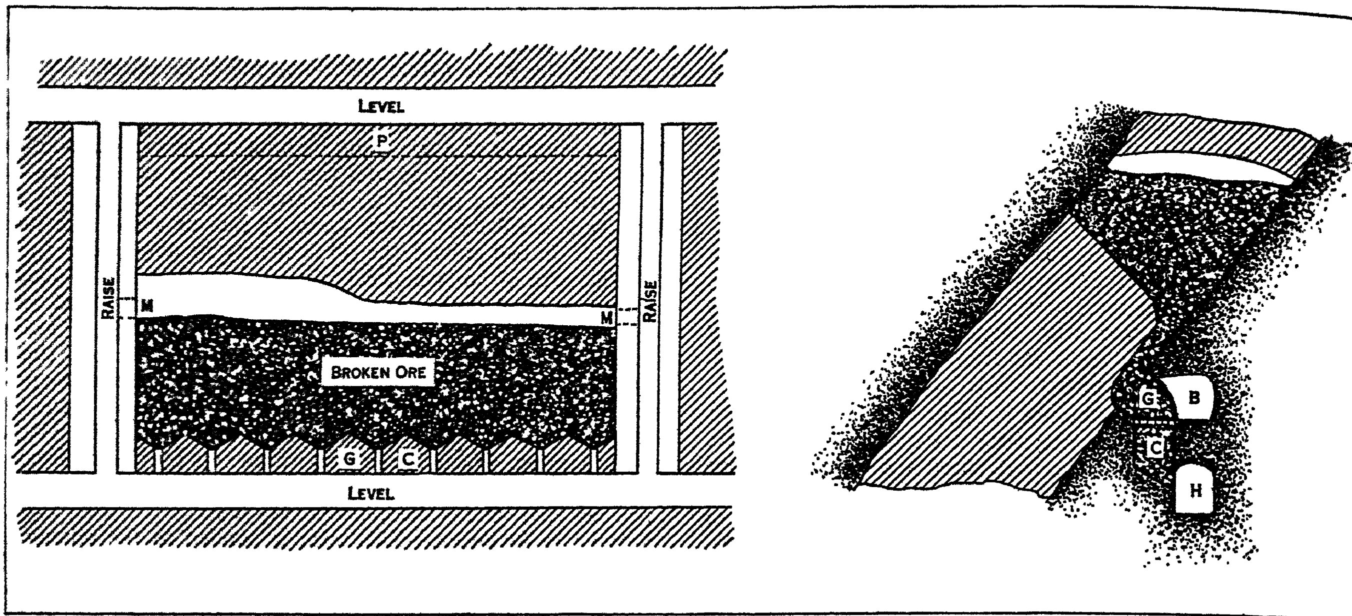


FIG. 5

Shrinkage Stoping.—This is also called magazine stoping. The ore is mined by overhand stoping. Only enough ore is drawn from the stope to afford working space to the miners who stand on the broken ore while drilling holes in the back. Broken ore occupies some 60% more volume than ore in place, consequently about one third of the ore must be drawn off, as it is broken, through chutes closely spaced, from 25 to 50 ft., along the bottom of the stope. Two-thirds of the ore is left in the stope. This method of mining is best suited to hard ores of uniform character, with walls which are firm and regular and dip at not less than 60° from the horizontal. The ore should work easily down the stope when it is being drawn. Soft walls are likely to slab off and dilute the ore with barren rock. Sorting is not practised except under unusual conditions, and little timbering is required. Ore that packs in the stope must be loosened by blasting. If the ore breaks in large blocks, these must be drilled with shallow holes and blasted; this is called block holing. One disadvantage of this method lies in the long time the ore is left in stopes, this being two or three years in some cases, and entails high interest charges for carrying the ore.

Fig. 6 shows shrinkage stoping as applied to a large ore body. The lower level is protected by a pillar through which short raises, *C*, for chutes are put up at 25 ft. intervals. Raises are driven through the pillars at the ends of the stope. Short-cuts, driven through the pillars at small vertical intervals, connect with the working space in the stope, as shown at *M*. To prevent large pieces of ore from logging the chutes grizzlies, *G*, are placed at the top of the chutes *C*. A pillar of ore, indicated by the fine line at *P*, may be left to protect the upper level. Later, pillars are mined by another method. Fig. 7 illustrates shrinkage stoping in a steeply dipping vein. The ore passes through the grizzly *G* into the chute *C* along the haulage *H*. *B* is a bulldozing chamber in which men can work at blasting the large pieces which do not pass the grizzly.



FIGS. 6 & 7

Sub-level Stoping.—This mining method was developed in the Michigan iron mines. The principles of the method are illustrated in fig. 8. Main levels are from 100 to 150 ft. apart, and are connected by raise. At intervals of 20 to 25 ft. vertically, sub-levels 7 to 8 ft. high are driven from the raise to the end of the stope. These sub-levels are commonly a single drift down the centre of the stope. By driving cross-cuts at the end, sub-level No. 1 is for a short distance widened to the limits of the stope. Inclined holes are drilled around the chute raises *C* which are put up from the haulage level at intervals of 25 ft. or even less. These holes are blasted to give a funnel-shaped top to the chutes. Holes are now drilled in the back over the sub-level, and a slice in the centre of the stope from level to level and the sub-levels is shot down, the broken ore falling into the chutes. Sub-level No. 2 is taken back by first cross-cutting to the full width of the stope, and then drilling down holes in the floor to remove part of the lower pillar and "uppers" in the back to take out half of the upper pillar. Thus miners in No. 2 sub-level retreat toward the raise, drilling down holes in the slice *B* and up holes in the slice *D*. The ore falls into the chutes. The ore should be firm and free

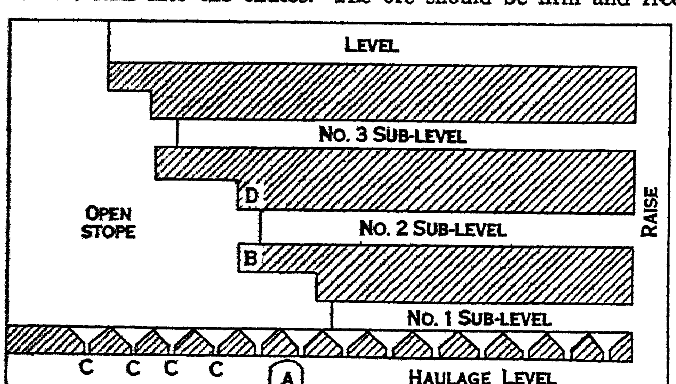


FIG. 8

from slips. The sub-levels are carried back in steps, one working face being some 30 ft. horizontally ahead of that above.

If the walls are soft some waste will fall and mix with the ore. If the ore is hard, the cost of driving the sub-levels and drilling the ore is increased. In long stopes a vertical cut may be made in the centre of the stope from level to level and the sub-levels are carried back each way from this centre point. In wide stopes, 40 to 100 ft. in width, two parallel haulage drifts may be driven. These are connected at intervals by cross cuts as at *A*. This method entails a high cost for development, but requires little timber and gives a large output from each stope because of the several working places. The ore can be drawn out at once. The method is limited to deposits having a dip of not less than 45°, since the ore should work freely down the footwall.

TOP SLICING

This method, developed from methods used in the north of England iron mines, was first used in the iron mines of the United States. Later it was adapted to the mining of copper and lead-zinc ores.

Continuous Horizon.—Mining is done in horizontal slices, 10 to 12 ft. thick, working downward from the top of the deposit. The first slice is taken just beneath the capping, which is supported by timbering. As the slice of ore is taken out lagging is laid on the floor to tightly cover the ore below. The posts supporting the capping are then shot out and the capping caves onto the timber floor or mat. This mat is temporarily supported by the timbering of the second slice. After the ore in the second slice is taken out, a timber floor is laid and the posts are shot out. Thus the timber mat, which serves to prevent the capping from mixing with the ore receives additions as each slice is stoped. From the haulage level a raise, containing a chute and manway, is put up to the top of the ore and a main drift is driven to the boundaries of the block. Cross drifts are turned off at right-angles to the main drift and are driven to the limits of the block. The ore is broken by breast stoping, and is shovelled into cars to be hauled to the chute. The back is supported by timbering. After a cross drift has been completed, the floor is covered with a layer of timber and the posts are shot out, using small charges of dynamite. The overlying capping or timber mat settles down onto the new floor. If capping in a caved drift tends to run into a working drift, the side of the latter is lagged to hold the capping. Since the timber is not recovered, it is as poor a grade as will do for temporary support. In variations of this method a form of square-set timbering is used, and successive cuts may be two sets wide and two or three sets high.

Panel, Block and Inclined Slicing.—A large ore body is not worked in one continuous horizon, but rather is a series of blocks or panels. Inclined top-slicing was devised to save shovelling the ore. The cuts (frequently called slices, though slice seems best applied to the entire series of cuts on one horizon) are inclined upwards from the chute at an angle of 33° with the horizontal, so the ore will roll down to the chute. This method does not permit sorting of the ore in the stope and is more difficult to work than horizontal slicing. The Mitchell method of top-slicing is a modified form in which inclined slices are carried up from a chute at 45° for from 11 to 15 ft. and are then turned horizontally. It is difficult to keep the working drifts open for a long time, hence a large ore body is worked in a series of small

independent units. Top-slicing is applicable to weak ore with poor walls. It is most suitable for deposits of large horizontal extent which have a capping that caves readily. It is a safe method and gives a high extraction of ore, up to 98%. However, the ore is mined by breast stoping and a large amount of timbering is required. The method is being replaced by others in which the ore is largely broken by undercutting and caving.

CAVING

Sub-level Caving.—This method is suitable for the large scale mining of ore that is moderately hard, that has fairly regular limits and a capping which caves readily. The method is used chiefly in the iron mines of the Lake Superior district. Fig. 9 illustrates the principles of the method. Details vary at different mines. From the haulage level (levels may be 75 to 100 ft. apart) raises are put up at 50 ft. intervals, and sub-levels are driven from the raises at vertical intervals of from 15 to 18 ft., leaving a horizontal pillar of ore some 9 ft. thick between the sub-levels. The development work on each sub-level consists of longitudinal drifts, marked No. 1 sub-level, No. 2 sub-level, etc., and cross drifts marked *D*. These are spaced about 50 ft. apart. Mining is started on the top sub-level, No. 4 in fig. 9, by driving a cross drift parallel to *D* across the block of ore at the end of the sub-level. The drift is timbered with three-piece sets of two slightly inclined posts and a cap and is lagged overhead. A second drift is driven alongside the first one, the feet of the posts in the two drifts overlap slightly. By removing a little of the lagging over the first drift, shallow holes can be drilled in the back and the ore blasted. Men in the second drift shovel the ore into cars for tramming to the chutes in the raises. After the ore is removed, the floor of the first drift is covered with a layer of timber, and a third drift is driven alongside the second drift and the operations are repeated. The capping caves and, as it is caught on the timber mat, enough pressure is developed by this weight on the ends of the horizontal pillars of ore to reduce considerably the amount of blasting needed to break the ore.

In fig. 9 the ore over drifts *A* has been shot down. Shovellers in drift *B* have removed this ore and have laid planks on the floor. As soon as a new drift has been driven alongside drifts *B*, mining the ore above *B* will be started. As in sub-level stoping, mining is done in a series of steps. From half to two-thirds of

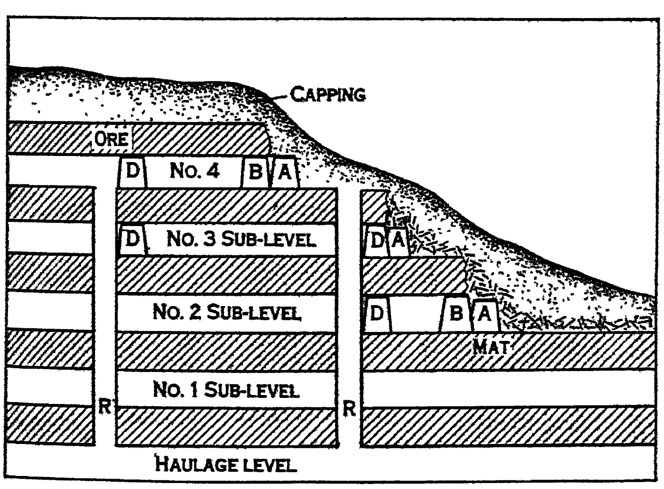


FIG. 9

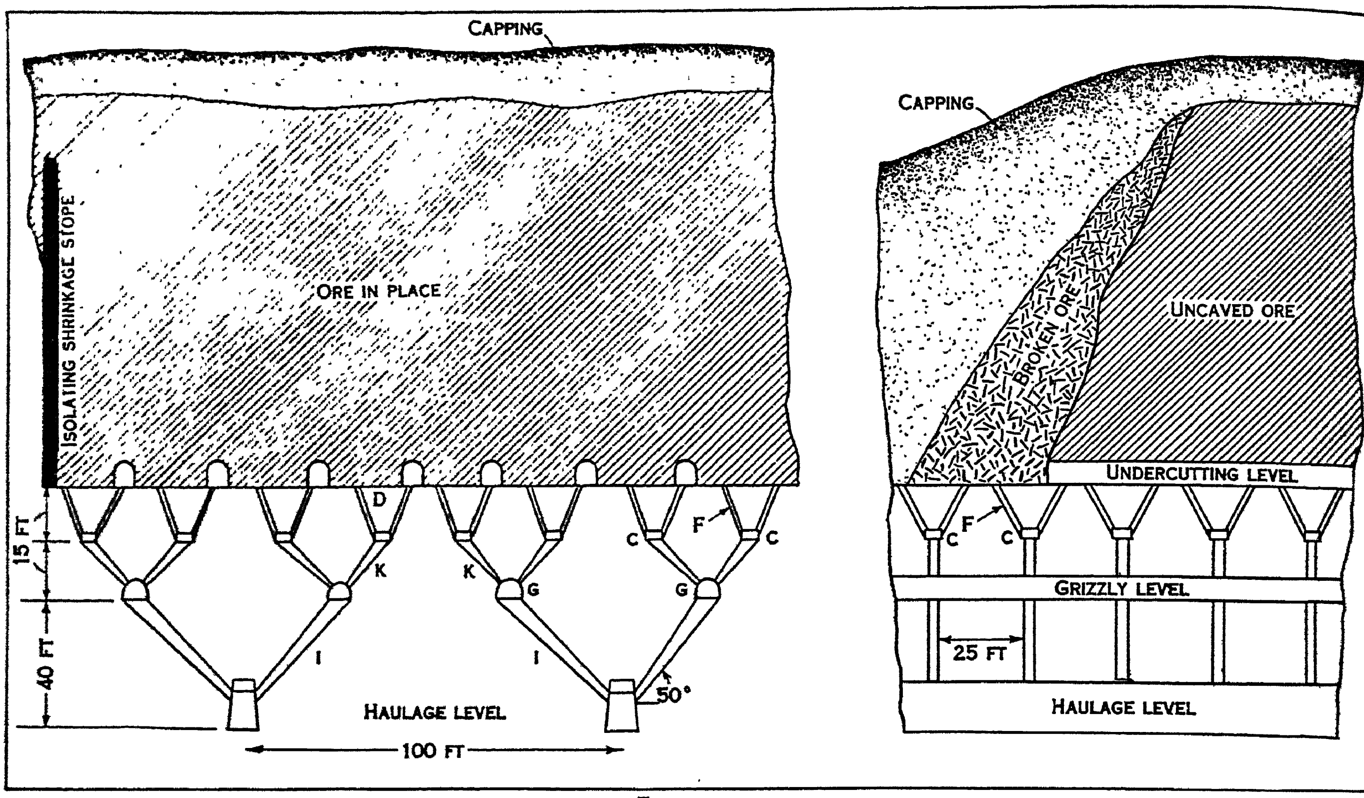
the ore is broken by caving. In some mines where mechanical scrapers are used, cuts are not taken at right angles to the main drifts but at a smaller angle to avoid working the scrapers around corners. The scrapers pull the ore to the chutes. Sub-level caving requires less timbering than top-slicing and the cost of mining is lower. However, the percentage of extraction is not so high and some capping becomes mixed with the ore.

Block-caving.—In this method a block of ore is undercut, and settles the height of the undercut. This relatively small movement of the ore is sufficient to break it into small pieces. Suitable ore bodies should be large, and the ore should be firm enough to stand well during the work of undercutting and yet be brittle enough to break up well during the process of settling. The capping should cave readily. The broken ore is drawn off at the bottom of the block until capping appears. Variations of block-caving are due to the methods of undercutting the ore and drawing off the ore. If *undercut from the main level,* the block is cut by intersecting drifts and cross drifts into a series of pillars, which are as small as safety permits. The pillars are drilled and blasted, and time is allowed for the ore to settle. At the Pewabic iron mine in Michigan, levels are from 100 to 125 ft. apart; the height of undercut is 7 feet. A block requires several weeks to settle, but continues to work for months. It was found that at the end of 6 to 8 months about 80% of the ore was fine enough to pass through a 3 in. ring. The broken ore is mined by driving a series of closely timbered drifts into the broken material. The ore runs in at the ends of the drifts and is shovelled into cars. When waste appears a few sets in the drift are blasted down and drawing is resumed at a new point, thus following a retreating system. If a block is *undercut from sub-level,* the general features are similar to those just described. From the main haulage-level, drifts are turned off at right-angles at say 50 ft. intervals, and are driven to the limits of the block. A sub-level is driven above the main level, and the block is undercut by intersecting drifts and cross drifts on the sub-level. Chutes are put up to the sub-level from the haulage level. The pillars are blasted and the ore is worked into chutes. In *caving into chutes,* the chutes are close together and their tops are widened into funnels. The ore as it caves falls into these funnels.

Block-caving With Branch Raises is a method followed at several large copper mines in the United States and in South America. The method is shown in figs. 10 and 11. From the haulage-level main inclined chutes (also called transfer raises or simply transfers), *i*, are driven to the grizzly level, where drifts, *g*, are used to connect a line of chutes. The tops of the chutes are covered with a grizzly made of rails to catch the large pieces of ore which would choke the chutes. From the grizzly level inclined chutes, *k*, are carried up and terminate in a square set, *C*, called a control set, from which two or four inclined raises, *F*, called "finger raises" are driven to the undercutting level at the bottom of the block. The tops of the finger raises are spaced 12·5 ft. apart each way, thus offering an ample number of points for drawing off the caved ore.

The ore is undercut by running a series of drifts, *D*, 25 ft. apart to the limits of the block. At one end of the block the ends of the drifts are widened. Holes are then drilled in the intervening ribs or pillars and in the back. Blasting these holes generally starts the caving. Isolating shrinkage stopes, called "boundary shrinks," are carried up across the ends or sides of the block before the ore is undercut to separate it from the adjoining ground and thus facilitate the caving. This method is suitable for ore that is soft or of medium hardness in which there is little or no waste. Hard ores which break in large blocks are better suited to shrinkage stoping. The capping should follow down freely after the ore, which should break into small pieces and run well into the chutes. Ores containing much fine material are likely to stick in the chutes, especially if wet. Details of the method vary at different mines. The undercutting level may be inclined to follow the bottom slope of the ore. Finger raises may vary in number from two to four and in slope from 33° to 45° or more. Chutes may have a slope as great as 70°, but vertical chutes tend to choke more easily than inclined ones. The spacing of the series of branch raises along the haulage way may vary from 25 to 100 feet.

The height of ore (called lift) in a block may be from 30 to 240 feet. A thick body of ore may be worked in more than one lift. For a given amount of development work, the higher the lift taken the less is the cost per ton for the development work, since the cost is spread over all the ore in a block. However, other factors such as the horizontal extent of the ore and the economic life of the workings must also be considered. Since the method is applied to low grade copper ores, between 1 and 2% copper,



FIGS. 10 & 11

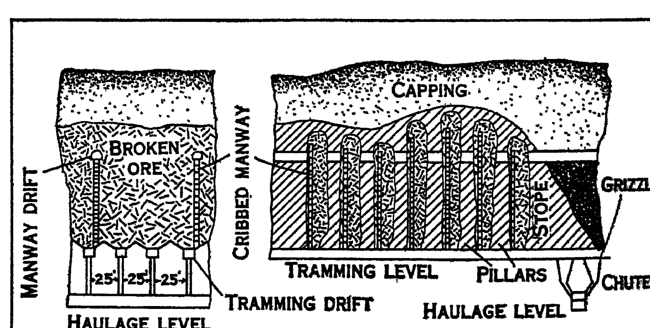
care must be taken to keep the diluting of ore by waste to a minimum. The line of contact between the broken ore and the cappings (*see* fig. 11) is usually between 40° and 70° with the horizontal. The flatter the angle the greater is the amount of broken ore in the stope, and trouble from packing of the ore is increased. The more temporary workings must be kept open a longer time, entailing a heavy expense. At the Ruth mine an angle of 40° resulted in a minimum dilution with capping; at the Inspiration mine an angle greater than 60° caused a tendency of the capping to break through into the chutes.

Results at different mines show a lowering of the estimated grade of the ore by only a small fraction of 1%, under favourable conditions less than 0·1%. The tonnage recovered from a block is generally slightly higher than the calculated volume of the block due to included capping. Some ore is lost. The actual recovery of the copper contents of blocks ranges from 83 to 99%.

COMBINED METHODS

Combined methods may take several forms, but variations of room and pillar mining, a series of alternating narrow stopes and pillars, are most common. The ore is sufficiently hard to permit of using shrinkage stoping in the rooms. The pillars serve to support the capping until the stopes are completed. The pillars are mined in a number of ways; *e.g.*, by top-slicing, sub-level caving or block-caving. In another variation of combined methods the stopes may be square-set stopes, and the pillars are mined by slicing. Figs. 12 and 13 illustrate one system of combined methods. Fig. 12 shows part of a longitudinal vertical cross-section through a stope, taken at right-angles to the plane of fig. 13. Stopes are about 15 ft. wide by 150 to 175 ft. long. Pillars are 10 ft. thick. The tramming level at the bottom of the stopes is a series of drifts 25 ft. apart laid out at right angles to the long axis of the stopes. From 75 to 100 ft. above the tramming level, manway drifts are run at 75 ft. intervals. Raises for manways are put up in the stopes and connect the tramway drifts with the manway drifts, thus affording good ventilation. As the ore is stoped the manways are cribbed to keep them open in the broken ore. Chain ladders are hung in the manways from the manway drifts. After the stopes in a block are completed, the pillars are cut off at the bottom and cave as the ore is drawn through chutes in the sides of the tramming drifts. The ore is trammed by hand to the grizzlies over the main chutes which lead to the haulage-level below. Undercutting the pillars and drawing off the ore is carefully controlled to give a steep line of contact between capping and broken ore. As one pillar is undercut the ore is drawn down to capping some 50 to 75 ft. farther back. Some 80% of the ore is drawn out through the chutes.

In regard to costs only generalized figures can be given. Mitke states that caving with branch raises costs from 37 to 96 cents per ton; combined shrinkage and caving (with one exception) costs from \$0.60 to \$1.00 per ton, and top-slicing due to the large amount of timber required costs from \$1.00 to \$2.50 per ton. To illustrate how conditions must control the choice of a mining method, V. A. Brussolo gives the following factors which determine the method to be followed: (1) safety, (2) size and shape



FIGS. 12 & 13

of ore body, (3) grade of the ore, (4) quantity of waste admixed with the ore, (5) character of rock surrounding the section to be mined, (6) flexibility. Of the ore mined at the Pilares mine during 1927, the percentage secured by different mining methods was as follows: horizontal cut and fill, 58·6%; rill stoping, 15·7%; shrinkage with filling, 14·4%; square-sets, 9·8%. Top-slicing, caving and combined methods account for the remaining 1·5%. (*See also* COAL AND COAL MINING; PROSPECTING; DREDGES AND DREDGING.)

BIBLIOGRAPHY.—H. C. Goodrich, *Shovel Operations at Bingham, Utah Copper Company* (1925); G. J. Young, *The Working of Un-*

stratified Mineral Deposits (1927); C. Raeburn and H. B. Milner, *Alluvial Prospecting* (1927); R. Peele, ed., *Mining Engineers' Handbook* (2d. ed., 1927); W. Lindgren, *Mineral Deposits* (3rd ed. rev., 1928); E. E. Payne, "Support of Workings on the Van Ryn Deep," *Journal Chem. Met. and Min. Soc.* (South Africa, July, 1926); J. Richardson, "Methods of Support of Hanging on New States, Area Ltd., with Special Reference to Concrete Columns," *Journal Chem. Met. and Min. Soc.* (South Africa, July, 1926); *see* also series of articles on mining methods by C. A. Mitke in the *Eng. and Min. Jour.* (Sept. 10, 1924; Oct. 8; Dec. 10, 24, 1917; March 3, April 7, May 1, 26, 1928); V. A. Brussolo, "Mining Methods at the Pilares Mine," *Min. Congress Jour.* (May, 1928). (R. S. L.)

MINION, a favourite, pet, or spoiled person. "Minion" is chiefly applied in a derogatory sense to the "creatures" of a royal court. In the sense pretty, delicate, dainty, the French form *mignon* or *mignonne* is often used in English. During the 17th century "minion" was the name of a type of cannon with a small bore. In printing, a size of type smaller than brevier and larger than nonpareil; it is also known as 7-point.

MINISTER, an official title both civil and ecclesiastical. The word *minister* as originally used in the Latin Church was a translation of the Greek διάκονος, deacon, and in this sense it is still technically used. *See* MINISTRY, THE CHRISTIAN.

For the civil title of minister *see* the articles MINISTRY and CABINET. For the history and meanings of the word "minister" in diplomacy, *see* DIPLOMACY.

MINISTRY, the office of a minister (*q.v.*) in all its meanings, political and religious, or the body of persons holding such an office and performing its duties; more particularly the body of persons who, in theory the servants at the head of the State, act as the responsible executive over the whole sphere of government. The word "ministry" is also in some cases applied to a particular department of government with its responsible head and permanent officials or staff.

In England, ever since the introduction of monarchical institutions the sovereign has always been surrounded by a select body of confidential advisers to assist the Crown in the government of the country. At no period could a king of England act, according to law, without advice in the public concerns of the kingdom; the institution of the Crown of England and the institution of the privy council (*q.v.*) are coeval. In the earlier stages the king's councillors, as confidential servants of the monarch, were present at every meeting of parliament in order to advise upon matters judicial in the House of Lords; but in the reign of Richard II. the privy council dissolved its judicial connection with the peers and assumed an independent jurisdiction of its own. In the reign of Henry VI. the king's council first assumed the name of privy council, and it was during the minority of this sovereign that a select council gradually emerged from the larger body of the privy council, which ultimately became the modern cabinet. Since the revolution of 1688, and the development of parliamentary government, the privy council has dwindled into comparative insignificance, and the power which it once swayed is now exercised by that unrecognized select committee of the council known as the cabinet (*q.v.*).

At first government by cabinet was as unpopular as it was irregular, and until the formation of the first parliamentary ministry by William III. the ministers of the king occupied no recognized position in the House of Commons; it was, indeed, a moot point whether they were entitled to sit at all in the lower chamber, and they were seldom of one mind in the administration of matters of importance. Before the revolution of 1688 there were ministers, but no ministry in the modern sense of the word; divisions in the cabinet were constantly occurring, and it was no uncommon thing to see ministers opposing one another in parliament upon measures that in modern times would be supported by a united cabinet. As the change from government by prerogative to government by parliament consequent upon the revolution of 1688 developed, and the House of Commons became more and more the centre and force of the State, the advantage of having ministers in the legislature to explain and defend the measures and policy of the executive Government began to be appreciated, and it became absolutely necessary that the advisers of the sovereign, who were responsible for every public act of the Crown, as well as for the general policy they had been called upon to administer, should have seats in both houses of parliament. These changes also introduced the practice and conception of having a leading minister who was to become known as the prime minister (*q.v.*). But political unanimity in the cabinet was not yet recognized as indispensable.

In 1812 an attempt was made to form a ministry consisting of men of opposite political principles, who were invited to accept office, not avowedly as a coalition government, but with an offer to the Whig leaders that their friends should be allowed a majority of one in the cabinet. This offer was declined on the plea that to construct a cabinet on "a system of counteraction was inconsistent with the prosecution of any uniform and beneficial course of policy." From that date it has been an established principle that all cabinets are to be formed on some basis of political union agreed upon by the members when they accept office together. It is now also distinctly understood that the members of a cabinet are jointly and severally responsible for each other's acts, and that any attempt to distinguish between a particular minister and his colleagues in such matters is unconstitutional.

During the 19th century the power of ministers was greatly extended, and their duties became more distinctly marked out. As now interpreted, the leading principles of the British Constitution are the personal irresponsibility of the sovereign, the responsibility of ministers, and the inquisitorial and controlling power of parliament. At the head of affairs is the prime minister, with the more important members of the administration constituting the cabinet. Certain of the subordinate members of the administration are occasionally invited to join the cabinet, while others are never in it.

For further details the articles CABINET, PRIVY COUNCIL, GOVERNMENT DEPARTMENTS, should be consulted, as well as the separate treatment of the more important offices under their own headings, as PRIME MINISTER, LORD HIGH CHANCELLOR, SECRETARY OF STATE; and FOREIGN OFFICE, ADMIRALTY, WAR OFFICE.

The corresponding lists of officers in the United States will be found under the title CABINET, a name which is universally used in that country.

TABLE OF LORD TREASURERS OR FIRST LORDS OF THE TREASURY FROM 1603, AND OF THE PRIME MINISTERS FROM 1721

[For the origin and history of the lord treasurer's office, *see* TREASURY, EXCHEQUER, and LORD HIGH TREASURER. Since the Commonwealth the office of lord treasurer has been executed by a board of commissioners, known as the lords of the Treasury, with the exception of the six lord treasurers whose names are printed in italics. Special rank was given to one of the commissioners as first lord of the Treasury, and from the end of the 17th century it has been customary for the leading minister of the Crown to occupy the office of first lord; in later times, therefore (with the few exceptions noted in the list given below), it has usually been held in conjunction with the premiership. The lord treasurer's commission sometimes enables the first lord to act also as chancellor of the exchequer (*see* Table of Chancellors of the Exchequer). The office of lord high treasurer of Scotland was united with that of England at the Union, and in 1816 the separate Irish Treasury was similarly incorporated.]

1603. Lord Buckhurst, cr. earl of Dorset 1604.
1608. Earl of Salisbury.
1612. Earl of Northampton and others. (Commissioners.)
1614. Earl of Suffolk.
1618. Archbishop Abbot and others. (Commissioners.)
1620. Sir H. Montagu, cr. Viscount Mandeville 1620, afterwards earl of Manchester.
1621. Lord Cranfield, cr. earl of Middlesex 1622.
1624. Sir J. Ley, cr. Lord Ley 1625, and earl of Marlborough 1626.
1628. Lord Weston, cr. earl of Portland 1633.
1635. Archbishop Laud and others. (Commissioners.)
1636. W. Juxon, bishop of London.
1641. Sir E. Littleton and others. (Commissioners.)
1643. Lord Cottington.
1649. Commissioners under the Commonwealth.
1660. Sir E. Hyde, after. earl of Clarendon, and others. (Commissioners.)
1660. *Earl of Southampton.*
1667. Duke of Albemarle and others. (Commissioners.)
1672. *Lord Clifford.*
1673. Viscount Dunblane, cr. earl of Danby 1674, after. duke of Leeds.
1679. Earl of Essex.
1679. Lord Hyde, cr. earl of Rochester 1682.
1684. Lord Godolphin.
1685. *Earl of Rochester.*
1687. Lord Bellasyse.
1689. Viscount Mordant, earl of Monmouth, after. earl of Peterborough.
1690. Viscount Lonsdale.
1690. Lord Godolphin.

1697. C. Montagu, cr. earl of Halifax 1700.
1699. Earl of Tankerville.
1700. Lord Godolphin.
1701. Earl of Carlisle.
1702. *Lord Godolphin*, after. earl of Godolphin.
1710. Earl Poulett.
1711. *Earl of Oxford.*
1714. *Duke of Shrewsbury*.
1714. Earl of Halifax.
1715. Earl of Carlisle.
1715. Sir R. Walpole.
1717. J. Stanhope, after. earl Stanhope.
1718. Earl of Sunderland.
1721. Sir R. Walpole (commonly regarded as the first of the prime ministers).
1742. Earl of Wilmington.
1743. Henry Pelham.
1754. Duke of Newcastle.
1756. Duke of Devonshire.
1757. Duke of Newcastle (W. Pitt and the duke of Newcastle's administration).
1762. Earl of Bute.
1763. George Grenville.
1765. Marquess of Rockingham.
1766. Duke of Grafton (W. Pitt, earl of Chatham, prime minister till 1768).
1770. Lord North.
1782. Marquess of Rockingham.
1782. Earl of Shelburne, after. marquess of Lansdowne.
1783. Duke of Portland (prime minister, Lord North, after. earl of Guilford).
1783. William Pitt.
1801. H. Addington, after. Viscount Sidmouth.
1804. William Pitt.
1806. Lord Grenville.
1807. Duke of Portland.
1809. Spencer Perceval.
1812. Earl of Liverpool.
1827. George Canning.
1827. Viscount Goderich, after. earl of Ripon.
1828. Duke of Wellington.
1830. Earl Grey.
1834. Viscount Melbourne.
1834. Sir R. Peel.
1835. Viscount Melbourne.
1841. Sir R. Peel.
1846. Lord J. Russell, cr. Earl Russell 1861.
1852. Earl of Derby.
1852. Earl of Aberdeen.
1855. Viscount Palmerston.
1858. Earl of Derby.
1859. Viscount Palmerston.
1865. Earl Russell.
1866. Earl of Derby.
1868. Benjamin Disraeli.
1868. W. E. Gladstone.
1874. B. Disraeli, cr. earl of Beaconsfield 1876.
1880. W. E. Gladstone.
1885. Sir Stafford Northcote, cr. earl of Iddesleigh 1885 (prime minister, marquess of Salisbury).
1886. W. E. Gladstone.
1886. Marquess of Salisbury.
1887. W. H. Smith (prime minister, Lord Salisbury).
1891. A. J. Balfour (prime minister, Lord Salisbury).
1892. W. E. Gladstone.
1894. Earl of Rosebery.
1895. A. J. Balfour (prime minister, Lord Salisbury till 1902; after 1902, A. J. Balfour).
1905 Sir H. Campbell-Bannerman.
1908. H. H. Asquith, cr. earl of Oxford and Asquith 1925.
1916. D. Lloyd George.
1922. A. Bonar Law.
1923. Stanley Baldwin.
1924. J. Ramsay MacDonald (from Jan. to Nov.).
1924. Stanley Baldwin.
1929. J. Ramsay MacDonald.

Table of Lord Chancellors (C.) or Lord Keepers (L.K.)

(For the history of these offices *see* under their own headings.)

1603. Sir T. Egerton, L.K., cr. Lord Ellesmere 1603, and Viscount Brackley 1616.
1617. Sir F. Bacon, L.K., cr. Lord Verulam 1618, and Viscount St. Albans 1621.
1621. J. Williams, bishop of Lincoln, L.K.
1625. Sir T. Coventry, L.K., cr. Lord Coventry 1628.
1640. Sir J. Finch, L.K., cr. Lord Finch 1640.
1641. Sir E. Littleton, L.K., cr. Lord Lyttleton 1641.
1645. Sir R. Lane, L.K.
1649. Interregnum.
1660. Sir E. Hyde, C., cr. Lord Hyde 1660, and earl of Clarendon 1661.
1667. Sir O. Bridgeman, L.K.
1672. Earl of Shaftesbury, C.
1673. Sir H. Finch, L.K., cr. Lord Finch 1674, C. 1675, cr. earl of Nottingham 1681.
1682. Sir F. North, L.K., cr. Lord Guilford 1683.
1685. Lord Jeffreys, C.
1690. Sir J. Maynard and others. (Commissioners.)
1690. Sir J. Trevor and others. (Commissioners.)
1693. Sir J. Somers, L.K., C., cr. Lord Somers 1697.
1700. Sir N. Wright, L.K.
1705. W. Cowper, L.K., cr. Lord Cowper 1706, C. 1707.
1710. Sir T. Trevor and others. (Commissioners.)
1710. Sir S. Harcourt, L.K., cr. Lord Harcourt 1711, C. 1713.
1714. Lord Cowper, C.
1718. Sir R. Tracy and others. (Commissioners.)
1718. Lord Parker, C., cr. earl of Macclesfield 1721.
1725. Sir J. Jekyll and others. (Commissioners.)
1725. Lord King, C.
1733. Lord Talbot of Hensol, C.
1737. Lord Hardwicke, C., cr. earl of Hardwicke 1754.
1756. Sir J. Willes and others. (Commissioners.)
1757. Sir R. Henley, the last lord keeper, cr. Lord Henley and C. 1760, and earl of Northington 1764.
1766. Lord Camden.
1770. Charles Yorke.
1770. Sir S. S. Smythe and others. (Commissioners.)
1771. Lord Apsley, succeeded as Earl Bathurst 1775.
1778. Lord Thurlow.
1783 Lord Loughborough and others. (Commissioners.)
1783. Lord Thurlow.
1792. Sir J. Eyre and others. (Commissioners.)
1793. Lord Loughborough, cr. earl of Rosslyn 1801.
1801. Lord Eldon.
1806. Lord Erskine.
1807. Lord Eldon.
1827. Lord Lyndhurst.
1830. Lord Brougham.
1834. Lord Lyndhurst.
1835. Sir C. C. Pepys and others. (Commissioners.)
1836. Lord Cottenham.
1841. Lord Lyndhurst.
1846. Lord Cottenham.
1850. Lord Langdale and others. (Commissioners.)
1850. Lord Truro.
1852. Lord St. Leonards.
1852. Lord Cranworth.
1858. Lord Chelmsford.
1859. Lord Campbell.
1861. Lord Westbury.
1865. Lord Cranworth.
1866. Lord Chelmsford.
1868. Lord Cairns.
1868. Lord Hatherley.
1872. Lord Selborne.
1874. Lord Cairns, cr. Earl Cairns 1878.
1880. Lord Selborne, cr. earl of Selborne 1882.
1885. Lord Halsbury.
1886. Lord Herschell.
1886. Lord Halsbury.
1892. Lord Herschell.
1895. Lord Halsbury, cr. earl of Halsbury 1898.
1905. Lord Loreburn.
1912. Lord Haldane.
1915. Lord Buckmaster.
1916. Lord Finlay.
1919. Lord Birkenhead, cr. earl of Birkenhead 1922.
1922. Lord Cave.
1924. Lord Haldane (from Jan. to Nov.).
1924. Lord Cave.
1928. Lord Hailsham.
1929. Lord Sankey.

Table of Chancellors of the Exchequer

The chancellor of the exchequer, as finance minister of the Crown, is required to be a member of the House of Commons, and is the person named second after the first lord of the Treasury in the patent appointing commissioners for executing the office of lord high treasurer (*see* p. 540, Table of Lord Treasurers). The title dates from the separate existence of the exchequer court, as the king's revenue court, in the reign of Henry III. (*See* Exchequer.) In Scotland the lord high treasurer, who in virtue of his office had a seat in the Scottish parliament, presided over the court of the exchequer, and this court was reserved by the Act of Union. But the judicial functions of the English and the Scottish courts of exchequer were transferred to the high court of justice and the court of session respectively in the early part of the 19th century. The office of chancellor of the exchequer has sometimes been held jointly with that of prime minister and first lord of the Treasury, and is so indicated by an "*" in the list of chancellors from the time of the Scottish Union given below:

1714. Sir R. Onslow.
1715. *Robert Walpole.
1717. *Lord Stanhope.
1718. John Aislabie.
1721. *Robert Walpole
1742. Sam. Sandys.
1743. *Henry Pelham.
1754. Hon. H B. Legge.
1761. Viscount Barrington.
1762. Sir Francis Dashwood, after. Lord le Despencer.
1763. *George Grenville.
1765. William Dowdeswell.
1766. Hon. Charles Townshend.
1767. Lord North.
1770. *Lord North.
1782. Lord John Cavendish.
William Pitt.
1783. Lord John Cavendish.
*William Pitt.
1801. *Henry Addington.
1804. *William Pitt.
1806. Lord Henry Petty.
1807. Spencer Perceval.
1809. *Spencer Perceval.
1812. N. Vansittart, after. Lord Bexley.
1823. F. J. Robinson, after. Viscount Goderich, and earl of Ripon.
1827. *G. Canning.
1827 J. C. Herries.
1828. H. Goulburn.
1830. Viscount Althorp, after. Earl Spencer.
1834. *Sir R. Peel.
1835. T. Spring-Rice, after. Lord Monteagle.
1839. F. T. Baring, after. Sir F.
1841. H. Goulburn.
1846. C. Wood, after. Sir Chas.
1852. B. Disraeli, after. earl of Beaconsfield.
W. E. Gladstone.
1855. Sir G. C. Lewis.
1858. B. Disraeli.
1859 W. E. Gladstone.
1866. B. Disraeli.
1868. G. W. Hunt.
R. Lowe.
1873. *W. E Gladstone.
1874. Sir S. Northcote, after. earl of Iddesleigh.
1880. *W. E. Gladstone.
1882. H. C. E. Childers.
1885. Sir M. Hicks-Beach.
1886. Sir William Harcourt.
Lord Randolph Churchill
1887. G. J. Goschen.
1892. Sir W. Harcourt.
1895. Sir M. Hicks-Beach.
1902. C. T. Ritchie.
J. Austen Chamberlain, after. Sir A.
1905. H. H. Asquith, after. earl of Oxford and Asquith.
1908. D. L. George.
1915. R. McKenna.
1916. A. Bonar Law.
1919. A. Chamberlain.
1921. Sir R. S. Horne.
1922. S. Baldwin.
1923. N. Chamberlain.
1924. P. Snowden.
1924. W. S. Churchill.
1929. P. Snowden.

Table of Secretaries of State

[With the substitution of two secretaries for one, there was, at first, no distinction of departments, each secretary taking whatever work the king saw fit to entrust him with. During the reigns of the first two Stuarts, there was a tendency to entrust one secretary with the correspondence with Protestant states and their allies, and the other with the correspondence with Catholic states. Probably in the reign of Charles II., and certainly as early as 1691, two departments, the Northern and the Southern, were instituted. In 1782 the departments were changed to Home and Foreign; *see* Secretary of State.]

TABLE OF SECRETARIES OF STATE FROM 1603

1603.	Sir R. Cecil, cr. Lord Cecil 1603, Viscount Cranbone 1604, earl of Salisbury 1605.	
1612.	Vacant.	
1614.	Sir R. Winwood.	
1615.	. . . .	Sir T. Lake.
1618.	Sir R. Naunton.	
1619.	. . . .	Sir G. Calvert.
1623.	Sir E. Conway, cr. Lord Conway 1625.	
1625.	. . . .	Sir A. Morton.
1625.	. . . .	Sir J. Coke.
1628.	Viscount Dorchester.	
1632.	Sir F. Windebank.	
1640.	. . . .	Sir H. Vane.
1641.	Sir E. Nicholas.	
1642.	. . . .	Viscount Falkland.
1643.	. . . .	Lord Digby.
1643.	Interregnum.	
1660.	Sir E. Nicholas. . . .	Sir W. Morrice.
1662.	Sir H. Bennet, cr. earl of Arlington 1665.	
1668.	. . . .	Sir J. Trevor.
1672.	. . . .	Henry Coventry.
1674.	Sir J. Williamson.	
1678.	Earl of Sunderland.	
1680.	. . . .	Sir L. Jenkins.
1681.	Lord Conway.	
1683.	Earl of Sunderland.	
1684.	. . . .	S. Godolphin.
1684.	. . . .	Earl of Middleton.
1688.	. . . .	Viscount Preston.
1689.	Earl of Shrewsbury. .	Earl of Nottingham.
1690.	Viscount Sidney.	
1692.	Sir J. Trenchard.	
1694.	. . . .	Earl of Shrewsbury.
1695.	Sir W. Trumbull.	
1697.	J. Vernon.	
1700.	Sir C. Hedges. . . .	Earl of Jersey.
1701.	. . . .	Earl of Manchester.
1702.	. . . .	Earl of Nottingham.
1704.	. . . .	R. Harley, cr. earl of Oxford 1711.
1706.	Earl of Sunderland.	
1708.	. . . .	H. Boyle, cr. Bn. Carleton 1714.
1710.	Lord Dartmouth, cr. earl of Dartmouth 1711.	H. St. John, cr. Viscount Bolingbroke 1712.
1713.	W. Bromley.	
1714.	J. Stanhope, cr. earl Stanhope 1718.	Viscount Townshend.
1717.	Earl of Sunderland. . .	J. Addison.
1718.	Earl Stanhope. . . .	J. Craggs.
1721.	Viscount Townshend. .	Lord Carteret.
1724.	. . .	Duke of Newcastle.
1730.	Lord Harrington.	
1742.	Lord Carteret, became Earl Granville 1744.	
1744.	Earl of Harrington.	
1746.	Earl Granville.	
1746.	Earl of Harrington.	
1746.	Earl of Chesterfield.	
1748.	Duke of Bedford.	
1751.	Earl of Holderness.	
1754.	. . . .	Sir T. Robinson, cr. Baron Grantham 1761.
1755.	. . . .	H. Fox.
1756.	. . . .	W. Pitt.
1761.	Earl of Bute.	
1761.	. . . .	Earl of Egremont.
1762.	G. Grenville.	
1763.	Earl of Halifax. . .	Earl of Sandwich.
1765.	Duke of Grafton. . .	H. S. Conway.
1766.	Duke of Richmond.	
1766.	Earl of Shelburne.	
1768.	. . . .	Viscount Weymouth.
1768.	Earl of Hillsborough, *Colonies.*	
1768.	Earl of Rochford.	
1770.	. . . .	Earl of Sandwich.
1771.	. . . .	Earl of Halifax.
1771.	. . . .	Earl of Suffolk.
1772.	Earl of Dartmouth, *Colonies.*	
1775.	Viscount Weymouth, cr. marquess of Bath 1789.	
1776.	Lord G. S. Germaine, *Colonies.*	
1779.	. . . .	Viscount Stormont.
1779.	Earl of Hillsborough, cr. marquess of Downshire 1789.	
1782.	W. Ellis, cr. Baron Mendip, 1794, *Colonies.*	
	Home Office	*Foreign Office*
1782.	Earl of Shelburne.	C. J. Fox.
1782.	Lord Grantham. . .	T. Townshend, cr. Baron Sydney 1783.
1783.	Lord North. . . .	C. J. Fox.
1783.	Marquess of Carmarthen.	Earl Temple.
1783.	. . . .	Lord Sydney.
1789.	W. W. Grenville, cr. Baron Grenville 1790.	
1791.	H. Dundas. . . .	Lord Grenville.

	Home Office	*Foreign Office*	*War and Colonial Office*
1794 . . .	Duke of Portland	Lord Grenville	H. Dundas, cr. Visct. Melville 1802.
1801 . . .	Lord Pelham, after. earl of Chichester	Lord Hawkesbury	Lord Hobart, after. earl of Buckinghamshire.
1803 . . .	C. P. Yorke	..	..
1804 . . .	Lord Hawkesbury	Lord Harrowby	Earl Camden.
1805 . . .	..	Lord Mulgrave	Viscount Castlereagh.
1806 . . .	Earl Spencer	C. J. Fox	W. Windham.
1807 . . .	Lord Hawkesbury, after. earl of Liverpool	G. Canning	Viscount Castlereagh.
1809 . . .	R. Ryder	Earl Bathurst	..
1809 . . .	..	Marquess Wellesley	..
1812 . . .	Viscount Sidmouth (H. Addington)	Viscount Castlereagh, after. Marquess of Londonderry	Earl Bathurst.
1822 . . .	R. Peel	G. Canning	..
1827 . . .	W. S. Bourne	Earl of Dudley	Viscount Goderich.
1827 . . .	Marquess of Lansdowne	..	W. Huskisson.
1828 . . .	R. Peel	Earl of Aberdeen	Sir G. Murray.
1830 . . .	Viscount Melbourne	Viscount Palmerston	Viscount Goderich, after. earl of Ripon.
1833 . . .	..	..	E. G. S. Stanley, after. Lord Stanley and earl of Derby.
1834 . . .	Viscount Duncannon, after. earl of Bessborough	..	T. Spring-Rice, after. Lord Monteagle.
1834 . . .	H. Goulburn	Duke of Wellington	Earl of Aberdeen.
1835 . . .	Lord J. Russell	Viscount Palmerston	Lord Glenelg.
1839 . . .	..	..	Marquess of Normanby.
1839 . . .	Marquess of Normanby	..	Lord J. Russell.
1841 . . .	Sir J. Graham, Bart.	Earl of Aberdeen	Lord Stanley, after. earl of Derby.
1845 . . .	..	..	W. E. Gladstone.
1846 . . .	Sir G. Grey	Viscount Palmerston	Earl Grey.
1852 . . .	Spencer H. Walpole	Earl of Malmesbury	Sir J. S. Pakington, after. Lord Hampton.
1852 . . .	Viscount Palmerston	Lord J. Russell	Duke of Newcastle.

TABLE OF FOREIGN SECRETARIES FROM 1853

1853. Earl of Clarendon.
1858. Earl of Malmesbury.
1859. Lord J. Russell, cr. Earl Russell 1861.
1865. Earl of Clarendon.
1866. Lord Stanley, after. 15th earl of Derby.
1868. Earl of Clarendon.

1870. Earl Granville.	1900. Marquess of Lansdowne.
1874. Earl of Derby.	1905. Sir E. Grey, cr. Viscount Grey 1916.
1878. Marquess of Salisbury.	1916. A. J. Balfour, cr. earl of Balfour 1922.
1880. Earl Granville.	1919. Earl Curzon, cr. Marquess Curzon 1921.
1885. Marquess of Salisbury.	1924. J. Ramsay MacDonald.
1886. Earl of Rosebery.	J. Austen Chamberlain, after. Sir A.
1886. Earl of Iddesleigh.	1929. Arthur Henderson.
1887. Marquess of Salisbury.	
1892. Earl of Rosebery.	
1894. Earl of Kimberley.	
1895. Marquess of Salisbury.	

Particulars of the leading ministers in modern times and the events with which their names are associated may be read in the article ENGLISH HISTORY. H. H. Asquith (Earl of Oxford and Asquith), was *home secretary* 1892–95; H. J. (Viscount) Gladstone (1905–10); W. S. Churchill (1910–11); R. McKenna (1911–15); Sir J. Simon (1915–16); H. (Sir Herbert) Samuel (1916); Sir G. (Earl) Cave (1916–19); E. Shortt (1919–22); W. C. (Viscount) Bridgeman (1922–23); A. Henderson (1924); Sir W. Joynson-Hicks (Viscount Brentford) (1924–29); and J. R. Clynes (1929–) occupied the same office. H. (Sir Henry) Campbell-Bannerman was *secretary for war* in 1886 and 1892–95; R. B. (Viscount) Haldane (1905–12). The resignation of Colonel (Major-General) J. E. B. Seely from this office in 1914 led to the prime minister (Asquith) taking it into his own hands from March to August of that year. The *war secretaries* who followed during the war were Earl Kitchener (1914–16); D. Lloyd George (June to December 1916); the Earl of Derby (1916–18); and Viscount Milner (April to December 1918). The *war secretaries* since the war have been W. S. Churchill (1918–21); Sir L. Worthington-Evans (1921–22); the Earl of Derby (1922–24); S. Walsh (1924) and T. Shaw (1929–). At the *Colonial Office*, Sir M. Hicks-Beach (Viscount St. Aldwyn) was secretary 1874–80 and Joseph Chamberlain 1895–1902; among others the office was held by A. Bonar Law and W. H. (Viscount) Long during the World War; J. H. Thomas (1924). In 1926, during the term of L. C. M. S. Amery (1924–29), a Dominions Office was set up and Mr. Amery held both offices until 1929; Lord Passfield (Sidney Webb) succeeded him in both posts. John (Viscount) Morley was *secretary for India* in 1905–10 and was followed by the Earl of Crewe (Marquess of Crewe) during 1910–15; J. A. (Sir Austen) Chamberlain (1915–17); Edwin Samuel Montagu (1917–22); Viscount Peel (1922–24); Lord Olivier (1924); Earl of Birkenhead (1924–28); Viscount Peel (1928–29); and W. Benn (1929–).

MINISTRY, THE CHRISTIAN. The purpose of this article must be to trace the history of the existing Christian ministries, assuming, as with but insignificant exceptions all Christian communities do, that a ministry is necessary for their welfare, and indeed for their existence. Practically, our enquiry must be into the development of local ministries. We cannot consider the authority or the actions of Apostles or prophets except as they shaped the constitution of the primitive churches.

That they did so, is clear. We find St. Paul appointing in the churches which he founded officers named "bishops" or "elders," titles which are synonymous. As his was a spiritual office it was a spiritual authority that he conveyed. In fact, a generation which expected an immediate and sudden return of the Lord, could have no interests that were not spiritual. There was one Christian duty that was pre-eminently spiritual. It was that of reproducing the Last Supper. It was dramatic. The leading Christian took the place of our Lord; he was, whether permanently or for the occasion, the chief of the body of bishops or elders. The rest of them sat at meat with him, while the congregation stood around. The sacred acts were repeated. Before liturgies were thought of, the president uttered an extemporary prayer; he spoke as an inspired prophet. Soon, as part of the same process which led to the use of written Gospels in lieu of reminiscences which were growing faint or came to be at second hand, a fixed form of service was composed. There was no longer the primitive confidence. Soon also, some unknown man of genius changed the actual into a symbolic meal. When those three steps had been taken, the church had advanced far towards its permanent shape. There was no necessity for an exceptional or prophetic ministry, and, in fact, the apostles who claimed to be such in the third generation had come to be regarded with suspicion, and the class soon died out.

Thus the local ministry had the field to itself. We have seen that the celebration of the Eucharist was its characteristic office. On this ground Ignatius calls the bishop the representative of Christ, and the presbyters the representatives of the Apostles. But the whole tendency of Christian thought was monarchical. Perhaps the original churches were collegiate, the authority which came to be vested in the bishop being at first held collectively by the body of presbyters or bishops. But this soon ceased. The government passed into the hands of the bishop, with the body of presbyters as his council. In fact there was an analogy with the mediaeval guilds of western Europe. In them, as they survive in the city of London, the society is divided into two classes, the "court" which governs and the "livery," from which the "court" is elected, but which has itself no powers of administration. So, under the Roman empire, the guild, or *collegium* was divided into the *ordo* which ruled and the *plebs* which obeyed, the whole membership being often called the *populus*. When the Christian societies grew in numbers it was natural that they should avail themselves of the liberty allowed to humble folk of combining in *collegia illicita, i.e.,* unlicensed, rather than illegal, guilds for such purposes as that of a burial club. No doubt other definitely religious ends were served by these organizations, in which the lead was naturally taken by the *ordo*. It is strange that in Latin and its derivative languages the technical term "orders" should have been borrowed from this quite secondary side of the office. In several languages *plebs* has similarly come to mean "parish"; Italian *pieve,* Welsh *plwyf*.

The authority of the ministry has been attributed to a grant from the Christian community, regarded as directly inspired by its Founder, of powers with which He had endowed it as a corporate body, to certain of its members. It has also been regarded as a power over the members of the church which was bestowed by the Founder, first upon His Apostles and subsequently, through them, on a permanent line of successors. In explanation of this was developed the doctrine of Orders as sacramental. In its final form, as held in the Roman communion, there are three distinct sacraments of orders, those of bishop, priest and deacon. The papacy, in spite of its authority, is not regarded as having the same sanction, for it has "no outward and visible sign." A pope is regarded as becoming invested with his office from the moment that he signifies his assent to his election.

But this doctrine, which was to become classical, in the form of a theory of the transmission of authority by the laying on of the bishop's hands, could not be older than the systematic development of Christian thought on the subject of sacraments. St. Ignatius had not asserted more than that the Eucharist of the bishop is more securely authentic than that celebrated by any other; he had not claimed that it, received at his hands or at those of his delegate, is alone valid. And the argument of St. Irenaeus that the test of orthodoxy is the doctrine handed down from the Apostles through the bishops is an appeal to succession in office, not to transmission of office. The successors of St. John, who had learned each from his predecessor, what St. John had taught, were witnesses who could be trusted, especially as the line was still brief and therefore the opportunities of error few.

In any case, the position of the bishop became secure, and he was universally established in the Christian churches. This pre-eminence of the one member of the ministry had the inevitable effect of depressing the others. The presbyters, or priests, remained as the council of the local church under the bishop's presidence. They still sat while others stood at worship, they were consulted by the bishop in all matters of importance, and they had the dignity of a corporate body. To this day, at the ordination of a priest, all members of that order who are present join in laying their hands upon the candidate for admission to their order. This has never been done at the ordination of deacons, upon whom the bishop alone lays hands. The reason is that originally deacons were the personal officers of the bishop,

chosen by him to be his assistants, and were not a corporate body. He was only concerned in their admission to orders. Presbyterate and diaconate were two separate branches of the clerical office, as in England now the professions of solicitor and barrister are distinct within the legal calling, nor was it usual to pass from the one to the other. But election to the episcopate was equally within the reach of both. In fact, a deacon had in early times the better chance, especially if at the time of vacancy he held the office of the bishop's chief deacon, or in later terms of archdeacon. At Rome the deacon usually succeeded.

This deacon was the administrative officer of the diocese. He managed its finance, he supervised the conduct of the minor clergy and the laity. He was better known to the congregation than anyone except the bishop, for he, like the other deacons, gave his whole time to his work, while the presbyters, apart from their duty as the bishop's counsellors, were only occasionally employed when the bishop had need of their services. This is strikingly shown in the consistent use of the title *sacerdos*, till well into the fourth century, for the bishop and for the bishop alone. St. Cyprian never uses it otherwise, and though other writers are not equally uniform in their usage, the word "priest" as we understand it and as it is employed in the Old Testament, normally means both in Greek and Latin none other than the bishop. He was still the regular celebrant, though he would from time to time charge one of the presbyters to execute this office for him; and indeed, as the churches grew larger and places of worship more numerous, these presbyters came regularly to preside at the Eucharist in places to which they were appointed, though that where the bishop himself for the occasion presided was for that day the centre of the local church. With the usual ministration of the Eucharist the deacons were thus more habitually connected than the priest. A deacon must be present to assist; it could even be said that he consecrated the chalice, for it was his duty to pour some of the consecrated wine into each of the flagons from which it was drawn for the communion of the laity. In this way as in many others the deacons were always before the public eye. No instance is known of a bishop, however small his see, who had no deacon. Many bishops had no more than one. The traditional number at Rome was seven, which may be due to the fact that Rome was divided for ecclesiastical as well as civil purposes into fourteen regions, over two of which each deacon may have presided. No doubt the record of the Acts, according to which seven was the number of deacons instituted at Jerusalem had its weight; but it is very doubtful whether deacons, as we know them, owe their origin to the Apostolic decision. Rome is the first church which is known to have had deacons with local authority; Alexandria the first with priests who had "parishes," to use the later term of their own. Perhaps we may trace the definite subordination of deacon to priest, which ended in the former office becoming a mere apprenticeship for the latter, to the idea, which sprang up in the fifth century, of a correspondence between the three orders of the Christian with the three orders of the Jewish. The name "levite" came to be not infrequently used for "deacon." It is more important that the second order of the ministry, in accordance with the same analogy, gained the title of *sacerdos*, the bishop being identified with the Jewish high priest. This must have led to the impression that the chief and characteristic function of the priest (a name which survived in general use) was that of celebrating the Eucharist. In fact, as Christianity spread so widely that it was beyond the power of the bishop to satisfy the need, the ordinary minister of both sacraments came to be not the bishop but the priest.

Passing over the minor orders, which are very ancient but only of archaeological interest, we must turn to the organization of the ministry, the theory of which had come to be that of transmission by laying on of hands. The bishop elect was approved and also consecrated (though the formal distinction between "consecration" to the episcopate and "ordination" to lower grades of the ministry is comparatively late) by neighbouring bishops who assembled at the vacant see on news of the late bishop's death. They admitted him to their own community by a corporate laying on of hands, just as the priest was admitted to his order by a similar act, the significance of which has been made less conspicuous by the lead taken by the bishop in the ordination. In any case, but perhaps wrongly, the validity of the rite, whether it be sacramental or no, has been regarded as dependent on the fact that the bishop's hands have been imposed. In regard to the third order there is no doubt of the historical justification for the bishop's acting alone.

When his staff was duly constituted by ordination, it was inevitable that it should be organized. We have seen the beginnings of local priests and deacons. But general organization could only be arranged after the peace and favour conferred by Constantine the Great. It was his will that the church should be co-extensive with his empire, that all its subjects should be induced—and persuasion before long was changed into compulsion—to become Christian, and that the doctrine throughout the Church should be uniform. Thus there arose a problem of administration, which was solved by making the area of civil administration that of the ecclesiastical diocese; and by constituting metropolitan and patriarchal regions corresponding to higher areas of civil government. As men grew familiar with these arrangements, which survived in principle, and often in detail, the fall of the western empire, they came to attach a certain sacredness to them; to the most important of those arrangements, that which gave unique authority to the patriarchate of Rome, they gave an actually theological significance. And the systematizing genius of an age which worked out scholasticism made the whole scheme of religious thought coherent; it was assumed that all was equally true and equally important.

Towards the end of the middle ages the weakest point in the system came to be the personal life, as contrasted with the official claims, of the clergy. Notorious scandals led men on to dispute the current theory of the ministry; and the religious practices which hitherto had satisfied the public conscience lost their impressiveness. Not to speak of earlier attempts at revolt, when Luther proclaimed his new system it was in fact a contradiction to the old. The clergy, though necessary for religion, were not authoritative; they were simply means towards the end of promoting the spiritual life of the community. Luther revived the mediaeval conception of the monarch as the vicar of God on earth. It was for him to provide religious ministrations for his people, and to compel them to take advantage of the provision. The theory had been worked out by opponents of the papal autocracy, especially in the fourteenth century, and was now to be put in practice. A sufficient justification was found in abuses which Rome, itself notoriously unreformed, refused to correct. The monarch (and the class was construed to include quite insignificant princes of Germany) was therefore bidden by virtue of his God-given *summepiskopat,* as it was called in Prussia till 1918, to correct the Church, and to provide for the continuance of a satisfactory ministry. Of its character the prince was to be judge; in Luther's eyes it was a heinous crime for anyone to officiate as a minister of religion without the prince's sanction. Such was the external authority of the Church; inwardly it was verified by the assurance which Luther and his followers enjoyed that they were in a satisfactory spiritual state. But Lutheranism has laboured under the difficulty of reconciling the two standards, that of loyalty to the society and that of inward feeling. The latter, known as Pietism, has always been suspected as tending to breed insincerity and disloyalty.

The rival school of reformed thought, while agreeing with the Lutheran in such traditional essentials as acceptance of the Bible, the Augustinian theology, and the duty of enforcing conformity to the recognized Church, assigned a higher office to the ministry and the Church. The latter is not under the authority of the state, but is the immediate organ of Christ, and its ministry has authority from Him, not from the monarch. It has also a pattern prescribed in Scripture. As the Old Testament gives direction for civil life, so do the epistles of the New for the organization of the Church. While Luther had been indifferent to systems of church-government, rejecting the opportunity of continuing the historical ministry which the adhesion of several bishops to his cause had given him and satisfied to dispense with any justification for

his ministry save that of its efficiency and the monarch's approval, Calvin framed a doctrine which raised the ministry to the mediaeval level. It had for him Divine authority; and its members formed a corporate body which not only should, in national synods, guide the religious life of nations, but also, when the world was fully reformed, assemble to control the universal faith and morals. But there was one profound change; Calvin taught the parity of ministers. There is but one sacred order; for St. Paul bishop was synonymous with presbyter, and his teaching is binding upon later generations. Authority is vested, not in Pope or bishop, but in representatives chosen out of the one order. First at Geneva, and then in Scotland and the Netherlands on a national scale, this government was established, and buttressed with an elaborate theology, which armed the ministry with formidable powers.

Both these novel systems had their weight in England. But there the Reformation began simply as Catholicism without the Pope, though under Edward VI. there was a swift though brief movement towards the continental pattern. The ancient ministry was retained, and survived even when, after the Marian reaction, England became definitely Protestant. This survival of antiquity had to be justified. Why, it was asked, is the English ministry different from that of the other reformed churches? The answer given, and found satisfactory on the continent, was that the ordination of its ministry is a matter within the power of each national church. The English, in its discretion, had chosen to retain the ancient use. It did not condemn other reformed churches which, of choice or of necessity, had dispensed with bishops. It recognized their ministries, and conversely they did the same, though each had no doubt that it had chosen the better course. This was the line taken by Ken, the future bishop and non-juror, when resident in Holland as chaplain to Mary, who was to be the queen of William III. But such tolerance did not satisfy the keener spirits on any side, and when the English Presbyterians under Elizabeth protested that English orders, because conferred by bishops, were invalid, Bancroft and his followers retorted that it was the orders of their critics that were invalid, because given by presbyters. When such arguments were in use reconciliation was no longer possible.

But, at any rate, both sides in this debate believed that it was Divinely ordered that churches should be national, covering the whole ground and including all citizens. Early in the Reformation period a contrary doctrine had been taught, chiefly, though not exclusively, by Anabaptists. This doctrine was that the little Apostolic churches, each independent of the others and united only in love, were the permanent pattern which Christians were bound to follow. Certain devout people felt drawn together. They associated freely; none might be compelled to join the society, nor might it be forced to admit any to membership. Every such society was complete in itself, and was immediately under Christ. By His authority it chose its minister, or ministers. But the choice, once made, was binding, for it was in the name of Christ, and by His inspiration, that it had been made, and the members must recognize His Will in it. Such was the doctrine in its best and most definite shape. But unhappily there can be no doubt that in many instances the appointment of a minister among Congregationalists has been practically a business agreement in which higher considerations have not lastingly prevailed. Their mode of religious organization has had little vogue outside the peoples of English speech; and in England their chief historical importance is that under Cromwell they frustrated the attempt to set up a Presbyterian church. One effect of this temporary victory was that they reduced the English Presbyterians from an organized society to a number of separate congregations, which were unable to escape the same declension from their original standard in regard to the ministry that had affected their rivals.

It remains to speak of the Methodist ministry. It is often said that John Wesley was driven out of the national church. But Wesley had reached the conviction that the Presbyterians were right as to the parity of ministers; he held that he had as much right to ordain as to administer the Lord's supper. He believed also in the value for practical religion of the society which he had founded, and organized with much skill. For him it was authenticated by its usefulness, and he was resolved to gain for it the loyalty of his adherents, for so he would be assured of their continuance in piety. To this end he ordained ministers first for America and Scotland, and finally for England. He did not realize that this meant separation; but he had inspired so strong a Methodist patriotism that his followers, many of whom had never been churchmen, had little attachment to the Church of England. They therefore continued to appoint ministers after his death in 1791 though they did not practice the laying on of hands till 1836, when they resumed it while carefully stating that it is not essential. Methodists, in all its forms, reject the Presbyterian theory of the transmission of the ministry. The corporate Methodist body claims to have the right of conferring the ministry, and holds that spiritual success verifies the claim.

Three great systems, we have seen, lay stress in different ways on corporate life; the historical, within which the authority of the ministry has been differently explained, the Presbyterian, which claimed to be a reversion to a primitive type which ought never to have been forsaken, and the Methodist, which frankly justifies itself by its success in edification. We have also considered the isolating type, in which the single congregation invested by Christ with His authority, appoints its minister. In none of these systems, widely as they may differ, is there any hesitation in asserting that a Power higher than human is at work. Even where, as with the Friends, the ministry may seem to a superficial observation to be reduced to insignificance because it was, and for the most part, except in the United States, still is voluntary, it is really taken most seriously as a Divine appointment. Not only in practice, but in principle, the Christian ministry is recognized universally as a providential ordinance, necessary for the maintenance of the society and for the sustenance of the spiritual life of its members.

Bibliography.—John Wordsworth, *The Ministry of Grace* (1902). T. M. Lindsay, *The Church and the Ministry in the Early Centuries* (1907). *Essays in the Early History of the Church and the Ministry* edited by H. B. Swete (1918). J. Tixeront, *L'Ordre et les Ordinations.*

(E. W. W.)

MINISTRY OF FOOD: *see* War Control of Food.

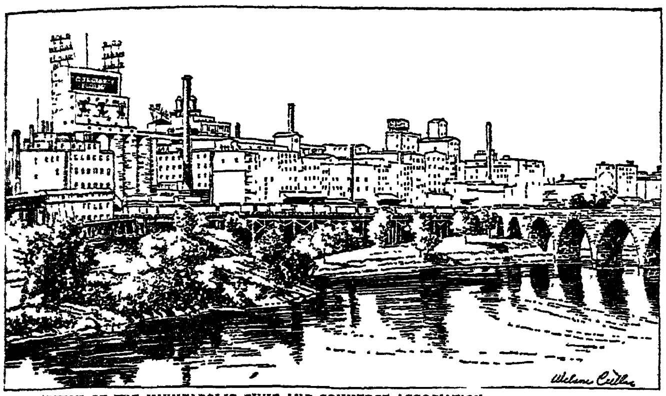
MINK, a name for certain large species of the genus *Putorius* (Polecat), distinguished by slight structural modifications connected with their semi-aquatic habits. The two best-known species, *P. lutreola,* of eastern Europe, and *P. vison,* the mink of North America are very similar. The former inhabits Finland, Poland and the greater part of Russia, west of the Ural Mountains. The latter is found throughout North America. Another form, *P. sibiricus,* from eastern Asia, connects the true minks with the polecats.

In size the mink resembles the English polecat—the length of the head and body being usually from 15 to 18in., that of the tail about 9in. The female is smaller than the male. The tail is bushy, but tapering at the end. The ears are rounded, and scarcely project beyond the fur. The pelage consists of a dense, soft, matted underfur, mixed with long, stiff, lustrous hairs. The gloss is greatest on the upper parts; on the tail the bristly hairs predominate. Northern specimens have the finest pelage. In colour the animal is ordinarily of a rich dark brown, with the back usually the darker and the tail nearly black. There is some white on the jaws, and often irregular white patches on the under parts. The fur is important in commerce.

The principal characteristic of the mink is its amphibious mode of life. It is to the water what the other weasels are to the land, or martens to the trees. It swims and dives with ease. It makes its nest in burrows in the banks of streams, producing five or six young once a year about April. Its food is very varied comprising crustacea, molluscs and members of all the vertebrate classes. It has a very disagreeable smell. (*See* Carnivora.)

MINNEAPOLIS, the largest city of Minnesota, U.S.A., a port of entry, and the county seat of Hennepin county; at the Falls of St. Anthony and the head of navigation on the Mississippi river, 2,160 m. from its mouth, immediately above and west of St. Paul, and exactly midway between the equator and the north pole. It is on Federal highways 10, 12 and 55; has direct airmail

service to Chicago, connecting there with the transcontinental airways, and is served by ten trunk railroad lines (the Burlington Route, the Chicago Great Western, the Chicago, Milwaukee, St. Paul and Pacific, the Chicago, St. Paul, Minneapolis and Omaha, the Great Northern, the Minneapolis and St. Louis, the Minneapolis, Northfield and Southern, the Northern Pacific, the Rock Island and the Soo Line) and by electric railways, terminal switching and belt lines, motor coach and truck lines in all directions and river barges. The population was 380,582 in 1920, of whom 88,032 were foreign-born white (largely from northern Europe and Canada), and was 464,356 in 1930, being the 15th city in the United States. The "Twin Cities" and their immediate suburbs constitute a great urban community with a population in 1930 of about 800,000. Minneapolis lies on both sides of the river, on a plateau 800 ft. above sea-level at the Falls and rising to points several hundred feet higher. It covers 58·72 sq.m. and has 22 m. of frontage on the Mississippi, which here averages about 1,200 ft. in width. Nineteen bridges (12 highway and 7 railroad) cross the river within the city limits, and some of them have great structural beauty. Clustered about the Falls, mostly on the west bank of the river, and approached by a long, low bridge of concrete, are the great flour mills, forming a huge mass of limestone masonry, impressive by its bulk and outline. With the addition in recent years of large creameries to the mill district, the silhouette against the western sky has come to be known as "the bread and butter skyline." Minnehaha Creek, the outlet of Lake Minnetonka, flows through the southern part of the city, and just before joining the Mississippi plunges over a cliff 50 ft. high in the falls celebrated by Longfellow (who never saw them, but formed his idea from a photograph) in his poem "Hiawatha." Minnehaha Falls are in one of the city's parks. Adjoining it, in grounds of 51 ac., given to the State by the city, is the State soldiers' home (1887). Just beyond (lying between Minneapolis and St. Paul, at the mouth of the Minnesota river) is the Ft. Snelling Military Reservation (established 1819), where the original fort built in 1822, an ivy-covered round stone tower, stands, with the modern barracks and other buildings of the post, on a high bluff overlooking the gorge of the Mississippi and the valley of the Minnesota. At Ft. Snelling a U.S. Veterans hospital of 560 beds was constructed in 1926–27. There are six large natural lakes and several smaller ones within the city limits. Twelve miles west is Lake Minnetonka, one of the oldest and most famous summer resorts of the North-west, a beautiful body of water 12 m. long, surrounded by wooded hills, with a dozen islands and a shore-line so indented by inlets and points that its length is variously estimated at from 250 to 500 miles. The city owns 131 parks, covering 4,777 ac., of which about 1,000 ac. is outside the city limits. The system embraces a playground or neighbourhood park for every square mile of residential area (and more than an acre to each hundred of the population), 4 public golf courses, 36 athletic fields, 131 tennis courts, 32 skating rinks, 11 lighted hockey rinks and 4 public bath-houses; and 56 m. of boulevards encircling the city, connecting the lakes and the larger parks and passing through beautiful residential districts—called the "Grand Rounds," one section of which is the Victory Memorial Driveway, dedicated in 1921.



BY COURTESY OF THE MINNEAPOLIS CIVIC AND COMMERCE ASSOCIATION

"THE MILLING SKYLINE." THE MISSISSIPPI RIVER WITH FLOUR MILLS IN THE BACKGROUND

Minneapolis has wide streets and many fine public and business buildings. Building permits in the nine years following the World War (1919–27) represented values aggregating $193,524,500. The assessed valuation of property for 1927 was $426,858,182. There are some 150 hotels of all grades, many of them with from 300 to 600 guest-rooms. A magnificent municipal auditorium of granite and Bedford stone (completed in 1927 at a cost exceeding $3,000,000) has an assembly room seating 10,545, a stage 50 by 90 ft., and many ingenious interior arrangements for comfort and convenience The Federal Reserve Bank, designed by Cass Gilbert and completed in 1924, is impressive and unusual. With only one entrance, and lighted entirely from above, it conveys a sense of tremendous strength and security. The Art Institute, designed by McKim, Mead and White (opened 1915) is a beautiful building 575 ft. long by 500 ft. deep. The main campus of the University of Minnesota (*q.v.*) occupies 128 ac. in a bend on the east bank of the Mississippi, entirely within the city of Minneapolis. Its memorial stadium (opened 1924) seats 52,000 spectators. Among the other educational institutions in the city are Augsburg college and Theological Seminary (Norwegian Lutheran, 1869), the Minnesota College of Law, Northwestern College of Law, the William Hood Dunwoody Industrial Institute (an endowed trade school founded in 1914) and the Minneapolis School of Art The public school system includes (1928) 88 elementary, 16 junior and senior high, and several special and vocational schools—a total of 113; and there are 21 parochial schools maintained by the Roman Catholic church. The public library (470,000 volumes, 1928) grew out of a private institution, the Athenaeum. There are 272 churches in the city, representing many faiths and denominations. The hospitals, public and private, have an aggregate of 3,500 beds. The civic and philanthropic agencies of the city, public and private, are affiliated for the purpose of promoting the general welfare in a Council of Social Agencies; and the 65 or 70 organizations among them which are not financed by endowment or from the public treasury or in some special way unite in a joint campaign for funds which raises about $1,100,000 annually. Three general daily newspapers are published in English, one in German, and one in Norwegian and Danish. There are special daily publications devoted to the interests of finance and commerce, the building trades, farming and grain dealers. The city operates under a charter secured in 1872, revised in 1881, and readopted in 1920 with the addition of the numerous amendments made to that date. Under the "home rule" amendment to the State Constitution, new charters representing various plans of government were formulated and presented to the voters in 1900, 1904, 1906 and 1913, but all were rejected. Administrative powers, under the present charter, are vested in a mayor, a council, and several boards (school, library, estimate and taxation and public welfare). Since 1912 the non-partisan system of nomination has been in effect. A city-planning commission was established in 1919, and in 1924 a zoning ordinance was adopted. The water-supply is taken from the Mississippi river, filtered and purified and distributed by a gravity system through 765 m. of mains. With extensions already planned, the plant will have a capacity of 150,000,000 gal. a day, while the average daily consumption at present is about 46,000,000 gallons.

Minneapolis is the principal industrial, commercial and financial centre of the North-west, with an immediate trade territory embracing Minnesota, North and South Dakota, Montana, and the northern part of Nebraska, Iowa, Wisconsin and Michigan. It is the seat of the Ninth Federal Reserve Bank, serving a territory in which there are 2,800 banks. Deposits in the 30 local banking institutions amounted to $344,666,507 on June 30, 1928; and debits to individual accounts aggregated $4,837,608,000 for the year 1928. The 1,200 factories and 1,200 wholesale houses have a total annual business estimated at $1,300,000,000. With the completion of improvements undertaken by the U.S. Government in 1894, navigation of the Mississippi up to the heart of the city was opened on July 3, 1917, when the first steamer passed through the new lock and tied up at the new municipal dock. Since then a

revival of river traffic (for freight) on the Upper Mississippi has set in, and this will be an important supplement to the transport facilities afforded by the ten trunk railways and numerous motor-truck lines which focus at Minneapolis. The terminal yards of the railroads have a capacity of 35,000 freight cars; and 623,790 were received and despatched in 1927. The enormous water-power of the Falls of St. Anthony, of which 60,000 h.p. is utilized, was the original factor determining the development of Minneapolis as a manufacturing centre. The perpendicular fall of the water is about 50 ft. and the rapids below add about 35 ft. In 1868 erosion of the soft limestone ledge threatened to destroy the source of power, but the loss was averted by the construction of a series of dams, a wooden "apron," and a concrete floor (completed 1879) at the joint expense of the U.S. Government and the citizens of Minneapolis. Flour-milling has long been the city's chief industry. The vast lumber industry, developed earlier and for many years equally important, reached its peak in 1899, with an output of 600,000,000 board feet, and then gradually dwindled, as the pine forests were exhausted and replaced by wheat fields, until in 1920 the last saw-mill went out of existence. The flour mills have a daily capacity of 78,800 bbl., and the grain elevators can store 63,433,000 bushels. The total output of the mills in 1927 was 11,540,042 barrels. Minneapolis is still the largest primary wheat market and the largest producer of flour and other grain products in the country, but since the World War reduction of freight rates *via* the Great Lakes has operated to transfer some of the grain trade and milling business to Buffalo and other points in the East. It is one of the world's largest markets for high-grade butter, its own creameries producing annually 7,500,000 lb.; and it is the largest flaxseed market and producer of linseed oil and cake, with mills having a capacity of 16,450,000 bu. of flax, 880,500 bbl. of oil, and 334,000 tons of cake. Other leading manufactures are motor vehicles, bodies and parts; knit goods; foundry and machine-shop products; structural and ornamental iron work. Three of the railroads have extensive construction and repair shops in the city, employing together some 5,000 men. The aggregate factory output in 1927 was valued at $348,416,571. Since the World War the "open shop" has prevailed in most of the trades.

History.—The first European visitor of record to the site of Minneapolis was Father Louis Hennepin, the French Jesuit missionary, who discovered the Falls of St. Anthony and named them for his patron saint. Probably he was preceded by some of the adventurous *coureurs de bois,* few of whom left written records of their travels; and Radisson and Groseilliers seem to have visited the region two decades earlier. The land east of the Mississippi became U.S. territory at the close of the American Revolution, but the west side was under Spanish and then French sovereignty until the purchase of the Louisiana territory in 1803. In 1766 the site was visited by the American traveller, Jonathan Carver; and in 1805 by Lieut. Pike, who bought from the Indians for a military reservation a tract including the greater part of the west side of the city. The fort was built in 1819. In 1822 its commandant set up a lumber mill, and a little later used it to grind flour also, but it was never profitable. In 1838 Franklin Steele built the first claim shanty on the east side of the Mississippi, opposite the Falls; by 1845 there was a population of 200 and the village of St. Anthony was incorporated; in 1848 Steele dammed the east channel of the river above the Falls and erected a group of saw-mills; and in 1852 Richard Rogers built a new and modern flour-mill. Meanwhile, by special act of Congress in 1849, permission was given to two Mexican War veterans to settle on the military reservation west of the river. Squatters followed, until by the time the land was opened to settlement in 1854 there was a population of about 200, who set up a village government in 1855, and named their settlement Minneapolis. There was great rivalry for commercial and industrial leadership between the two settlements. St. Anthony was chartered as a city in 1860; Minneapolis in 1867; in 1870 the population of Minneapolis was 13,066, of St. Anthony, 5,013; and in 1872 they united, under the name of the larger. About 1859 the milling industry began to develop. Farmers hauled their wheat to the St. Anthony mills from as far north as St. Cloud and as far south as Mankato, and camped on the island below the Falls until they could get it ground. The period of great expansion began about 1870, when the lumbering industry had provided an accumulation of capital and the agricultural development of the country was increasing the supply of wheat. The output increased from 200,000 bbl. in 1870 to 2,051,840 in 1880, 6,988,830 in 1890 and 15,982,725 in 1900. The maximum on record was 17,769,280 bbl. in 1914. In 1878 some of the mills were destroyed by a flour-dust explosion, in which 18 employees lost their lives. Pop. in 1880 was 46,887; in 1890 164,738; in 1900 202,718; in 1910 301,408; and in 1920 380,582. Minneapolis, like its neighbour Saint Paul, has a low general death rate, a low infant mortality, little illiteracy, a small proportion of children employed for wages, a high percentage in school, a high percentage of home ownership and an index figure for cost of living below the average for large American cities.

MINNESINGERS, the name given to the German lyric poets of the 12th and 13th centuries. The term *Minnesang,* strictly applicable to the poems expressing the homage (*Minnedienst*) rendered by the knight to his mistress, is applied to the whole body of lyric poetry of the period, whether dealing with love, religion or politics. The idea of *amour courtois,* with its excessive worship of woman, its minute etiquette and its artificial sentiment, was introduced into German poetry from Provençal literature; but the German *Minnesang* was no slavish imitation of the poetry of the troubadours. Its tone was, on the whole, healthier and more sincere. The minnesinger usually belonged to the lower ranks of the nobility, and his verses were addressed to a married woman, often above him in rank. He was not permitted to give his lady's name, or to betray her identity; and a direct expression of passion would also have contravened the rules. The poems were from the first sung in open court to a melody (*Weise*) of the poet's own composing, with the accompaniment of a fiddle or small harp.

The Older Songs.—These consisted of a single strophe cast in three divisions, two (known as *Stollen*) identical in form, stating and developing the argument, the third (*Abgesang*) of different form, giving the conclusion. Later on, two or more strophes were used in a single poem, but the principle of their structure was retained. In this form were cast the *Tagelied,* a dialogue describing the parting of lovers at dawn; and the crusading song. Side by side with these existed the *Spruch,* written in a single undivided stanza, destined for recitation and often cast in the form of a fable. The lay (*Leich*) was written in unequal strophes, each formed of two equal divisions. It was applied in the first instance to sacred lyrics, and was first used in love poems by the Alsatian minnesinger Ulrich von Gutenberg.

The earliest minnesinger whose name has come down to us is von Kürenberg (*fl. c.* 1160), a scion of an Austrian knightly family whose castle lay on the Danube, west of Linz. His songs, however, contradict the root idea of *Minnedienst,* since the lady is the wooer, and the poet, at the most, an acquiescent lover. They take the form of laments for an absent lover, complaints of his faithlessness and the like. Among the other Austrian and south German lyrists who show small trace of foreign influence was Dietmar von Aist (d. *c.* 1171), though some of the songs attributed to him seem to be of later date. While the love-song remained in the hands of noble singers, the *Spruch* was cultivated by humbler poets. The elder of the two or three poets concealed under the name of Spervogel was a wandering singer who found patronage at the court of the burgraves of Regensburg, one of whom himself figures among the earlier minnesingers.

Characteristic Period.—In German *Minnesang* this begins at the close of the 12th century with the establishment of the Provençal tradition in western Germany through the poems of Heinrich von Veldeke and Friedrich von Hausen. National elements abound in Veldeke's songs, although the *amour courtois* dominates the whole; Friedrich von Hausen (d. 1190) followed Provençal models closely, as did also the Swiss Count Rudolf von Fenis. The greatest name among the earlier minnesingers is that of Heinrich von Morungen, a Thuringian poet who lived on in popular story in

the ballad of "The Noble Moringer." He brought great imaginative power to bear on the common subjects of *Minnesang*, and his poetry has a very modern note. The formal art and science of *Minnesang* reached full development in the subtle love-songs of Reinmar, the Alsatian "nightingale of Hagenau." He became a member of the court of Duke Leopold V. (d. 1194) of Austria, and there Walther von der Vogelweide (*q.v.*) was first his disciple, and then perhaps his rival. Walther, the greatest of mediaeval German lyric poets, had Reinmar's technical art, but in feeling was more nearly allied to Morungen. He raised the *Spruch* to the dignity of a serious political poem, which proved a potent weapon against the policy of Innocent III. The *Tagelieder* of Wolfram von Eschenbach give him a high place in *Minnesang*, although his fame, like that of Heinrich von Veldeke and Hartmann von Aue, chiefly rests on his epics. A new style—called by Lachmann *höfische Dorfpoesie*—was developed by Neidhart von Reuental (d. *c.* 1250), who belonged to the lower Bavarian nobility. He wrote songs to accompany the dances of the village beauties, and comic and realistic descriptions of village life to please the court. He was acknowledged by the Meistersinger as one of the 12 masters of song. Nevertheless, with him the decadence may be said to have begun.

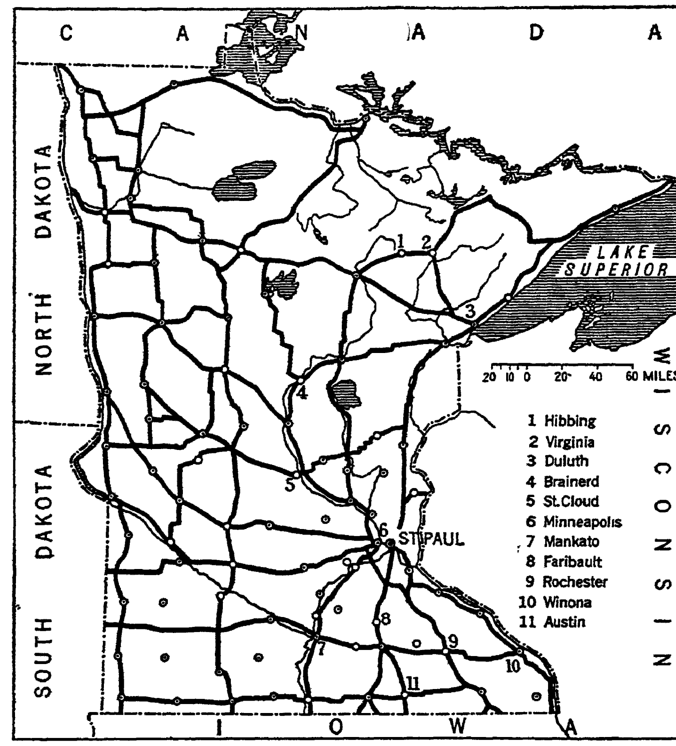
The Styrian poet Ulrich von Lichtenstein (d. *c.* 1275) unconsciously caricatured chivalry itself by his *Frauendienst*, in which he relates the absurd feats which he had undertaken at his lady's command, while Steinmar (*fl. c.* 1276) deliberately parodied court poetry in his praises of rustic beauty and good living. In the lays, songs and proverbs of Tannhäuser something of both elements, of the court and the village, is to be found. The Austrian poet Reinmar von Zweter (d. *c.* 1260) left some hundreds of *Sprüche* political or social in their import. The didactic motive came more and more to the front in the 13th century. The wandering Swabian poet Marner (d. *c.* 1270) cultivated especially the *Spruch*, laughed at the Provençal and courtly tradition, and there is no very great step from his learning and his feuds to the conditions of *Meistergesang*.

BIBLIOGRAPHY.—The chief mss. containing the work of the 300 or more minnesingers whose work has been partially preserved are the old Heidelberg ms. (13th century), the Weingarten-Stuttgart ms. (14th century) and the Great Heidelberg ms. (14th century), formerly known as the Manasse ms. This last is the most comprehensive of all. It has been printed by F. Pfaff (Heidelberg, 1899). The completest collection of the minnesingers' verses is F. H. von der Hagen, *Minnesinger* (4 vols., Leipzig, 1838); K. Lachmann and M. Haupt, *Des Minnesangs Frühling* (ed. F. Vogt, 3rd ed., Leipzig, 1920) is a collection of the minnesingers prior to Walther von der Vogelweide. There is a comprehensive selection of 97 minnesingers by Karl Bartsch, *Deutsche Liederdichter des 12. bis 14. Jahrhunderts* (ed. W. Golther, 7th ed., 1914); *see* also F. Pfaff, *Der Minnesang der 12. bis 14. Jahrhunderts*, pt. i. (Stuttgart, 1892). English translations of early German lyrics are F. C. Nicholson, *Old German Love Songs* (1907). *See* also WALTHER V. D. VOGELWEIDE.

For historical and critical work on the minnesingers, *see* H. Paul, *Grundriss der germanischen Philologie*, vol. ii. (Strasbourg, 2nd ed., 1901), where further references will be found; also A. E. Schönbach, *Die Anfänge des deutschen Minnesanges* (Graz, 1898); F. Grimme, *Geschichte der Minnesänger*, vol. i. (Paderborn, 1892); K. Burdach, *Reinmar der Alte und Walther von der Vogelweide* (Leipzig, 1880); A. Schultz, *Das höfische Leben zur Zeit der Minnesänger* (2nd ed., Leipzig, 1889); E. Wechssler, *Das Kulturproblem des Minnesangs*, i. (Halle, 1909).

MINNESOTA, a north-central State of the United States of America. It is bounded north by the Canadian provinces of Manitoba and Ontario, east by Lake Superior and Wisconsin, south by Iowa and west by South and North Dakota. It is the eleventh State in size in the Union, with a total area of 84,682 sq.m., of which 3,824 sq.m. are water surface. It is about 400 m. long (43° 30′ to 49° 24′ N.) and averages 240 m. wide (89° 29′ to 97° 15′ W.). Its name, of Sioux Indian origin, was first applied to the river of that name, and means "cloudy," "turbid," or "invisible" water.

Physical Features.—An extensive water-parting in the north-central part of the State, an elevation whose inclination is almost imperceptible, determines the course of three great continental river systems. From this central elevation the land slopes off in all directions. The highest point in the State, however, is in the Misquah hills north of Lake Superior, where the altitude reaches 2,230 ft.; another high point of 1,960 ft. occurs in the Coteau des Prairies in the south-west; and the Mesabi range, in St. Louis county, rises to an elevation of 1,920 feet. The average elevation is 1,200 feet. Only in the valleys of the Red, Minnesota and Mississippi rivers and along the shore of Lake Superior does the altitude drop below 800 ft., the lowest being 602 feet. The south-



MAP OF MAIN ROADS IN MINNESOTA

ern part of the State was originally open, rolling prairie interspersed with groves of oak and other deciduous timber. A region known as the "Big Woods," composed of broad-leaved, hard-wood trees, extended up the Minnesota valley to the big bend. The northern part, aside from the Red river valley, was one dense coniferous forest, made up largely of white, Norway and jack pine, but containing also some birch, poplar, maple and oak. Outside of certain forest reserves much of the land has been cleared or the best timber cut, though about 15 million acres of Minnesota land —much of it in the rocky eastern area north of Lake Superior—is better suited to forest than to any other use. Of the three river systems mentioned above, the Mississippi—which has its source in Lake Itasca in the north-central part of the State—drains, with its tributaries, approximately the southern two-thirds of the State. Below its junction with the St. Croix, it forms the eastern boundary and is bordered by high bluffs, well-wooded for the most part, but crowned here and there by picturesque limestone cliffs. Its tributaries in this region, the Cannon, Zumbro and Root rivers, also flow through beautiful and fertile, though narrow valleys, considerably below the general level of the prairies. The principal tributaries, however, are the St. Croix and Minnesota rivers. The former forms the Wisconsin boundary for some distance, and is navigable for about 50 m. from its mouth. The latter rises in Big Stone lake on the western boundary and flows, with a great angle to the south, almost entirely across the State, a course of about 450 miles. All these tributaries furnish considerable water-power, as does the Mississippi itself at the Falls of St. Anthony, St. Cloud and Little Falls.

Glacial action not only determined the direction and character of these rivers, but made numerous swamps, and by scouring out rock basins, damming rivers and leaving morainal hollows became responsible for the countless lakes of Minnesota. Doubtless it has many more than any other State in the Union, the number being estimated at over 10,000. The lakes in the south, which occupy glacial moraines for the most part, are generally broad and shal-

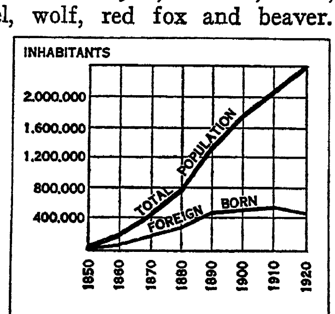
low, while those in the north, formed by glacial basins scoured in solid rock, are generally deep, with ragged, rocky, pine-covered shores. The most interesting feature of the glacial epoch is the extinct Lake Agassiz, which the receding ice of the later glacial period left in the Red river valley of Minnesota, North Dakota and Manitoba. This lake drained southward into the Gulf of Mexico by way of the Minnesota and Mississippi rivers until the ice-sheet that had prevented its natural drainage to the north had melted sufficiently to allow it to be drained off into Hudson bay through the Nelson river. The remarkably level character of the Red river district is due to horizontal deposits in the bottom of this lake, which have been little dissected by river erosion. The largest of the present lakes in this district, Red lake, has an area of 494 square miles. On the northern boundary are the Lake of the Woods (1,485 sq.m.) and Rainy lake (345 sq.m.), draining northward into Hudson bay. The "Park Region" centring in Otter Tail county, contains several thousand lakes. Lake Minnetonka, near Minneapolis, has many bays and islands. There are 22 State parks, 13 of which have areas of over 100 acres. These include Itasca State park (32,000 ac.) about the sources of the Mississippi; Interstate park in Chisago county, and the Minneopa State park, containing Minneopa falls, near Mankato.

Over the greater part of the State the soil consists of surface drift of glacial origin—a dark brown or black sandy loam of great fertility, adapted to cereal crops. In the east-central part of the State the soil is sandy and is devoted largely to potatoes.

Fauna.—The lakes provide excellent fishing. The State game and fish commissioner has charge of a number of hatcheries and field stations which annually help to restock the lakes and streams; in 1926–27 they distributed 520,173,700 young fish. Game birds are abundant. In the lake regions ducks are especially plentiful and more than a million are killed by hunters each year. As a result of short open seasons and the establishment of game refuges, the number of quail, sharp-tailed grouse, upland plover and ring-necked pheasants is increasing. Bear, deer, moose, elk and caribou are the only large game animals.

There is a permanent closed season on all these animals except deer and bear, and only every other season is open for deer, which enjoy a wide range over the northern half of the State. Refuges have been established, and despite the fact that about 22,000 deer are killed in open seasons by sportsmen, their numbers are increasing. The important fur animals are lynx, bobcats, mink, muskrat, skunk, raccoon, weasel, wolf, red fox and beaver.

Climate.—Minnesota has a comparatively low mean annual temperature, but there is great variation, the average annual range for Minneapolis and St. Paul being 119°. The cold increases not only from south to north, but to some degree from east to west. The amount of rain decreases from east to west, varying from nearly 31 in. to less than 25 in. at some points, but in all sections there is enough moisture for humid farming.



GRAPH OF GROWTH OF POPULATION IN MINNESOTA, AND NUMBER OF FOREIGN-BORN, 1850–1920

Population.—In 1920 Minnesota had a population of 2,387,125 and ranked 17th among the States. In 1930 the population was 2,563,953, an increase of 176,828 or 17·4 percent. The state ranked 18th; the density per sq.m. was 31·7 against 29·5 in 1920. Of the 1920 total, 2,368,936 were whites, 8,809 negroes and 8,761 Indians. The negroes increased by 1,725 between 1910–20 and the Indians decreased by 292. The Indians were mostly Chippewa in the northern part of the State. The foreign-born population numbered 486,164; of these 112,117 were from Sweden, 90,188 from Norway, 74,634 from Germany, 33,732 from Canada, 29,108 from Finland and 25,125 from the United Kingdom and Ireland. In recent years many south-eastern Europeans have settled in the northern iron-mining districts. The urban population represented 34·1% of the whole in 1900, and 44·1% in 1920. The following table gives the population and the percentage of increase of cities having more than 20,000 inhabitants in 1930:—

Cities	1930	1920	1920-30 Inc.	1910
Minneapolis . .	464,356	380,582	22·0	301,408
St. Paul . . .	271,606	234,698	15·7	214,744
Duluth . . .	101,463	98,917	2·6	78,466
St. Cloud . . .	21,000	15,873	32·3	10,600
Winona . . .	20,850	19,143	8·9	18,583
Rochester . . .	20,621	13,722	50·3	7,844

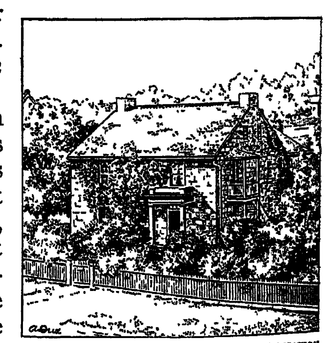
Government is conducted under a Constitution adopted on Oct. 13, 1857, and frequently amended. A proposed amendment must be passed by a majority in both houses of the legislature and be approved by a majority of the votes cast at a general election. The legislature is composed of two houses—the senate and the house of representatives—members of the former being chosen for four years and of the latter for two years. There may be one senator for every 5,000 people, and one representative for every 2,000 people. There has been no reapportionment, however, since 1913. There were, in 1927, 67 senators and 131 representatives. The executive department is made up of a governor, lieutenant governor, secretary of State, treasurer and attorney general, all elected for two years, and an auditor elected for four years. Since 1925 the governor, secretary of State, treasurer, auditor and attorney general together constitute an executive council which unifies the executive policy of the administration.

The governor has a veto which must be exercised within three days after a bill is passed, or it becomes law without his signature. A two-thirds vote of each house is necessary to override the veto. The lieutenant governor presides over the senate and succeeds the governor in case of the latter's death. A Reorganization Act, passed in 1925, combined some of the existing State boards and commissions and created the department of administration and finance. This is administered by a commission of three—comptroller, commissioner of the budget, and commissioner of purchases—appointed by the governor and removable at his pleasure.

The supreme court consists of a chief justice and four associate justices, each elected for a term of six years, and two commissioners who are appointed by the court. The State is divided into 19 judicial districts, each of which has a district court. In most districts one district judge is able to care for all cases. In every county there is a probate court presided over by a probate judge, and justices of the peace and municipal justices handle local cases.

Finance.—Tangible property was valued in 1922 at $8,548,000,000, giving the State a rank of 12th in wealth. This valuation represents an increase over that for 1912 of $3,116,000,000. The per caput wealth in 1922 averaged $3,442.

Taxable property was valued in 1926 at $6,667,617,283 and its assessed valuation in 1927 was $2,403,963,745. On this a direct State tax of 7·70 mills was levied, resulting in $15,011,334 direct taxes. The receipts were apportioned as follows: to the State revenue fund 3·3 mills; to the soldiers' bonus fund 1·50 mills; to the road and bridge fund 1·00 mill; and to the State school tax fund 1·23 mills. An additional tax of $26,695,256 was levied by the counties, $9,533,333 by townships, $40,200,180 by school districts, and $38,558,066 by cities and villages.



BY COURTESY OF THE ST. PAUL ASSOCIATION
SIBLEY HOUSE, WHERE THE FIRST GOVERNOR OF MINNESOTA LIVED

According to a report made by the bureau of the census in 1926, the cost of general government in Minnesota averaged 58 cents per caput, as compared with an average of 75 cents for all the States. Per caput expenditures for the development and conservation of natural resources amounted to $1.20 as compared with a 45 cent average throughout the United States. Per caput expendi-

tures for education amounted to $5.79 as against $3.57, the average in all States.

On Dec. 31, 1927 there were 1,163 banks (281 of them national banks) with total resources and liabilities amounting to $1,162,-417,000, capital and surplus of $96,557,000, and deposits of $890,213,000, of which $517,243,000 were savings deposits. In the general depression during the four years preceding 1926 the banks suffered greatly, there being 70 suspensions in 1926 and 46 in 1927 among State banks.

Education.—General supervision of the State public school system is placed in the State department of education and control of the department is vested in a non-salaried board of education, consisting of five representative citizens appointed by the governor and approved by the senate. The board's powers are exercised through the State commissioner of education, whom it elects.

As soon as the required standards are met the department metes out State aid in a certain fixed proportion. In addition to this fixed aid there is a supplemental aid designed mainly to help the poor school districts. In 1927 there were 400 consolidated schools, and 32,289 pupils were transported to and from them. Other means also were used to improve the rural schools. Only 2,054 rural schools were taught by teachers with first-grade certificates in 1911; in 1928 the number holding first-grade certificates or advanced diplomas was 8,137.

Pupils enrolled in the public school system numbered 440,083 in 1909–10 and 550,330 in 1926–27. Of the latter number 464,461 were in elementary schools, and 85,869 in secondary schools. The number of teachers was 22,099, and they received salaries amounting to $27,698,732. Total expenditures for the public school system of the State have increased from $13,724,000 in 1909–10 to $54,264,674 in 1926–27.

Teachers are trained at the College of Education in the University of Minnesota and at six teachers' colleges, and in high-school normal training departments. The teachers' colleges in 1927–28 had 3,307 students and 225 instructors. There were, in addition to those enrolled in teachers' colleges, 22,646 collegiate students in the State in 1925–26, 1,142 post-graduates and 2,446 professional students. In 1926–27 there were also 63 nurses' training schools in the State with 3,851 students, and in 1924–25, 17 commercial schools with 4,833 students.

Most important of the institutions of higher learning is the University of Minnesota (*q.v.*). Privately supported colleges of liberal arts are Carleton and St. Olaf at Northfield, Gustavus Adolphus at St. Peter; Hamline and Macalester at St. Paul; and St. John's at Collegeville.

Charities and Corrections.—The State board of control, created in 1901, had, in 1926, general control over 18 State charity and corrective institutions, and supervision over 14 county tuberculosis sanatoria. It inspects jails, poorhouses, infirmaries; inspects and licenses maternity hospitals and infant's homes; supervises the administration of mother's pensions; safeguards the interests of illegitimate children; administers the soldiers' welfare fund; appoints county child welfare boards; and acts as a board of parole and discharge for the State Training school for boys and the Home school for girls.

Agriculture and Live Stock.—Minnesota is pre-eminently an agricultural State. In farm value of all crops it ranked fifth among the States in 1924 and 1925, and in 1926, because of unfavourable crop conditions, seventh. In 1926, however, it was first in the production of barley and flax, second in oats and rye, third in spring wheat and potatoes and fifth in corn. These rankings indicate the extent to which crop diversification is practised. The total acreage devoted to all crops was approximately 18,000,-000 and their estimated value for 1926 was $327,008,000, as compared with $372,062,000 for the year 1925 and $421,485,000 for the year 1924. Lower prices and unfavourable weather conditions were responsible for the decrease in value. The acreage and value of the principal crops in 1926 follow: corn, 4,343,000 ac., $82,691,-000; oats, 4,532,000 ac., $43,915,000 (1926 yield exceptionally poor); tame hay, 2,091,000 ac., $38,922,000; potatoes, 298,000 ac., $34,270,000; spring wheat, 1,967,000 ac., $30,243,000; flax, 910,-000 ac., $16,851,000; barley, 1,307,000 ac., $16,664,000; and wild hay, 1,865,000 ac., $15,964,000. The spring wheat acreage is gradually decreasing, while that of flax is rapidly increasing. Apples are the only fruit crop raised commercially to any extent. Live stock marketed in 1926 totalled $166,008,395 as compared with $142,095,045 in 1925. Horses on farms have decreased since 1918; there were 810,000 valued at $62,645,000 on Jan. 1, 1927, as compared with 827,000 head valued at $66,733,000 a year earlier. Minnesota ranked sixth in the number of all cattle on farms on Jan. 1, 1927, there being 2,739,000 head valued at $125,165,000. In 1925 and 1926 sheep-raising made rapid progress, the 670,000 reported Jan. 1, 1927, being a larger number than in any previous year. They were valued at $6,529,000. The wool production has shown a corresponding increase, the 1926 production amounting to 3,392,000 lb., as compared with the 1919–23 average of 2,547,000 pounds. In 1927 swine numbered 3,525,000 with a farm value of $61,688,000. The aggregate gross value of all live stock on farms amounted to $257,119,000 on Jan. 1, 1927. In the five-year period from 1920–25 butter production nearly doubled, increasing from 139,000,000 lb. to 260,000,000 lb. In dairy products generally Minnesota is second only to Wisconsin.

The number of farms in 1927 was 175,139, nearly 3,000 less than in 1920, and the total area of farm land also was somewhat less. The farm population in 1925 was 875,749, or 33·5% of the total population. The average acreage per farm was 159·7; 58·1% of the land area was occupied by farms. The depression in the farm industry after the World War is shown by the decrease in value of all farm property from $3,787,420,000 in 1920 to $2,761,684,000 in 1925. The decrease was mainly in land, for the value of buildings increased. The average value per farm dropped from $21,221 to $14,672, and land from $91.00 per acre to $59.77.

Mining and Lumbering.—From 1919 to 1924 inclusive Minnesota supplied approximately 60% of the entire iron ore production of the nation. In 1927 36,504,854 of the 61,778,000 tons which formed the national output were mined in the State. The value of ore shipped amounted to $90,289,000 in 1927. The ore comes from three distinct districts known as the Vermilion, Mesabi and Cuyuna ranges, named in the order of their discovery and development. All these ranges lie in the northern part of the State, the Vermilion farthest to the east and the Cuyuna farthest to the west (*see* Iron and Mining).

Iron represents about 98% of Minnesota's total mineral output and is the only metal produced. The remainder is made up largely of quarry products. In early years the quarrying of limestone was very important, especially along the bluffs of the Mississippi and its tributaries. As population pushed northward into the granite country and as prosperity began to demand a more permanent building stone, granite assumed greater importance. The value of the stone output in 1923 was $2,412,000.

Minnesota was formerly one of the leading lumber States. In 1899 it held third rank with an output of 2,342,000,000 ft., but careless exploitation has reduced the timber resources. The production of 1919 was but 700,000,000 ft. and by 1925 it had dropped to 579,000,000 feet. In the latter year the State fell to 18th place in lumber production but still held first place in the production of white pine. Wood pulp production is also important, amounting in 1925 to 81,542 tons. In preparation for reforestation the State forestry department was reorganized in 1925. There are two national forests with a combined area of 1,490,000 ac., and two State forests of 21,000 acres.

Manufactures.—In 1925 manufactures were valued at $1,101,-856,000, of which $331,932,000 was added by factory processes. There were 100,614 men employed in manufacturing at wages amounting to $123,767,000. First in importance was the flour and feed-milling industry with an output in 1925 valued at $215,637,-578, exceeding that of any other State. The lumber and flour-milling industries built up Minneapolis, which for many years has been the centre of flour-milling in the United States. It produces about 60% of the mill products of Minnesota. In 1927 there were in Minneapolis 66 elevators with a storage capacity of 63,433,000 bu., greater than that of any other city in the world. Slaughtering and meat-packing was the second manufacturing industry, its output in 1925 amounting to $182,555,429. This industry centres in

South St. Paul. Minnesota's advance as a dairy State was accompanied by an increase in the manufacture of dairy products, an industry third in importance in 1925 with an output valued at $123,456,850. It is widely distributed among the smaller towns. Saw-mill, planing-mill and other timber products amounted in value to $42,289,000 in 1925. Minneapolis in the last decades of the 19th century was the mill centre of the lumber industry, but the last saw-mill there was dismantled in 1921. Next in importance are motor vehicles, $38,761,000; railroad car and repair shops, $35,829,552; and linseed-oil, meal and cake products, $32,933,341. Printing and publishing, bakery products, knit goods, boots and shoes, confectionery and ice-cream contribute greatly to the total. Iron ore is now worked in huge iron and steel plants near Duluth, and farm machinery is manufactured in large quantities.

One of the phenomena of recent years has been the development of electric light and power. Production in kilowatt hours increased from 87,579,000 in 1907 to 1,040,000,000 in 1926.

Transport.—Both by water and by land Minnesota is exceptionally well provided with transport facilities. Duluth stands at the head of the Great Lakes and through its port passes most of the iron-ore and a large share of the grain grown in the Northwest. It also is a receiving port and distributing point for coal and other products for the Northwest. Railways connect with the iron ranges, while others, expanding and intersecting, reach out into the wheat lands of the Dakotas, Montana and western Canada. At the head of navigation on the Mississippi stand Minneapolis and St. Paul. Efforts have been made in recent years, with some success in 1927 and 1928, to develop freighting on the river between Minneapolis and St. Louis, but perhaps the greatest importance of the river is the check it affords against extravagant freight rates by rail. In 1927, 369 buses were operating over 6,211 m. of route, carrying 12,351,612 passengers.

Of the 6,936 m. in the State trunk highway system, 1,327 m. were paved and 4,936 m. were heavily gravelled at the beginning of 1928. Disbursements for this trunk system amounted in 1925 to $17,599,213 and in 1926 to $19,439,209. Building and maintenance of the trunk highways has been financed by motor tax, gasolene tax and Federal aid entirely, and no bonds have been issued. Provision is made for keeping the trunk system open for motor travel all winter. The rural roads have a mileage of 110,929, of which 25,628 m. are surfaced. Expenditures on rural roads of all classes amounted to $30,349,000 in 1926 and $30,702,000 in 1927. Motor vehicles registered in the State numbered 654,350 in 1927, as compared with 332,652 in 1921 and 28,776 in 1912.

History.—The first European visitors to the territory now embraced in the State of Minnesota found it occupied mainly by two Indian tribes, the Ojibway or Chippewa, who lived in the heavily wooded northern portion, and the Dakota or Sioux, who made their homes in the more open country of the South and West. Between the two tribes there was almost continual warfare. The first white men known to have entered the State were Frenchmen. Radisson and Groseilliers may have reached Minnesota territory on an expedition overland from Lake Michigan in 1655. It is more probable that they visited Minnesota on a journey south-west from Lake Superior about 1659. Daniel Greysolon, sieur du Luth (Duluth), is known to have penetrated the territory south-west of Lake Superior in 1679 as far as Mille Lacs, where he set up the standard of Louis XIV. The following year Du Luth crossed via the Bois Brule-St. Croix route to the Mississippi, where he met a party of three Frenchmen led by Michael Accault. They had been sent up the river by La Salle to make the first exploration of the upper Mississippi. Accompanying this expedition was Father Louis Hennepin, who during his wanderings before meeting Du Luth discovered and named the falls of St. Anthony, and who later wrote the first published description of the country. Nicolas Perrot, a trader, ascended the Mississippi in 1686 to Lake Pepin, on the east shore of which he built a fort. Again in 1688 he visited the region, and in 1689 he proclaimed the sovereignty of France over it. In 1695 Le Sueur, who had traded on the upper Mississippi for some years, established a post on Isle Pelée (Prairie island) in the Mississippi between Hastings and Red Wing. In 1700 he ascended the Minnesota river to the mouth of the Blue Earth river at Mankato, whereon he built Fort L'Huillier.

A period of lethargy followed these early explorations, due to the death in 1698 of the energetic governor, Frontenac, who had encouraged them, and the absorption of France in the War of the Spanish Succession (1701–13). All French garrisons in the northwest were withdrawn. Not until Sept. 1727 did another French expedition reach the region. Then the Sieur de la Perrière landed on the west bank of Lake Pepin, built a fort, and the Jesuit fathers who accompanied him established a mission, but both institutions were short lived. In 1731 a party under La Vérendrye explored the chain of lakes along the northern border of Minnesota, and a detachment under his nephew, La Jémeraye, built Fort St. Pierre on the north bank of Rainy Lake. In the next year the main expedition pushed on to the Lake of the Woods, where, within Minnesota borders, they built Fort St. Charles, occupied for 20 years, or longer than any French establishment in the territory. In the treaty of Paris (1763) at the close of the Seven Years War in Europe, the French ceded to England all their possessions east of the Mississippi except the island on which New Orleans is located; those west of that river they had cautiously ceded to Spain in a secret treaty the previous year.

During the period of English and Spanish possession fur-trading operations were carried on by traders of both nations. The only notable explorer to enter the Minnesota country at this time was Jonathan Carver, who was sent out to treat with the Indians, in 1766, by Major Rogers, commandant at Mackinac, and who spent the winter of 1766–67 among the Sioux of the Minnesota valley. In the spring he went down the Minnesota with a large party of Indians and at a cave near the present site of St. Paul, since known by his name, he held a council with the natives. Thence he travelled to Prairie du Chien, where he joined an expedition under Capt. Tute sent out by Rogers to find a route to the "western sea." Carver later published a lively account of his travels, which was widely read in Europe. After the Revolutionary War, the English relinquished their portion of the region (Treaty of Paris, 1783) to the newly formed United States. There was no force to expel the English from the north-west wilderness, however, and the British flag remained flying over the trading-posts of the Northwest Company in Minnesota until after the War of 1812. This company had been formed to organize systematically the fur trade of the north-west. Its headquarters for the region during the last two decades of the 18th century were at Grand Portage, at the east end of the famous portage between Lake Superior and the Pigeon river.

In 1803 the western part of Minnesota was acquired by the United States as part of the Louisiana Purchase. In 1805–06, at the instance of President Thomas Jefferson, Lieut. Zebulon M. Pike led an exploring expedition up the Mississippi as far as Leech lake and Upper Red Cedar or Cass lake. He visited the main posts of the North-west Company and took formal possession for the United States. He also negotiated with the Indians for a tract of land at the confluence of the Minnesota and Mississippi rivers upon which, in 1819, the post later known as Ft. Snelling was established. For many years this remained the most north-western military post in the United States, and it was also the centre of the fur trade in the region. In 1816 the Northwest Company's traders were forced out of Minnesota and their posts were taken over by the American Fur Company, which was soon doing business throughout the upper valley of the Mississippi. In 1818 the jurisdiction of Michigan Territory was extended to the Mississippi river, and its governor, Lewis Cass, in 1820 conducted an expedition to search for the source of the Mississippi, which he was satisfied was in the large body of water named Cass lake in his honour. In 1823 extensive explorations of the Minnesota and Red river valleys were conducted by Major Stephen S. Long, and subsequently knowledge of the Minnesota country was extended by investigations of the region by Henry R. Schoolcraft, who discovered Lake Itasca, the source of the Mississippi, in 1832.

A settlement was attempted in 1812 by Lord Selkirk in Hudson's Bay Company territory in the Red river valley, but failed. A nucleus of settlement also grew up at Mendota, on the Minnesota river opposite, Ft. Snelling, the headquarters of the American

Fur Company. In 1837 two treaties, one with the Chippewa and the other with the Sioux, were negotiated, extinguishing the Indian title to the wedge of land between the Mississippi and St. Croix rivers and opening it to settlement. Following these treaties thriving settlements grew up at St. Paul and Stillwater. In 1849 the bill organizing the Territory of Minnesota was passed by Congress and Alexander Ramsey was appointed governor. The first territorial legislature met at St. Paul on Sept. 3 of the same year. By the Federal census of 1850 the territory had 6,077 inhabitants, most of whom lived east of the Mississippi, or along the Red river in the extreme north-west. Treaties negotiated in 1851 with the Sioux opened to settlement the greater part of the land in the territory west of the Mississippi; and treaties with the Chippewa in 1854 and 1855, negotiated largely in the interests of the lumbermen, extinguished the Indian title to nearly two-thirds of the northern half of the State. Such an unparalleled rush to the new lands took place that a census in 1857 showed a population of 150,037. The lumbering business was booming and building up the towns of Stillwater and St. Anthony (Minneapolis). River steamers to the number of 119 in 1855 and 292 in 1857 landed at St. Paul with settlers and goods, making that city the commercial centre of the territory. Other river towns proved prosperous ports of entry from which settlers trekked to the interior, sometimes individually, sometimes by whole colonies transplanted from Eastern States. In July 1857, a convention met and drew up a State Constitution, which was adopted the following October by an almost unanimous popular vote. On May 11, 1858, the State was admitted to the Union with its present boundaries.

Minnesota furnished nearly 22,000 men for the Federal armies during the Civil War. Even more important to the State than the war in the South was the need for defending her frontier against the uprising of the Indians within her borders. The Sioux felt that they had been deceived and outdone in the treaty of 1851. In 1858 their small reservation was halved and most of the payment went to the traders. Many of the natives resented the Government's attempts to make them farmers. When in the summer of 1862 there was delay in the payment of annuities, bands of the Sioux suddenly began to massacre the settlers in the Minnesota valley. These attacks continued with increasing fury (more than 350 whites losing their lives) until forces under Col. Sibley decisively defeated the Indians under Little Crow, their principal leader, at Wood lake. Three days later 269 white captives were released. Many of the Sioux fled into the Dakota country, but expeditions under Sibley in 1863 and Sully in 1863 and 1864 marched against them and drove them beyond the Missouri.

The coming of peace marked the beginning of a new period of rapid growth, the Federal census of 1870 showing a population of 439,706 or a gain of 155·6% in ten years. During the same decade railway construction, which had begun with a line between St. Paul and St. Anthony in 1862, reached close to 1,000 miles. The period 1870–80 was one of great discontent among the farmers, and one expression of their feeling was their opposition to certain wide-spread abuses of the railroads. A number of regulatory laws, usually called the "granger-acts" because they were sponsored by farmer organizations known as "granges," passed the legislature. Cases arising out of these acts, and carried to the U.S. Supreme Court, which decided against the railroads, had far-reaching results in establishing principles of public regulation of common carriers. The railways themselves suffered severely in the panic of 1873, while the farmers were troubled by severe and repeated grasshopper invasions that destroyed the crops over large areas. Despite these setbacks, Minnesota's population increased 77·6% in the decade from 1870 to 1880; settlements spread over the prairies of the west and south-west, and down the Red river valley. Many of the newcomers were Scandinavian and German immigrants. Wheat became the great crop of the prairies.

In the north the forests were falling under the organized attack of great lumber companies. Agricultural conditions revived, railroads again were being built, and the basis was laid for steady growth in the following decades. In 1884 the mining of iron-ore was begun on the Vermilion range and in 1890 and 1891 the much larger deposits of the Mesabi range were discovered. Railways were built to the mines and by 1900 31 million tons of ore had been taken out. By the end of 1927, 780,323,313 tons had been shipped from the Mesabi and 53,095,923 tons from the Vermilion range. In 1911 shipments began from the Cuyuna range and by 1927 they totalled 25,106,581 tons. Scores of prosperous towns have grown up along the ranges, and the mines have also contributed largely to the prosperity of Duluth.

As wheat began to exhaust the land, the farmers turned more and more to diversified farming and the raising of live stock, and gradually dairying came into prominence. Immediately following the World War agrarian unrest manifested itself first in the Non-Partisan League and later in the Farmer-Labor Party. This party was able to elect two members to the U.S. Senate—one to fill an unexpired term. In 1924, however, the State elections were carried by the Republicans, including one senator.

Bibliography.—For contemporary conditions consult the reports and publications of various State officers, boards and departments, especially the *Biennial Reports* of the treasurer, tax commission, auditor, commissioner of highways, etc.; also the publications of the agricultural experiment station of the University of Minnesota, the *Bulletins* of the State department of agriculture, and State dairy and food department, and *Bulletins* of the experiment station of the University of Minnesota School of Mines (No. 4 being a "Bibliography of Minnesota Mining and Geology," 1915).

The best history of the State is W. W. Folwell, *A History of Minnesota* (St. Paul, 1921–). Valuable also are E. D. Neill, *History of Minnesota* (4th ed., Minneapolis, 1882); and *Minnesota in Three Centuries*, by various authors (1908). For other phases of the State's history and life *see* N. H. Winchell, *The Aborigines of Minnesota* (St. Paul, 1911); D. E. Willard, *The Story of the North Star State* (St. Paul, 1922); W. H. C. Folsom, *Fifty Years in the North-west* (St. Paul, 1888); H. P. Hall, *Observations* (St. Paul, 1904), *Minnesota in the Civil and Indian Wars* (St. Paul, 1890); W. P. Shortridge, *The Transition of a Typical Frontier* (Menasha, 1922); J. G. Pyle, *The Life of James J. Hill* (1917); M. W. Odland, *Life of Knute Nelson* (Minneapolis, 1926); M. L. Hansen, *Old Fort Snelling* (Iowa City, 1918); J. F. Williams, *A History of the City of Saint Paul* (St. Paul, 1876); W. Van Brunt, *Duluth and St. Louis County, Minnesota* (Chicago, 1921); A. N. Winchell, *Handbook of Mining in the Lake Superior Region* (Minneapolis, 1920); E. V. Robinson, *Early Economic Conditions and the Development of Agriculture in Minnesota* (Minneapolis, 1915); H. Larson, *The Wheat Market and the Farmer in Minnesota* (1926); M. Hartsough, *The Twin Cities as a Metropolitan Market* (Minneapolis, 1925); W. C. Edgar, *The Medal of Gold* (Minneapolis, 1925); W. Anderson, *A History of the Constitution of Minnesota* (Minneapolis, 1921); F. F. Holbrook, *Minnesota in the Spanish-American War and the Philippine Insurrection* (St. Paul, 1923); and F. F. Holbrook and Livia Appel, *Minnesota in the War with Germany* (St. Paul, 1928–). *See* also the 17 vols. of the *Minnesota Historical Collections* (St. Paul, 1872–1920); and *Minnesota History, A Quarterly Magazine* (formerly *Minnesota History Bulletin*, St. Paul, 1915 *seq.*), both published by the Minnesota Historical Society.

(S. J. Bu.)

MINNESOTA, UNIVERSITY OF, established under the Territorial Act in 1851 and perpetuated by provisions of the State Constitution, the university of Minnesota began its work of instruction in 1868. By 1928 it had become one of the largest of American universities. The scope of its instruction is exemplified by the fact that during the academic year from Sept. 1926 to June 1927, 12,232 students pursued regular work in such varied subjects as science, literature and arts; engineering and architecture; agriculture, forestry and home economy; law; medicine, nursing and medical technical service; dentistry and dental nursing; mines; pharmacy; chemistry; education; business administration; graduate and special war courses.

The university also conducts a summer session in nearly all of its schools and colleges with a total enrolment of over 5,000 students. It conducts four schools of agriculture of less than college grade, and one teacher-training high school, the enrolment in the five schools being 1,430 during 1926-27. Extension courses having regular class instruction in sciences, arts, business administration and engineering were pursued by 6,318 students, correspondence study courses by 2,184 students, and a wide variety of special short courses by 1,512 students. A total of 1,916 degrees was granted during 1926–27, of which 195 were awarded by the graduate school, 34 of these being the degree of Doctor of Philosophy.

The university carries on an extensive programme including

research and State service. In co-operation with the Federal Government the agricultural experiment station, through an expenditure of $392,000, studies important agricultural problems. The Mayo foundation for research in medicine works in co-operation with the Mayo clinic at Rochester, Minn., upon the most fundamental problems of human diseases. The engineering experiment station also conducts researches. State services of a wide variety are provided by the university in lecture courses, entertainments, reading and study materials, boys' and girls' club work and county agricultural agents. (L. D. C.)

MINNOW (*Phoxinus phoxinus*), a cyprinid fish of Europe and northern Asia, distinguished from the dace and chub by its small scales. A length of 3 or 4 in. is usual, but specimens 7 in. long are known. In America the name is given to other small cyprinids, and to some cyprinodonts. Top minnow is the name given in America to those species of the cyprinodont genus *Fundulus*, which swim at the surface, particularly *F. notatus*.

MINO DI GIOVANNI (1431–1484), called DA FIESOLE, Italian sculptor, was born at Poppi in the Casentino. He had property at Fiesole. Vasari's account of him is very inaccurate. Mino was a friend and fellow-worker with Desiderio da Settignano and Matteo Civitale, all three being about the same age. Mino's sculpture is remarkable for its finish and delicacy of details, as well as for its spirituality and strong devotional feeling. Of Mino's earlier works, the finest are in the duomo of Fiesole, the altarpiece and tomb of Bishop Salutati, executed before 1466. In the Badia of Florence are an altarpiece and the tombs of Bernardo Giugni (1466) and of Count Hugo of Andersburg (1481), all sculptured in white marble, with life-sized recumbent effigies and attendant angels. The pulpit in Prato Cathedral, in which he collaborated with Antonio Rossellino, finished in 1473, is very delicately sculptured with bas-reliefs of great minuteness, but somewhat weakly designed. Soon after the completion of this work Mino went to Rome, where he executed the tomb of Pope Paul II. (now in the crypt of St. Peter's), the tomb of Francesco Tornabuoni in S. Maria sopra Minerva, and a beautiful little marble tabernacle for the holy oils in S. Maria in Trastevere. Some of Mino's portrait busts and profile bas-reliefs are preserved in the Bargello at Florence; at the Berlin Museum and in the collections of Baron Schickler and of Dreyfus in Paris; they are full of life and expression.

See Vasari, Milanesi's ed. (1878–82); Wilhelm Bode, *Die italienische Plastik* (Berlin, 1893); D. Angeli, *Mino da Fiesole* (Florence, 1905).

MINOR, a word used both as an adjective and as a substantive for that which is less than or inferior to another. "Minor Friars," or "Minorites," was the name (*fratres minores*, lesser brothers) given by St. Francis to the order he founded (*see* FRANCISCANS); "minor canons" are clergymen attached to a cathedral or collegiate church, but not members of the chapter, who read and sing the daily service. (For the distinction between holy and minor orders in Christian hierarchy *see* ORDERS.) The name "Minor Prophets" is used collectively of the twelve prophetical books of the Old Testament from Hosea to Malachi inclusive. For the "minor premise" in Logic, *see* SYLLOGISM. In law, a "minor" is a person under legal age (*see* INFANT).

For the "minor of a determinant" in mathematics, *see* DETERMINANT. In astronomy, the term minor planets is given to the members of the solar system which have their orbits between those of Mars and Jupiter (*see* PLANETS, MINOR).

As used in music the term minor is opposed to major as indicating an interval of smaller size, a minor interval containing a semitone less than the corresponding major interval. (*See* MAJOR and HARMONY.)

MINORCA (Menorca), the second in size of the group of Spanish islands in the Mediterranean sea, known as the Balearic islands (*q.v.*), 27 m. E.N.E. of Majorca. Pop. (1920), 42,147; area, 260 sq.m. The coast is deeply indented, especially on the north, with numerous creeks and bays—that of Port Mahon (17,866), being one of the finest in the Mediterranean, if not the best of them all, according to the popular rhyme—

> Junio, Julio, Agosto y Puerto Mahon
> Los mejores puertos del Mediterraneo son—

"June, July, August and Port Mahon are the best harbours of the Mediterranean." (*See* PORT MAHON.) The climate is not so equable as that of Majorca, and the island is exposed in autumn and winter to the violence of the north winds. Its soil is of very unequal quality; that of the higher districts being light, fine, and fertile, and producing regular harvests without much labour, while that of the plains is chalky, scanty, and unfit for pasture or the plough. Some of the valleys have a good alluvial soil; and where the hills have been terraced they are cultivated to the summit. The *Hedysarum coronarium* or *zulla*, as it is called by the Spaniards, is largely cultivated for fodder. Wine, oil, potatoes, hemp and flax are produced in moderate quantities; fruit of all kinds, including melons, pomegranates, figs and almonds, is abundant. Horned cattle, sheep and goats are reared, and small game abound. In the district of Mercadal and in Mt. Santa Agueda are found fine marbles and porphyries; lime and slate are also abundant. Lead, copper and iron might be worked were it not for the scarcity of fuel. There are manufactures of wool, hemp and flax. A road, constructed in 1713–15 by Richard Kane, runs through the island from south-east to north-west, and connects Port Mahon with Ciudadela.

MINORITIES, the protection of racial, linguistic and religious minorities in the sphere of international law. Such protection is not an innovation introduced by the treaties concluded at the end of the World War. Diplomatic history affords several examples of treaties containing special clauses which aim at providing certain guarantees for groups of the population of a different race, language or religion from that of the majority of the population of the State to which they belong. (X.)

HISTORY

The World War has been described as a "War of Nationalities." At any rate, it resulted in the overthrow of four empires, and the creation in Europe of a number of new or greatly enlarged States, which were based on the principle of nationality. This process was imperfectly carried out, partly because its complete application is impossible in a continent where the nationalities are so mixed, and partly because the victors refused in some cases to apply it to their disadvantage. Nevertheless, many of the previous minorities became majorities in the newly organized States, and others were able to coalesce with men of the same nationality already organized in a State. Naturally so great a reversal of conditions has created difficult problems, which can only be understood by a reference to history.

Religious Minorities.—Since no State is comprised of an absolutely homogeneous mass of people of the same race and religion, there have always been "minorities" of one kind or another. In the middle ages there were religious minorities, such as the Albigenses in southern France, which developed an organization of their own, so strong that they were considered specially dangerous and suppressed by the Church by special means. After the Reformation had completely disrupted the religious unity of Europe, religious minorities were present in all States and were treated with great rigour in the majority of them. In some cases the ruler tried to enforce the religion of a minority, but in nearly all cases this failed, and the religion of the majority was adopted as that of the State and that of the minority forbidden. After 1648 the religious position was stabilized and played a less important part and gradually in some countries the idea of toleration of religious belief grew up. But to the end of the 19th century there was always a tendency in some States to deny full religious equality to minority sects.

Nationality.—Meanwhile, minorities of another and even more disruptive kind had been growing up. From the end of the 18th century onwards the idea of nationality, which had long been in existence in western Europe grew immensely stronger and penetrated throughout the Continent. The exact causes of this great increase in national feeling are not exactly known. It can be partially traced to the French Revolution, whose ideas were carried all over Europe by Napoleon's armies but perhaps, the most important cause was the spread of education. Dormant nationalities were awakened or made much more self-conscious by

teachers, who, drawn largely from the middle class, and in revolt against the aristocratic and semi-feudal government, which still persisted in many parts of Europe, used the national feeling as a means of revolt against rulers, who were often of another nationality. The universities, some of which were newly founded, were sometimes the centre of such movements, and the professor was their prophet. The historians, especially, by reviving a knowledge of periods in which the racial minorities had played a great part, had a great effect on their compatriots. Moreover, the change in industry and transport enhanced the efficiency and importance of the State machine. The unit became larger and men no longer thought in terms of their village or county. Their contacts with officials at a distance became more numerous especially after the extension of railways. Both this cause, and the spread of education made language assume a new importance. It was irksome to be governed by men who could not be understood, and impossible to be educated by them.

The growth of democratic ideas made men desire to choose their rulers, and elected assemblies inevitably increased the expression of national feelings. Thus each minority began to demand more and more government by its own nationals, and, where these were organized in another State, to look to that State for help against its own rulers. Side by side with these national aspirations there still persisted religious ties such as those of the Greek or Roman Churches, which were sometimes strong enough to hold the other in check. There were, moreover, racial as distinct from national groups, which helped to unite Slav and Teuton or was at any rate an instrument in the hands of Russia and Germany, the most powerful representatives of each "race."

These forces operating throughout the 19th century were one of the main causes of the formation of the German empire and the unification of Italy, bringing together men of the same nationality, hitherto divided into small units. But the German empire made by the sword of Prussia contained also Danes and Lorrainers incorporated in it by force, as well as the Poles given to Prussia by the Treaty of Vienna (1815). Italy on the other hand, being weak, many Italians were still left under the domination of the Austrian Government. Meanwhile, as a result of national feeling, the Austro-Hungarian empire had grown less united. The German part had been cut off from Germany by Prussia's arms. The Hungarians established an equality with the German-ruled half of the monarchy. In both parts, the Slavs became self-conscious after the revolution of 1848 and struggled to express themselves. The same process had begun even earlier in the Balkan peninsula, where the Christian nationalities, with the assistance of the Great Powers, especially of Russia, threw off the Turkish yoke and gradually obtained autonomy and complete independence, the whole culminating in the Balkan Wars of 1912–13, when they had become strong enough to defeat the Turks themselves. The nationalities along the Russian frontier, also, developed from the same causes, but only two were strong enough to make their cause much known in the rest of the world—the Finns, because of their previous connection with Sweden and semi-independence, and the unquenchable Poles, whose insurrections in 1830 and 1863, though ruthlessly put down, had shown that they were still determined to assert their national rights. In other countries there were also, minorities, which did not accept their position, the most alive being the Irish, whose struggle for Home Rule or semi-independence went on uninterruptedly throughout the 19th century.

In pre-war Europe, therefore, there was a body of people, which has been estimated at about 100 millions, which was discontented with its rulers, and wished to obtain complete independence, or to unite with some other State, or to have some form of autonomy inside their present State. There were the people of Alsace-Lorraine the majority preferring France to Germany, or at least some form of autonomy, and the Danes of Schleswig, as well as the Poles of Posen and Upper Silesia of whom the former could look back to citizenship in a Polish State of fairly recent date, while the latter, though most of them were more recent emigrants, were still conscious of their Polish nationality, which was reinforced by their Catholicism, which contrasted with the Protestantism of the Prussian State.

Austria-Hungary was a mosaic of nationalities. In the Austrian part they had been given much autonomy. The Czechs and Poles of the north and the Slavs of the south had obtained many cultural rights, and played a great part in the government. In the Hungarian part, however, the Magyars since they had won their own rights in 1867 had done their best to deny them to their minorities. The Slovaks and Ruthenes in the north, one with an affinity to the Czechs, and the other to the Ruthenes of Galicia and Russia, were kept down in every way. The Croats and Serbs of the south, and the Rumans of Transylvania were more able to assert themselves after an independent Rumania and Serbia came into existence. But they were denied adequate representation under a pseudo-democratic constitution, and their cultural rights were reduced to the lowest possible minimum. The situation was indeed a difficult one, for islands of Magyars and Germans extended into these lands, and especially in Transylvania, the landlords tended to be of the dominant race. An economic motive was thus added to the other causes of the increase of the national spirit of the minorities, whose combined total was greater than that of the Germans in Austria, or that of the Magyars in Hungary.

In the Balkans, though the Turks were confined to the region round Constantinople the subsequent interference of the Powers and the war between the Balkan States had resulted in large minorities being left under alien rule. Rumania, Serbia and Greece all had Bulgarian subjects. Indeed the mixture of races in Macedonia and other parts was such that minorities were inevitable, though the final arrangement might have been much juster. The creation of Albania had made another national State, but both in its northern frontier with Serbia and its southern with Greece national minorities were necessarily left in all three States.

Meanwhile in the Russian empire the Poles were subjected to worse treatment than in Germany and, of course, much worse than in Austria. The Finns lost many of their old privileges and grew more rebellious in consequence. The peasants of the Baltic provinces of Esths, Letts and Lithuanians were also much affected by the revolution in Russia, a result of the weakness of the Government in the Russo-Japanese War, and there were fierce agrarian outbreaks, later ruthlessly suppressed. In Ireland by 1914 the attempt by the Liberal Government to pass a Home Rule bill against the wishes of the Protestant minority had brought civil war into sight.

The World War.—The war completely reversed this situation. From the outset each side endeavoured to foment the aspirations of the minorities under the control of their enemies. The Germans were at first the most active, and had most success, because of their military victories over Russia. By this means a new Poland was constituted and the Baltic nationalities revived under German control. Attempts were even made to create a Ruthenian revival in South Russia. But the Allied efforts were in the long run more lasting and effective. They were gradually able to reach the minorities of Austria-Hungary, efforts which were facilitated by the co-operation of exiles, who established "Governments" in the Allied countries. The accession of the United States, where President Wilson had already advocated the right of self-determination, added strength to their agitation and money was contributed by their American kinsmen. When therefore, the tide of war turned, the national minorities of Austria-Hungary asserted their right to complete independence, and though, by the secret treaties with Italy and Rumania, the Allies had somewhat violated the principle of nationality, yet they were already pledged to recognize the claims of the Czechs, the Southern Slavs, the Rumanians, the Poles to form new States out of the mosaic.

Thus the Peace treaties were a recognition of the rights which the minorities had claimed, and the new frontier lines of Europe followed more closely than any that had preceded them the ethnographical frontier lines. But, of course, in the intermixture of nationalities it was inevitable that minorities should still exist, and it was perhaps also inevitable that the defeated countries should lose more than a strict interpretation of ethnographical frontiers would have taken from them. Some mitigation was obtained by the institution of plebiscites in Schleswig, Klagenfurt

and in Upper Silesia, where the line of demarcation was later settled by the League of Nations. Nevertheless, both against Germany in the east, against Austria in the south and most of all on all the frontiers of Hungary, lines were drawn, which were in some cases determined by other considerations, and included greater minorities than was necessary in the new States. While such a transfer would in any case have caused great suffering and protest, this has been increased by the arbitrary nature of some of these frontier lines. And since many of the former minorities now rule over those who had previously tyrannized over them, bitter memories tend to make them unjust in their turn. Germany, for example, while accepting to a certain extent the loss of Posen to Poland, has felt deeply the loss of Danzig, the corridor to Poland and the partition of Upper Silesia, though these two last can be defended on ethnographical grounds. The Polish State includes also other nationalities, such as the Ruthenians of Galicia, and the White Russians, which were increased by the occupation of Vilna. The Czechs were allotted all Bohemia and therefore, the two and a half million Germans in it became a minority, while strategic reasons included numbers of Hungarians in Slovakia, as well as the Ruthenes of the Carpathians. Similarly the Rumans obtained not only the inevitable islands of Magyars and Germans in Transylvania, but also a large slice of Hungary proper, though not nearly so much as their secret treaty had promised them. The Italians, also, obtained a large portion of South Tirol, which was almost purely German, while their extension round the Adriatic brought many Slovenes and Serbs under their rule. Thus in one way or another nearly thirty millions of Europeans were still living as "minorities," the majority necessarily so, since they were surrounded by men of other race, but others arbitrarily included as a result of the war.

The situation was naturally much worse in some parts than others. The Germans of Czechoslovakia for example were united by many ties to the Czechs and were soon to take part in the activities of the new State. But the situation is very different as regards the Magyars who are sustained by the unceasing propaganda of their compatriots in Hungary. Even worse is the situation between Hungary and Rumania, where a policy of land expropriation has added bitterness to the struggle. The minorities in Greece and Yugoslavia have been sustained by an active organization, which styles itself "Macedonian," and is only partially connected with Bulgaria. The Germans of the Tirol, in spite of promises made in 1919, have been subjected by the Italian Fascist Government to a régime, which has caused a loud outcry not only in Austria, but also in Germany. Europe still contains, therefore, in its minorities a number of explosive forces of which the future is uncertain, but which obviously need special treatment. How far that has been organized under the League of Nations is described below, but it remains to sketch here such efforts as were made in the 19th century with a similar object and the causes of their failure.

The protection of minorities by the action of an outside power is a very old one. It constantly occurred with regard to religious minorities, Cromwell's action on behalf of the Protestants of Piedmont being a well-known one. But the attempt to protect by international treaty dates only from the settlement of 1814–15; the British Government insisted on clauses being inserted in the treaty which guaranteed, though only in vague terms, the rights of the Poles to special treatment by the Governments of Russia, Austria and Prussia. It was on these clauses that Britain and France founded their protests against Russian action after the insurrections of 1830 and 1863. Moreover, when the new State of the Netherlands was created in 1814, by adding Belgium to Holland, the new king guaranteed, in a document drawn up by the victorious Allies, religious equality and equal commercial opportunity to his new Belgian subjects. It was, however, in the Balkan peninsula, that the principle was to receive its fullest recognition. New States were created out of the Turkish empire by the action of the Powers, who had therefore both the opportunity and the duty to place limits on the sovereign power of the new States, as a condition of their recognition. This policy began in 1830 in connection with Greece and was continued throughout the century. It was again applied to Greece in 1863, and 1881, when additions to its territory were agreed to by the Powers and it was made a cardinal feature of the Treaty of Berlin. Clauses protecting religious minorities were inserted, as a condition of the recognition of Serbia, Montenegro, Bulgaria and Rumania. Turkey herself could not be treated in exactly the same manner, since she was already an established State. But in return for the guarantee of her territory made in 1856 at the Treaty of Paris, the sultan made, expressly as it was said of his own free will, a declaration that he would maintain religious liberty, while in the Treaty of Berlin the Powers took note of a similar declaration.

One of the main causes of these provisions especially as regards Rumania was a desire to protect the Jews. Efforts to obtain for them full civil rights and freedom of religion in Germany by international action had been made as early as the Treaty of Vienna (1815). Jewish communities in France, Britain and, later, in the United States not only influenced their Governments, while the Treaty of Berlin was being made, but established organizations to watch over the execution of the clauses of the treaty, which protected the Jews with the other national minorities.

Nevertheless, it was admitted that this attempt to protect the minorities by treaty was not a success. No machinery was set up to see that the promises of the new States were carried out, and they were often evaded or broken. Protests could be made and were sometimes made by one of the signatories of the treaty, but there was no means of ascertaining the facts and no method by which the Great Powers could act as a body in the name of Europe. Consequently the new governments who resented interference in their domestic concerns by outside Powers found it comparatively easy to defy their sponsors, when they wished to do so. When, therefore, the question arose at the Paris Conference, where again the Jewish community through a special delegation brought their influence to bear on the proceedings, it was only natural that some new method of control should be sought to protect the minorities in the new or greatly enlarged States, which were then being made. Opportunity was found in the permanent machinery of the League of Nations, to whom the supervision of the special treaties on this subject was entrusted. It was, of course, only on new States or on States that had been greatly enlarged as a result of the war that the obligations were imposed. No Great Power would submit to them, and Italy therefore, in spite of her new accessions of territory, is outside this machinery described below.

Bibliography.—The best account of how the present position arose is in *Les Minorités Nationales d'Europe et la Guerre Mondiale*, by Th. Ruyssen (1923), which has a good bibliography. For the history of protection of minorities in the 19th century *see* Iford L. Evans, "The Protection of Minorities," *British Year Book of International Law, 1923–24;* H. W. V. Temperley, *A History of the Peace Conference of Paris*, vol. v. Chapter II. (an authoritative account of the motives of the Powers). A German account is in F. Wertheimer, *Deutschland, die Minderheiten und der Völkerbund* (Berlin, 1926). For the influence of the Jews *see* Max J. Kohler and Simon Wolf, *Jewish Disabilities in the Balkan States* (New York, the American Jewish Committee, 1916) and Lucien Wolf, *Notes in the Diplomatic History of the Jewish Question* (Jewish Historical Society of England, 1919). (C. K. W.)

THE LEAGUE OF NATIONS

In the new system established after the World War, the League of Nations was entrusted with the task of guaranteeing the stipulations concerning the position of minorities. The States established, restored or territorially enlarged by the treaties of peace, as well as Austria, Bulgaria, Hungary and Turkey, accepted certain special obligations concerning the position of racial, linguistic and religious minorities in their territories; these undertakings, which were recognized in general as fundamental laws of the States in question, and as obligations of international concern, were placed under the guarantee of the League of Nations.

It is perhaps well to mention that, in accordance with these provisions, minorities consist—apart from a clause concerning all the *inhabitants* of a country—of those of its *nationals* who belong to a different race or religion, or speak a different language from the majority of the population. The system therefore does not affect either foreigners living in a country the majority of whose population belongs to a different race, religion or language from

their own, or nationals of the country belonging to minorities other than racial, religious or linguistic minorities, such as social or political minorities, etc.

International Instruments.—The international instruments in force in 1928 containing stipulations for the protection of minorities placed under the guarantee of the League of Nations may be classified as follows:

1. Special treaties signed at Paris during the Peace Conference:

(1) Treaty between the Principal Allied and Associated Powers and Poland, signed at Versailles on June 28, 1919;
(2) Treaty between the Principal Allied and Associated Powers and the Kingdom of the Serbs, Croats and Slovenes, signed at St. Germain on Sept. 10, 1919;
(3) Treaty between the Principal Allied and Associated Powers and Czechoslovakia, signed at St. Germain on Sept. 10, 1919;
(4) Treaty between the Principal Allied and Associated Powers and Rumania, signed at Paris on Dec. 9, 1919;
(5) Treaty between the Principal Allied and Associated Powers and Greece, signed at Sèvres on Aug. 10, 1920.

2. Special chapters inserted in the general treaties of peace:

(1) Treaty of Peace with Austria, signed at St. Germain-en-Laye on Sept. 10, 1919 (part iii., section v., articles 62 to 69);
(2) Treaty of Peace with Bulgaria, signed at Neuilly-sur-Seine on Nov. 27, 1919 (part iii., section iv., articles 49 to 57);
(3) Treaty of Peace with Hungary, signed at Trianon on June 4, 1920 (part iii., section vi., articles 54 to 60);
(4) Treaty of Peace with Turkey, signed at Lausanne on July 24, 1923 (part i., section iii., articles 37 to 45).

3. Declarations made before the Council of the League of Nations:

(1) Declaration by Albania, dated Oct. 2, 1921;
(2) Declaration by Estonia, dated Sept. 17, 1923;
(3) Declaration by Finland (in respect of the Åland islands), dated June 27, 1921;
(4) Declaration by Latvia, dated July 7, 1923;
(5) Declaration by Lithuania, dated May 12, 1922.

4. Conventions:

(1) German-Polish Convention on Upper Silesia, dated May 15, 1922 (part iii.);
(2) Convention concerning the Memel Territory, dated May 8, 1924 (Article 11, and Articles 26 and 27 of the Statute annexed to the Convention).

These lists of existing international instruments show the exceptional character of the system of protection of minorities by the League of Nations. The creators of the system had no intention of establishing a general jurisprudence applicable wherever racial, linguistic or religious minorities existed. They simply aimed at facilitating the solution of the problems which might arise from the existence of racial, linguistic or religious minorities in certain countries in which there was reason to suppose that, owing to special circumstances, these problems might present particular difficulties.

It is not enough to ascertain that a more or less considerable proportion of the population of a country belongs to a different race, language or religion to that of the majority in order to deduce the existence of a minority problem which would justify a special system of international protection being set up. The French-speaking population of Switzerland and, even more, the population of the Italian-speaking cantons constitute linguistic minorities, but nobody could maintain that they need international protection. On the other hand, there are genuine minorities in Europe which have not been placed under the protection of the League of Nations, and whose situation, in the opinion of many, constitutes a delicate problem which could have been resolved more easily and rapidly if the League had been able to intervene. The population of the minorities which, in virtue of existing engagements, have been placed under the protection of the League of Nations, may be estimated approximately between 25 and 30 millions. It is extremely difficult to speak of the minorities outside this system of protection, because it is almost impossible to draw a line between the cases where the existence of a minority population raises the problem of international protection and where such a problem does not arise. The existence of these minority groups has led to proposals being made that a general system of minorities protection by the League of Nations should be applied to all States equally, and at different times discussions on this subject have taken place in the League assembly. It must also be kept in mind that a certain number of questions which before the war presented themselves rather in the form of an aspiration towards territorial autonomy are tending now to develop into minorities questions.

These very brief indications, which do not pretend to have included all the European minorities which have remained outside the scope of the League's protection, should, nevertheless, suffice to explain why the notion of a general system of minorities protection by the League of Nations, applicable to all States, is upheld by a large number of persons, and why it should already have been the subject of frequent discussion in the League.

Even while the minorities treaties were being drafted at the Peace Conference, several of the States concerned raised objections. At the plenary meeting of the Conference on May 31, 1919, the representatives of these countries stated that they were prepared to accept obligations regarding the protection of minorities if all the States Members of the League accepted similar obligations. (*See* H. W. V. Temperley, *History of the Peace Conference,* vol. v., p. 129.)

Moreover, the Polish delegation, in a memorandum submitted to the Peace Conference, pointed out that the Treaty of Versailles contained no stipulations concerning the protection of minorities in Germany similar to those which Poland was asked to accept concerning the protection of German minorities in Poland. Germany, in the chapter of her counter-proposals to the peace terms which concerned the League of Nations, demanded the general protection of minorities, and in particular the protection of the German minorities in the territories ceded by her; she declared her willingness to treat minorities in her own territory according to the same principles.

At the meeting of May 31, 1919, M. Clemenceau and President Wilson replied to these objections. Their arguments will be found in Clemenceau's covering letter to Paderewski referred to below. Furthermore, the Allies, on their reply of June 16, 1919, to the German counter-proposals, called attention to the guarantees which would be given by the minorities treaties to the German minorities in the ceded territories, and noted the German delegation's declaration that Germany was prepared to treat minorities in her territory according to the same principles.

The tendency towards the generalization of the system of the protection of minorities became evident once more at the third session of the Assembly of the League of Nations (1922). In the Sixth committee of this Assembly the Latvian representative, Dr. Walters, put forward the idea of a minorities law established on the same basis for all States. The Finnish representative, M. Erich, proposed that the Assembly should ask the Council to set up a commission to study the question of the protection of minorities in general. The Estonian representative supported this proposal, which, however, was subsequently withdrawn. Finally, the Sixth committee submitted to the Assembly a number of resolutions, which the Assembly adopted at its meeting of Sept. 21, 1922. The fourth of these resolutions was as follows:

> The Assembly expresses the hope that the States which are not bound by any legal obligations to the League with respect to minorities will nevertheless observe in the treatment of their own racial, religious or linguistic minorities at least as high a standard of justice and toleration as is required by any of the treaties and by the regular action of the Council.

Three years later, in 1925, at the sixth session of the Assembly (meeting of Sept. 14, 1925), the Lithuanian delegation submitted the following proposal:

> The Lithuanian delegation proposes that the Sixth Assembly of the League should set up a special committee to prepare a draft convention to include all the States Members of the League of Nations and setting forth their common rights and duties in regard to minorities.

This proposal was discussed by the Sixth committee of the Assembly at its meeting of Sept. 16, 1925. The majority of the speakers who took part in the debate were opposed to the Lithuanian view; a few wished to reserve their opinion; and the Rumanian and Polish representatives declared themselves in favour of the proposal in principle. The Lithuanian delegate having finally withdrawn his proposal, the Assembly decided, on Sept. 22, to

inform the Council of the discussion which had taken place in the Sixth committee in this connection. The Council, at its meeting of Dec. 9, 1925, merely took note of the Assembly's resolution.

At the same meeting of the Council, M. de Mello Franco, (Brazil), as rapporteur on minorities questions, stated his personal views, in the course of which he pronounced definitely against generalizing the system for the protection of minorities. In M. de Mello Franco's opinion, "the mere co-existence of groups of persons forming collective entities, racially different, in the territory and under the jurisdiction of a State, is not sufficient to create the obligation to recognize the existence in that State, side by side with the majority of its population, of a minority requiring a protection entrusted to the League of Nations. In order that a minority, according to the meaning of the present treaties, should exist, it must be the product of struggles, going back for centuries, or perhaps for shorter periods, between certain nationalities, and of the transference of certain territories from one sovereignty to another through successive historic phases." As these factors were not constant in all the States Members of the League of Nations, it would not be possible, in M. de Mello Franco's opinion, for all these States to adhere to a general convention such as that proposed by the Lithuanian representative.

THE PROTECTION OF MINORITIES UNDER THE GUARANTEE OF THE LEAGUE OF NATIONS

The Minorities Treaties.—In pursuance of certain clauses in the general treaties of peace, Greece, Poland, Rumania, Czechoslovakia and the Kingdom of the Serbs, Croats and Slovenes agreed to the insertion in special treaties with the principal Allied and Associated Powers of the provisions which these Powers judged necessary to protect the interests of inhabitants differing from the majority of the population of these States in race, language or religion. For Greece, *see* Treaty of Neuilly, article 46; for Poland, Treaty of Versailles, article 93; for Rumania, Czechoslovakia and the Kingdom of the Serbs, Croats and Slovenes, Treaty of St. Germain, articles 60, 57 and 51 respectively. Articles 44 and 47 of the Treaty of Trianon confirm the pledges given to Hungary by the Kingdom of the Serbs, Croats and Slovenes and Rumania respectively.

The drafting of these treaties was entrusted to a commission of the Peace Conference, called the Commission on New States, set up on May 1, 1919. The following countries were represented on this commission: France (M. Berthelot), the United States (Mr. Miller and Mr. Hudson), Great Britain (Mr. Headlam Morley), and later also Italy (M. de Martino and M. Castoldi) and Japan (M. Adatci).

The first treaty prepared by this commission was that concluded with Poland. Its text was transmitted to M. Paderewski, the prime minister of Poland, with a letter from the president of the Conference, M. Clemenceau. This letter may be said to contain the "considerations" which in the Peace Conference's opinion form the basis of all treaties dealing with minorities. The letter first of all lays stress on the fact that the minorities treaties do not inaugurate any fresh departure. It had for a long time, said M. Clemenceau, been the established procedure of the public law of Europe, when a new State was created, or when an existing State absorbed any considerable amount of territory, for the formal recognition of the situation by the Great Powers to be accompanied by a request on the part of these Powers to the Government thus recognized that it should undertake to apply certain definite principles of government in the form of an agreement possessing an international character.

M. Clemenceau went on to point out that the new minorities treaties nevertheless differed in form from previous conventions relating to similar questions. This change of form was a necessary consequence of an essential part of the new system of international relations inaugurated by the establishment of the League of Nations. Formerly the guarantee for provisions of this nature was vested in the Great Powers. Experience had shown that this arrangement was ineffective in practice, and it was also open to the criticism that it might give the Great Powers, either individually or in combination, a right to interfere in the internal constitution of the States affected which could be used for purely political purposes. In the new system the guarantee was entrusted to the League of Nations. Furthermore, added M. Clemenceau, a clause had been inserted in the treaties by virtue of which disputes which might arise in connection with the guarantees in question should be submitted to the Permanent Court of International Justice. In this way the differences which might arise were removed from a political to a juridical sphere—a fact which facilitated an impartial decision.

The stipulations relating to the protection of minorities contained in the special minorities treaties and in the treaties of peace mentioned in category 2 were placed under the guarantee of the League of Nations by special resolutions of the Council of the League. *See* report to the Sixth Assembly on the work of the Council and the secretariat (pages 44 and 45).

Declarations Made Before the Council.—On Dec. 15, 1920, the Assembly, on the fifth committee's proposal, adopted the following resolution:

> In the event of Albania, the Baltic and the Caucasian States being admitted to the League, the Assembly requests that they should take the necessary measures to enforce the principles of the minorities treaties, and that they should arrange with the Council the details required to carry this object into effect.

Of the above States, Albania and Finland were alone admitted during the First Assembly, and questions regarding the minorities in these two countries were considered by the Council at several of its meetings.

As early as June 27, 1921, the Council of the League of Nations, after recognizing the sovereignty of Finland over the Åland islands, adopted a resolution regarding the guarantees which Finland undertook to grant to the population of the Åland islands for the preservation of their language, their culture and their local Swedish traditions. By the terms of this resolution, the Council was to see that the guarantees were duly observed. Finland was to forward to the Council, together with its own observations, any complaints or claims by the Åland landsting on the application of these guarantees, and the Council could consult the Permanent Court of International Justice if the question was of a legal nature.

Finland further submitted to the Council a memorandum conveying detailed information as to the rights guaranteed to minorities in Finland by the constitutional law of that country. The Council noted this information at its meeting of Oct. 2, 1921.

At the same meeting the Albanian representative signed a declaration containing provisions similar to those in the minorities treaties. This declaration was ratified by Albania on Feb. 17, 1922, and placed under the guarantee of the League of Nations.

During the Second Assembly, before the admission of Estonia, Latvia and Lithuania to the League, the representatives of these States signed a declaration by which the Estonian, Latvian and Lithuanian Governments accepted the Assembly resolution of Dec. 15, 1920, and stated their readiness to enter into negotiations with the Council for the purpose of determining the scope and the details of the application of their international obligations for the protection of minorities.

The Council, in Jan. 1922, requested the representative of Brazil to enter into negotiations with the representatives of these States.

On May 12 the representative of Lithuania, M. Sidzikauskas, signed before the Council a declaration containing provisions similar to those in the Polish Minorities Treaty.

Minority questions in Latvia and Estonia have been on the agenda at several meetings of the Council, and the representatives of Estonia and Latvia submitted several memoranda giving the views of their Governments.

At a meeting of the Council on July 7, 1923, the Latvian delegation made a declaration containing proposals which were accepted by the Council and which the Latvian Government subsequently approved on July 29, 1923.

This declaration brought to an end the negotiations between the Latvian Government and the Council with regard to the protection of minorities in Latvia. The Council, however, retains the right to re-open the question if it considers that the position of minorities in Latvia does not correspond to the general principles embodied in the Minorities treaties. The Latvian Government may also

ask that the negotiations be taken up again. The declaration, furthermore, contains stipulations as to the procedure to be adopted for petitions addressed to the League concerning the position of minorities in Latvia. This procedure is similar to that established by the Council for countries that have signed the minorities treaties. The Latvian Government undertakes in principle to give the Council any information that it may require if a question concerning the position of minorities in Latvia is brought before it by one of its members. In case of differences of opinion on questions of law or fact arising out of the declaration, either the Latvian Government or the Council may request that the difference be brought before the Permanent Court of International Justice for an advisory opinion. At its meeting of Sept. 17, 1923, the Council adopted a resolution and accepted proposals contained in a declaration which was enounced by the Estonian representative.

According to this resolution, the Council takes note of the information communicated to it by the Estonian representative in his report of Aug. 28, 1923, concerning the position of racial, linguistic and religious minorities in Estonia. The report states that the protection of minorities in Estonia is at present provided for by the Estonian constitution in a manner conforming to the general principles embodied in the minorities treaties. The Council, however, retains the right to reconsider the position of minorities in Estonia in case the application of the principles of the minorities treaties as laid down in the recommendation of the League Assembly voted on Dec. 15, 1920, should no longer be sufficiently safeguarded. For this purpose the Council may ask the Estonian Government to furnish it with any information it may require as to minorities questions that may be brought before it by one of its members. In case of differences of opinion on questions of law or fact arising out of this resolution, recourse may be had to the Permanent Court of International Justice for an advisory opinion.

The declaration subsequently made by the Estonian representative laid down the procedure to be followed with regard to information addressed to the League on the position of minorities. This procedure corresponds to that already described in the case of Latvia.

The Conventions.—The decision which was adopted on Oct. 20, 1921, by the conference of ambassadors in conformity with the opinion expressed by the Council of the League, lays down as follows:

(1) That the Polish Minorities Treaty of June 28, 1919, is applicable to the Polish portion of Upper Silesia;

(2) That considerations of equity, as well as the maintenance of the economic life of Upper Silesia, require that the German Government should accept similar provisions, at least for a provisional period of 15 years, as regards the German portion of Upper Silesia;

(3) That the provisions of the convention to be concluded between the German and Polish Governments in this connection should constitute obligations of international concern both for Germany and for Poland, and should be placed under the guarantee of the League of Nations in the same manner as those of the treaty of June 28, 1919.

On the basis of this decision, negotiations between Germany and Poland were begun at Beuthen in Dec. 1921, and were resumed at Geneva on Feb. 15, 1922.

The results of these negotiations were embodied in part III. (articles 64–158) of the German-Polish Convention signed at Geneva on May 15, 1922.

The first division of this part of the Convention contains a synoptic table, setting out in one column those articles of the Polish Minorities Treaty which Poland undertakes to apply in the Polish portion of Upper Silesia, and in another column parallel engagements entered into by Germany.

However, in order that the protection of minorities in the plebiscite portions of the territory might be based upon principles of equitable reciprocity, and in order that the special conditions arising out of the provisional régime might receive due consideration, the contracting parties agreed to observe, for a period of 15 years, certain more detailed provisions concerning civil and political rights, religion, private education, public elementary education, vocational training and extension classes, secondary and higher education, the official language of administration and the language to be employed in all legal proceedings of whatever nature.

The Convention also deals with the right of petition and methods of appeal. A minorities office is to be set up in each portion of the plebiscite territory. Persons belonging to a minority may, after having filed a complaint with the highest administrative authority, submit a petition to the minorities office of their State for consideration. If the minorities office does not succeed in obtaining satisfaction for the petitioners, it will transmit the petition, together with any comments it may wish to make, to the president of the Mixed Commission for his opinion. The president will give the members of the Mixed Commission an opportunity to express their views. (The Mixed Commission is composed of two Germans and two Poles, with a president of some other nationality.)

The president will then make known his opinion to the minorities office, which will communicate it to the proper administrative authorities. In case the petitioners are not satisfied with the findings of the administrative authority, they may appeal to the Council of the League of Nations.

Such appeals must be addressed to the minorities office, which will see that they are forwarded to the Council by the Government.

The Council is also competent to give a decision concerning any individual or collective petition addressed to it directly by persons belonging to a minority.

The Convention concerning the Memel Territory contains only two provisions relating to the protection of minorities. The first (article 11 of the Convention and article 26 of the statute annexed to it) stipulates that the Lithuanian declaration of May 12, 1922, applies to minorities within the Memel Territory, with the exception of paragraph 4 of article 4, relating to the use of the minority languages in the law courts. This exception is due to the fact that, in accordance with the second stipulation (article 27 of the statute) the Lithuanian and the German languages are recognized on the same footing as official languages in the Memel Territory.

Certain States have concluded special conventions concerning the position of their respective minorities, but these have not been placed under the guarantee of the League of Nations, *e.g.*, the Treaty of Brünn between Austria and Czechoslovakia, dated June 7, 1920; the Treaty of April 23, 1925, between Poland and Czechoslovakia, etc. Mention may also be made of article 33 of the Convention of Nov. 9, 1920, between Poland and the Free City of Danzig, under which Danzig undertakes to apply to minorities provisions similar to those which are applied by Poland in execution of the Polish Minorities Treaty. The Agreement of Oct. 24, 1921, between Danzig and Poland, in execution of the Convention of Nov. 9, 1920, deals in articles 225 and 226 with the question of language, and in article 227 and annex with the question of education in connection with the Polish minority at Danzig.

THE RIGHTS AND DUTIES OF MINORITIES

Various treaties guaranteed to racial, linguistic or religious minorities certain rights, which may be grouped under the following headings; (*a*) a number of general rights more or less common to all minorities in countries which have accepted the system of the protection of minorities by the League; (*b*) certain special rights guaranteed to minorities situated in more or less exceptional circumstances.

GENERAL RIGHTS

Right to Nationality.—The various minorities treaties contain special provisions with regard to changes in nationality as a result of territorial redistribution[1]. The principle contained in these provisions is that the nationality of a newly-created or enlarged country may be acquired: (*a*) by the fact that a person was habitually resident in the transferred territory, or had rights of citizenship (or "pertinenza") there at the time of the coming

[1]Articles of the Treaties of Peace with Austria, Bulgaria, Hungary and Turkey which refer to nationality had not been placed under the guarantee of the League until 1929.

into force of the treaty[1], and (*b*) by the fact that a person was born in the territory of parents habitually resident there, even though at the date of the coming into force of the treaty the persons concerned were not themselves habitually resident in the territory[2].

The various treaties also lay down that all persons born in the territory of one of these States and not born nationals of another State shall *ipso facto* become nationals of such State.

Finally, the minorities treaties contain certain provisions with regard to the right of option. Persons over 18 years of age who, as a result of territorial changes and the operation of provisions regarding nationality, became nationals of one of the new or territorially enlarged States, were allowed to opt for any other nationality which was open to them. The period fixed in the minorities and peace treaties for the exercise of this right of option was two years as from the date of the coming into force of these treaties. Persons who exercised this right were, within the succeeding twelve months after option, to leave the territory of the State whose nationality they had lost. The treaties authorized them to retain their immovable property in the territory of the State which they had left and to carry with them their movable property of every description, no export duties being imposed upon them in connection with the removal of such property. The minorities treaties contain a special clause under which the States concerned undertake to place no hindrance of any sort in the way of exercise of this right of option.

Life, Personal Liberty and Freedom of Worship.—Under the minorities treaties, the various States undertake to assure to all their inhabitants full and complete protection of life and liberty; they recognize that their inhabitants shall be entitled to the free exercise, whether public or private, of any creed, religion or belief whose practices are not inconsistent with public order or public morals.

These rights therefore have been established not merely on behalf of citizens belonging to a minority, but for the benefit of all the inhabitants of the country. Nevertheless, as will be explained later, the League's guarantee applies only in the case of persons belonging to racial, linguistic or religious minorities.

Equal Treatment.—The various minorities treaties embody the following general principles: (*a*) equality of all nationals of the same country before the law, (*b*) equality in the matter of civil and political rights, and (*c*) equality of treatment and security in law and in fact.

In the arguments in support of its Advisory Opinion No. 6 with regard to the question of settlers of German origin in Poland, the Permanent Court of International Justice interpreted these provisions on equality as follows: "The facts that no racial discrimination appears in the text of the law of July 14, 1920, and that in a few instances the law applies to non-German Polish nationals who took over property as purchasers from original holders of German race, make no substantial difference. . . . There must be equality in fact as well as ostensible legal equality in the sense of the absence of discrimination in the words of the law."

The treaties also lay down that differences of race, language or religion shall not prejudice any national of the country in the matter of admission to public employments, functions and honours or the exercise of professions and industries; that nationals belonging to minorities shall have an equal right to establish, manage and control at their own expense charitable, religious and social institutions, schools and other educational establishments, with the right to use their own language, and to exercise their religion freely therein.

[1]In the case of Poland, the Serb-Croat-Slovene Kingdom and Czechoslovakia, this provision must be interpreted in conjunction with certain provisions of the Treaties of Versailles (article 91, § 2), of St. Germain (article 76), and Trianon (article 62), according to which persons who established their place of residence or acquired rights of citizenship in various circumstances subsequent to a certain date (Jan. 1, 1908 in the case of Poland, and Jan. 1, 1910, in the case of the Kingdom of the Serbs, Croats and Slovenes and Czechoslovakia) do not acquire the nationality of these States without an authorisation from the latter.

[2]In its Advisory Opinion, Number 7, of Sept. 15, 1923, the Permanent Court of International Justice interpreted this provision, with regard to the Polish Treaty, as referring only to the habitual residence of the parents at the date of birth of the persons concerned.

The Use of the Minority Language.—These rights as defined in the treaties take the form of three obligations accepted by the States concerned, namely:

(*a*) The obligation to impose no restriction on the free use by any national of any language in private intercourse, in commerce, in religion, in the press or in publications of any kind, or at public meetings.

(*b*) The obligation to grant nationals speaking a language other than the official language adequate facilities for the use of their language, either orally or in writing before the courts.

(*c*) The obligation to grant adequate facilities in towns and districts where there is a considerable proportion of nationals speaking a language other than the official language of the State, to ensure that in the primary schools[1] the instruction shall be given to the children of such nationals through the medium of their own language.

This provision does not, however, prevent the Government from making the teaching of the official language obligatory in these schools.

Public Funds.—The treaties also lay down that in towns and districts where there is a considerable proportion of nationals of the country belonging to racial, religious or linguistic minorities, these minorities shall be assured an equitable share in the enjoyment and application of the sums which may be provided out of public funds under the State, municipal or other budget, for educational, religious or charitable purposes.

SPECIAL RIGHTS

Jewish Minorities. (a) *Greece.*—In towns and districts where there is a considerable proportion of Greek nationals of the Jewish religion the Government undertakes to respect their Sabbath. This provision does not, however, exempt Jews from such obligations as shall be imposed upon all other Greek nationals for the necessary purposes of military service, national defence or the preservation of public order (article 10 of the Greek Minorities Treaty).

(b) *Lithuania and Poland.*—The Lithuanian Declaration (article 7) and the Polish Treaty (article 10) provide for the constitution of educational committees appointed by the Jewish communities with a view to providing under the general control of the State for the distribution of the proportional share of public funds allocated to Jewish schools and for the organization and management of these schools. Respect for the Sabbath is also stipulated. It is also laid down that no election shall be held on a Saturday. This provision, however, does not exempt Jews from such obligations as shall be imposed upon all other nationals for the necessary purposes of military service, national defence or the preservation of public order. (Article 8 of the Lithuanian Declaration and article 11 of the Polish Treaty.)

(c) *Rumania* recognizes as Rumanian nationals *ipso facto* and without the requirement of any formality Jews inhabiting any Rumanian territory, who do not possess another nationality (article 7 of the Rumanian Minorities Treaty).

Valachs of Pindus.—Greece has agreed to accord to the communities of the Valachs of Pindus local autonomy under the control of the Greek State, in regard to religious, charitable or scholastic matters. (Article 12 of the Greek Minorities Treaty.)

Mount Athos.—Greece has agreed (article 13 of the Greek Minorities Treaty) to recognize and maintain the traditional rights and liberties enjoyed by the non-Greek monastic communities of Mt. Athos under article 62 of the Treaty of Berlin, which reads: "The monks of Mount Athos, of whatever country they may be natives, shall be maintained in their former possessions and advantages, and shall enjoy, without any exception, complete equality of rights and prerogatives."

Muslims in Albania, Greece and the Serb-Croat-Slovene Kingdom.—The Greek Treaty (article 14), the Treaty with the Kingdom of the Serbs, Croats and Slovenes (article 10) and the Albanian Declaration (articles 2 and 3) lay down that all necessary measures shall be taken to enable questions of family law and personal status to be regulated in accordance with

[1]It should be observed that in the Czechoslovak Treaty there is no mention of "primary schools," the word employed being "instruction" in general without any limitation.

Muslim usage. At the same time these treaties guarantee the protection of mosques, cemeteries and other religious establishments.

Czech and Saxon Communities in Transylvania.—Rumania has agreed to grant these communities local autonomy in religious and scholastic matters, subject to the control of the Rumanian State (article 11 of the Rumanian Minorities Treaty).

Ruthene Territory South of the Carpathians.—Czechoslovakia has agreed to constitute this territory as an autonomous unit within the Czechoslovak State, and to accord to it the fullest degree of self-government compatible with the unity of that State. The régime is, according to the provisions of the treaty, to include a special diet having powers of legislation in all linguistic, scholastic and religious questions, in matters of local administration, and in other questions which the laws of the Czechoslovak State may assign to it. The governor of this territory must be appointed by the president of the republic and its officials must be chosen as far as possible from the inhabitants of the territory (articles 10 to 13 of the Czechoslovak Minorities Treaty).

THE DUTIES OF MINORITIES

The treaties contain no stipulations regarding the "duties" of minorities towards the States of which they form part.

The Third Ordinary Assembly of the League, however, in 1922, when defining certain points of the procedure to be followed in settling minority questions, also adopted the two following resolutions regarding the "duties" of minorities:

While the Assembly recognizes the primary right of the minorities to be protected by the League from oppression, it also emphasizes the duty incumbent upon persons belonging to racial, religious or linguistic minorities to co-operate as loyal fellow-citizens with the nations to which they now belong.

The secretariat of the League, which has the duty of collecting information concerning the manner in which the minorities treaties are carried out, should not only assist the Council in the study of complaints concerning infractions of these treaties, but should also assist the Council in ascertaining in what manner the persons belonging to racial, linguistic, or religious minorities fulfil their duties towards their States. The information thus collected might be placed at the disposal of the States Members of the League of Nations if they so desire.

THE LEAGUE OF NATIONS GUARANTEE AND PROCEDURE

All the Minorities Treaties, and also the chapters of the treaties of peace with Austria, Bulgaria, Hungary and Turkey[1] which relate to minorities, contain a clause establishing a League of Nations guarantee for such of their provisions as affect minorities. This clause reads as follows:

Poland (or Austria, Czechoslovakia, etc.) agrees that the stipulations in the foregoing Articles, so far as they affect persons belonging to racial, religious or linguistic minorities, constitute obligations of international concern and shall be placed under the guarantee of the League of Nations. They shall not be modified without the assent of a majority of the Council of the League of Nations. The United States, the British empire, France, Italy and Japan[2] hereby agree not to withhold their assent from any modification in these articles which is in due form assented to by a majority of the Council of the League of Nations.

Poland (or Austria, Czechoslovakia, etc.) agrees that any Member of the Council of the League of Nations shall have the right to bring to the attention of the Council any infraction, or any danger of infraction, of any of these obligations, and that the Council may thereupon take such action and give such direction as it may deem proper and effective in the circumstances.

Poland (or Austria, Czechoslovakia, etc.) further agrees that any difference of opinion as to questions of law or fact arising out of these Articles between the . . . Government and any one of the principal Allied and Associated Powers or any other Power, a Member of the Council of the League of Nations[3], shall be held to be a dispute of an international character under article 14 of the Covenant of the League of Nations. The . . . Government hereby consents that any such dispute shall, if the other party thereto demands, be referred to the Permanent Court of International Justice. The decision of the Permanent Court shall be final and shall have the same force and effect as an award under article 13 of the Covenant.

The first paragraph of these provisions confines the League's guarantee to "persons belonging to racial, religious or linguistic minorities." The significance of this restriction will be realized when we remember that the Minorities Treaties establish certain very important rights, such as the right to protection of life and liberty and certain rights as to equality, and this not only for the benefit of minorities but for that of all nationals, and indeed all the inhabitants of the country. If, therefore, a State which had subscribed to these undertakings infringed any provision establishing one of these rights, to the prejudice of a person not belonging to a minority, such an act would not bring the League's guarantee into play as the guarantee in this case applies only with regard to minorities.

According to the second paragraph, the members of the council (in other words certain Governments) alone have the right to bring to the attention of the Council any infraction or danger of infraction of any of the provisions relating to minorities. Accordingly, the report of the Italian representative, M. Tittoni, adopted by the Council on Oct. 22, 1920, mentions the sharp distinction between the right of the members of the Council (that is to say, certain Governments) to bring to the attention of the Council any infraction or danger of infraction of the terms of the treaties, and the right of the minorities themselves, or of States not represented on the Council, to bring such infractions or dangers of infraction to the League's notice. The directing of the Council's attention by one or more of its members to an infraction or danger of infraction is a judicial act which has the effect of bringing the question officially to the Council's notice, whereas a communication by which an infraction or danger of infraction is brought to the League's notice otherwise than by a Member of the Council merely constitutes a petition or report and cannot in itself have the effect of officially bringing the matter before the Council.

The right of the treaties thus established, according to which members of the Council alone can notify the Council of cases of infraction of the Minorities Treaties, has on a number of occasions given rise to discussion and controversy. Thus, at the time of the negotiations which led to the Albanian Declaration regarding the protection of minorities, the Greek Government asked that a clause should be inserted granting it the right to bring to the notice of the Council any infraction or danger of infraction of the obligations which Albania was about to assume. The Council thought that there was no occasion to insert such a clause, as it would have constituted an exception to the general principles adopted in all the Minorities Treaties. (*See* Minutes of the 14th Session of the Council Sept.–Oct. 1921, pp. 115 and 162.) In 1925 Count Apponyi, the Hungarian representative at the Sixth session of the Assembly, maintained that it ought to be possible for the Council to be notified directly, by means of petitions from certain sources—from supreme ecclesiastical organizations or the cultural or economic institutions of the different countries. (*See* Records of the 6th Assembly [plenary meetings], page 73.) M. de Mello Franco (Brazil), discussing this question in the personal statement which he made to the Council on Dec. 9, 1925, drew attention to the practical difficulties to which such a procedure would give rise, and also asserted that it was incompatible with the letter of the treaties in force, by which even States which are members of the League but have no seat on the Council have no power to bring to the latter's notice cases of infraction or danger of infraction of the terms of the minorities treaties.

The second paragraph of the provisions concerning the League of Nations guarantee further lays down that when once a Minorities question has been brought before it, the Council may "thereupon take such action and give such direction as it may deem proper and effective in the circumstances."

The extremely general character of this wording and the wide powers it confers upon the Council will at once be noticed, as also the fact that no indication is given as to the procedure to be fol-

[1] The Albanian and Lithuanian Declarations contain the same provision. For Estonia and Latvia, *see* p. 558.

[2] The Treaties of Peace with Austria, Bulgaria and Hungary read as follows: "The Allied and Associated Powers represented on the Council . . ." The United States of America is not mentioned in the Treaty of Lausanne.

[3] The Treaty of Lausanne reads as follows here: " . . . and any one of the other Signatory Powers or any other Power, a member of the Council of the League of Nations . . . (article 44)."

lowed by the Council in the settlement of Minorities questions[1]. The only rule of procedure applicable to this paragraph is that provided in article 4 of the Covenant of the League, which lays down that any member of the League not represented on the Council shall be invited to send a representative to sit as a member at any meeting of the Council during the consideration of matters specially affecting the interests of that member.

In practice the Council has always felt that it should act as an organ of conciliation in these matters, and accordingly all the Minorities questions with which it has had to deal have been settled by agreement with the Governments concerned. In two cases (the questions of settlers of German race in Poland and the acquisition of Polish nationality), the Council asked the Permanent Court of International Justice for an advisory opinion on certain points.

The third paragraph of the provisions relating to the League of Nations guarantees deals with the reference of minorities questions to the Permanent Court of International Justice. M. Clemenceau himself, in his covering letter to the Polish Minorities Treaty emphasized the importance of this clause whereby, as he said, "differences which may arise will be removed from the political sphere and placed in the hands of a judicial body." Acting in the spirit of this declaration the Third Assembly, in its resolution II. of Sept. 21, 1922, recommended that the members of the Council should appeal without unnecessary delay to the Permanent Court of International Justice for a decision in case of a difference of opinion with the Governments concerned as to questions of law or fact relating to the application of the minorities treaties.

PROCEDURE

The Council did not consider it necessary to institute a special procedure for the examination of minorities questions brought before it by any of its members, but laid down such procedure for petitions and communications in regard to the protection of minorities addressed to the League but not sponsored by any of the members of the Council.

This procedure provides machinery within the framework of the treaties, enabling minorities to appeal to the League by means of petitions, and it also ensures consideration of these petitions by a suitable body.

The treaties merely refer to the duty incumbent upon members of the Council of seeing that the clauses provided for the benefit of minorities are duly observed, but the members of the Council realized, even at their very first meetings, that, however desirous they might be of observing the spirit of the minorities treaties, they would find it very difficult in practice to keep themselves directly informed as to how these treaties were being applied. Moreover, it was in some ways undesirable that minorities should apply direct to members of the Council individually; appeals of this kind would have the same disadvantages as the old system of protection of minorities by the intervention of the Great Powers which the League of Nations guarantee had been specifically intended to obviate. The direct appeal of minorities to a foreign power would have the further disadvantage that it might be interpreted by the Government under which the minorities were placed as an act of disloyalty on their part. It was in order to obviate these difficulties that the Council of the League established its procedure for minorities as the best method of rendering effective the protection guaranteed to minorities by the League.

The Council was also anxious to give minorities a guarantee that their petitions would receive serious consideration; hence the institution of the "Minorities Committee."

The system of procedure as it exists to-day was not established all at once; it is the outcome of long experience and a series of adaptations. It is to be found in a number of Council resolutions which supplement or rectify each other, namely the report of the Italian representative and the Council resolutions of Oct. 22 and 25, 1920, and the resolutions of June 27, 1921, Sept. 5, 1923, and June 10, 1925.

The basic idea underlying the procedure thus instituted is that petitions are intended purely for purposes of *information.* The Council has carefully eliminated anything that might lead to procedure in which the respective cases of the minority and of the Government concerned would be heard as if they were two parties to a lawsuit, because it considered that such a situation was incompatible with the ideas and principles underlying the present organization of States.

Accordingly the secretary-general in principle merely acknowledges the receipt of a petition, and does not keep the petitioner informed as to what is done with it. (On this subject *see* the memorandum of the secretary-general, approved by the Council on June 10, 1926 [*Official Journal,* July, 1926, pp. 878 and 986].) The position of the petitioner in this procedure has frequently given rise to controversy. Reference may be made, for instance, to the speech of the Hungarian representative, Count Apponyi, at the Sixth session of the Assembly (Sept. 14, 1925). On that occasion Count Apponyi expressed himself definitely in favour of a procedure in which both parties, and therefore the representatives of the petitioners, would have an opportunity of presenting their case. In reply to this, M. de Mello Franco (Brazil) said in his personal statement to the Council dated on Dec. 9, 1925, that in his opinion such a conception "would give rise to dangers which would threaten the moral ends towards which the system of protection instituted by the minorities treaties is tending."

An analysis is given below of the various Council resolutions laying down the procedure for minorities' petitions (Resolutions of Oct. 22 and 25, 1920, June 27, 1921, Sept. 5, 1923, June 10, 1925).

Acceptance of Petitions.—As soon as a petition regarding the protection of minorities is received by the League secretariat it is submitted to a preliminary examination by the competent section. The object of this examination is to decide whether the petition can be accepted and the necessary procedure applied to it, or whether it should be declared inadmissible and rejected.

It is the secretary-general who has to decide whether a petition can be accepted or not. The Government to which the petition refers may, however, object to this decision, in which case the question must be submitted to the acting President of the Council, who may appoint two other members of the Council to assist him in the consideration of the matter. Lastly, if the State concerned so requests, this question of procedure may be placed on the Council's agenda (Council resolution of Sept. 5, 1923).

The conditions which a petition must fulfill in order to be accepted were laid down by the Council in its resolution of Sept. 5, 1923. They are as follows:

1. *Origin of the Petition.*—The only condition required is that the petition must not emanate from an anonymous or unauthenticated source.

2. *Form of Petitions.*—Petitions must not be worded in violent language.

3. *Contents of Petitions.*—As regards their contents petitions (*a*) must have in view the protection of minorities in accordance with the treaties; (*b*) in particular, must not be submitted in the form of a request for the severance of political relations between the minority in question and the State of which it forms a part and (*c*) must contain information or refer to facts which have not recently been the subject of a petition submitted to the ordinary procedure.

[1]The report submitted by the Sixth committee to the Third Assembly (1922) mentions an observation by Prof. Gilbert Murray (South Africa) to the effect that in certain localities of mixed population, where conflicts were frequent and serious, order had frequently been maintained and tranquillity restored by the mere presence of consuls or other representatives of foreign Governments who could impartially report on events and bring to bear the influence of a wider public opinion. Prof. Gilbert Murray also observed that cases might arise in which the presence of such a representative of the League might have an even more beneficent effect, in view of the disinterestedness and the moral prestige possessed by the League, and suggested that the Council might well consider the desirability in suitable cases of employing such representatives, with the consent of the Government concerned, to allay public excitement and gradually restore tranquillity in disturbed districts. The Committee felt the force of these observations and placed them on record, but, considering the variety of possible contingencies and the wide discretion in the hands of the Council for meeting them, thought best not to embody the proposals in a definite resolution.

Preliminary Communication of Petitions to the Government Concerned.—Originally (*see* report of M. Tittoni, Oct. 22, 1920) the Secretary-General, if he considered that a petition could be accepted, used to communicate it without comment to the Members of the Council for information.

The State concerned, if a Member of the League, was informed simultaneously with the Council as to the subject of the petition, it being a rule that every document communicated to the Members of the Council for information is communicated immediately to all Members of the League. In this way the State concerned had an opportunity of submitting to the Members of the Council such observations as it thought desirable to make.

Certain Governments, however, raised objections to this practice and proposed amendments to the procedure. On the basis of their proposals, the Council, by its resolution of June 27, 1921, modified the procedure so that all petitions concerning the protection of minorities, under the provisions of the treaties, from petitioners other than Members of the League, were communicated to the State concerned before being brought to the notice of the Members of the League. That State had a time-limit of three weeks within which to inform the secretariat whether it intended to make any comments or not. If its reply were in the affirmative, it had a total period of two months in which to submit its observations, which would be communicated, together with the petition, to the members of the council and to the Members of the League.

This procedure is still in force for the preliminary communication of petitions to the Governments concerned, but, as will be seen later, it has been modified as regards the communication of petitions to all the Members of the League.

There are, however, two exceptions to the above-mentioned rule. In both cases the petition is not communicated in advance to the Government concerned but is sent simultaneously to that Government and to the Members of the Council. The first of these exceptions refers to "exceptional and extremely urgent" cases. In such cases the Secretary-General, before communicating the petition to the Members of the Council, need only inform the representative of the State concerned accredited to the League secretariat. The question whether a case is of an exceptional nature or extremely urgent is left to the discretion of the Secretary-General. The second exception refers to petitions from a Government which is a Member of the League. As it was decided to communicate petitions in advance to the Government concerned only in the case of petitions "from petitioners other than Members of the League," it must be assumed that the original procedure remains in force as far as Members themselves are concerned.

The Council, in its resolution of Sept. 5, 1923, authorized the Member of the Council acting as president to extend, at the request of the Government concerned, the period of two months within which that Government must send in its observations.

Communication of Petitions to Members of the Council.—M. Tittoni's report explicitly provided that petitions should be sent by the secretary-general to the Members of the Council without comment. It was careful to add, however, that this communication of petitions did not constitute a juridical act, because the Council did not become competent to deal with a question unless one of its Members notified it that the subject of the petition constituted an infraction or danger of infraction of the Treaties. As already pointed out, therefore, this communication of petitions was intended purely for purposes of information. According to the procedure now in force (resolution of June 27, 1921) petitions are communicated to members of the Council either immediately, if the Government concerned declares that it does not wish to submit any observations on the petition, or at the end of the period of three weeks, if the Government concerned has not replied to the communication transmitting the petition to it, or, if the Government concerned says that it intends to present observations, as soon as these reach the secretariat. (Another possibility is that the Government concerned might state its intention to submit observations, but might not send them within two months; in such a case however, it would doubtless ask for an extension of the time-limit.) As already stated, urgent petitions and petitions from Governments of Members of the League are communicated simultaneously to the Members of the Council and the Government concerned. At the time when M. Tittoni's report was adopted by the Council the communication of a petition to members of the Council meant that it would also be communicated to all the Members of the League, since, as explained in the report, it was the settled practice of the secretary-general that every document communicated to the Members of the Council for information should also be sent to all members of the League. As, however, this practice gave rise to objections on the part of certain Governments which were signatories to minorities treaties[1], the Council, in its resolution of Sept. 5, 1923, decided that the communication of petitions and of observations (should there be any) by the Government concerned should be restricted to the Members of the Council, but that communication could be made to other members of the League or to the general public at the request of the Governments concerned or by virtue of a resolution passed by the Council.

The restriction which the Council introduced on Sept. 5, 1923, gave rise to a discussion by the Sixth committee of the Fourth Assembly (meeting of Sept. 25, 1923), as a result of which the Assembly, on Sept. 26, adopted a resolution confirming the Council's resolution of Sept. 5, but adding that "by virtue of paragraph v. of the Assembly resolution dated Sept. 21, 1922[2], the Government of any member of the League can request the secretariat to communicate to it any petitions (together with the observations of the Government concerned) which have been communicated to the Council."

The Minorities Committee[3].—The Council introduced into its procedure provisions whereby petitions, when once communicated to the members of the Council in ordinary cases together with the observations of the Government concerned, would be carefully considered by them. The object of this examination is to enable the members of the Council to decide whether they should or should not bring the subject of the petition to the Council's notice as constituting an infraction or danger of infraction of the treaties. With this object the Council decided in its resolution of Oct. 25, 1920, that with a view to assisting its members in the exercise of their rights and duties in the matter it was desirable that the president of the Council and two members appointed by him in each case should proceed to consider any petition or communication with regard to an infraction or danger of infraction of the clauses of the minorities treaties. There was thus instituted what came to be commonly known as the "Committee of Three" or "Minorities Committee," which has become one of the normal organizations of the League in the matter of the protection of minorities.

This committee was formed essentially in the interest of the minorities themselves, in order to enable them to appeal direct to the League. On this subject the *Supplementary Report* (A. 7. [*a*] 1925, p. 20) to the Sixth Assembly on the work of the Council contains the following passage: "(By the creation of the Minorities Committee) the Council has . . . placed at the disposal of the minorities a special body which enables them to state their claims without infringing in any way either the letter or spirit of the Treaties."

(a) *Composition of the Committee.*—A minorities committee

[1]This question was dealt with by the Polish and Czechoslovak Governments, by the former in its notes of Jan. 16 and Aug. 22, 1923, and by the latter in its note of April 5, 1923. These notes were summarized in the report submitted to the Council on Sept. 5, 1923, by M. de Rio Branco (Brazil). (See *Official Journal,* Nov. 1923, p. 1426.)

[2]Paragraph v. reads as follows: "The secretariat of the League which has the duty of collecting information concerning the manner in which the Minorities Treaties are carried out should not only assist the Council in the study of complaints concerning infractions of these treaties, but should also assist the Council in ascertaining in what manner the persons belonging to racial, linguistic or religious minorities fulfil their duties towards their States. The information thus collected might be placed at the disposal of the States Members of the League of Nations if they so desire."

[3]For all matters relating to the Minorities Committee see *Supplementary Report* to the Sixth Committee on the work of the Council and of the secretariat (A. 7 [*a*] 1925, pp. 17–20).

is formed to deal with each petition. Until June 10, 1925, these minorities committees were composed of the acting President of the Council at the time when the petition and the observations of the Government concerned were circulated to the members of the Council, and two other members chosen by the President from among any of his colleagues. On June 10, 1925, the Council adopted a resolution confirming, as regards the composition of these committees, certain rules which were already applied in practice and were designed to ensure that the committees would be independent and impartial. According to this Council resolution the members of a minorities committee cannot include either the representative of the State to which the persons belonging to the minority in question are subject, or the representative of a neighbouring State or of a State a majority of whose population belong from the ethnical point of view to the same people as the persons who are members of the minority in question. If the acting President of the Council himself comes under any of these three categories, recourse will be had to the member of the Council who was president before him and who is not in the same position.

(b) *The Committee's Method of Work.*—The above-mentioned *Supplementary Report to the Sixth Assembly* gives the following particulars as regards the working of the minorities committee:

"After the communication of the petition to the Council, with the observations, if any, of the interested Government, the director of the minorities section addresses a letter, accompanied by a copy of the document in question, to the acting president of the Council, reminding him that it is his duty to appoint two of his colleagues in order to proceed without delay to an examination of the document. As soon as the president has sent his reply, the director of the minorities section gets into touch with the two other members of the Council.

"The minorities section, in some cases in collaboration with the legal section, prepares for the use of the three members of the committee a written statement on the questions of fact and law raised by the observations of the interested Government. Further, the minorities section is at the disposal of the members of the Committee and of the members of the Council to procure for them any supplementary information which they may wish to receive.

"The meetings of the minorities committee, or more correctly of the various minorities committees, which are simultaneously at work, generally take place during the sessions of the Council. Of late, some meetings have also taken place between the sessions of the Council owing to the difficulty of finding in all cases during the sessions of the Council the time necessary for the discussion of these matters, which are sometimes extremely detailed and prolonged, and which always have a delicate side to them and require the most conscientious preparation both by the secretariat and by the members of the Council.

"The examination of a case by the minorities committee is not, of course, restricted to the formal meetings of the committee. It is the duty of each member of the committee, as well as of the secretariat, to proceed to this examination without delay after the communication to the Council of the document relating to the case. The secretariat begins an examination of the case without waiting for the distribution of this document. The discussion is accordingly, from the first meeting of the three members of the committee, except perhaps in cases of extreme urgency, based on a very considerable amount of preparatory work.

"The meetings of the committee are held in private, and no formal minutes are kept. Each committee is free to adopt its own procedure.

"It results from the object of the work undertaken by a minorities committee that its members are free to form the best opinion they can of all the factors in the case which they are asked to examine. They may take into consideration the greater or less importance of the case, and its more or less general significance. They may take into account the attitude more or less conciliatory of the interested Government towards the requests of the minority as well as the attitude more or less loyal of the persons belonging to the minority. They may form the opinion, in a particular case, that the petitioner should have resorted to the administrative or judicial authorities of the country before addressing the League of Nations. In the minorities committees all these factors are continually discussed and taken into consideration.

"The members of the committee may, moreover, enter into correspondence with the interested Government with a view to removing doubts or misunderstandings or making friendly suggestions to the Government to induce it to modify its attitude on a point which, failing such a solution, would appear to the members of the committee to be a case which should be brought to the attention of the Council. Before deciding whether it should or should not draw the attention of the Council to a matter which is the subject of a petition the members of a committee have in many cases asked the interested Government for supplementary information either in general terms or by putting definite questions. In some cases, such requests have been accompanied by other suggestions, as, for example, that the interested Government should postpone taking any steps which might have the effect of creating a *fait accompli* before the committee was in a position to take a decision on the question of substance.

"The members of the committee have, in certain cases, made personal representations to the representative of the interested Government, with the object of drawing friendly attention to the advisability of putting an end to the difficulties with which the minority is concerned. In the majority of cases the committee addresses the Government in question through the director of the minorities section of the secretariat, either by writing or verbally, either formally or informally.

"The committee often does not reach a final decision, even after having received all the supplementary information which it may desire. The case may be regarded rather as a link in a long chain than as an independent affair, and the members of the committee sometimes consider that such a case, although of secondary importance in itself, may be of a character to be brought before the Council, if other similar cases should arise. The committee, in these circumstances, invites the minorities section to follow the case for a certain period of time, and to notify it if there should arise any fact which would appear to justify a further discussion between its members."

(c) *Object of the Committee's Examination.*—In its resolution of Sept. 5, 1923, the Council clearly specified that the consideration by the committee of petitions and the observations of the Governments concerned is intended solely to determine whether one or more members of the Council should draw the Council's attention to an infraction or danger of infraction of any of the clauses for the protection of minorities. As the Council also stated in the same resolution, the fact that the committee is considering a petition or observation in no way affects the right of any member of the Council not represented on the committee to draw the Council's attention to an infraction or danger of infraction of those clauses.

It will be clear from what has been said above regarding the working of the minorities committee what an important part this committee plays as a means of conciliation and pacification in this difficult and delicate problem. The flexibility of its procedure enables its members to take into account the special circumstances of each case. In short, the work of the minorities committee has enabled full effect to be given to a resolution which was adopted by the Assembly at its Third Session (1922) with a view to defining the League's methods in the matter of the protection of minorities. "While in cases of grave infraction of the minorities treaties it is necessary that the Council should retain its full power of direct action," so it is set forth in the resolution of 1922, "the Assembly recognizes that in ordinary circumstances the League can best promote good relations between the various signatory Governments and persons belonging to racial, religious or linguistic minorities placed under their sovereignty by benevolent and informal communications with those Governments."

THE COUNCIL OF THE LEAGUE AND THE PROTECTION OF MINORITIES

Since its creation, the Council has at almost every session been called upon to consider questions connected with the protection of racial, linguistic or religious minorities. Mention should be made in the first place of the steps taken by the Council to prepare the declarations concerning the protection of minorities made by Albania, Finland, Estonia, Latvia and Lithuania. The first part of this article contains information concerning the work of the Council in this domain.

The Council has also had occasion to establish, in a series of resolutions which have been examined in the previous pages, the procedure applicable to petitions addressed to the League of Nations concerning the protection of minorities. It is not necessary to dwell here at any length on this aspect of the Council's work, which has already been studied in a previous section of this article. Nor is it necessary to revert to the discussions of the minorities committees of the Council with regard to minority petitions.

Finally, the Council has dealt with a number of definite cases connected with the situation of certain minorities in various countries. These questions, which in most cases had formed the subject of petitions addressed to the League, were placed on the Council's agenda through the action of certain members of the Council, who, in accordance with the procedure, had been asked to examine them. The complicated nature of these ques-

tions makes it impossible to give even a brief summary of the main facts. It has seemed preferable, therefore, merely to give a list of the various minorities and the questions concerning them considered by the Council, indicating the sessions at which they were examined.

Situation of the Muslim Minority of Albanian Origin in Greece.—Council sessions of Sept. and Dec. 1924, and March, June and Sept. 1925.

Bulgarian and Greek Protocols for the Protection of the Greek Minority in Bulgaria, and the Bulgarian Minority in Greece.—Council sessions of Sept. 1924 and March and June 1925.

Minorities in Upper Silesia.—Since the coming into force of the convention on Upper Silesia between Germany and Poland the Council has dealt with a number of minorities questions which it has had to consider in virtue of one or another article of this convention. These were mainly concerned with schools. So far back as its session in March 1924, the Council examined a case connected with the opening of three German minority schools in Polish Upper Silesia; at its session in March 1927, it was called upon to settle a question of principle concerning the admission of children to German minority primary schools in Polish Upper Silesia. Subsequently, at its session in March, June and Sept. 1928, the Council had to examine a number of questions connected with German minority schools in Polish Upper Silesia.

The Council further examined, at its session in March 1926, a petition concerning the personal status of Karl Michalik, a member of the Polish minority in German Upper Silesia, and a petition from the "Union of Poles in Germany" concerning the payment of certain indemnities by the German Government. Finally, at its session in June, Sept. and Dec. 1928, the Council examined two petitions concerning the security of the Polish minority in German Upper Silesia, and the German minority in Polish Upper Silesia respectively.

Jewish Minority in Hungary. (Question of the "*Numerus clausus*".)—Sessions of Sept. 1922 and Dec. 1925.

Position of the Polish Minority in Lithuania.—Council sessions in March, June and Sept. 1925.

German Minority in Poland.—(a) Question of colonists of German race in Poland, and (b) Acquisition of Polish nationality. The Council was engaged in examining these questions from its session in Dec. 1921, until its session in June, 1924. On each of these questions the Council asked for an advisory opinion from the Permanent Court of International Justice.

Hungarian Minority in Rumania. Question of Colonists of Hungarian Race in the Banat and Transylvania.—Council sessions of March, June and Sept. 1925.

Minorities in Czechoslovakia.—Question concerning the autonomy of the Ruthene territory south of the Carpathians. Session of Nov. 1920.

Minorities in Turkey.—(a) Greek minority in Constantinople and Turkish minority in Western Thrace. Council sessions of Oct. 1924 and March and Dec. 1925. (b) Armenian minority in Turkey. Council sessions of Dec. 1925. (P. de Az.)

Bibliography.—L. A. Villari, *La Protezione delle Minoranze* (1915); L. Dominian, *Frontiers of Language and Nationality in Europe* (1917); D. Schäfer, *Unterdrückte Völker* (1918); W. Lutolawski and E. Romer, *The Ruthenian Question in Galicia* (1919); O. Optet, *Der Schutz der nationalen Minderheiten* (1919); M. Vichniac, *La Protection des droits de minorités dans les traités internationaux de 1919–20* (1920); E. Schmid, *Wie können nationale Minderheiten geschützt werden?* (1920); F. Turba, *Das Nationalitätproblem und der Völkerbund* (1920); K. Wolzendorff, *Grundgedanken des Rechts der nationalen Minderheiten* (1921); R. Vidrasco, *De la reserve du droit des minorités et du contrôle des Puissances* (1921); L. Epstein, *Der Nationale Minderheitenschutz als internationales Rechtproblem* (1922); Z. Baranyai, *A Kisobbsegi Jogok Védelme* (1922); K. Berlin, *Folkenes Selvbestemmelsesret og de nationale Mindretals Beskyttelse. Aorbog for de Nordiske Interparlamentariske Gruppe* (1922); F. Brodihn, *Das positive Recht der nationalen Minderheiten* (1922); C. Cereti, *Di un nuovo orientamento del diretto internazionale. Nei rapporti tra Stato e Nazione* (Genoa, 1922); J. Fouques Duparc, *La Protection des Minorités de race, de langue et de religion; étude du droit des gens* (1922); E. Hofmannsthal, *Minoritatenschutz,* International Law Association (Buenos Aires Conference, 1922); J. Carrera, *La protecciò de los Minories Nacionals* (Barcelona, 1923); Ifor L. Evans, *The Protection of Minorities.* British Year Book of International Law (1923–24); A. Hajn, *Problèm Ochrany Mensin* (Prague, 1923); R. Laun, *Entwurf eines Internationales Vortrages über den Schutz nationaler Minderheiten* (1923); J. Lucien-Brun, *Le Probleme des Minorités devant le droit international* (1923); H. Rauchberg, "Der internationale Schutz der nationalen Minderheiten," *Prager Juristische Zeitschrift,* Nr. 7–8 (1923); H. Rosting, *Protection of Minorities by the League of Nations.* American Journal of International Law (1923); Spectator, "Le Mineranze e le Società delle Nazioni," *Problemi Italiani,* fasc. 19, (Rome, 1923); W. Szagunn, "Vom Rechte der nationalen Minderheiten," *Archiv für Politik und Geschichte,* Heft 2 (Berlin, 1923); M. H. Bochen, *Europa irredenta* (1923); Union des Associations pour la Societé des Nations: Reunion à Prague, 1922; Reunion à Vienne, 1923; Union Interparlementaire: Vingtième Conference à Vienna, 1922; Vingt et unième Conference à Copenhague, 1923; C. Heymann, *La situation des minorités en Slovaque et en Russie Subcarpathique* (1923); Tenekides, *Le Status des minorités et l'exchange obligatoire des populations grecoturques* (1924); T. Ruyssen, *Les minorités nationales de l'Europe* (1924); J. Calve, *Mehrheit und Minderheit* (1924); K. Krofta, *Die Deutschen in Böhmen* (1924); J. H. Schultz, *La Minorité allemande dans le Sleswig du Nord* (1924); L. Crato, *Das Minoritätsproblem in Grossrománien* (1925); R. Brunet and E. Loewenfeld, *De la protection des minorités par la Societé des Nations* (1925); R. Donald, *A Danger Spot in Europe: the Saar Valley* (1925); S. Gangas, *Die Minderheit* (1926); J. Auerhelm, *Die Sprachlichen Minderheiten in Europa* (1926); International Law Association: Vienna Conference, 1926, *Rapport du Comité des Minorités;* F. Wertheimer, *Deutchland, die Minderheiten und der Völkerbund* (1926); L. P. Mair, *The Protection of Minorities* (1928).

See also British and American Year Books of International Law for exhaustive bibliographies; League of Nations Publications, *Declaration concerning the Protection of Minorities in Lithuania, 1923* (Annex to the Supp. Report A. 6. a. 1926); *Protection of Minorities in Upper Silesia* (I.B.1, I.B.2, 1927); *Admission of Children to German Minority Schools in Silesia, Action Taken* (1927).

MINOR PLANET. The minor planets or asteroids are a vast host of very small planets that revolve round the sun in orbits that nearly all lie between those of Mars and Jupiter, though a few of them transgress these limits. The existence of a planet between Mars and Jupiter was suspected before any of them were found, on the ground of an empirical law of planetary distances which was first put forward by Titius, a contemporary of Kepler, though it attracted more notice when Bode restated it in 1772. The law assigned the following numbers as representing the distances very closely: Mercury 4, Venus 7, Earth 10, Mars 16, (blank) 28, Jupiter 52, Saturn 100, (next planet) 196. It will be seen that, except in the first case, each interval is double the preceding one.

When in 1781 Sir W. Herschel discovered Uranus, which fitted exactly with the next term in the series after Saturn, conviction was strengthened of the existence of a planet in the gap, and a society of 24 astronomers, with Baron de Zach at its head, was formed to devote itself to the search. Giuseppe Piazzi, director of the Palermo Observatory, was not a member of this society, but on Jan. 1, 1801, while examining a region in Taurus, he observed a small star which he had not seen in the place before; he soon found that it was moving, and followed it up till Feb. 11. In the interval it ceased to retrograde, and commenced to advance. In the following autumn difficulty was experienced in finding the body again; this served as an incentive to the mathematician Karl Friedrich Gauss to improve the existing methods of computing orbits from a few observed positions. As a result of his calculations Heinrich W. M. Olbers of Bremen recovered Piazzi's planet just a year after its discovery. (The three astronomers associated with the finding of the first asteroid have been commemorated by naming the planets numbered 1,000, 1,001, 1,002 Piazzia, Gaussia and Olbersia.) The new planet was named Ceres; its distance agreed exactly with the value predicted by the Titius-Bode law, but it was very small (modern measures give a diameter of 480 miles, about one-fifth of the moon's), and its orbit was inclined to the ecliptic at the large angle of $10°37'$. Perhaps these circumstances led Olbers to suspect that it was one of a group of small planets, for he continued to sweep the sky after he had recovered it, and three months later he found Pallas, whose distance from the sun proved to be almost the same as that of Ceres; its orbit was inclined at the very large angle of $34°43'$, and the eccentricity was also large. A third and fourth member, Juno and Vesta, were added to the family within six years by Harding and Olbers

respectively. Vesta is the brightest of the whole family, sometimes attaining visibility to the naked eye; but its diameter is only half that of Ceres. It was natural that the discovery of these four little planets, revolving in closely adjacent orbits, should suggest the idea that a larger orb had been rent asunder by an explosion. This idea held the field for many years, and indeed has been revived of late in a modified form. It seems to have been assumed that four fragments completed the set, and search was abandoned till 1830; it was then renewed by M. Hencke of Driessen, who after fifteen years' search found Astraea, and commenced a chain of discoveries which has continued without intermission. By 1890 about 300 small planets had been found, all by visual search at the telescope, a very laborious method, necessitating the charting or memorizing of numbers of faint stars and searching for strangers among them. At the time Prof. Max Wolf of Königstuhl, Heidelberg, introduced the photographic method of search, which had been suggested earlier by Dr. Isaac Roberts. An equatorial telescope with a photographic plate in the focus was made to follow the stars, which were registered as discs, while a planet appeared as a short trail owing to its motion during the exposure. This method produced a great acceleration in the rate of discovery, and nearly two thousand announcements of discoveries were made between 1890 and 1927. Not all of these have been permanently numbered. When the number of planets grew large there was found to be a danger of mistaking a previously discovered planet for a new one, and it was decided to postpone the numbering of a planet till five good observations, extending over some weeks, were available, thus enabling a reliable orbit to be deduced. 1,055 planets have now (1927) been numbered, but several hundreds more are known to exist, and approximate orbits have been found for some of them.

DESCRIPTION OF THE PLANETS

The following description is confined to the first 900 members, as details of the remainder were not available when it was prepared. There are two stragglers well on the inside of the family; these are Eros (see separate article) whose mean distance is less than that of Mars, and Hungaria (which, curiously, was the very next discovery to Eros in order of time) at a mean distance of 1·9 astronomical units. The main body begins at mean distance 2·1 units, and continues without a break up to 3·5 units. Then follows a gap with a group of six (the Hilda group) at 3·9 units, and an isolated planet, Thule, at 4·3 units. Its name is from the classical "Ultima Thule," as it was thought to mark the outer boundary of the family till the Trojan group was found; that group consists of six planets, whose mean distance is 5·2 units, the same as that of Jupiter (*see* TROJAN PLANETS).

Although the main body has no absolute gaps there are several very sparse regions in it. These correspond to the distances where the period is a simple fraction of Jupiter's period, 11·86 years. The most notable gap is at 3·3 units, where the period is half Jupiter's; there is also a marked one at 2·5 units, period one-third of Jupiter's; the others are more feebly marked. The richest region of all is just inside the chief gap. Similarly in Saturn's ring the brightest part is just inside the great division, which is at a distance from Saturn corresponding to half the period of Mimas. In each case the reason is the same; repeated perturbations at the same region of the orbit cause a slight change in the period and distance; inward shift has predominated, causing the rich region inside the gap. The influence of Jupiter on the motions of the asteroids is made manifest in another way: when the positions of their perihelia, or nearest approaches to the sun, are plotted on a diagram, it is seen that they congregate towards Jupiter's perihelion; the density of distribution is here three times as great as in the opposite region.

The eccentricities of the orbits are distributed as follows: 209 planets have eccentricity between 0 and ·087, 375 between ·087 and ·174, 248 between ·174 and ·259, 49 between ·259 and ·342, 7 between ·342 and ·423, while four stragglers, Albert, Alinda, Ganymede and Hidalgo have eccentricity greater than one-half. The figures for inclination of orbits to the ecliptic are: 222 planets between 0° and 5°, 297 between 5° and 10°, 222 between 10° and 15°, 98 between 15° and 20°, 35 between 20° and 25°, 14 between 25° and 30°, and 3 above 30°. There seems to be a tendency for high eccentricity and inclination to go together.

The diameters can be estimated only by the amount of light that we receive, since with few exceptions they are too small to measure even with the largest telescopes; the albedo has to be estimated, and some uncertainty is thus introduced. 195 planets have estimated diameters exceeding 61 miles, 502 between 61 and 25 miles, 193 between 25 and 10 miles, and 22 less than 10 miles, but these last very small ones can be seen only when they come fairly near to the earth, so there may be many of them undiscovered in the outer part of the asteroid zone. Estimates of the total mass of the family have been made, assuming a density equal to that of the moon; the following is taken from "Astronomy," by Drs. Russell, Dugan and Stewart p. 352. The total mass of the known asteroids is about 1/3000 of that of the earth, Ceres and Pallas accounting for half of the whole; the undiscovered ones, though probably numerous would be mainly small, so that 1/500 of the earth is an extremely liberal estimate for the whole family. It thus appears that, even if united, they would form an insignificant planet.

There appears to be no reason to expect that the smaller planets would have a spherical form. In the case of large planets the force of cohesion is negligible compared with the gravitational forces, and any large departure from the figure of equilibrium is impossible; but with small bodies cohesion would be stronger than gravitation. Irregular forms are suggested by the fact that the light of many asteroids is variable; this indicates either irregularity of shape or unequal albedo of different parts of the surface. It has been stated that the observed light curves are satisfied better by the unequal-albedo explanation, but the observations are so delicate that this can scarcely be considered decisive. On the albedo hypothesis the variation of light would have the same period as the rotation, on the other hypothesis half the period. The periods of light-change are a few hours—three hours for Eunomia, five and a quarter for Eros, eight and three-quarters for Tercidina. It may be possible to examine the shape of Eros at the near approach, in Jan. 1931, as it should show a disc with large instruments.

The explosion hypothesis, after having been generally abandoned, has been revived in recent years by some astronomers. Dr. H. J. Jeffreys ("The Earth," p. 60) suggests that a primitive satellite of Jupiter may have escaped from the control of that planet and subsequently exploded, possibly through the raising of its internal temperature by radioactive matter; some of the fragments might again explode, which would explain the wide distribution of the orbits. Again Prof. K. Hirayama, after an exhaustive study of the orbits, and an attempt to find their primitive or undisturbed forms, found five families of planets, each family having orbits so closely related as to suggest a common origin. The families are named from their brightest member; the Flora family, distance 2·2, has 57 members; the Maria family, distance 2·5, 13 members; the Coronis family, distance 2·9, 15 members; the Eos family, distance 3·0, 23 members; the Themis family, distance 3·1, 25 members. Prof. Hirayama conjectured that each family was produced by the explosion of a single planet, but it appears that the facts might also be explained on the "planetesimal" hypothesis, by postulating that several knots or condensations were present in the streams of particles, each knot subdividing before final concentration so as to form a group of tiny planets instead of a single larger one. The well-defined "Hilda" group may perhaps be added to the five families. Another interesting group is named after "Albert," the first member to be discovered; it has two other members, Alinda and Ganymede (not to be confused with Jupiter's third satellite). These are extremely small bodies (the first two are about three miles in diameter, the third about 20). They have periods of about four years; and they approach at perihelion within some twenty million miles of the earth's orbit, but recede at aphelion to within a unit of Jupiter's orbit. When in opposition at perihelion they have direct motion in longitude, whereas retrograde motion is the usual rule in that position; the reason is that their linear velocity then

exceeds that of the earth. Owing to their small size they cannot be observed at all except when fairly near perihelion. Albert was unfortunately insufficiently observed at its first apparition, and is now lost; but the other two have been very well observed. A still more remarkable asteroid is No. 944 Hidalgo, discovered by Dr. Baade at Bergedorf observatory in 1920. Its perihelion distance is two units from the sun, its aphelion distance nine and a-half units (near the orbit of Saturn), its period 13·84 years, and the inclination of its orbit to the ecliptic 43½ degrees. The orbit is distinctly of a cometary character, but the object was carefully examined, and failed to show the faintest sign of nebulosity, so it is difficult to classify it as a comet. It approaches Jupiter's orbit closely one and three-quarter years after perihelion, so its present orbit may be due to perturbations by that planet. A similar but still more remarkable asteroid, discovered at Tokyo in January 1927, and temporarily designated Tokyo 1, has perihelion distance one and a quarter units, but aphelion near the orbit of Uranus, its period being 34·8 years. Its inclination is only six degrees, so it passes near Jupiter's orbit. It seems possible that both this object and Hidalgo are the remains of comets which have lost their supply of gas, and whose nuclei resemble asteroids in appearance.

The task of keeping the thousand members of the asteroid family from being lost is a heavy one, and needs international co-operation both in computation and observation. The chief centres for computation are the Recheninstitut at Berlin, the Nice and Marseilles observatories, and Berkeley observatory, California; while observations (mainly photographic) are made at Königstuhl, Bergedorf, Simeis (Crimea), Uccle, Marseilles, Nice, Algiers, Barcelona, Johannesburg, Yerkes observatory, etc. The late Dr. J. Palisa made many discoveries and observations at Vienna.

The following work by Dr. G. Stracke gives full details about the discovery and the elements of all the asteroids found up to the year 1925, together with other particulars. "Identifizierungsnachweis und Elemente der Kleinen Planeten" (*Veröffentlichungen des Astronomischen Rechen-Instituts zu Berlin-Dahlem*, No. 45). (A. C. D. C.)

MINOS, a semi-legendary king of Crete, the son of Zeus and of Europa. By his wife, Pasiphaë, he was the father of Ariadne, Phaedra, and others. Ariadne is equated with Aphrodite; Pasiphaë has been explained as a lunar deity, and a goddess of that name was worshipped in Laconia (Plutarch, *Agis*, 9). Minos reigned over Crete and the islands of the Aegean three generations before the Trojan war. He "reigned for eight years and was the gossip of Zeus" (*Odyssey*, xix. 178), which may mean that he was a divine being, an incarnate god, replaced every ninth year (so Frazer). He was the author of the Cretan constitution and the founder of its naval supremacy (Herodotus iii. 122; Thucydides i. 4). In Attic tradition and on the Athenian stage, Minos is a cruel tyrant, the heartless exactor of the tribute of Athenian youths to feed the Minotaur (q.v.). Recent discoveries in Crete (q.v.) prove the existence of a civilization, the "Minoan" culture, the lord of which may well have had Athens and many other places tributary to him. Minos himself is said to have died at Camicus in Sicily, whither he had gone in pursuit of Daedalus, who had given Ariadne the clue by which she guided Theseus through the labyrinth. He was killed by the daughter of Cocalus, king of Agrigentum, who poured boiling water over him in the bath (Diod. Sic. iv. 79). Subsequently his remains were sent back to the Cretans, who placed them in a sarcophagus, on which was inscribed: "The tomb of Minos, the son of Zeus." After his death he became judge of the shades in Hades, associated with Aeacus and Rhadamanthus.

MINOT, LAURENCE (*fl.* 1333–1352), English poet, the author of 11 battle-songs, first published by Joseph Ritson in 1795 as *Poems on Interesting Events in the reign of King Edward III.* They had been discovered by Thomas Tyrwhitt in an early 15th century ms. (Cotton Galba, E. IX., British Museum) which bore on the fly-leaf the misleading inscription: "Chaucer, Exemplar emendate scriptum." The poems were evidently written contemporaneously with the events they describe. The first celebrates the English triumph at Halidon Hill (1333), and the last the capture of Guines (1352). Nothing whatever is known of Minot's life, but the minuteness of his information suggests that he accompanied Edward on some of his campaigns. Though his name is Norman, he writes vigorous and idiomatic English of the northern dialect with some admixture of midland forms. His poems are instinct with a fierce national feeling.

There are excellent editions of Minot's poems by Wilhelm Scholle (*Quellen und Forschungen*, vol. lii., Strasbourg, 1884), with notes on etymology and metre, and by J. Hall (2nd ed., 1897).

MINOT, a city of North Dakota, U.S.A., in the valley of the Mouse river, 236 m. W. by N. of Grand Forks; the county seat of Ward county. It is on Federal highway 2 and the main lines of the Great Northern and the Soo Line railways. Pop. (1920) 10,476 (84% native white); was 16,099 in 1930 by Federal census. The winding river, bordered by trees and shrubs, flows through the city, and the valley is surrounded by high, bluff-like hills. There are 200 ac. in public parks. The Minot State Teachers college (opened 1913) occupies a beautiful campus of 70 ac. and had a total net enrolment in 1926–27 of 2,334. Minot is the chief trading centre for the northern part of the State, where dairying, poultry-raising, and balanced farming are rapidly developing, supplementary to the basic occupation of wheat-growing. Its tributary territory is about the size and shape of the State of Indiana. The nearest larger city to the west is Great Falls (Montana), 600 m. away. There are wholesale groceries, distributors of agricultural implements and automobiles, and many other jobbing houses doing a large business. Bank debits to individual accounts in 1927 amounted to $84,000,000. Minot lies within the great lignite coal fields of the State, and the largest strip lignite mine in the world lies not 30 m. from the city. Minot was founded in 1886, when the Great Northern railway reached this point. About 5 years later the Soo Line crossed the Great Northern here, establishing the new town as a natural distributing centre for north-western North Dakota and north-eastern Montana. It was incorporated as a city in 1887 and has had a commission form of government since 1909.

MINOTAUR [Gr. Μινώταυρος, from Μίνως, and ταῦρος, bull], in Greek mythology, a fabulous Cretan monster having the body of a man and the head of a bull. This creature was supposed to be the offspring of Pasiphaë, the wife of Minos, and a snow-white bull, sent to Minos by Poseidon for sacrifice. Minos, instead of sacrificing it, spared its life, and Poseidon, as a punishment, inspired Pasiphaë with an unnatural passion for it. The monster which was born was shut up in the Labyrinth (q.v.). It happened that Androgeus, son of Minos, had been killed by the Athenians, who were jealous of the victories he had won at the Panathenaic festival. To avenge the death of Androgeus, Minos demanded that seven Athenian youths and seven maidens should be sent every ninth year to be devoured by the Minotaur. When the third sacrifice came round Theseus volunteered to go, and with the help of Ariadne (q.v.) slew the Minotaur.

It seems possible that a confused reminiscence of actual bull-baitings, perhaps a sacred rite, which are attested by Cretan wall-paintings, has something to do with this story. Pictures of half-human monsters are also common; *see* especially the seal-impression of a minotaurlike creature, *Brit. Sch. Ath.* VII. p. 18. But their meaning, like the original significance of the myth, awaits explanation.

See Helbig in Roscher's *Lexikon der Mythologie;* F. Durrbach in Daremberg and Saglio's *Dictionnaire des antiquités;* A. B. Cook in *Classical Review* xvii. 410; J. G. Frazer, *Golden Bough* iv. 10 et seq.

MINSK, a former government of Russia, now in the White Russian S.S.R. (*q.v.*).

MINSK, the capital of the White Russian S.S.R., on the Svisloch river, a non-navigable tributary of the Berezina, in 53° 54′ N., 27° 33′ E., at the intersection of the Moscow-Warsaw and Libau-Kharkov railways. Pop. (1926) 123,613. It was the headquarters of the IV. Army Corps under the Tsarist government. Its close proximity to the west Russian front involved it in the disorders of the Russian retreat. In November 1917 an executive committee of soviet workers, soldiers and peasants was formed in the town, but in 1918 Minsk was occupied by German troops, who advanced as far as the Dnieper river, but withdrew after the

revolution in Germany. In spring, 1919, a Polish army occupied the district, and Minsk did not settle down to peaceful development until the beginning of 1921. The effects of this period of destructive strife are still evident, and there is terrible overcrowding in the city, owing to the rapid growth of its population and the destruction of housing accommodation during the war.

The province around Minsk is more favourably situated as regards agriculture than the rest of White Russia, and the town therefore has a less serious unemployment problem, though the situation is sufficiently difficult, especially in view of the interruption of its trade with the west, owing to changes of boundary. The town has smelting and machinery works, a bristle industry depending on the marked development of pig-breeding in the province, a brewery, two leather factories and a paper factory. The town has a municipal electricity and water supply. There is a White Russian government university, a communist university, and an institute for research into White Russian culture, with a Polish and a Jewish branch. An institute was established in 1927 to study the problems of White Russian agriculture and forestry. The numerous small Jewish traders were thrown out of occupation after the 1917 revolution and efforts have been made to settle them in other parts of Russia in order to relieve the local unemployment problem.

Its position near the west has always made it liable to invasion. Minsk is mentioned in Russian annals in the 11th century under the name of Myen'sk, or Menesk. In 1066 and 1096 it was devastated, first by Izyazlav and afterwards by Vladimir, prince of Kiev. It changed rulers many times until the 13th century, when it became a Lithuanian fief. In the 15th century it was part of Poland, but as late as 1505 it was ravaged by Tatars, and in 1508 by Russians In the 18th century it was taken several times by Swedes and Russians Russia annexed it in 1793, but within a few years it was laid waste by Napoleon I. (1812).

MINSTER, two towns of Kent, England.

1. Minster-in-Thanet, in the Isle of Thanet, lies above the Minster marshes, Stour valley, 4 m. W. of Ramsgate by rail. Pop (1921) 2,915. The church of St. Mary has a Norman nave and Early English transepts and chancel. The carved choir-stalls are a notable feature. The church belonged to a nunnery, founded at the close of the 7th century. Fruit-growing is carried on.

2. Minster-in-Sheppey, a seaside resort in the Isle of Sheppey. Pop. (1921) 3,059. It has a fine church, dedicated to St. Mary and St. Sexburga, originally attached to a 7th century convent founded by Sexburga, widow of Erconberht, king of Kent. The present building is a portion of the 12th century conventual church founded by William de Corbeuil, archbishop of Canterbury; it retains also traces of pre-Norman work. The abbey gatehouse remains. There are oyster beds in the neighbouring sea

MINSTER, the church of a monastery, or one to which a monastery has been attached. In the 10th century the name was applied to the churches of outlying parishes, and is now given to some of the English cathedrals, such as York, Lincoln, Ripon and Southwell, and to large churches or abbeys, like those of Sherborne, Wimborne or Westminster.

MINSTREL. The word "minstrel," derived from the Latin *minister*, a servant, was used after the 13th century to signify a household entertainer, its earlier equivalent being "jogelour" (Fr. *jongleur*). Still earlier the same part was played by the Teutonic gleeman or *scôp*. In the Anglo-Saxon poem that bears his name, Widsith, the far-traveller, wanders from place to place, from the Picts and Scots in the west to the Medes and Persians in the east, singing and telling stories and welcomed everywhere; from the Ostrogoth Eormanric (Hermanric, d. 375) he receives a collar of gold, and on his return home he is given an estate. Other early poems, such as *Beowulf*, show the honour in which these minstrels were held in pagan times; but, although patronized by Charlemagne, they were denounced by the Church with a vigour and frequency which show how ineffective such denunciations were in stemming their popularity.

The term minstrel covered a great variety of performers. At the head of the profession the place of the *scôp* was taken in the 11th century by the *trouvère* (*q.v.*) or the *troubadour* (*q.v.*), who was often a man of high social standing. Such a *trouvère* was Taillefer, who led the Norman attack at Hastings, singing the song of Roland and juggling with his sword. After the Conquest, Berdic, *joculator regis*, is shown by Domesday to have been given estates in Gloucestershire; and the traditions that Rahere, founder of St. Bartholomew's priory at Smithfield, had been minstrel to Henry I., and that Richard I. was discovered in his captivity by his minstrel Blondel, if not true to fact, show the position occupied by such persons in popular opinion. Master Henry, *versificator regis*, to whom Henry III. made various gifts, may have been one of the last of the English *trouvères;* certainly after that king's reign the minstrels seem to take a lower place in society. Kings and nobles still kept their minstrels, even so strict a churchman as Bishop Robert Grosseteste having a private harper, but they were more professional musicians. For these there were professional schools at Beauvais, Cambrai, Lyons and elsewhere, and in many towns they formed themselves into gilds, of which the earliest known is the *Pui* of Arras, founded in 1105. The minstrels' gild of Paris, of which the head was called *roy des ménestriers*, was founded in 1321 and lasted to 1776; in London the minstrels were incorporated in 1469, and all minstrels in the country were ordered to join the gild, but this order was ignored, and when a new charter was granted in 1604 the gild's jurisdiction was limited to three miles beyond the city. The gild still exists as the Corporation of Musicians of London. Canterbury had such a fraternity in 1526, and that of Beverley claimed to date from the time of Athelstan, certainly existed in the 15th century, and was reorganized in 1555, when rules were made that members must be minstrels to men of honour, "waits" to some town,[1] or otherwise approved. The minstrels of the county of Chester were from an early date (traditionally 1210) under the control of the head of the family of Dutton, whose rights were recognized in all the vagrancy acts from 1572 onwards; as late as 1756 the heir of Dutton held a court at Chester fair and issued licences to musicians. Similarly at Tutbury John of Gaunt in 1380 established a *roy des ministralx*, whose court was still held at the end of the 17th century.

Mediaeval account rolls of the expenses of royal and noble households, towns and monasteries are full of payments, often lavish, to all kinds of minstrels, musicians, players and jugglers, and at the marriage of Princess Margaret in 1290 no fewer than 426 minstrels, English and foreign, attended. Most of these came with noble guests, and the king himself, Edward I., had a large staff of musicians, partly minstrels and partly military band, as had his successors. But by the 15th century the day of the real minstrel was passing; and with the coming of printing the taste for listening to long chanted ballads and romances died out, and the minstrel became more and more an instrumental performer, just as the "minstrels' galleries" in the halls of Tudor houses were purely for instrumental or choral music. With the 16th century the minstrels became players, in the sense of actors, or degenerated into that "thing of shreds and patches," the wandering minstrel.

Even from early times there had been many of these unattached, vagrant entertainers, picking up a precarious living by performing in fairs and village taverns, or thrusting themselves brazenly into the halls of the great, risking kicks for the sake of halfpence. It was against these, headed by the Goliards (*q.v.*), that the Church chiefly fulminated for their ribaldry, indecency and lack of reverence. The State also viewed them with disfavour as men who wasted their own time and that of their listeners, and, not unjustifiably, as promoters of sedition. For these masterless men carried the news from place to place, sang biting lampoons against unpopular ministers, or voiced the wrongs of the poor; and such revolts as the Peasants' rising of 1381, Jack Cade's of 1450, and other more local riots seem to have owed much to their activity. Consequently from the time of the Black Death (1349) onwards, and particularly after 1572, they were continually in danger of the stocks, the whipping-post and prison.

[1]The chief English towns, such as London, York, Chester, Bristol, Coventry, etc., had minstrels, usually called "waits," who wore a livery and silver badge and combined the duties of town band and night-watchman, "piping the watch" at fixed hours of the night.

The best account of the subject is in E. K. Chambers, *The Mediaeval Stage*, i., 23–86, and ii. 230–266 (1903); where references are given to other works. *See* also A. Schultz, *Das höfische Leben zur zeit der Minnesinger* (1889); J. Jusserand, *English Wayfaring Life* (3rd ed., 1925). (L. F. S.)

MINT. A place where coins are manufactured, usually with the authority of the State.

According to Herodotus, the first mint was probably that established by Gyges in Lydia towards the end of the 8th century B.C. for the coining of gold, silver and electrum, an alloy of gold and silver. Silver was coined in the island of Aegina soon afterwards. The art of coining was introduced by the Greeks into Italy and other countries bordering on the Mediterranean and into Persia and India. Subsequently the Romans laid the foundations of modern minting. Coining originated independently in China at a later date than in the Western world, and spread from China to Japan and Korea.

In Britain gold and silver were coined before the arrival of the Romans, and after the Norman Conquest the number of mints increased to about 70, more than now exist in the world. The necessity for so many mints arose from the imperfect means of communication. The coins were occasionally tested at Westminster, and if any deficiency in their weight or fineness was found the "moneyers" or minters were punished as traitors. About 1180, officers were appointed to supervise the coinage on behalf of the king and to collect the seigniorage (*q.v.*), which generally took the form of a deduction from the amount of bullion sent to the mint for coinage. The work was done by contractors at a great profit; Sir Isaac Newton, for example, amassed a fortune as master of the mint and contractor for the coinage. In 1850 the contract system was abolished and since then the work has been conducted by civil servants, all profits becoming part of the revenue. The London mint was built in 1810, when the old mint in the Tower of London was closed after being in use for centuries.

In the United States the Philadelphia mint was opened in 1792 and there are other mints at San Francisco and Denver, opened to provide markets for the gold produced near them. In most countries a single mint is found to be sufficient, but there are six in Germany and two in Australia. Many countries do not possess a mint, their coinages being executed under contract.

The Supply of Bullion to Mints.—In England, in the middle ages, the king was accustomed to send to the mint the produce of his own silver mines. The right of levying seigniorage was sometimes waived by the king to encourage his subjects to bring gold and silver to the mint, but in spite of this inducement supplies were often deficient, and several instances are recorded in which alchemists were called in to effect transmutation of baser metals into gold.

Silver bars, which usually weigh from 1,000 to 1,200 oz. troy each, are bought by the mints only when new or additional issues of silver coin are required for circulation or reserve. In the first years after the World War very little new silver was required for coinage in Britain, owing to the widespread melting down of old silver coin for sale and its replacement by base metal coins or by silver of lower standard. The intrinsic value of the silver in coins is usually much less than the nominal or face value at which they pass in circulation in their own country. Thus in Great Britain one ounce of a silver alloy containing 50% of silver is converted into 5s.6d. in silver coin, whatever may be the market price of silver bullion (in 1927 this was about 29d. per oz. of fine silver). The difference between the minted and unminted values is retained by the State to cover the cost of manufacture and as a source of revenue. The system in other countries is similar, but generally with less difference in value between the minted and unminted silver. Thus the United States dollar contains 371·2 grains or 0·77 oz. of fine silver.

Refined gold ingots suitable for minting (the "bar gold" of commerce) are usually about 400 oz. troy in weight. They could be taken to the London mint for coinage without charge previous to 1925, but in that year the right was withdrawn except from the Bank of England. The branch mints in Australia continue to receive unrefined gold from the mines for refining and coinage although at a small charge. In the United States, Canada, India and Japan the mints also receive unrefined gold and refine it.

Alloys Used in Coinage.—The earliest gold and silver coins made by the Greeks consisted of the pure metals (990–997 fine, *i.e.*, 990–997 parts in 1,000) or of electrum. After electrum had fallen into disuse, pure gold continued to be used, but under the Roman emperors copper was intentionally added and in the two centuries preceding the fall of Rome very base alloys of gold were coined, some containing only 2% of gold or even less. In the middle ages these base alloys were discarded and the "byzant" of Constantinople and the early coins of Western Europe were intended to be absolutely fine. The gold standard of $\frac{11}{12}$ or 916·6 (22 carats fine) was adopted in England in 1526 and remains unchanged.

The silver standard of 925 (11 oz. 2dwt. of silver and 18dwt. of alloy) was probably first introduced in England by the Saxons but has not been maintained continuously. Henry VIII. reduced it to 10 oz. silver and 2 oz. alloy and afterwards to 4 oz. silver and 8 oz. alloy. Under Edward VI. the standard, at first debased further to 3 oz. silver and 9 oz. alloy, was afterwards raised again, and the standard of 925 was restored by Elizabeth. In 1920 it was reduced to 500, but the name "standard silver" generally means silver 925 fine. The 900 standard for both gold and silver coins was introduced in France soon after the Revolution and was later adopted in most other countries. The standard in India is 916·6 for both gold and silver.

Copper was originally added to gold in coins to reduce the cost of metal, but it has long been recognized that gold-copper and silver-copper last longer in circulation than pure metals owing to their greater hardness. Rate of wear, however, does not depend entirely on hardness, but also on the resistance of coins to corrosion. Coins become greasy in circulation and the fatty acids corrode the copper, forming a friable crust on the surface which is easily rubbed off. Accordingly coins containing much copper are not so resistant to wear as those of higher standard and more often present a dirty appearance in circulation. The average life of silver coins of the 925 standard in circulation in Great Britain was about 40 years in the 19th century, the larger coins lasting longer and the smaller ones for a shorter time.

Subsidiary coins have in the past generally consisted of copper, but in France soon after the Revolution of 1789 copper became scarce and the church bells were melted down to eke out the supply. The bells consisted of an alloy of copper and tin with a little zinc and the coins containing some of it were found to have advantages over those of pure copper. A mixture of these metals in the proportion of copper 95%, tin 4%, zinc 1% ("coinage bronze") was adopted in 1851 by France for subsidiary coins and afterwards by almost every country in the world.

The copper-nickel alloy or "nickel-bronze" (consisting of copper 75%, nickel 25%) has been used since its introduction in Belgium in 1861. Aluminium-bronze (copper 91%, aluminium 9%) has been used instead of silver for francs and two-franc pieces in France since 1921 and has been adopted elsewhere.

Manufacture of Coins.—Until the middle ages coins were struck between engraved dies by hand hammers and hand minting persisted in the native States of India until the 19th century. The Romans cast their larger copper coins. Modern methods may be said to date from 1553 when rolls for reducing the thickness of cast bars, machines for punching-out round discs from sheets of metal, and screw presses for striking coins were introduced in Paris. In England the new machinery was tried in 1561 and finally adopted in 1662. (For a detailed account of the history of minting, *see* NUMISMATICS.)

The operations employed in the manufacture of gold and silver coin are as follows:—(1) Refining the metal to make it fit for coinage. Gold is refined at only a few mints and very little silver is refined even by these. (For a description of the processes, *see* GOLD: *Mining and Metallurgy* and SILVER: *Metallurgy*, etc.) (2) Melting the metal and casting it into bars. (3) Rolling the bars into strips or "fillets." (4) Cutting out discs or blanks from the strips. (5) Adjusting the weight of the blanks. (This is omitted in some mints.) (6) "Marking" or edge-rolling the blanks to

produce a raised rim or to impress a design on the edge. (7) Annealing the blanks and, in some mints, cleaning them in acid. (8) Striking the blanks between dies. (9) Weighing each coin.

Among the incidental operations are: (*a*) The valuation of the bullion, by weighing and assaying it. (*b*) "Rating" the bullion, or calculating the amount of copper to be added to make up the standard alloy. (*c*) Recovering the values from ground-up crucibles, ashes and floor sweepings (the mint "sweep"). (*d*) Assaying the melted bars. (*e*) "Pyxing" the finished coin, or selecting specimens to be weighed and assayed. (*f*) "Telling" or counting.

At the London mint about 2,750 oz. (86 kilograms) of gold are melted in a pot, but larger crucibles holding nearly 6,000 oz. (188 kilograms) are used for silver. The amount of metal to be melted in mints is small and its value great, so that small charges in the furnaces are convenient. The necessity for perfect uniformity in composition, discussed in the sequel, is also in favour of small charges. The cost of fuel is a small item and any loss of metal a serious matter. So crucible melting retains its place in mints.

The silver-melting furnaces employed in the London mint are cylindrical in shape inside and are heated by ordinary illuminating gas. The charge consists of refined silver bars with the required amount of copper, together with scrap silver from former operations and old coin if available. When ready for pouring, the crucible is lifted out of the furnace by means of circular tongs which are suspended from a travelling electric crane. The crucible is placed in a pouring cradle which can be tilted by gear wheels worked by a hand crank. The contents of the crucible are then stirred by a rotating mechanical stirrer in order to ensure proper uniformity of composition and a portion is dipped out for assay.

The limits of error allowed by law in the composition of gold and silver coins are narrow. In British gold coins the allowance or "remedy" for fineness is 2 per 1,000 of gold above or below the standard of 916·6. In most countries a divergence of only 1 per 1,000 of gold is allowed and little difficulty is experienced in keeping coins within the limits. Silver-copper alloys, however, even though perfectly mixed when molten, become of different composition in different parts on solidification. The only alloy of uniform composition when solid is that containing 720 parts of silver and 280 of copper. This is the "eutectic" alloy (*see* ALLOYS) and is used for coinage in Holland and Mexico.

Rolling.—The cast bars are reduced to the thickness of the coin by repeated passages between rolls, which are divided into breaking-down, thinning and finishing or gauging rolls, the last named being of the smallest diameter. The reduction of thickness in the bars is accompanied by a slight increase in their width and a very great increase in their length, so that it is generally necessary to cut them into two parts.

By repeated passages through the rolls the bars are hardened, and to facilitate further reduction they are usually softened by *annealing* before being passed to the finishing rolls. In some mints the strips are annealed. In the United States mints the use of very carefully refined metal has made it possible to discontinue the annealing. When the strips are reduced to the correct thickness they are examined by the "tryer," who cuts out one or two blanks from each strip with a hand machine and weighs them on a delicate balance. If the blank is too heavy the strip is again passed through the rolls.

The degree of accuracy required is indicated by the tolerance or "remedy" allowance in weight, which is different for each coin, and is the maximum difference from the standard weight which is allowed by law. In the sovereign it is 0·2 grain or about 1·62 per 1,000. As the mean thickness of a sovereign is 0·0466in. the remedy in weight corresponds to a difference of less than $\frac{1}{10,000}$in. in the thickness of the strip. Remedies in weight and fineness are intended to cover accidental variations.

Cutting and Marking Blanks.—In the cutting machine (fig. 1) the revolution of a cam causes two or more short steel cylinders or cutters to enter holes in two parallel plates fixed to the bed of the machine. When the coinage strip is brought between the plates, the cutters descend and force discs of metal through the holes in the lower plate. After each descent of the cutters, the strip is advanced by small gripping or feeding rolls to the next position. The discs fall down a tube to a receptacle.

The blanks are then passed to an edge-rolling machine, by which they are thickened at the edge so as to form a rim to protect the finished coin from wear. The operation is called marking, because originally the edges were not only thickened but were also marked with an inscription, as is still done in some mints. The letters are sometimes sunk and sometimes raised.

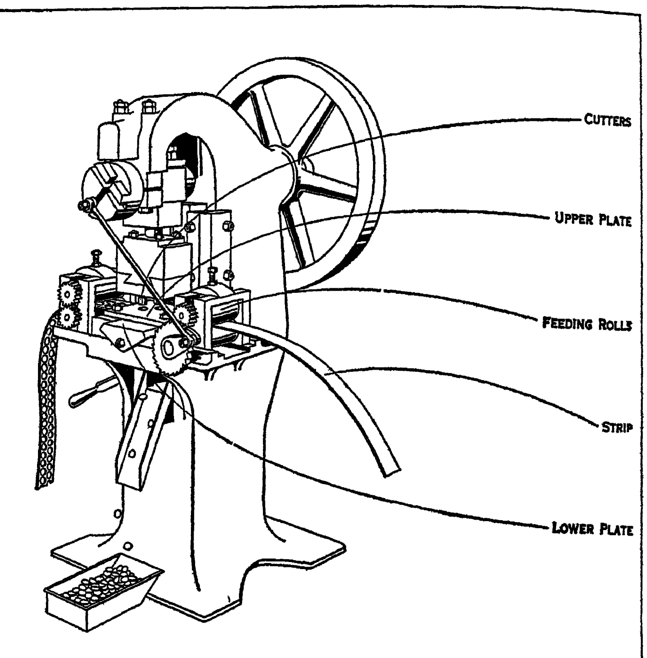


FIG. 1.—CUTTING MACHINE SHOWING HOW THE COIN BLANKS ARE PUNCHED, TWO AT A TIME, FROM THE STRIP OF SILVER BY THE DESCENT OF STEEL CYLINDERS

Like the graining or "milling" on the edges of coins, the inscriptions were intended to put a stop to the practice of clipping and filing coins, which was prevalent in the 16th and 17th centuries.

Annealing and Blanching the Blanks.—The blanks are next softened by annealing, and are then thoroughly cleaned before being passed to the coining presses. The blanks thus cleaned are charged into a hopper at one end of the furnace and conveyed towards the other end by a revolving Archimedean screw. In a few minutes they are raised to a dull red heat and become blackened by the formation on the surface of a film of oxide of copper. They leave the furnace by falling through an aperture into water. The oxide of copper is removed by solution in hot dilute sulphuric acid, sometimes with the addition of bichromate, and a layer of pure frosted silver is left on the surface, which appears dead white in colour, and has lost its metallic lustre. The operation is called "blanching." The blanks are washed in water to remove all trace of acid and are then dried.

Striking the Coins.—The blanks are converted into coin by receiving an impression from engraved dies. Each blank is placed on the lower of two dies and the upper die is brought down forcibly upon it. The pressure causes the soft metal to flow like a viscous solid, but its lateral escape is prevented by a collar which surrounds the blank while it is being struck. The collar may be plain, or crenated ("milled"), or engraved.

Modern coining presses are improved forms of the lever press invented by Uhlhorn in 1839 which replaced screw presses. One of the London mint presses is shown in fig. 2. The blanks are fed by hand or by an automatic feeder into the machine which performs the rest of the operations. A blank is carried forward by a moving slide and placed exactly on the lower die by iron fingers, the "layer-on." This imitates the action of the human finger and thumb which it has superseded. The collar encircles the blank and the upper die is brought down and pressed upon it. By means of continued revolution the machine next lifts the upper die, and the lower die rises simultaneously and pushes the coin out of the collar. Lastly the layer-on pushes off the finished

coin (which falls down a tube into a bowl) and places another blank on the die. Coining presses strike about 100 coins a minute.

The dies consist of hard carbon steel, and the process of making them is complicated. The original design of the artist, in the form of a large plaque of plaster of Paris, is reproduced in relief in iron or bronze by casting or in nickel by electro-deposition. An exact copy of the plaque in miniature, of the diameter of the coin to be produced, is made by a reducing machine.

The machine has two adjustable heads and on these are mounted

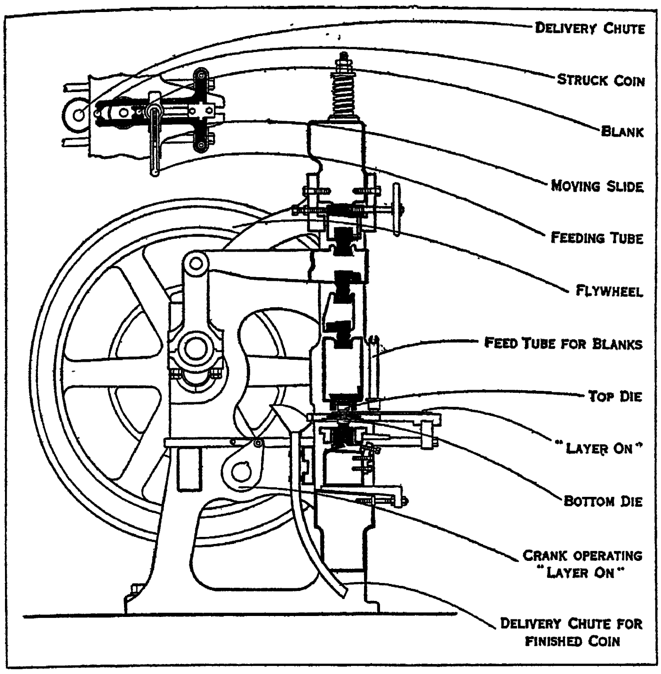


Fig. 2.—Coining press showing the massive structure of a modern press, which retains its rigidity while striking a heavy blow equivalent to a pressure of many tons

the model or plaque and a block of soft steel. In front of them is a balanced arm, pivoted at one end, and carrying both the tracer point, which presses against the model, and the revolving cutter. The model and steel block are rotated synchronously and at the same time the free end of the balanced arm is gradually raised. The result is that the tracer and cutter are made to travel in fine spirals over all parts of the model and steel block respectively, converting the block into the "reduction" punch.

The old way of making the original steel copy of the artist's design was by hand engraving (*see* Numismatics), a method still in use for slight changes in the design, as for example a change of date, and for all purposes in some mints.

Dies strike about 50,000 coins before they are worn out.

Weighing the Coins.—Gold and silver coins are examined individually by eye on the overlooking machine, upon which the coins are spread on a travelling belt, arranged so that both faces of the coins are exposed in succession. Each coin is then tested by ringing and finally weighed separately by being passed over delicate automatic balances. Automatic balances for weighing single coins were introduced at the Bank of England in 1843.

In the London mint both light and heavy coins are returned to the melting pot. The proportion of rejected gold coin varies with the quality of the bullion, and may exceed 10%. The percentage of rejected silver is usually less than 1%.

Trial of the Pyx.—Periodical examinations of the coins issued by the mint have been made from very early times in England by persons appointed by the Crown. Specimens are selected from the finished coins and are put into a box or "pyx." At intervals these coins are weighed and assayed by a skilled jury and the results reported to the Government. The trial is now held annually by the Company of Goldsmiths. (*See* also the article Money.)

Bibliography.—Rogers Ruding, *Annals of the Coinage of Great Britain* (1840); F. Lenormant, *La Monnaie dans l'Antiquité* (1878); Sir W. C. Roberts-Austen, "Alloys used in Coinage" (*Journ. Soc. of Arts*, London, 1884); *Annual Reports of the Deputy Master of the Mint* (London, 1870 onwards); *Annual Reports of the Director of the (United States) Mint* (Washington). (T. K. R.; H. W. L. E.)

MINT, botanically *Mentha*, a genus of plants of the family Labiatae, comprising about 25 species of perennial herbs, widely distributed throughout the temperate and sub-tropical portions of the globe, but chiefly in the temperate regions of the Old World. The species have square stems, opposite, aromatic leaves, and a stoloniferous creeping rootstock. The flowers are arranged in axillary clusters (cymes), which either form separate whorls or are crowded together into a terminal spike. The corolla is usually small and of a pale purple or pinkish colour; it has four nearly equal lobes, and encloses two long and two short stamens.

In Great Britain a number of species are indigenous or naturalized but the forms easily hybridize so that there is great confusion in the genus. *Mentha viridis* is the garden mint or spearmint (*q.v.*), which is commonly used for culinary purposes; it is distinguished by its smooth, sessile leaves and lax tapering flower-spikes. It is probably a cultivated race of the next species, *Mentha sylvestris,* which chiefly differs from the above in its coarser habit and hairy leaves, which are silky beneath, and in its denser flower-spikes. This plant is supposed to be the mint of Scripture, as it is extensively cultivated in the East; it was one of the bitter herbs with which the paschal lamb was eaten. *M. aquatica* grows in ditches, and is easily recognized by its rounded flower-spikes and stalked hairy leaves. *M. piperita,* or peppermint (*q.v.*), has stalked smooth leaves and an oblong obtuse terminal spike of flowers; it is cultivated for its volatile oil. *M. pratensis* belongs to a group which have the flowers arranged in axillary whorls and never in terminal spikes; it otherwise bears some resemblance to *M. viridis. M. Pulegium,* commonly known as pennyroyal, has small oval obtuse leaves and flowers in axillary whorls, and is remarkable for its creeping habit and peculiar odour. It was formerly popular for medicinal purposes. All the genus *Mentha* abound in a volatile oil, contained in resinous dots in the leaves and stems. Most mints blossom in August.

The name mint is also applied to plants of other genera, *Monarda punctata* being called horsemint, *Pycnanthemum linifolium* mountain mint, and *Nepeta Cataria* catmint.

MINTO, GILBERT ELLIOT, 1st Earl of (1751–1814), was the eldest son of Gilbert Elliot (1693–1766), Lord Minto. About 1763 Gilbert and his brother Hugh were sent to Paris, where their studies were supervised by David Hume and where they became intimate with Mirabeau. Gilbert entered Christ Church, Oxford, and was called to the bar. In 1776 he entered parliament as an independent Whig. He became very friendly with Burke, whom he helped in the attack on Warren Hastings and Elijah Impey, and on two occasions was an unsuccessful candidate for the office of speaker. In 1794 Elliot was appointed to govern Corsica, and in 1797 he assumed the additional names of Murray-Kynynmond and was created Baron Minto. From 1799 to 1801 he was envoy-extraordinary to Vienna, and having been for a few months president of the board of control he was appointed governor-general of India at the end of 1806. During his viceroyalty he had to provide against the danger from Napoleon, and deal with the nearer menace of the Sikh power at Lahore. Before he gave up office in 1813 Java and the Moluccas had been added to the Empire. He was then created Viscount Melgund and earl of Minto. He died at Stevenage on June 21, 1814 and was buried in Westminster Abbey.

See Hon. G. F. S. Elliot, *The Border Elliots and the Family of Minto* (Edinburgh, 1897); the article India: *History;* also the *Life and Letters of the first Earl of Minto, 1751–1806* (1874) and *Lord Minto in India, 1807–1814* (1880), both edited by the countess of Minto; and Sir J. F. Stephen, *The Story of Nuncomar and the Impeachment of Sir E. Impey* (1885).

MINTO, GILBERT JOHN ELLIOT-MURRAY-KYNYNMOND, 4th Earl of (1845–1914), was born in London on July 9, 1845. He was educated at Eton and Trinity College, Cambridge, and joined the Scots Guards in 1867. In 1870 he sent in his papers and went to live in Lincolnshire, where he acted as a gentleman rider for four years. He rode four times in the Grand National, and in the 1876 race he broke his neck. He survived,

and turned newspaper correspondent. In this capacity he was in Spain with the Carlist army in 1874, and in Turkey in the Russo-Turkish war. He was present in an unofficial way at the second Afghan war in 1879, and very nearly went to Kabul with Cavagnari's party who were murdered there next year. He went to the Egyptian war in 1882 in the same casual way, and fought with the mounted infantry at Ismailia.

He married Mary Grey in 1883, and the haphazard part of his life came to an end. In 1883 he went to Canada as military secretary to Lord Lansdowne; here he served in the Riel rebellion campaign and was offered the post of commandant of the North West Mounted Police. He returned to England in 1886, and spent twelve years at home, chiefly occupied with his volunteer corps, the Border Mounted Rifles, and studying the theory of warfare. In 1891 he succeeded his father as Lord Minto. In 1898 he was made Governor-General of Canada. Here his great problem was the difference in point of view between Chamberlain, with his vision of Imperial Federation, and Sir Wilfred Laurier, prime minister of Canada, whose vision, concentrated on Canada, included no such thing. Minto's invariably constitutional behaviour and his soothing personal influence helped to surmount some unpleasant situations, notably the Alaskan question and that of the Canadian contingent in the Boer war. Laurier said of him, "He is the most constitutional governor we have had."

Minto returned to England in November 1904, and in August 1905, he was appointed Viceroy of India in succession to Curzon. Curzon left him a ticklish legacy; he had changed many things in a very short time, and he had been an autocrat. Not the least of Minto's troubles was the tradition of centralisation he found; not the least of his assets were his great-grandfather's work a hundred years before, and India's long memory. Minto started at once to restore responsibility to the Viceroy's council. The relation between Minto and his secretary of State, Morley, was interesting. They liked and trusted one another personally, but Morley, as secretary of State, was a difficult man to handle. He tended for more than one reason, to be autocratic; he started by overriding his own council, he went on to ignore the Viceroy's council and to attempt to reduce the Viceroy himself to a satellite of the secretary of State. Minto handled the situation very cleverly; more than one of his suggestions, quietly thrown out in letters, came back to him in the majesty of Morley's somewhat Olympian despatches. But Morley's constant interference in the details of administration, raised a serious constitutional question, and very nearly provoked Minto's resignation. The breach with Kitchener that Curzon had left was immediately healed, and the two men worked together harmoniously in preparing India's case when the details of the Russian Convention were being arranged. Minto took a long step towards the solution of the frontier problem when he made a firm friend of the Amir of Afghanistan, who paid him a visit in Calcutta. But Morley was somewhat inclined to ignore views on the wider aspects of Imperial policy coming from India, and in the event of the Convention of 1907 nearly undid all Minto's work for the conciliation of the Amir.

But all other aspects of Minto's viceroyalty are of small moment compared with the supreme importance of the Reforms. (*See* India.) On this matter Minto and Morley saw eye to eye from the start. There were even times when the Tory Viceroy outran the prudence of the Radical secretary, and when the battle was won Morley said to Lady Minto, "I am swimming in a popular tide through victories which are not my own." In spite of strong opposition in India and at home the steps were gradually taken. The first was the appointment of an Indian member to the Secretary's Council; the second, much more hotly disputed, the appointment of Sinha to the Viceroy's council in March 1909. In May of the same year the Reform Bill was passed, the foundation of the new policy of gradual extension of self-government to India. Even Minto's enthusiasm for a progressive policy was perhaps not more to his credit than the determination with which, while he firmly suppressed sedition and violence, he refused to let them deter him from his chosen path. Lord Minto returned to England in Nov. 1910 and died at his home at Minto on March 1, 1914.

See J. Buchan, *Lord Minto*, 1924.

MINT PAR OF EXCHANGE. A mint par of exchange can only exist between two currencies based upon the same metal. It is defined as the fixed intrinsic value of the currency-unit of one country expressed in terms of the other. It depends solely upon the amount and fineness of the metal that the law of each country enacts what its currency-unit shall contain.

Thus, in England, 20 lb. gold, $\frac{11}{12}$ fine, equals £934·5; in Switzerland, 1kilog. gold, $\frac{9}{10}$ fine, equals Frs. 3,100; in the United States, 258 grains gold, $\frac{9}{10}$ fine, equals \$10.

The mint par of exchange can now be readily calculated. Take England and Switzerland:

$$
\begin{aligned}
\pounds 934{\cdot}5 &= \text{20lb. std. gold, } \tfrac{11}{12} \text{ fine.}\\
&= 18{\cdot}33 \text{ lb. fine gold.}\\
&= 6{\cdot}841 \text{kilogs. fine gold.}\\
\text{Frs.}3{,}100 &= \text{1kilog. gold, } \tfrac{9}{10} \text{ fine.}\\
&= {\cdot}900 \text{kilogs. fine gold.}
\end{aligned}
$$

$$\text{Then Frs. } \frac{3100 \times 6{\cdot}841}{{\cdot}9} = 6{\cdot}841 \text{kilogs. fine gold} = \pounds 934{\cdot}5$$

$$\text{or, Frs. } \frac{3100 \times 6{\cdot}841}{{\cdot}9 \times 934{\cdot}5} = \pounds 1$$

$$\text{or, simplifying, Frs. } 25{\cdot}22 = \pounds 1$$

Until 1928 the same formula applied to France.

Foreign exchange operators have a quicker way of calculating pars, known as "the chain rule." This is illustrated below, in the calculation of the pound against the dollar:

? dollars	=£1
£934·5	= 20 lb. gold std.
12 lb. std.	= 11 lb. fine.
1 lb. fine	= 5,760 grains fine.
9 grains fine	= 10 grains, $\frac{9}{10}$ fine.
258 grains, $\frac{9}{10}$ fine	= \$10.

Then the answer is:

$$\$ \; \frac{1 \times 20 \times 11 \times 5760 \times 10 \times 10}{934{\cdot}5 \times 12 \times 1 \times 9 \times 258} = \$4{\cdot}867$$

The chain rule is:

(1) State the question in the top equation.

(2) Begin each new equation with the same kind of item as ends the preceding one.

(3) See that the final equation ends with the same kind of item as began the first.

(4) Divide the product of the left-hand side into the product of the right.

(*See* also Currency; Foreign Exchange; Mint Price of Gold.) (N. E. C.)

MINT PRICE OF GOLD. In any form of metallic currency it is essential that the law should lay down the weight of metal that each coin should contain, as otherwise uniformity would be lost, and the currency would have no fixed value and purchasing power and would cease to command confidence. Furthermore, the law usually reserves the right to coin money to the official mint, which is a government institution. From this it follows that all gold or silver bullion which the holders wish to turn into coin has to be handed over to the mint in the form of bullion and returned by the mint in the form of coin.

The need for this double transfer immediately raises the question of the terms on which the mint is prepared to act. In these terms, three main factors are involved. These are the mint price of gold or silver, seigniorage and loss of interest.

Confining this examination to gold, it is clear that if, as is always the case, the weight and fineness of gold in each given coin is fixed by law the mint price of gold is equally fixed. Thus the English law lays down that twenty pounds weight troy of standard gold shall be coined into 934 sovereigns and one half-sovereign, and standard gold is defined as twenty-two carats fine gold to two carats of alloy in the pound weight troy, or eleven-twelfths fine.

The mint price of gold in England can thus be calculated at once:

$$
\begin{aligned}
\pounds 934{\cdot}5 &= \text{20 lb. standard gold}\\
&= \text{240 oz. }\;\text{"}\;\;\text{"}
\end{aligned}
$$

$$\therefore \text{1 oz. standard gold} = \pounds\frac{934{\cdot}5}{240} = \pounds 3 \text{ 17s. } 10\tfrac{1}{2}\text{d.}$$

£3 17s. 10½d., or—to use the form in which it is more usually expressed—77s. 10½d. per oz. standard, is the mint price of gold in London.

United States law enacts that a ten-dollar piece shall consist of 258 grains gold, nine-tenths fine. This makes the mint price of gold $20.67183 per oz. fine.

Having shown how the mint price is calculated, it remains to determine its significance. It simply expresses the amount of coin that the mint will return to the tenderer of a given amount of bullion. Thus in England if 20 lb. of standard gold are tendered to the mint the holder will receive back £934 10s.

It will be seen that, so far, the mint has made no charge for the cost of coining the gold. In England this was the case, but abroad the mint usually does make a charge. This is called seigniorage (*q.v.*) and it has the effect of reducing the mint price of gold.

The third point, namely loss of interest, arises from the fact that it usually takes a week or ten days for gold bullion to be minted. During this period the owner of the gold is earning no interest upon it. This also has a practical effect upon the mint price of gold, as can be seen very simply from the following calculation.

Assume that the operation of minting takes ten days, and that the current rate of interest is 5%. Then in London, one ounce standard gold equals 77s. 10½d. in ten days' time, which is only equivalent to 77s. 9d. spot cash.

The Bank and the Mint.—This fact has long had in London a curious result. Under the Bank Act of 1844 the Bank of England is bound to buy gold offered to it at a minimum price of 77s. 9d. per standard ounce. Hence, in practice, all bullion brought into England was not tendered to the mint for coinage, but sold outright to the Bank, who thus became in practice the sole tenderer of gold to the mint. This procedure was formally recognized by the Gold Standard Act of 1925, which lays down that only the Bank of England now has the right to tender gold to the mint for coinage. The London bullion market to-day is governed not by the mint price of gold, but by the fact that the Bank is to-day bound by law to buy gold offered to it at a minimum price of 77s. 9d. per standard ounce and to sell gold in bars of 400 ounces fine at a maximum price of 77s. 10½d. This keeps the market price between these two limits, and the Bank has "a turn" corresponding roughly to the loss of interest during minting. (*See* also CURRENCY.) (N. E. C.)

MINUCIUS, FELIX MARCUS, one of the earliest if not the earliest, of the Latin apologists for Christianity. He is now exclusively known by his *Octavius,* a dialogue on Christianity between the pagan Caecilius Natalis and the Christian Octavius Ianuarius, a provincial lawyer, the friend and fellow-student of the author. The form of the dialogue is modelled on the *De natura deorum* and *De divinatione* of Cicero.

The *Octavius* is admittedly earlier than Cyprian's *Quod idola dii non sint,* which borrows from it; how much earlier can be determined only by settling the relation in which it stands to Tertullian's *Apologeticum.* Since A. Ebert's exhaustive argument in 1868, repeated in 1889, the priority of Minucius has been generally admitted; the objections are stated in the *Dict. Chr. Biog.* article by G. Salmon. Editions: F. Sabaeus-Brixianus, as Bk. viii. of Arnobius (Rome, 1543); F. Balduinus, first separate edition (Heidelberg, 1560); Migne, *Patrol. Lat.* iii. 239; Halm in *Corp. Scr. Eccl. Lat.* (Vienna, 1867); H. A. Holden; Rausch (1913). Translations: R. E. Wallis, in *Ante-Nic. Fathers,* vol. iv.; A. A. Brodribb's *Pagan and Puritan.*

MINUET, a dance for two persons in ¾ time. At the period when it was most fashionable it was slow, ceremonious, and graceful (*see* DANCE). The name is also given to a musical composition written in the same time and rhythm. Haydn introduced it into the symphony; in Beethoven's hands it became the scherzo.

MINUIT, PETER (*c.* 1580–1638), Dutch governor of New Amsterdam and colonizer of New Sweden, was born of Dutch ancestry in Wesel, Rhenish Prussia, about 1580. He removed to Holland and in 1625 received the appointment of director-general of the Dutch West Indies Company's settlements in North America, known as New Netherlands, of which he became the first formal governor under the new government. He landed on Manhattan island on May 4, 1626, and sometime between July and September he called the native Indian chiefs into council and from them for merchandise valued at 60 guilders purchased the entire island, which he intended to make the centre of Dutch settlement. On its southern point he built a blockhouse, warehouse and mill, around which the early settlers made their homes. He ruled wisely until 1631 when he was recalled by the company because he had been too liberal in granting trading privileges to Dutch patroons, which the company feared would endanger their monopoly. A few years later he entered Swedish service and was given command of the two vessels of Swedish and Finn colonists which in March 1638, made the first settlement upon the Delaware river, near Wilmington, Del. There Minuit built Ft. Christiana and successfully managed the colonists' early relations with the Indians and the Dutch. In June 1638, he set out on a trading expedition to the West Indies and, when near the island of St. Christopher, the ship he was on was carried away in a sudden storm and never heard from again.

MINUSINSK, a town of Asiatic Russia in the Siberian area, in 53° 56′ N., 91° 40′ E., on the Minusinsk river, about 5 m. from its junction with the Yenisei. Pop. (1926) 20,403. The town is situated in the fertile Minusinsk district, which has rich black earth, where the warm dry summer enables spring wheat to ripen before the autumn frosts. The town has a flour-milling industry and exports about 4,000 tons of flour per annum to the Lower Yenisei. Sugar beet grows well and a sugar factory exists. Timber is floated down the river from the forests and saw-milling is one of the chief occupations of the town. The Tatar nomads of the Minusinsk steppes are noted stock-raisers. Before the settlement of Russians in the agricultural area after the 1907 Government survey they wandered over the whole region. The mineral wealth of the Minusinsk district is great, but is not yet much exploited. There are coal and copper beds, antimony is found in the rivers, Glauber's salt is obtained from the sulphate of sodium found near the left bank of the Yenisei river, and sulphate of soda from two small lakes lying between Achinsk and Minusinsk. The Minusinsk oasis, sheltered by the mountains, well watered and fertile, has been settled from time immemorial and is rich in the remains of the stone, bronze and iron age. Among the specimens collected in its fire-proof museum are a fine and representative collection of bronze implements, and relics of Chinese origin dating from the Han dynasty of the second century B.C. The collections were arranged by Prince Alexander Kropotkin and M. Martianov when they were exiled to Minusinsk in 1877.

MINUTE MEN, in the American War of Independence, militia-men who had undertaken to turn out for service at a minute's notice. In Massachusetts the minute men were enrolled by an act of the provincial congress of Nov. 23, 1774, and in Boston and vicinity were more prominent than elsewhere prior to the outbreak of the war. The Americans who fought in the opening action of Lexington were "minute men."

MIOCENE, in geology, the system of strata which occurs between the Oligocene and the Pliocene and thus forms the lower of the two divisions of the Neogene or newer Tertiary period. The term is derived from the Greek μεῖον, less, and καινός, recent, and was introduced by Sir Charles Lyell. The name indicates that the system has a smaller number of recent species than is found in the overlying Pliocene.

Conditions During the Miocene.—The close of the Oligocene was marked by a very general regression of the sea. The beginning of the Neogene, that is of the Miocene, was marked by a widespread marine transgression, followed later by a general regression. Thus the whole Miocene corresponds to a cycle of sedimentation, quite distinct from the Pliocene cycle which follows it. As in the Older Tertiary period the marine transgression took place in Europe from three directions—from the North sea, the Atlantic and the Mediterranean. The Miocene deposits are found in basins connected with each of these three areas.

The North sea of Miocene times was never as extensive as that of Eocene or Oligocene times, it did not invade the Paris basin and did little more than cover the fringes of eastern England, northern Belgium, Holland and northern Germany. The fauna is entirely different from that of the Mediterranean and correlation is difficult, especially as the North sea seems to have been cut off from the Atlantic by a ridge across the Straits of Dover.

The Atlantic washed the shores of France as it does to-day, and broad gulfs covered part of Brittany and Aquitaine, and there was a wide communication with the Mediterranean across the south of Spain.

The Mediterranean sea of Miocene times has left deposits which are the best known of all Miocene strata. The Alps had already been built up as far as general features are concerned, and the Miocene transgression was restricted to the surrounding peri-Alpine depression. From the Middle Miocene onwards the eastern Mediterranean was cut off from the western and also from the seas of India and the east. It became an inland sea with a specialized fauna.

Life of the Period.—From the beginning of the Miocene there is an entire difference between the faunas of the North sea and the Atlantic-Mediterranean, and it is difficult to give lists of characteristic fossils except for special areas. The fauna of the Atlantic-Mediterranean area is obviously the parent of the existing Mediterranean fauna. Amongst foraminifera nummulites give place to Lepidocyclines, many of large size. Amongst fossils of zonal importance echinoderms such as *Clypeaster, Scutella* and *Echinolampas* are especially abundant; amongst the numerous lamellibranchs and gastropods many species of *Pecten* are of very restricted vertical range. The important mammalian forms are noted below. For an account of the flora reference should be made to the article PALAEOBOTANY. It has been argued that the marked increase of herbivorous mammals in the Miocene, including *Hipparion,* was due to the spread of turf-forming grasses and that animal migration was greatly facilitated by the drying up of the Mediterranean.

Miocene Stratigraphy.—The following stages have been distinguished in the Mediterranean Miocene:

Marine Facies		Eastern European Facies
3 Sahelian		Pontian
2 Vindobonian	Torbonian facies Helvetian facies	Sarmatian
1 Burdigalian		. .

The *Burdigalian stage* is here taken as the base of the Miocene, since reasons have been given for regarding the Aquitanian as the highest Oligocene. (*See* OLIGOCENE.) The Aquitanian marks the beginning of the Miocene transgression, but contains a number of characteristic marine shells which are not found in later beds. The Burdigalian (type area Bordelais) is marked by a conspicuous transgression of the sea in the peri-Alpine region. Continental deposits of this age, notably the Orleanais sands, are marked by the appearance of such probroscideans as *Mastodon angustidens, M. turricensis, Dinotherium cuvieri,* of *Rhinoceros aurelianensis, Anchitherium,* etc.

The Vindobonian stage (type in the Vienna basin) is marked by further local transgressions such as in Bas-Dauphiné and in the enclosed Vienna Basin. The base of the stage, often of a sandy facies, has been designated the Helvetian (from the marine "mollasse" of Switzerland), whilst at the top there are sometimes blue marls with a deep-water fauna of *Pleurotomas*—a facies distinguished as Tortonian (from Tortona, Piedmont). In the continental equivalents, such as the deposits of Sansan and Simorre (Gers) and La Grive-St.-Alban (Isère) the characteristic mammals are *Mastodon angustidens, Dinotherium bavaricum, Rhinoceros sansaniensis, Dicrocerus elegans* and the last *Anchitherium.*

The Pontian Stage (from Pont-Euxin) consists of continental fluviatile or lacustrine deposits forming the final stage of the Miocene cycle. The Pontian includes the famous deposits of Pikermi near Athens and is distinguished palaeontologically by the appearance of *Hipparion, Mastodon longirostris,* the presence of *M. turricensis,* the last *Dinotherium; Rhinoceros schleiermacheri, Gazella deperdita.* Marine equivalents of the Pontian occur in certain parts of Algeria and have been called the Sahelian (after Sahel d'Oran). In eastern Europe where the huge stretch of the eastern Mediterranean was separated from the western the true Pontian is underlain by a brackish water series (the Sarmatian, from the country of the Sarmates in the south of Russia), which may be the equivalent of the upper Vindobonian.

Turning now to the North sea Miocene, the regression of the sea at the end of the Oligocene was such that the lowest Miocene is found only in Denmark, Schleswig-Holstein and the neighbourhood of Hamburg and is absent from England, Belgium and Holland. The middle Miocene is marked by a southward transgression, the sea reaching as far south as Bremen and Osnabrück in Germany and covering much of Belgium where ferruginous sands constitute the Bolderian (Bolderberg, near Hasselt, Belgium). The presence of Aquitanian fossils in the Bolderian suggests a connection with the Atlantic at this time. The upper Miocene is represented by glauconitic sands near Antwerp, the Anversian of the Belgians. It is still doubtful whether the Miocene is represented in England except by lavas and some interstratified beds on the west coast of Scotland and northern Ireland. A Miocene fauna is found in the "Boxstones" at the base of the East Anglian Pliocene and it is claimed on palaeontological grounds that part of the Lenham beds, occurring in pockets in the chalk downs of Kent and Surrey, is Miocene.

Outside Europe the Miocene is well displayed in parts of northern India (where the Gaj series is Burdigalian) and has yielded a rich harvest of mammalian remains (especially from the Bugti beds); in the old gulfs of south-eastern Asia it is partly marine, partly continental—including, for example, the upper part of the Peguan of Burma, whilst the lower part of the fresh-water Irrawaddian is Pontian. Along the Atlantic slope of the United States and around the Gulf of Mexico the complete Miocene series is present, the Sarmatian and Pontian occur also in California. Miocene rocks are important in the West Indies and the Antilles. (*See* under EOCENE.)

See the writings of G. E. Pilgrim in the *Records of the Geological Survey of India* on the correlation of Eastern deposits. (L. D. S.)

MIOT DE MÉLITO, ANDRÉ FRANÇOIS, COMTE (1762–1841), French statesman and scholar, was born at Versailles (Seine-et-Oise) on Feb. 9, 1762. He was a high official in the war office before the Revolution, and under the Republic he eventually became secretary-general for foreign affairs, and served on many foreign missions. In 1806 he joined Joseph Bonaparte in Naples as minister of the interior, afterwards following him to Spain as comptroller of the household, but he returned to France in the retreat of 1813. He took no part in politics after Waterloo. He was admitted in 1835 to the French Academy for his translations of Herodotus (Paris, 1822) and Diodorus (Paris, 1835–38). He died in Paris on Jan. 5, 1841.

See his diary covering the period 1788–1815, and published by his son-in-law, General von Fleischmann in 1858, Eng. trans. 2 vols., 1881. *See* also A. Gaudin, *Les Arrêtés, Miot* (Ajaccio, 1896).

MIQUEL, JOHANN VON (1829–1901), German statesman, was born at Neuenhaus, Hanover, on Feb. 19, 1829, being descended from a French family which had emigrated during the Revolution. He studied law at Heidelberg and Göttingen. The writings of Karl Marx converted him to socialism; but though he entered into correspondence with Marx, with the idea of starting a revolutionary movement, he took no open part in the events of 1848–49. He was one of the founders of the German *Nationalverein,* and in 1864 he entered the Hanoverian parliament as a Liberal and an opponent of the Government. He accepted the annexation of Hanover by Prussia without regret, and was one of the Hanoverians whose parliamentary abilities at once won a commanding position in the Prussian parliament, which he entered in 1867. He was burgomaster of Osnabrück from 1865 to 1870, and again from 1876 to 1879, being in the meantime (1870–73) a director of the Discontogesellschaft. In 1879 he was elected burgomaster of Frankfort-on-Main, where he dealt energetically with social questions, especially that of the housing of the poor. Probably owing to his early study of socialism, he was very ready to support the new state socialism of Bismarck. He was the chief agent in the reorganization of the National Liberal party in 1887, in which year he entered the imperial Reichstag. After Bismarck's fall he was Prussian minister of finance (1890–1900). He reformed the Prussian system of taxation, but failed in an attempt to reform the system of imperial finance in 1893–94. Miquel had

given up his Liberalism, and aimed at practical measures for improving the condition of the people irrespective of the party programmes; some of his measures—such as that for taxing "Waarenhäuser" (stores)—were of a very injudicious nature. He professed to aim at a union of parties on the basis of the satisfaction of material interests, a policy to which the name of *Sammlung* was given; but his enemies accused him of intriguing against the three chancellors under whom he served. His sympathy for the Agrarians increased his unpopularity among Liberals and industrials; he insisted that the State, which for half a century had done everything to help manufactures, might now attempt to support the failing industry of agriculture. He resigned in June 1901, and died on Sept. 8, at Frankfort.

Miquel's *Reden* were edited (4 vols., 1911–14) by Schultz and Thimme. *See* W. Mommsen, *Johannes Miquel* (vol. i., 1928).

MIR: *see* Village Communities.

MIRABEAU, ANDRÉ BONIFACE LOUIS RIQUETI, Vicomte de (1754–1792), nicknamed "Barrel Mirabeau," brother of the orator Mirabeau, was one of the reactionary leaders at the opening of the French Revolution. In 1789, he was elected by the noblesse of Limoges a deputy to the States General. He emigrated about 1790, and raised a legion which was to bear his name; but his insolence alienated the German princes, and his command was taken from him. He died in August 1792 at Freiburg im Breisgau.

See Joseph Sarrazin, *Mirabeau Tonneau, ein Condottiere aus der Revolutionszeit* (Leipzig, 1893); and Eugène Berger, *Le Vicomte de Mirabeau (Mirabeau Tonneau), 1754–1792* (1904).

MIRABEAU, HONORÉ GABRIEL RIQUETI, Comte de (1749–1791), French statesman, was born at Bignon, near Nemours, on March 9, 1749. The family of Riquet, or Riqueti, originally of the little town of Digne, won wealth as merchants at Marseilles, and in 1570 Jean Riqueti bought the château and seigniory of Mirabeau, which had belonged to the Provençal family of Barras. In 1685 Honoré Riqueti obtained the title of marquis de Mirabeau. His son Jean Antoine married Françoise de Castellane, and left at his death, in 1737, three sons—Victor, marquis de Mirabeau, Jean Antoine, bailli de Mirabeau, and Comte Louis Alexandre de Mirabeau. The great Mirabeau was the eldest surviving son of the marquis. When but three years old he had a virulent attack of small-pox which left his face disfigured, and contributed to his father's dislike of him. He was educated at a military school in Paris, and in 1767 received a commission in a cavalry regiment which his grandfather had commanded years before. He crossed his colonel in love, and the ensuing scandal led his father to ask for a *lettre de cachet,* and Mirabeau was imprisoned in the isle of Ré. This was the first recorded of many affairs of the heart. On his release, the young count obtained leave to accompany as a volunteer the French expedition to Corsica. After his return, he tried to keep on good terms with his father, and in 1772 he married a rich heiress, Marie Emilie de Marignane. His wild extravagance, however, forced his father to forestall his creditors by securing his detention in semi-exile in the country, where he wrote his earliest extant work, the *Essai sur le despotisme.* A violent quarrel brought another *lettre de cachet* and imprisonment in the Château d'If. In 1775 he was removed to the castle of Joux, to which, however, he was not very closely confined, having full leave to visit in the town of Pontarlier. Here he met Marie Thérèse de Monnier, the Sophie of the famous letters. He escaped to Switzerland, where Sophie joined him; they then went to Holland, where he lived by hackwork for the booksellers; meanwhile Mirabeau had been condemned to death at Pontarlier for *rapt et vol,* and in May 1777 he was seized by the French police, and imprisoned by a *lettre de cachet* in the castle of Vincennes.

The early part of his confinement is marked by the indecent letters to Sophie (first published in 1793), and the obscene *Erotica biblion* and *Ma conversion,* while to the later months belongs his political work, the *Lettres de cachet,* published after his liberation (1782). The book exhibits an accurate knowledge of French constitutional history skilfully applied in an attempt to show that an existing actual grievance was not only philosophically unjust but constitutionally illegal. It shows, though in rather a diffuse and declamatory form, that application of wide historical knowledge, keen philosophical perception, and genuine eloquence to a practical purpose which was the great characteristic of Mirabeau, both as a political thinker and as a statesman.

With his release from Vincennes (August 1782) begins the second period of Mirabeau's life. He found that his Sophie was an idealized version of a rather common and ill-educated woman, and she consoled herself with the affection of a young officer, after whose death she committed suicide. Mirabeau first set to work to get the sentence of death still hanging over him reversed, and by his eloquence not only succeeded in this but got M. de Monnier condemned in the costs of the whole law proceedings. From Pontarlier he went to Aix, where he claimed the court's order that his wife should return to him, but he lost his case by accusing his wife of infidelity, on which the court pronounced a decree of separation. He then intervened in the suit pending between his father and mother before the parlement of Paris, and attacked the ruling powers so violently that he had to leave France and again go to Holland. About this time began his connection with Mme. de Nehra, and his life was strengthened by the love of his *petite horde,* Mme. de Nehra, his adopted son, Lucas de Montigny, and his little dog Chico. After a period of work in Holland he went to England, where he was admitted into the best Whig literary and political society of London, through his old schoolfellow Gilbert Elliot. Among his most intimate English friends were the 1st marquess of Lansdowne, better known as Lord Shelburne, and Samuel Romilly. Romilly undertook to translate into English the *Considérations sur l'ordre de Cincinnatus,* which Mirabeau had written in 1785.

The *Considérations sur l'ordre de Cincinnatus* which Romilly translated was the only important work Mirabeau wrote in the year 1785. He now turned his thoughts to employment from the French foreign office, either in writing or in diplomacy. He first sent Mme. de Nehra to Paris to make peace with the authorities and then returned himself, hoping to be employed as a political pamphleteer, but he ruined his chances by a series of writings on financial questions. On his return to Paris he had become acquainted with Étienne Clavière, the Genevese exile, and a banker named Panchaud. From them he heard plenty of abuse of stock-jobbing, and seizing their ideas he began to regard stock-jobbing, or agiotage, as the source of all evil, and to attack in his usual vehement style the Banque de St. Charles and the Compagnie des Eaux. This last pamphlet brought him into a controversy with Beaumarchais, who certainly did not get the best of it, but it lost him any chance of literary employment from the government. But after a preliminary tour to Berlin at the beginning of 1786 he was despatched in July 1786 on a secret mission to the court of Prussia, from which he returned in January 1787, and of which he gave a full account in his *Histoire secrète de la cour de Berlin* (1789). He was in Berlin at the time of the death of Frederick the Great. He failed to conciliate the new king Frederick William; and thus ended Mirabeau's one attempt at diplomacy. During his journey he had made the acquaintance of Jakob Mauvillon (1743–1794), whom he found possessed of a great number of facts and statistics with regard to Prussia; these he made use of in his *De la monarchie prussienne sous Fréderic le Grand* (London, 1788). He had offered himself as a candidate for the office of secretary to the Assembly of Notables which the king had just convened, and to bring his name before the public published the *Dénonciation de l'agiotage.* The violence of this book ruined his chance of election, and he had to retire to Tongres; he further injured his prospects by publishing the reports he had sent in during his secret mission at Berlin. But 1789 was at hand; the states-general was summoned; Mirabeau's period of probation was over.

On hearing of the king's determination to summon the states-general, Mirabeau started for Provence, and offered to assist at the preliminary conference of the noblesse of his district. They rejected him; he appealed to the *tiers état,* and was returned both for Aix and for Marseilles. He elected to sit for Aix. At every important crisis his voice was heard in the Assembly, though his

advice was not always followed. He possessed at the same time great logical acuteness and the most passionate enthusiasm. From the beginning he recognized the need of strong government. At the same time he thoroughly comprehended that for a government to be strong it must be in harmony with the wishes of the majority of the people. He had carefully studied the English constitution in England, and he hoped to establish in France a system similar in principle but without any slavish imitation of the details of the English constitution. In the first stage of the history of the states-general Mirabeau's part was very great. He always knew his own mind, and was prompt in emergencies. To him is to be attributed the successful consolidation of the National Assembly. When the taking of the Bastille had assured the success of the Revolution, he warned the Assembly of the futility of passing fine-sounding decrees and urged the necessity for action. He declared that the famous night of Aug. 4 was but an orgy, giving the people an immense theoretical liberty while not assisting them to practical freedom, and overthrowing the old régime before a new one could be constituted. His failure to control the theorizers showed Mirabeau, after the removal of the king and the Assembly to Paris, that his eloquence would not enable him to guide the Assembly by himself, and that he must therefore try to get some support. He wished to establish a strong ministry, which should be responsible like an English ministry, but to an assembly chosen to represent the people of France better than the English House of Commons at that time represented England. The duchesse d'Abrantès states in her *Mémoires* that he thought of becoming a minister of the crown as early as May 1789, but the queen rejected the idea. He tried in vain to work with Lafayette, and then with Necker, for whose financial scheme he obtained the assent of the Assembly. After the events of the 5th and 6th of October the comte de la Marck consulted Mirabeau as to what measures the king ought to take, and Mirabeau, delighted at the opportunity, drew up an admirable state paper, which was presented to the king by Monsieur, afterwards Louis XVIII. The whole of this *Mémoire* should be read to get an adequate idea of Mirabeau's genius for politics; here it must be summarized.

The main position is that the king is not free in Paris; he must therefore leave Paris and appeal to France. "Paris n'en veut que l'argent; les provinces demandent des lois." But where must the king go? "Se retirer à Metz ou sur toute autre frontière serait déclarer la guerre à la nation et abdiquer le trône. Un roi qui est la seule sauvegarde de son peuple ne fuit point devant son peuple; il le prend pour juge de sa conduite et de ses principes." He must then go towards the interior of France to a provincial capital, best of all to Rouen, and there he must appeal to the people and summon a great convention. It would be ruin to appeal to the noblesse, as the queen advised: "un corps de noblesse n'est point une armée, qui puisse combattre." When this great convention met the king must show himself ready to recognize that great changes have taken place, that feudalism and absolutism have for ever disappeared, and that a new relation between king and people has arisen, which must be loyally observed on both sides for the future. "Il est certain, d'ailleurs, qu'il faut une grande révolution pour sauver le royaume, que la nation a des droits, qu'elle est en chemin de les recouvrer tous, et qu'il faut non seulement les rétablir, mais les consolider." To establish this new constitutional position, between king and people would not be difficult, because "l'indivisibilité du monarque et du peuple est dans le coeur de tous les Français; il faut qu'elle existe dans l'action et le pouvoir."

Such was Mirabeau's programme, from which he never diverged, but which was far too statesmanlike to be understood by Louis, and far too positive to be palatable to the queen. Mirabeau followed up his *Mémoire* by a scheme of a great ministry to contain all men of mark—Necker as prime minister, "to render him as powerless as he is incapable, and yet preserve his popularity for the king," the duc de Liancourt, the duc de la Rochefoucauld, La Marck, Talleyrand, bishop of Autun, at the finances, Mirabeau without portfolio, G. J. B. Target, mayor of Paris, Lafayette generalissimo to reform the army, Louis Philippe, comte de Ségur (foreign affairs), Mounier and I. R. G. le Chapelier. This scheme got noised abroad, and was wrecked by a decree of the Assembly of Nov. 7, 1789, that no member of the Assembly could become a minister. The queen utterly refused to take Mirabeau's counsel, and La Marck left Paris. In April 1790 he was suddenly recalled by the comte de Mercy-Argenteau, the Austrian ambassador at Paris, and the queen's most trusted political adviser, and from this time to Mirabeau's death he became the medium of almost daily communications between the latter and the queen. Mirabeau at first attempted again to make an alliance with Lafayette, but it was useless, for Lafayette was not a strong man himself and did not appreciate "la force" in others. From the month of May 1790 to his death in April 1791 Mirabeau remained in close and suspected, but not actually proved, connection with the court, and drew up many admirable state papers for it. In return the court paid his debts; but it ought never to be said that he was bribed, for the gold of the court never made him swerve from his political principles. He regarded himself as a minister, though an unavowed one, and believed himself worthy of his hire.

On the question of the veto Mirabeau declared for the king's absolute veto and against the compromise of the suspensive veto. On the question of procedure he got his friend Romilly to draw up a detailed account of the rules and customs of the English House of Commons, in the vain hope that the Assembly might adopt them. On the subject of peace and war he supported the king's authority, and with some success. Mirabeau almost alone of the Assembly held that the soldier ceased to be a citizen when he became a soldier; he must recognize that a soldier's first duty is obedience. Lastly in finance he attacked Necker's "caisse d'escompte," which was to have the whole control of the taxes, as absorbing the Assembly's power of the purse; and he heartily approved of the system of assignats, but with the reservation that they should not be issued to the extent of more than one-half the value of the lands to be sold.

Of Mirabeau's attitude with regard to foreign affairs something must be said. He held that the French people should conduct their Revolution as they would, and that no foreign nation had any right to interfere with them while they kept themselves strictly to their own affairs. But he knew that foreign monarchs were being prayed by the French emigrés to interfere on behalf of the French monarchy. To avoid any pretext for such interference was his guiding idea in foreign policy. He had been elected a member of the *comité diplomatique* of the Assembly in July 1790, and became its reporter at once. As matters became more strained, he entered into daily communication with the foreign minister, Montmorin, advised him on every point, and, while dictating his policy, defended it in the Assembly. How great a work he did is best proved by the confusion which ensued in this department after his death. For indeed in the beginning of 1791 his death was near. The excesses of his youth had weakened his strong constitution, and his parliamentary labours completed the work. Some time before the end he sent all his papers over to Sir Gilbert Elliot, who kept them under seal until claimed by Mirabeau's executors. Every care that science could afford was given by his friend and physician, Cabanis. The people kept the street in which he lay quiet, but medical care, the loving solicitude of friends and the respect of all the people could not save his life. When he could speak no more he wrote with a feeble hand the one word "dormir," and on April 2, 1791, he died.

No man ever so thoroughly used other men's work, and yet made it all seem his own. "Je prends mon bien où je le trouve" is as true of him as of Molière. His first literary work, except the bombastic but eloquent *Essai sur le despotisme* (Neufchâtel, 1775), was a translation of Robert Watson's *Philip II.*, done in Holland with the help of Durival; his *Considérations sur l'ordre de Cincinnatus* (London, 1788) was based on a pamphlet by Aedanus Burke (1743–1802), of South Carolina, who opposed the aristocratic tendencies of the Society of the Cincinnati, and the notes to it were by Target; his financial writings were suggested by the Genevese exile, Clavière. During the Revolution he received yet more help; men were proud to labour for him, and did not murmur because he absorbed all the credit and fame. Etienne Dumont, Clavière, Antoine Adrien Lamourette and Etienne Salomon Reybaz were but a few of the most distinguished of his collaborators. Dumont prepared famous addresses which Mirabeau used to make the Assembly pass by sudden bursts of eloquent declamation; Clavière worked out his figures, and wrote

his financial discourses; Lamourette wrote the speeches on the civil constitution of the clergy; Reybaz not only wrote for him his famous speeches on the assignats, the organization of the national guard and others, which Mirabeau read word for word at the tribune, but even the posthumous speech on succession to the estates of intestates, which Talleyrand read in the Assembly as the last work of his dead friend. He took other men's labour as his due, and impressed their words, of which he had suggested the underlying ideas, with the stamp of his own individuality; his collaborators were glad to help forward the Revolution through its greatest thinker and orator. As an orator his eloquence has been likened to that of both Bossuet and Vergniaud, but it had neither the polish of the old 17th century bishop nor the flashes of genius of the young Girondin. It was rather parliamentary oratory in which he excelled, and his true compeers are rather Burke and Fox than any French speakers. Personally he had that which is the truest mark of nobility of mind, a power of attracting love and winning faithful friends. (H. M. St.; X.)

Authorities.—The best edition of Mirabeau's works is that published by Blanchard in 1819–22, in ten volumes, of which the first two contain his *Oeuvres oratoires;* from this collection, however, many of his less important works and the *De la monarchie prussienne* are omitted. For details of his life consult *Mémoires biographiques, littéraires et politiques de Mirabeau, écrits par lui-même, par son père, son oncle et son fils adoptif,* which was issued by his adopted son, Lucas de Montigny (8 vols., 1834–35); *Correspondance entre Mirabeau et le comte de la Marck,* ed. A. de Bacourt (2 vols., 1851), some additional letters appeared in the German edition (3 vols., Leipzig, 1851–52). Other published correspondence is *Lettres de Mirabeau à Chamfort* (1796); *Lettres du comte de Mirabeau à Jacques Mauvillon* (Brunswick, 1792); *Lettres originales de Mirabeau, écrites du donjon de Vincennes, 1777–1780,* published by L. P. Manuel (4 vols., 1792); and, on the same subject, Paul Cottin, *Sophie de Monnier et Mirabeau d'après leur correspondance inédite* (1903); *Lettres à Julie,* edited by D. Meunier and G. Selois (Paris, 1903); *Lettres inédites* (1806), edited by J. F. Vitry. The *Histoire secrète* forms the basis of H. Welschinger's *La Mission secrète de Mirabeau à Berlin* (Paris, 1900). The most useful modern books are Louis and Charles de Loménie, *Les Mirabeau* (5 vols., 1878 and 1889); Alfred Stern, *Das Leben Mirabeaus* (2 vols., 1889); E. Rousse, *Mirabeau* (1891) in the Grands Ecrivains Français; A. Mézières, *La Vie de Mirabeau* (1892); L. Barthou, *Mirabeau* (1919); Meunier, *Autour de Mirabeau* (1926). On his eloquence and the share his collaborators had in his speeches *see* F. A. Aulard, *Orateurs de l'assemblée constituante* (1882). For his death *see* the curious brochure of his physician, Cabanis, *Journal de la maladie et de la mort de Mirabeau* (Paris, 1791, ed. H. Duchenne, Paris, 1890). English works include P. F. Willert, *Mirabeau* (1898) in the "Foreign Statesman" series; C. F. Warwick, *Mirabeau and the French Revolution* (1905); W. R. H. Trowbridge, *Mirabeau, the demi-god* (1907); H. E. von Holst, *The French Revolution Tested by Mirabeau's Career* (Chicago, 1894); and F. Fling, *Mirabeau and the French Revolution* (London and New York, 1908).

MIRABEAU, VICTOR RIQUETI, Marquis de (1715–1789), French author and political economist, father of the great Mirabeau, was born at Pertuis on Oct. 4, 1715. In 1728 he joined the army, but never rose above the rank of captain. After retiring from the army he wrote his *Testament politique* (1747), in praise of the middle ages. This was followed by *L'Utilité des états provinciaux* (1750), attributed at the time to Montesquieu; *L'Ami des hommes, ou traité de la population* (1756); written under the influence of Quesnay; *Théorie de l'impôt* (1760), a vehement attack on the farmers-general of the taxes. The last named book brought him imprisonment and exile to his estate at Bignon. There the Physiocratic School had its centre, and in 1765 Mirabeau bought the *Journal de l'Agriculture, du Commerce et des Finances* to serve as its organ. His health and his fortune were broken by a prolonged law-suit with his wife, in which his defence was undertaken by his son. The marquis died at Argenteuil on July 11, 1789.

See L. de Loménie's *Les Mirabeau* (2 vols., 1879). Also Oncken, *Der ältere Mirabeau und die oekonomische Gesellschaft in Bern* (Berne, 1886); H. Ripert, *Le Marquis de Mirabeau, ses théories politiques et économiques* [*thèse pour le doctorat*] (1901); De Lavergne, *Les Economistes français du 18me siècle.*

MIRACLE, anything wonderful, beyond human power, and deviating from the common action of nature, a supernatural event. The term is particularly associated with the supernatural factors in Christianity. To the Lat. *miraculum* correspond Gr. *τέρας* in the New Testament, and Heb. פֶּלֶא (Exod. xv. 11; Dan. xii. 6) in the Old Testament. Other terms used in the New Testament are *δύναμις* "with reference to the power residing in the miracle worker" (*cf.* גְבוּרָה Deut. iii. 24 and בְּרִיאָה Num. xvi. 30), and *σημεῖον* "with reference to the character or claims of which it was the witness and guarantee" (*cf.* אוֹת Exod. iv. 8); that the power is assumed to be from God is shown by the phrases *πνεύματι θεοῦ* (Matt. xii. 28; *cf.* Luke iv. 18) and *δακτύλῳ θεοῦ* (Luke xi. 20).

The two conceptions once common in the Christian church, that on the one hand miracles involved an interference with the forces and a suspension of the laws of nature, and that, on the other hand, as this could be effected only by divine power, they served as credentials of a divine revelation, are now generally abandoned. As regards the first point, it is now generally held that miracles are exceptions to the order of nature as known in our common experience; and as regards the second, that miracles are constituent elements in the divine revelation, deeds which display the divine character and purpose; that they are *signs* and not merely *seals* of truth. Various theories have been advanced which endeavour to discover the means by which the exceptional occurrence is brought about; but the explanation is merely hypothetical, and we are not helped in conceiving the mode of the divine activity in the working of miracles. The important consideration from the religious standpoint is that God's activity should be fully recognised.

An attempt has been made to discover a natural law which will explain some at least of the miracles of Jesus. Matthew Arnold (*Literature and Dogma,* pp. 143–144) and Harnack (*Das Wesen des Christentums,* p. 18) ascribe the healing miracles to the commanding influence of so great a personality as Jesus. While recent *psycho-therapy* (auto- or hetero-suggestion) lends some support to the theory it may be pointed out: (1) that the *nature* or *cosmical* miracles—feeding of the five thousand, stilling of the storm, withering of the fig-tree—are as well attested as the miracles of healing; (2) that many of the diseases, the cure of which is reported, are of a kind with which *moral therapeutics* could not effect anything (*see* Dr. R. J. Ryle in *Hibbert Journal* V. 586); (3) that Christ never failed to ascribe His power to the Father dwelling in Him. Should medical research prove that organic diseases as well as functional disorders, dependent on neurotic conditions, yield to such treatment, Jesus' use of the method in anticipation of this long development of medical science, would demand explanation. Even if it be shown that in His healing acts He was in His compassion for man, and confidence in God bringing into play hitherto unsuspected resources in Himself or in others, His transcendence personally of His age and surroundings would remain.

An attempt is made to get rid of the distinctive nature of miracle when the exceptionalness of the events so regarded is reduced to a *new subjective mode* of regarding natural phenomena. H. E. G. Paulus dismisses the miracles as "exaggerations or misapprehensions of quite ordinary events." A. Ritschl has been unjustly charged with this treatment of miracles. But what he emphasizes is on the one hand the close connection between the conception of miracles and the belief in divine providence, and on the other the compatibility between miracles and the order of nature. He declines to regard miracles as divine action contrary to the laws of nature. So for Schleiermacher "miracle is neither explicable from nature alone, nor entirely alien to it." What both Ritschl and Schleiermacher insist on is that the belief in miracles is inseparable from the belief in God, and in God as immanent in nature, not only directing and controlling its existent forces, but also as initiating new stages consistent with the old in its progressive development.

We may accept Dorner's definition as adequate and satisfactory. "Miracles are sensuously cognizable events, not comprehensible on the ground of the causality of Nature and the given system of Nature as such, but essentially on the ground of God's free action alone. Such facts find their possibility in the constitution of nature and God's living relation to it, their necessity in the aim of revelation, which they subserve" (*System of Chr.*

Doc. II. p. 161). By the first clause inward moral and religious changes due to the operation of the Spirit of God in man are excluded, and rightly so (*see* INSPIRATION). The negative aspect of miracles is that they are not explicable by the order of nature as we know it; the positive that owing to their character we are led to refer them directly to the divine causality. When the existence of God is denied (atheism) or His nature is declared unknowable (agnosticism), or He is identified with nature itself (pantheism), or He is so distinguished from the world that His free action is excluded from the course of nature (deism), miracle is necessarily denied. It is only the theistic view of God as personal power—that is as free-will ever present and ever active in the world,—which leaves room for miracles. Although the *possibility* of miracles is often confidently denied, such denial rests on an unproved assumption; since we do not know the continuity of nature so thoroughly as to be able to declare that this or that event is necessarily an interruption of it.

Lotze has shown, not only how the possibility of miracles can be conceived (*Mikrokosmos* III. 364); but even that the mode of the divine working may be made intelligible (*op. cit.* II. 54).

If we conceive God as personal, and His will as related to the course of nature analogously to the relation of the human will to the human body, then the laws of nature may be regarded as habits of the divine activity, and miracles as unusual acts which, while consistent with the divine character, mark a new stage in the fulfilment of the purpose of God.

The doctrine of Evolution, instead of increasing the difficulty of conceiving the possibility of miracle, decreases it; for it presents to us the universe as an uncompleted process, and one in which there is no absolute continuity on the phenomenal side; for life and mind are inexplicable by their physical antecedents, and there is not only room for, but need of, the divine initiative, a creative as well as conservative co-operation of God with nature. Such an absolute continuity is sometimes assumed without warrant; but Descartes already recognized that the world was no continuous process, "Tria mirabilia fecit Dominus; res ex nihilo, liberum arbitrium et hominem Deum." The theory of *psycho-physical parallelism* recognizes that while there is a correspondence between mental and material phenomena, changes in the mind and changes in the brain, the former cannot be explained by the latter, as the transition from the one to the other is unthinkable. William James distinguishes the *transmissive* function of the brain from the *productive* in relation to thought, and admits only the former, and not the latter (*Human Immortality* p. 32). Thus as life is transcendent and yet immanent in body, and mind in brain, and both utilize their organs, so God, transcendent and immanent, uses the course of nature for His own ends; and the emergence both of life and mind in that course of nature evidences such a divine initiative as is assumed in the recognition of the possibility of miracles. For such an initiative there must be adequate reason; it must be prepared for in the previous process, and it must be necessary to further progress.

The proof of the possibility of miracle leads us inevitably to the inquiry regarding the necessity or the sufficient reason of miracles. The necessity of miracles is displayed in their connection with the divine revelation; but this connection may be conceived in two ways. The miracles may be regarded as the *credentials* of the agents of divine revelation, as by Butler (*Analogy* part II. Chap. vii). This view, however, is now generally abandoned, for it is recognized that acts of superhuman power, even if established by adequate historical evidence, do not necessarily certify their divine origin. Their moral quality must correspond with the character of God; and they must be connected with teaching which to reason and conscience approves itself divine. The miracle and the doctrine mutually illuminate one another. Accordingly, the *credentials* must also be *constituents* of the revelation, as the character of Jesus ever shines through His miracles. The *wonders* and the *powers* are also *signs*. As God is the Saviour, and the chief end of the revelation is redemption, it is fitting that the miracles should be acts of divine deliverance from physical evil. This congruity of the miracle with divine truth and grace is the answer to Matthew Arnold's taunt about turning a pen into a pen-wiper or Huxley's about a centaur trotting down Regent Street.

The miracles of Jesus—the relief of need, the removal of suffering, the recovery of health and strength—reveal in outward events the essential features of His divine mission. The divine wisdom and goodness are revealed in the course of nature, but also obscured by it. The existence of physical evil, and still more of moral evil, forbids the assumption without qualification that the real is the rational. God in nature as well as in history is fulfilling a redemptive as well as perfective purpose, of which these miracles are appropriate signs. It is an unwarranted idealism and optimism which finds the course of nature so wise and so good that any change in it must be regarded as incredible. On the problem of evil and sin it is impossible here to enter; but this must be insisted on, that the miracles of Jesus at least express divine benevolence under those conditions in which the course of nature obscures it; and are therefore, proper elements in a revelation of grace, of which nature cannot give any evidence.

Having discussed the possibility and necessity of miracles for the divine revelation, we must now consider whether there is sufficient historical evidence for their occurrence. Hume maintains that no evidence, such as is available, can make a miracle credible. Mill states the position with due care. "The question can be stated fairly as depending on a balance of evidence, a certain amount of positive evidence in favour of miracles, and a negative presumption from the general course of human experience against them" (*Essays on Religion,* p. 221). The existence of "a certain amount of positive evidence in favour of miracles" forbids the sweeping statement that miracles are "contrary to experience." The phrase itself is, as Paley pointed out, ambiguous. If it means *all* experience it assumes the point to be proved; if it means only *common* experience then it simply asserts that the miracle is unusual—a truism. The *probability* of miracles depends on the conception we have of the free relation of God to nature, and of nature as the adequate organ for the fulfilment of God's purposes. If we believe in a divine revelation and redemption transcending the course of nature, the miracle as signs of that divine purpose will not seem improbable.

For the Christian Church it is the miracles of Jesus which are of primary importance. The Gospels assumed their present form between A.D. 60 and 90. Their representation of the moral character, the religious consciousness, the teaching of Jesus, inspires confidence. The narratives of miracles are woven into the very texture of this representation. In these acts Jesus reveals Himself as Saviour. In His sinless perfection and filial relation to God He is unique, and His works are congruous with His Person. Of the supreme miracle of His resurrection there is earlier evidence than of any of the others (1 Cor. xv. 3–7, before A.D. 58). His conquest of death is most frequently appealed to in the apostolic teaching. The Christian Church would never have come into existence without faith in the Risen Lord. Yet it must be remembered that the *fact* of the resurrection does not stand or fall with the *mode* in which it was conceived; and that the mode of a belief is necessarily dependent upon the pre-suppositions, scientific and religious, of the age in which it is held. The accounts in the Old Testament of miraculous events are obviously conditioned by the presuppositions of the age and would in most cases be recorded differently to-day. The supernatural element that is prominent in the Old Testament is regarded by the authors of its various books as God's providential guidance and guardianship of His people, and His teaching and training of them by His prophets.

In Roman Catholicism, in mediaeval as in modern times, the working of miracles has been ascribed to its saints; but the character of most of these miracles is such as to lack probability. Further, these records are imitative. As Christ and the apostles worked miracles, it is assumed that those who in the Church were distinguished for their sanctity would also work miracles; and there can be little doubt that the wish was often father to the thought.

BIBLIOGRAPHY.—Hume, *Essay on Miracles;* Schleiermacher, *Reden über die Religion;* J. B. Mozley, *Bampton Lectures* (7th ed., 1892); Temple, *Bampton Lectures* (1885); Westcott, *The Gospel of the Resurrection;* Bruce, *The Miraculous Element in the Gospels* (1890);

Illingworth, *Divine Immanence* (1898); J. Wendland, *Miracles and Christianity* (1911); F. R. Tennant, *Miracle and its Philosophical Presupposition* (1928). (A. E. G.)

MIRA DE AMESCUA, ANTONIO (1578–1644), Spanish dramatist, combined to a high degree creative power with evenness of execution. Two of his plays—*La Adversa fortuna de Don Bernardo de Cabrera* and *El ejemplo mayor de la desdicha y capitan Belisario*—are respectively the sources of Rotrou's *Don Bernardo de la Cabrère* and *Belisaire*. Moreto's *Caer para levantar* is simply a recast of Mira's *El Esclavo del demonio*, a celebrated drama which clearly influenced Calderón when composing *La Devoción de la cruz;* and there is manifestly a close relation between Mira's *La Rueda de la fortuna* on the one hand and Corneille's *Héraclius* and Calderón's *En esta vida todo es verdad y todo es mentira.*

MIRAGE, an optical illusion due to progressive variations in the refractive indices of adjacent layers of the atmosphere. It embraces the phenomena of the visionary appearance of sheets of water in arid deserts, the images of ships and icebergs in the atmosphere of the Polar regions, the *Fata Morgana,* and "looming" as witnessed in mists or fogs.

A ray of light, when traversing a homogeneous medium is deviated from its original path by any transparent medium of different refractive index which it enters at an angle less than a right angle; it is therefore readily seen that the path of a ray through continuously varying media is necessarily curved, being compounded of an infinite number of infinitesimally small rectilinear deviations. The atmosphere is a medium of continuously varying refractive index. Meteorological optical phenomena, caused by variations in the refractive index of the atmosphere, may be grouped as: (1) permanent variation as experienced during a normal ascent through the atmosphere, and (2) sporadic variations occasioned by irregular heating. The first variation necessitates the correction of astronomical observations and of geodetic measurements of heights; it is also important in the phenomena of the twilight (*q.v.*) and the afterglow. The second type of variation gives rise to mirages.

A common occurrence is the appearance of an isolated lake in hot sandy deserts. The sand, *e.g.,* of the Sahara, being abnormally heated by the sun, causes the neighbouring air to expand, and its density and refractive index, are diminished, the minimum value being attained in the lowest layers. It reaches a maximum at a certain height, and then decreases according to the permanent variation. Any object viewed across such a heated area is seen by two sets of rays: one set passing near the earth and assuming a path convex to the horizon, the second set more remote from the earth and concave to the horizon. The object will thus appear double for an inverted image is also seen as though mirrored by the sand. The sky's image appears as a sheet of water often surrounded by rocks, reeds and trees, all being reflections of actual objects but frequently distorted out of recognition. Similar mirages may often be seen over smooth surfaces, *e.g.,* tarred roads, on calm hot days, apparent pools of water flood the roadways and surrounding objects are reflected in them. For experimental verification of the phenomena *see* R. W. Wood, *Phil. Mag.* 1899.

A mirage, frequently observed at sea in high northern latitudes, is the appearance of ships and icebergs as if inverted and suspended in the clouds. In this case, a stratum of hot air is at some distance above the sea level, the rays of light near the horizon are practically horizontal, while those at greater elevations are concave. If the change in density is so great that only the upper rays reach the eye then inverted ships appear in the clouds, although nothing is visible on the ocean.

The *Fata Morgana,* of the Straits of Messina, consists of an apparent vertical elongation of an object situated on the opposite shore. The distribution of density resembles that attending a desert mirage, but the changes of refractive index are not so abrupt. The object is really viewed through horizontally stratified media consisting of a central sheet of maximum refractive index, over- and under-laid by sheets with decreasing refraction effects. The entire system acts as a lens, magnifying the object in a vertical direction. If, in addition to this type of horizontal stratification, the atmosphere possesses a similar vertical stratification, then the object would be magnified along two dimensions. These conditions sometimes prevail in misty or foggy weather, more particularly at sea, and thus give rise to the phenomena known as "looming." A famous land example is the "spectre of the Brocken" (*q.v.*). The chromatic halos which so frequently encircle these appearances are caused by diffraction (*see* HALO). Lenses formed of non-homogeneous material and having the maximum refractive index along the central axis, have been prepared, and reproduce some of the effects already described.

The mathematical explanation of this subject was first given by Gaspard Monge; *see* J. Pernter, *Meteorologische Optik* (1906); E. Mascart, *Traité d'optique* (1899–1903); R. W. Wood, *Physical Optics* (1905); R. S. Heath, *Geometrical Optics* (1887).

MIRAJ, a native state of India, in the Southern Mahratta States, Bombay. Since 1820 it has been subdivided between a senior and a junior branch. The territory of both is widely scattered among other native states and British districts. Area of the senior branch, 343 sq.m.; pop. (1921), 82,580; tribute £800. Area of the junior branch, 211 sq.m.; pop. (1921), 34,665, tribute £500. The chiefs are Brahmans of the Patwardhan family. The town of MIRAJ, at which the chief of the senior branch resides, is situated near the river Kistna; it is a junction of the Madras & Southern Mahratta railway for the branch to Kolhapur. Pop. (1921), 21,424. The chief of the junior branch has his residence at Bhudgaoh (pop. 3,305).

MIRAMON, MIGUEL (1832–1867), Mexican soldier of French extraction, was born in the city of Mexico, Sept. 29, 1832, and was shot with the Emperor Maximilian at Queretaro on June 19, 1867. While still a student he helped to defend the military academy at Chapultepec against the forces of the United States; and, entering the army in 1852, he rapidly came to the front during the civil wars. It was largely due to Miramon's support of the ecclesiastical party against Alvarez and Comonfort that Zuloaga was raised to the presidency; and in 1859 he was called to succeed him in that office. Decisively beaten by the Liberals in 1860, he spent some time in Europe advocating foreign intervention in Mexican affairs, and returned as a partisan of Maximilian. His ability as a soldier was shown by his double defence of Puebla in 1856.

MIRANDA, FRANCISCO (*c.* 1754–1816), Spanish-American soldier and adventurer, born at Carácas, Venezuela. After serving with the French in the American War of Independence, he began to plot for the independence of Spanish America, was discovered, fled to the United States and thence to England. He travelled to Austria, Turkey, Russia and back to England, always in the vain hope of finding material support for his scheme. In April 1792 he was in Paris; he distinguished himself under Dumouriez, was entrusted in 1793 with the siege of Maestricht and commanded the left wing of the French army at Neerwinden. Although he had given notice of Dumouriez's treachery, he was tried on May 12, acquitted and re-imprisoned till after the 9th Thermidor. He escaped after the *coup d'état* of Fructidor to England; disappointed in his efforts there, in the United States and in Paris—whence he was expelled—he equipped the "Leander" in 1806 at his own expense with the aid of two American citizens, Colonel W. S. Smith and Mr. S. G. Ogden, and backed by the English admiral, Sir A. Cochrane, landed near Carácas and proclaimed the Colombian republic. A false report of peace between France and England caused the English admiral to withdraw his support. In 1810 the events which brought about the Peninsular War had divided the authorities in Spanish America, and Miranda again landed, and declared a republic both in Venezuela and in New Granada or Colombia. Defeated by the Bourbon governor, the count of Monte Verde, he capitulated on July 26, 1812, on condition that he should be deported to the United States. The condition was not observed; Miranda was moved from dungeon to dungeon, and died on July 14, 1816, at Cadiz.

See Buchez et Roux, *Histoire parlementaire,* xxvii. 26–70 (for his trial); J. Biggs, *History of Miranda's Attempt in South America* (1809); Veggasi, *Revolución de la Colombia;* W. S. Robertson, *Francisco de Miranda and the revolutionizing of Spanish America* (1908); Marqués de Rojas, *El General Miranda* (1884), and *Miranda dans*

la révolution française (Carácas, 1889); R. Becerra, *Ensayo histórico documentado de la vida de Don F. de M.* (Carácas, 1896).

MIRANDOLA, a town of Emilia, Italy, province of Modena, 19½ m. N. by E. of Modena by rail (also on the main Bologna-Verona line), 59 ft. above sea level. Pop. (1921), 4,424 (town), 18,941 (commune). The Pico family held the town from the 14th century to 1710, Giovanni (b. 1463, d. 1494) being its ablest and most learned member (*see* PICO). S. Francesco contains some of their tombs.

MIRANHAN, an independent linguistic stock of South American Indians, so called from the Miranhas, one of its most important tribes. They live on the Cauinary river and between the lower Yapura and Putumayo rivers on the border between Brazil and Colombia. They are a barbarous, cannibalistic people, who perforated and enormously enlarged the nasal alae which could be put over the ears. The teeth are also filed and blackened. The men wear a tight belt of bast, with breech-clout, the women wear a bast skirt. They are a sedentary, agricultural folk, living in large, square houses, with clayed walls and gable thatched roof. Their hammocks are of palm-leaf fibre, very beautifully made, and are widely traded.

See C. F. P. von Martius, *Beiträge zur Ethnographie und Sprachenkunde Amerika's etc.* (Leipzig, 1867); T. Koch-Grüneberg, "Der Miranya" (*Verh. Berliner Gesellschaft für Anthropologie etc.*, vol. xlii., pp. 896–914).

MIRBEAU, OCTAVE HENRI MARIE (1850–1917), French dramatist and journalist member of the Goncourt Academy, was born at Trevières (Calvados) on Feb. 16, 1850. He was educated in a Jesuit school at Vannes, and at the University of Paris. He then became dramatic critic of the Bonapartist paper, *L'Ordre*. For a short time before 1877 he was *sous-préfet* and then *préfet* of Saint-Girons, but from that time he devoted himself to literature. In 1890 he began to write for the *Révolte*, but his anarchist sympathies were definitely checked by the murder of President Carnot in 1894. He married in 1887 the actress Alice Regnault. His first novel, *Jean Marcellin* (1885), attracted little attention, but he made his mark as a *conteur* with a series of tales of the Norman peasantry, *Lettres de ma chaumière* (1886). *Le Calvaire* (1887), a chapter of which on the defeat of 1870 aroused much rancour, was followed by *L'Abbé Jules* (1888), the story of a mad priest; by *Sebastien Roch* (1890), a bitter picture of the Jesuit school in which his own early years were spent; *Le Jardin des supplices* (1899); *Les Mémoires d'une femme de chambre* (1901); *Les Vingt-et-un jours d'un neurasthénique* (1902); and *Dingo* (1913), the story of a dog. His dramatic work is finer, and René Lalon has compared his social drama *Les Mauvais Bergers* (Théâtre Renaissance, 1897) with the work of Becque. Equally fine was his *Les Affaires sont les Affaires* (Théâtre Français, 1903), which was adapted by Sydney Grundy for Sir H. Beerbohm Tree in 1905. Some of his short pieces are collected as *Farces et moralités* (1904). He died in Paris on Feb. 16, 1917.

MIRFIELD, an urban district in the West Riding of Yorkshire, England, 4¾ m. N.E. of Huddersfield, on the L.M.S. railway. Pop. (1931), 12,099. It is situated on the river Calder, and is served by the Calder canal. It lies in the carpet and blanket manufacturing area, and the large industrial population is employed in these and in the woollen and cotton industries. There are numerous collieries, and an Anglican theological college.

MIRKHOND (1433–1498) [Mohammed bin Khāwandshāh bin Hahmūd] was born in 1433. From his early youth he applied himself to historical studies and literature in general. In Herāt, where he spent the greater part of his life, he gained the favour of that famous patron of letters, Mīr 'Alīshīr (1440–1501). At the request of Mīr 'Alīshīr, himself a distinguished statesman and writer, Mīrkhond began about 1474, in the quiet convent of Khilāsīyah, which his patron had founded in Herāt as a house of retreat for literary men of merit, his great work on universal history, *Rauẓat-ussafā fi sīrat-ulanbiā walmulūk walkhulafā* or *Garden of Purity on the Biography of Prophets, Kings and Caliphs.* He made no attempt at a critical examination of historical traditions, and wrote in a flowery and often bombastic style, but in spite of this drawback, Mirkhond's *Rauẓat* remains one of the most marvellous achievements in literature. The main portion of the last volume is probably the work of his grandson, the historian Khwāndamīr (1475–1534), to whom also a part of the appendix must be ascribed.

For accounts of Mirkhond's life *see* De Sacy's "Notice sur Mirkhond" in his *Mémoires sur diverses antiquités de la Perse* (Paris, 1793). Besides the lithographed editions of the whole work in folio (Bombay, 1853, and Teheran, 1852–56) and a Turkish version (Constantinople, 1842), the following portions of Mirkhond's history have been published by European Orientalists: *Early Kings of Persia*, by D. Shea (London, 1832) (Oriental Translation Fund); *L'Histoire de la dynastie des Sassanides*, by S. de Sacy (in the above-mentioned *Mémoires*); *Histoire des Sassanides (texte Persan)*, by Jaubert (Paris, 1843); *Historia priorum regum Persarum*, Persian and Latin, by Jenish (Vienna, 1782); *Mirchondi historia Taheridarum*, Persian and Latin, by Mitscherlik (Göttingen, 1814, 2nd ed., Berlin, 1819); *Historia Samanidarum*, Persian and Latin, by Wilken (Göttingen, 1808); *Histoire des Samanides*, translated by Defrémery (Paris, 1845); *Historia Ghaznevidarum*, Persian and Latin, by Wilken (Berlin, 1832); *Geschichte der Sultane aus dem Geschlechte Bujeh*, Persian and German, by Wilken (Berlin, 1835); followed by Erdmann's *Erläuterung und Ergänzung* (Kazan, 1836); *Historia Seldschuckidarum*, ed. Vullers (Giessen, 1837); and a German trans. by the same.

MIRROR, an optical instrument which produces images of objects by reflection. In ancient times it was merely a polished sheet of metal, and was called a speculum; in modern times a mirror is a sheet of polished glass silvered at the back.

If an object CD (fig. 1) is placed in front of a plane mirror AB, every ray such as CP, starting from a point C on the object and striking the mirror, will proceed after reflection along a line PQ, which if produced will pass through the point E, found by dropping a perpendicular CM on the mirror and producing it to a distance ME behind the mirror equal to the distance MC. For it is obvious that the triangles CAD and EAD will always be equal, and therefore that the angles at P which the rays CP and PQ make with the mirror will be equal. Thus to an eye at Q the appearance will be exactly the same as if the light had come from this point E, wherever the eye may be, so long only as the line EQ cuts the surface of the mirror. The image formed by a plane mirror is therefore optically perfect, and free from all aberration.

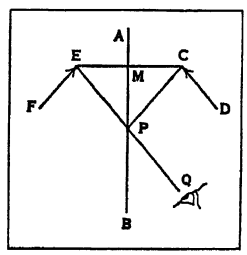


FIG. 1

The image of a solid object is not however a solid of the same shape as the object. For instance the image of a man's face may be imagined to be obtained by making a rubber mask of the face, and then everting it. The image will only be the same shape as the object if the face is perfectly symmetrical, right and left. (*See* LIGHT.)

Combination of Two Plane Mirrors.—If a beam of light, ABCD (fig. 2), is reflected in succession from two plane mirrors which are parallel to one another, as all the angles which they make with the normals to the mirrors are obviously equal to one another, the path of the light after the second reflection must be parallel to the original one AB. This final direction will therefore not be altered however the mirrors are turned about, provided only that the mirrors are kept parallel to one another. But the beam itself is displaced parallel to itself by an amount which depends upon the separation of the mirrors and the angle of incidence of the beam. Moreover any near object PQ seen by reflection will appear in a position P′Q′, found by drawing lines PP′, DD′, QQ′, from PQ parallel to the common normal NN′, and twice its length. By rotating the pair of mirrors round any axis parallel to PQ, the image P′Q′ can be made to describe the surface of a cylinder of which PQ is the axis.

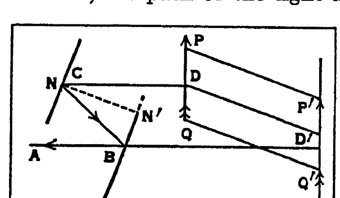


FIG. 2

If in fig. 2, we suppose the mirror B to remain still, and we rotate the mirror C by an angle ω, the ray CD will be turned through an angle 2ω, and the emergent beam will make this angle 2ω, with the incident beam. This angle between the two

beams is therefore independent of the angle of incidence of the original beam upon the first mirror, and will be unaffected by any movement or rotation of the pair of mirrors, so long as the angle between the mirrors is kept unchanged, and the line of intersection of their planes is kept parallel to itself.

A very important use of this property is made in the construction of the common sextant (*q.v.*).

Multiple Reflections.—If two parallel mirrors are set up facing one another and an object, *e.g.*, a candle, is placed between them, not only is this reflected by each mirror, giving two images, but each of these images is again reflected, and so on. In fact if the mirrors are strictly parallel there should be an infinite series.

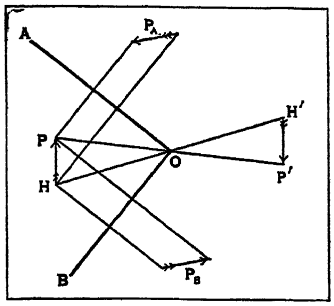


FIG. 3

Two mirrors at right angles yield some interesting effects. An object P (fig. 3) will give images P_A and P_B after one reflection in OA and OB respectively, and (if the angle AOB is exactly a right angle), a single image Q after two reflections. This image can be constructed by drawing lines from the several points of the object P, through O the line of intersection of the mirrors, and producing them to an equal length. It is then obvious that this image will not be affected by rotating the pair of mirrors about O. If the mirrors are set up in a vertical plane, with the line of intersection vertical, a person looking at himself in them, will find his right hand H reflected over to H′ on the left of the image as he sees it. If he moves to one side, the image moves to the opposite side, so that he can always see it while he remains within the angle AOB.

Optical Illusions.—Many optical illusions can be produced by the aid of plane mirrors, usually unsilvered or semisilvered or platinised ones are required. One of the commonest devices is to vary the illumination of the objects, of which some are placed behind and some in front of the mirror. An eye will see only one of these, if it is illuminated strongly and the other left dark.

Optical Illusions with a Concave Mirror.—A concave mirror AB′ A′B (fig. 4), will produce at QQ′ a real image of an object at PP′. If R and L are the right and left eyes of the observer, the right eye will see the image by rays coming from the portion BB′ of the mirror, and the left eye by those coming from the portion AA′. If therefore the mirror is large enough to extend from A to B, the image will be seen by both eyes as though the light were actually coming from an object at QQ′, and seems to be perfectly real and tangible. Thus an apple supported in a box UVWX (fig. 5) against a black velvet background, and lighted by a lamp L, can be projected by a concave shaving mirror among other fruit R on a plate CD. It will disappear if the observer moves to one side, or L is turned out.

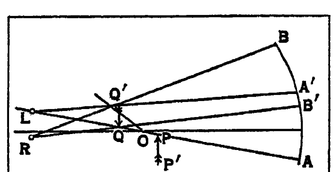


FIG. 4

Very striking effects are produced if water or mercury is allowed to run out from a tube, and splash into a glass dish; then if a second actual tube and glass dish are put to coincide with the images of the tube and dish, it will appear as if the liquid is falling upwards.

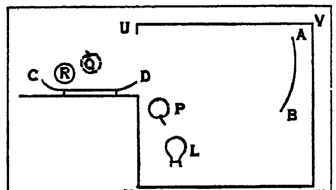


FIG. 5

The Tetrahedral Prism.—Let YOZ, ZOX, XOY, be three plane mirrors, mutually perpendicular, intersecting in OX, OY, OZ. Describe a sphere with centre O, and cutting the mirrors in great circles YZ, ZX, XY (fig. 6). Let a beam of light parallel to PO fall on the inside faces of these mirrors. Each of the mirrors will intercept and reflect part of the beam, which will then fall in turn on each of the other mirrors. Draw a great circle through XP, cutting YZ in M and measure MP′ equal to MP, the light reflected in the mirror YOZ will travel parallel to P′O after reflection. As the angle at M is a right angle, it is obvious that OP′ will make the same angles with OY and OZ that OP does, and that the angle it makes with OX is the supplement of that made by OP with OX. So reflection with any mirror changes the angle with the normal to that mirror into its supplement; successive reflection in all three mirrors will change all the angles made by OP with the normals OX, OY, OZ, into their supplements, *i.e.*, the beam will return exactly along its path.

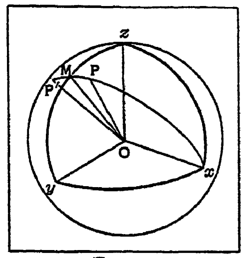


FIG. 6

As the final direction of the beam is simply the opposite of the original direction, it is not affected by rocking the system of mirrors. The mirrors are usually in the form of a tetrahedral prism, *i.e.*, corner of a cube cut off by a plane meeting the edges at equal distances from the corner. On looking into the prism each eye sees itself in a line with the vertex, and no change seems to take place when either eye is closed.

Astronomical Mirrors.—The earlier astronomical mirrors were made of speculum metal, but they were exceedingly difficult to cast owing to strains produced in cooling, and the surface was liable to be imperfect. For these reasons glass has been almost exclusively used for the large mirror since the discovery by Liebig of the method of front silvering it. Very large mirrors, ground from single slabs of glass, have been made successfully. Apparently the limit of size has been nearly if not quite reached, for it is doubtful if the annealing of much larger and thicker slabs would be possible. Professor Ritchey who was responsible for the construction and figuring of some of the largest mirrors, has recently, however, described a built-up cellular glass structure, by which he believes that mirrors up to as large as 30 feet in diameter could be made. An upper and a lower plate of glass of moderate thickness are connected together by vertical ribs of about the same thickness. This forms a structure of comparatively light weight and great rigidity, which will retain its form at all temperatures. He believes it should be sufficiently rigid to be ground and figured to the required degree of accuracy to form the optical image.

The first rough working of these mirrors may be done in one of several ways. They may be turned with a diamond; or they may be ground with a grindstone made of carborundum or alundum, both glass and stone being rotated; or an iron ring fed with grinding material may be used. This grinding tool is a disc of iron of about the same size as the mirror itself, and it is formed with a convex surface of the same radius of curvature as the mirror is to have. In any case the final grinding and smoothing are done with this tool, the mirror resting upon it, face down. After the whole surface has been brought to the desired curve, the rough grinding is complete. It next has to be "smoothed." The smoothing is produced by continuing the grinding with a series of finer and finer grinding materials. After the smoothing is finished the surface should be grey when dry, and appear perfectly free from any pits or scratches, even when it is examined with a magnifying lens. The next stage is the polishing, which is done with moist rouge (ferric oxide), washed to remove any coarse particles. For this part of the process the tool is covered with a thin layer of semi-elastic material, pitch mixed with ashes or wool.

During polishing the curve is checked at frequent intervals, first to see that it has been ground to the radius desired, and then to see if it is approaching the paraboloidal shape, which it has ultimately to reach; for this final change from the true sphere is usually all effected in the polishing. The method devised by Foucault is always used for these tests. A pin point of light is placed to one side of the centre of curvature of the mirror. If the mirror is a perfect sphere the reflected light will all pass through a point on the opposite side of the centre, and an eye at this point, or even a little further from the mirror but in a line with this point, will see the whole mirror filled with light. Also if a straight edge be moved up from one side to cut the beam at

this point, the whole mirror will darken uniformly.

If the mirror is not a perfect sphere, no point can be found at which the mirror can be made to darken uniformly; but if it is a surface of revolution points can be found at which given zones will darken all over at the same time.

To obtain a *flat* surface, it is necessary to work three mirrors, call them A, B, C. These are then tested in pairs by the "Newton's ring" method. If A and B touch all over, and B and C and also C and A, they must all three be flat.

Elliptic Mirrors (generated by the rotation of an ellipse about its major axis) have been successfully applied to cinematograph projection, and to "flood-arcs" for theatre lighting. The mirrors are made of glass, and are silvered at the back, and then copper-plated to protect the silver. The carbons between which the arc is formed are supported in the axis of the mirror, which is pierced in its centre to allow the positive carbon to pass through; the crater of the negative carbon faces the mirror, and is adjusted at its focus. An enlarged image of the crater would then be formed at the farther focus of the mirror; but before reaching this focus, the light passes through a concave lens, which further magnifies the image of the crater, so that it is now large enough to cover the whole of the picture to be projected, which is 0·7 by 0·9 inches. The picture thus becomes virtually a self-luminous one, and the light from it enters the projecting lens as a slightly divergent beam. This method of dealing with the light differs fundamentally from that in the ordinary projecting lantern.

Searchlight Mirrors.—Another very important application of the concave mirror is to the naval searchlight. Here it is required to project a nearly parallel beam, so that an intense light may be concentrated upon any desired distant object. The mirror must therefore have a paraboloidal figure, as this is the surface that has the property that a ray from the focus, striking the surface at any point, will be reflected in a direction parallel to the axis of the parabola. The parabola in this case must subtend a large angle at the focus, if it is to reflect the bulk of the light from the arc, and it will therefore differ greatly from the shape of a sphere. Thus the methods used to produce the parabolic mirror of a telescope (which only subtends a few degrees at its focus) cannot be used in this case. Such surfaces are difficult to grind.

To evade these difficulties, a French Colonel Mangin in 1774 described a very ingenious mirror made in the shape of a concavo-convex lens with spherical surfaces, silvered on the convex side. By a proper choice of the radii of the two surfaces, the mirror behaves as a parabolic one, and gives a nearly parallel beam. These mirrors were used for some twenty years, but they were expensive, very liable to be cracked by the heat, and of course would be shattered by a single bullet. Mirrors made of sheet metal, pressed or spun to the required curvature, and coated on the inside with silver or gold, or other reflecting metal, and polished, do not reflect so much light.

A method of grinding a glass mirror to have a surface with any desired conic section was patented by Schuckert in 1888. He uses a very small tool, which can therefore fit the surface with sufficient approximation, and is constrained to travel in a conic-section. Other ways have since been devised for obtaining a glass mirror of the required shape. (R. S. Cl.)

MIRROR-WRITING. That form of writing which, like an impression on blotting paper, is reversed and becomes legible on holding up to a mirror. It is often associated with left-handedness, may occur in all classes of persons, from the mentally deficient to the genius, may concern adults or children and may be conscious or unconscious (as in right-sided hemiplegia.) In unconscious instances, the explanation seems to be that the right-sided hemiplegic who writes with his left hand mirror-wise, has a derangement of the visual component of speech, and the patient is therefore subject to the independent activity of stored-up memories localized in the right hemisphere.

See M. Critchley, *Mirror Writing* (1928). (W. S. L.-B.)

MIRZAPUR, a city and district of British India, in the Benares division of the United Provinces. The city is on the right bank of the Ganges; pop. (1921), 54,994. The river front, lined with stone ghats or flights of stairs, mosques, Hindu temples and dwelling-houses of the wealthier merchants, is handsome; but the interior of the town is mainly composed of mud huts. Formerly it was the emporium of trade between central India and Bengal, which has now been diverted to the railways. It has European and Indian lac factories, and manufactures brass vessels and woollen carpets. The London Mission manages a high school and an orphanage. The municipal limits include the town of Bindhachal, an important centre of pilgrimage, with the shrine of Vindhyeshwari.

The District of Mirzapur extends into the Sone valley. Area, 4,368 sq. miles. It is crossed from east to west by the Vindhya and Kaimur ranges. A central jungly plateau connects these and separates the valley of the Ganges from that of the Sone. The part north of the Vindhyas is highly cultivated and thickly peopled, but the rest of the district consists largely of ravines and forests with a sparse population. The population in 1921 was 724,183. It comprises a large part of the hereditary domains of the maharaja of Benares and is revenue-free.

MISCARRIAGE, in its widest sense a going astray, a failure. In law, the word is used in several phrases; thus, a miscarriage of justice is a failure of the law to attain its ends. In the Statute of Frauds in the expression "debt, default or miscarriage of another," the word is considered to mean a species of wrongful act for the consequence of which the law makes a party civilly responsible.

In strict medical nomenclature miscarriage implies the birth of a non-viable foetus at or after the sixth month of pregnancy, parturition before that time being termed abortion. Where the child is viable, *i.e.*, at or after the seventh month of pregnancy, the condition is termed a premature birth. Popularly, a miscarriage implies birth of a non-viable foetus independent of the duration of pregnancy. Birth of a dead foetus of viable age is termed a "still-birth." (*See* Abortion.)

MISCEGENATION, a mixture or blending of two races (from Lat. *miscere*, to mix, and *genus*, race).

MISDEMEANOUR, the generic term used in English law to include all those offences against the criminal law which are not by common law or statute made treason or felony. In *Russell on Crimes* it is defined as a crime for which the law has not provided a particular name. The term misdemeanour includes not only all indictable offences below the degree of felony, some of them grave crimes, such as sedition, riot and perjury, but also the petty misdemeanours, which may be dealt with summarily by justices of the peace, and the most trifling breaches of local by-laws.

Numerous acts or omissions are punishable as "misdemeanours by interpretation." In other words, disobedience to the command or prohibition of a statute as a matter of public concern is indictable as a misdemeanour, even if the statute does not so describe it, unless the terms of the statute indicate that some other remedy alone is to be pursued. For some misdemeanours penal servitude may be imposed by statute. But as a rule the appropriate punishment is by fine or imprisonment, without hard labour or both, at the discretion of the court unless limited by a particular statute. The offender may also be put under recognizance to keep the peace and be of good behaviour.

At the present time the practical difference in English law between misdemeanour and felony lies in some matters of procedure, for instance, an arrest for misdemeanour may not be made without judicial authority except under specific statutory authority.

MISE, an Anglo-French term denoting originally a payment. The *Rotuli Misae* of John's reign, for example, record the king's current disbursements from day to day. In a more technical sense, the word is applied to the payments made by the county palatine of Chester to each new earl, and by the Welsh to each new lord of the Marches, or to a prince or king on his entry into the country. By transference of idea the word came early to mean the settlement of a dispute by arbitration or agreement, and in this sense is familiar in English history in the "Mise of Amiens," in January, and that of Lewes, in May 1264.

MISENUM, ancient port, Campania, Italy, about 3 m. S. of Baiae (*q.v.*) at the west end of the Gulf of Puteoli (Pozzuoli). Until the end of the Republic it was a favourite villa resort dependent on Cumae. Agrippa made the fine natural harbour into

the main naval station of the Mediterranean fleet (31 B.C.). In 890 it was destroyed by the Saracens. The harbour consisted of the outer basin, or Porto di Miseno, protected by moles, of which remains still exist, and the present Mare Morto, separated from it by a comparatively modern embankment. The town lay on the south side of the outer harbour, near the village of Miseno, where remains of a theatre and baths have been found. Remains of villas can also be traced; the largest of these, which occupied the summit of the promontory, belonged first to Marius, then to Lucullus, and then to the imperial house. Tiberius died in it.

MISERICORD or **MISERERE,** in architecture, a small bracket placed upon the under side of the folding seats of church choir stalls, to furnish a support or rest against which the priest or clerk can lean while still canonically standing. Its name comes from the fact that these brackets were supplied in pity for the arduous task of remaining constantly standing during long services. The misericords of the choir stalls in Gothic churches both in France and Italy are usually richly carved, often with grotesque figures.

MISHAWAKA, a city of St. Joseph county, Indiana, U.S.A., on the St. Joseph river and Federal highway 20, 90 m. S.E. of Chicago and 4 m. E. of South Bend. It is served by the Grand Trunk, the New York Central, and two industrial railways. Pop. (1920) 15,195 (85% native white); was 28,630 in 1930 by Federal census. It has large manufacturing industries, with an output in 1927 valued at $28,632,700. Chief among them are a rubber-regenerating plant, and factories making over 14,000,000 pairs of rubber and woollen boots, shoes and overshoes, 30,000 trunks, and large quantities of power-transmission machinery, sand-cutting and sand-blast equipment, trunks and machinery made to special order. Mishawaka was an Indian princess, and there was a village bearing her name on the site of the present city. In 1833 St. Joseph Iron Works was laid out on the south side of the river, and in 1836 Indiana City on the north side. In 1838 the two settlements, together with smaller hamlets, were incorporated as the town of Mishawaka, and in 1899 it was chartered as a city.

MISHMI, a hill tribe north of the Brahmaputra in Assam, India, divided into four groups, said to be endogamous, called Chulikata (crop-haired), Bebejiya, Taroan and Miju, the customs of the two last differing a little from those of the two former. These groups are divided into patrilineal exogamous septs. They claim to have reached their present habitat from the north, except one sept, which came from the south. Polygamy is allowed and a man's widows go to his heir. Headmen are chosen by heredity, qualified by wealth and personality. Offences within the sept are punished by the kindred, otherwise the blood-feud is resorted to and revenge obtained by killing or enslaving some member of the offender's sept. All use arrows poisoned with aconite, but, while the first two groups use the simple bow and cane helmets, the two latter use the cross-bow and no helmets. All believe in a home of the dead under ground, and all bury, but the Taroan and Miju dig up their dead after five days and burn them.

See O'Callaghan, *The Mishmis* (Assam Census Report, 1921), Apdx. B. II.

MISHNAH: *see* TALMUD.

MIŠIĆ, ZIVOJIN (1855–1921), Serbian statesman, was born July 7, 1855 at Struganik near Valievo, the son of well-to-do peasant parents. He passed through the old Artillery school in Belgrade and served in the Serbo-Turkish War of 1877 and the Serbo-Bulgarian War of 1885. During the Bosnian annexation crisis he became assistant chief-of-staff to Gen. Putnik; he also fought in the first and second Balkan Wars. When the Austrians invaded Serbia in Nov. 1914, Mišić was appointed to the command of the I. Army. His simple and unaffected heroism inspired his soldiers with confidence: and after the decisive victory of Rudnik early in Dec. the Austrians were driven out of Serbia.

Mišić, who had been created voivode after Rudnik, again served with distinction during the retreat of the Serbian Army in the winter of 1915. He resumed command of the I. Army on the Salonika front in Aug. 1917, and in June 1918 was made chief-of-staff. A convinced believer in the idea of Yugoslav unity, he promoted the efforts of the exiled Yugoslav committee to organize Yugoslav legions on every front. He died on Jan. 20, 1921.

MISIONES, a territory of northern Argentina, bounded north by Paraguay and Brazil, east and south by Brazil and west by Paraguay and the Argentine province of Corrientes. Its boundary lines are formed by the upper Paraná and Iguassú rivers on the north, the San Antonio and Pequiry-guassu streams on the east and the Uruguay river on the south. Area, 11,511 sq.m.; pop. (1914) 53,563, chiefly Indians and *mestizos.* The territory is a region of roughly-broken surfaces, divided longitudinally by low mountains, called the Sierra Imán and Sierra Grande de Misiones. The greater part of the country is covered with forest and tropical jungle. The temperature ranges from about 49° F for the coolest month, July, to around 77° for the warmest month, January. Its products are chiefly confined to *yerba mate* or Paraguay tea (*Ilex paraguayensis*), tobacco and oranges and other fruits. Communication with the capital is maintained by lines of steamboats running to Corrientes and Buenos Aires, and by a railway which has been built from Asunción in Paraguay to Buenos Aires, crossing the Paraná, Encarnación to Posadas, by ferry. Posadas (pop. [1914], 15,734), the capital, on the Paraná, officially dates from 1865. It is at the extreme west of the territory, and is the terminal port for the steamers from Corrientes.

MISKOLCZ, a Hungarian town situated on the eastern slope of the Bükk mountains, in the fertile valley of the Szinva. It is an old but thriving town that clearly reflects its position on the frontiers of several forms of religious expression in its Gothic, Roman Catholic, Eastern Catholic, Lutheran and Calvinistic churches. This aspect is closely connected with its function as a centre of contact for hill and plain, an activity further apparent in the four large annual fairs at which there is a large trade in cereals and flour, wine and fruit, cattle and hides and other agricultural products; in addition there are flour mills, tanneries, boot factories and porcelain works. Like many of the towns on or near the Hungarian plain it has suffered greatly at the hands of invaders, notably the Mongols in 1241–43, who killed about 85,000 Hungarians on the Mohi heath, south-west of the town, and during the Turkish wars in the 16th and 17th centuries, and has been devastated by fire three times, in 1781, 1843 and 1847. About 4 m. S.W. of the town are the warm springs and baths of Tapolcza. The population of Miskolcz (1920) is 56,982.

MISPICKEL or **ARSENOPYRITE,** a mineral consisting of iron sulpharsenide $FeAsS$; it contains 46% of arsenic, and is of importance as an ore of this element. Mispickel is an old name of German origin, and as *Mistpuckel* was used by G. Agricola in 1546. The crystals are orthorhombic; they are often prismatic in habit and the prism is usually terminated by the deeply striated faces of an obtuse dome. The colour is silver-white or steel-grey, with a metallic lustre, but it is often tarnished yellow; the streak is greyish-black. The hardness is $5\frac{1}{2}$–6, and the specific gravity 5·9–6·2.

Mispickel occurs in metalliferous veins with ores of tin, copper, silver, etc. It is occasionally found as embedded crystals, for example, in serpentine at Reichenstein, Silesia. In Cornwall and Devon it is associated with cassiterite in the tin-lodes, but is also found in the copper-lodes; it is the principal source of arsenious oxide, the "white arsenic" of commerce (*see* ARSENIC). The chief supplies are from Cornwall and Devon, Freiberg in Saxony, Canada and the United States.

MISPRISION, a term in English law, almost obsolete, used to describe certain kinds of offence. Thus we have misprision of treason and misprision of felony. But there is no misprision of misdemeanour.

Misprision of Treason is the concealment or keeping secret of high treason, and the punishment is loss of the profit of the lands of the offender during life, forfeiture of all his goods and imprisonment for life.

Misprision of Felony is the concealment or procurement of the concealment of a felony committed by another person, punishable on indictment by fine and imprisonment.

In the United States, misprision of treason is defined to be the crime committed by a person owing allegiance to the United

States, and having knowledge of the commission of any crime against them, who conceals and does not, as soon as may be, disclose and make known the same to the president or to some judge of the United States, or to the governor, or to some judge or justice of a particular state.

MISRULE, LORD OF, in mediaeval times the master of the Christmas revels. Probably J. G. Frazer (*Golden Bough* III.) is right in suggesting that the lord or abbot of misrule is the successor of the king of the Roman Saturnalia, who personated Saturn. Stow (*Survey*) writes: "In the feast of Christmas there was in the King's House . . . a Lord of Misrule . . . and the like had ye in the house of every nobleman of honour or good worship, were he spiritual or temporal." The mayor and sheriffs of London also had lords of misrule but by an act of Common Council (1555) their expenses were severely curtailed. These mock-monarchs began their reign on Allhallows Eve, and misruled till Candlemas. In Scotland they were known as "Abbots of Unreason," and in 1555 a special Act suppressing them was passed. In Tudor times their reign was marked by much expense.

MISSAL, the book containing the liturgy, or office of the mass (*missa*), of the Roman Catholic Church. The earlier *Sacramentary,* the book used by the celebrant at the altar, contained merely the fixed canon of the mass or consecration prayer and the variable collects, *secretae* or *orationes super oblata,* prefaces, and post-communions for each fast, vigil, festival or feria of the ecclesiastical year; for a due celebration of the Eucharist other books were required for use by the choir, deacon and subdeacon, viz., the *Antiphonarium Missae,* afterwards called the *Graduale,* containing the proper antiphons (introits), responsories (graduals), tracts, sequences, offertories, communions and other portions of the communion service designed to be sung by the schola or choir, and the *Lectionarium* (or *Evangeliarium* and *Epistolarium*) with the proper lessons. But as the custom grew, from the 8th century onwards, of private celebrations in which the priest had to say the whole service the contents of these separate books came by degrees to be combined in a single volume, the *Missale plenum.* All modern missals are of this last description. The *Missale romanum ex decreto ss. concilii tridentini restitutum,* now in almost exclusive use throughout the Latin obedience, owes its present form to the council of Trent, which undertook the preparation of a correct and uniform liturgy, and entrusted the work to a committee of its members. This committee had not completed its labours when the council rose, but the pope was instructed to receive its report when ready and to act upon it. The "reformed missal" was promulgated by Pius V. on the 14th of July 1570, and its universal use enjoined, the only exceptions being churches having local liturgies which had been in unbroken use for at least two centuries. It has subsequently undergone slight revisions under Clement VIII.(1604), Urban VIII. (1634) and Leo XIII.(1884), and various new masses, both obligatory and permissive, universal and local, have been added. The Roman, like all the Western liturgies, is distinguished from those of the Eastern Church by its flexibility. A distinctive character has been given to the office for each ecclesiastical season, for each fast or festival of the year, almost for each day of the week; and provision has also been made of a suitable communion service for many of the special occasions both of public and of private life.

The meagre liturgical details furnished by the *Sacramentarium gregorianum* are supplemented by the texts of the *Ordo romanus,* the first of which dates from about the year 770. The ritual they enjoin is that for a pontifical high mass in Rome itself; but the differences to be observed by a priest *quando in statione facit missas* are comparatively slight. The Gregorian *Antiphonarius sive gradualis liber ordinatus per circulum anni,* as its name implies, contains those variable portions of the mass which were intended to be sung by the schola or choir. It gives for each day for which a proper mass is provided: (1) the *Antiphona* (Antiphona ad Introitum) and *Psalmus;* (2) the *Responsorium* and *Versus,* with its *Alleluia* and *Versus;* (3) the *Offertorium* and *Versus;* (4) the *Communio* and *Psalmus.*

The first pages of the modern Roman missal are occupied with the *Calendar* and a variety of explanations relating to the year and its parts, and the manner of determining the movable feasts. The general rubrics (*Rubricae generales missalis*) follow, explaining what are the various kinds of mass which may be celebrated, prescribing the hours of celebration, the kind and colour of vestments to be used, and the ritual to be followed (*ritus celebrandi missam*), and giving directions as to what is to be done in case of various defects or imperfections which may arise. The *Praeparatio ad missam* and *Gratiarum actio post missam* which comes next, are in a short manual of devotion to be used as opportunity may occur before and after celebration. Next comes the proper of the season (*Proprium missarum de tempore*), occupying more than half of the entire volume. It contains the proper introit, collect (one or more), epistle, gradual (tract or sequence), gospel, offertory, secreta (one or more), communion and post-communion for every Sunday of the year, and also for the festivals and ferias connected with the ecclesiastical seasons, as well as the offices peculiar to the ember days, Holy Week, Easter and Whitsuntide. Between the office for Holy Saturday and that for Easter Sunday the ordinary of the mass (*Ordo missae*), with the solemn and proper prefaces for the year, and the canon of the mass are inserted. The proper of the season is followed by the proper of the saints (*Proprium sanctorum*), containing what is special to each saint's day in the order of the calendar, and by the *Commune sanctorum,* containing such offices as the common of one martyr and bishop, the common of one martyr not a bishop, the common of many martyrs in paschal time, the common of many martyrs out of paschal time, and the like. A variety of masses to be used at the feast of the dedication of a church, of masses for the dead, and of votive masses (as for the sick, for persons journeying, for bridegroom and bride) follow, and also certain benedictions. Most missals have an appendix also containing certain local masses of saints to be celebrated *ex indulto apostolico. See* MASS: VESTMENTS.

MISSI DOMINICI, the name given to the officials commissioned by the Frankish kings and emperors to supervise the administration of their dominions. Their institution dates from Charles Martel and Pippin the Short, who sent out officials to see their orders executed. When Pippin became king in 754 he sent out *missi* in a desultory fashion; but Charlemagne made them a regular part of his administration, and a *capitulary* issued about 802 gives a detailed account of their duties. They were to execute justice, to enforce respect for the royal rights, to control the administration of the courts, to receive the oath of allegiance, and to supervise the conduct and work of the clergy. They were to call together the officials of the district and explain to them their duties, and to remind the people of their civil and religious obligations. In short they were the direct respresentatives of the king or emperor. The inhabitants of the district they administered had to provide for their subsistence, and at times they led the host to battle. In addition special instructions were given to various *missi,* and many of these have been preserved. The *missi* were not permanent officials, but were generally selected from among persons at the court, and during the reign of Charlemagne personages of high standing undertook this work. They were sent out in twos, an ecclesiastic and a layman, and were generally complete strangers to the district which they administered. Even under Charlemagne it was difficult to find men to discharge these duties impartially, and after his death in 814 it became almost impossible. Under Louis I. the nobles interfered in the appointment of the *missi,* who, selected from the district in which their duties lay, were soon found watching their own interests rather than those of the central power. Their duties became merged in the ordinary work of the bishops and counts, and under Charles the Bald they took control of associations for the preservation of the peace. About the end of the 9th century they disappeared from France and Germany, and during the 10th century from Italy.

See G. Waitz, *Deutsche Verfassungsgeschichte* (Kiel, 1844); E. Dobbert, *Ueber das Wesen und den Geschäftskreis der missi dominici* (Heidelberg, 1861); L. Beauchet, *Histoire de l'organisation judiciaire en France, époque franque* (1865); V. Krause, *Geschichte des Institutes der missi dominici* in the *Mittheilungen des Instituts für österreichische Geschichtsforschung,* Band XI. (Innsbruck, 1880); E.

Bourgeois, *Le Capitulaire de Kiersy-sur-Oise* (1885); N. D. Fustel de Coulanges, *Histoire des Institutions politiques de l'ancienne France* (1889–90).

MISSIONS, is the term used to denote organized efforts for the spread of a religion, those who carry out the work being known as missionaries. Both "missions" and "missionaries" have hence come to be used of similar propagandist work in other spheres (*e.g.*, "a missionary of peace"). Not only Christianity, but also Buddhism, Zoroastrianism and Islam are, or have been, missionary religions. The phrase "foreign missions" customarily used indicates that the work is carried on in countries which are foreign relatively to those from which it emanates, though the increasingly equal partnership of the younger Churches of the East and Africa with the older Churches of the West tends to render the words "foreign missions" slightly misleading. The history of Christian missions may, for practical purposes, be divided into three chief periods: (1) the primitive, (2) the mediaeval, and (3) the modern.

THE PRIMITIVE PERIOD

Christian missions begin with Jesus Christ, in whom the universalistic religion found in the nobler Judaism (*e.g.*, in "second" Isaiah, some of the Psalms and Jonah) achieved its fulfilment. In His person, work and teaching the unity, holiness, and love, of God, the forgiveness of sins, the ideal of human conduct and the divine order into which the world is to be transformed, are all expressed freed from local and racial limitation. The initial failure of the Palestinian Church to see the universal character of the Christian message was forgotten in the spontaneous movement of expansion in which Stephen, Philip and Barnabas led, followed by the greatest of all missionaries, the apostle Paul, who evangelized a large part of Asia Minor and the most important cities of Greece. The refusal of Paul to bind upon the Gentile converts Jewish customs such as circumcision marked a decisive movement in Christian history. From this point Christianity pushed its way rapidly into all the great centres of population. We should remember the great number of Greek Jews converted at Pentecost (Acts ii.), and scattered subsequently to the ends of the Roman world.

A famous testimony to the spread of Christianity is that of the younger Pliny, who in his letter to Trajan (A.D. 112) records that Christianity had taken such a firm hold of the province that its influence had penetrated to remote country districts, pagan festivals were almost entirely neglected, and animals for sacrifice could hardly find purchasers. Harnack in his *Expansion of Christianity* estimates the hold obtained by Christianity in the countries of the Roman Empire at the end of the third century as follows: (1) Christians numbered nearly one half of the population and Christianity was the standard religion of the people in most of Asia Minor, in the part of Thrace that lay over against Bithynia, in Armenia and in the city of Edessa. (2) Christianity claimed a very material part of the population, influenced the leading classes and held its own with the other religions in Antioch and Crete, Syria, Cyprus, Alexandria together with Egypt and the Thebais, Rome and lower Italy, parts of central Italy, Proconsular Africa and Numidia, Spain, the maritime parts of Greece, and the southern coasts of Gaul. (3) Christians were sparsely scattered in Palestine, Phoenicia, Arabia, certain parts of Mesopotamia, the interior districts of Greece, the provinces in the north of Greece, the northern part of central Italy, and the provinces of Mauretania and Tripolis. (4) Christianity was weak or barely existent in the regions to the north and north-west of the Black Sea, the western part of upper Italy, middle and upper Gaul, Belgium, Germany, Rhoetia and the towns of ancient Philistia.

After the end of the third century missionary enterprise was carried on chiefly on the borders of the Empire. Among the most famous missionaries of this period were Gregory the Illuminator, the apostle of Armenia, about A.D. 300, Ulfilas the apostle of the Goths, about 325, Chrysostom, who founded at Constantinople in A.D. 404 a training school for native Gothic evangelists, Martin of Tours, who evangelized central Gaul, and Patrick, a Scot or Briton, who was taken to Ireland a captive, escaped and became a monk in France, returned to Ireland as a missionary and is traditionally held to be the man who made Ireland the "isle of saints."

THE MEDIAEVAL PERIOD

Celtic Missionaries.—The passionate zeal of the Celtic missions has never been surpassed in Christendom. The men came from the Celtic Churches of the Scottish Highlands and Ireland, out of a Christianity that is probably a legacy of the Roman occupation of Britain. Their missionary passion owed little to the central organization of Rome. Columba, the founder of the monastery of Iona in A.D. 563, an Irishman who was to pay back the debt Ireland owed to Scotland in Patrick, was the leader, and he was followed by Aidan who evangelized Northumbria, Columban who preached in the Vosges and to the Burgundians, Callich (St. Gall) the apostle of Switzerland and many others. Their work ranged from Switzerland and the Rhine to the Faröes and Iceland.

Missions from Rome as Centre.—The work of the Celtic missionaries proved lacking in permanency, and the work of later missionaries was directed from Rome and drew on other races in order to supplement the wonderful pioneering of the Celts. The English missionaries, Wilfrid, Willibrord, and, most famous of all, Winfrid or Boniface, the apostle of Germany, representatives of a newly evangelized Church, went in the seventh and eighth centuries to the Low Countries, Friesland, Saxony, Upper Hessia, Thuringia. Anskar (801–865) took the message to the pagan Scandinavian vikings, and was followed by the Englishman Haakon and the famous Olaf Tryggvason through whom the people of Iceland, Greenland and the Orkney and Shetland Islands were evangelized.

Missions from Constantinople as Centre.—While Rome was attending to the missionary task in northern, central and western Europe, the Eastern church did not forget the Slavonic world at its gates. South Russia and the Balkans were evangelized from Constantinople; in 863 Cyril and Methodius produced a Slavonic Bible and a Slavonic liturgy. The work spread from Bulgaria through Moravia to Bohemia and Poland and finally to Russia, where at the end of the tenth century with the baptism of Vladimir there was symbolized the conversion of Russia, the greatest of all the children of the Eastern Church.

As there was a pause between the end of the great expanding movement of the primitive Church in the Roman Empire and the beginning of mediaeval missions, a pause during which the Church was consolidating its gains and establishing Christian civilization, so now there is a pause until the opening of the modern period. Of the world outside Europe, the world of the Moslem, or the still remoter world of the Hindu and the Buddhist, the mediaeval Church knew almost nothing; although the Nestorian Christians spread their influence throughout the whole East, in Arabia, Palestine, Persia, India and even China, and as many as twenty-five metropolitans are said to have owed allegiance to the Nestorian patriarch. With the terrible persecution of Jenghiz Khan and Tamerlane the Nestorian churches withered away, and are represented now only by tiny remnants of "Chaldeans." The Crusades, which were no true missionary movement, permanently embittered the relations between Christendom and Islam. There are a few great stories that flash out as precursors of the wider missionary movement to come—Ramon Lull's undying zeal for the conversion of Islam, crowned by martyrdom outside the gates of Bugiah in North Africa in 1315, the visit of St. Francis of Assisi to the Sultan, the embassies of Dominicans and Franciscans (to whom with the Benedictines had fallen most of the missionary labour of the Church) to Tartary, and the travels of Marco Polo accompanied by two Dominicans, to the court of Kublai Khan.

MODERN MISSIONS

Early Movements. (1) *Roman Catholic.*—Modern Missions begin with the new world-outlook to which the Renaissance, the Reformation, and the discovery both of the passage to India by the Cape of Good Hope and of the American continent all conduced. The outlook of Christendom was magically changed. No longer were Christian nations in central and western Europe pent up into a corner with the Moslem hosts barring the way to an East virtually unknown to Christendom. The Roman Church first embraced the missionary implications of this new world-outlook, beginning with proselytizing in the Portuguese and Span-

ish colonies, as at Goa, but stimulated later by the counter-Reformation to unprecedented missionary efforts as for example in Mexico and Peru. Loyola founded the Society of Jesus, and one of his chief associates, Francis Xavier, landed at Goa on May 6, 1542. Ten years later he died on the Isle of St. John (Hiang-Shang). In that short span he had roused the Christians at Goa to a new life, laboured with a success whose effects still endure among the fisher folk near Cape Comorin, gathered many converts in Malabar, visited Malacca and founded a mission in Japan.

The Jesuits produced other men of the first rank as missionaries. Matteo Ricci laboured in China for 27 years, and Robert de Nobili tried in India to be a Brahman to the Brahmans, an experiment which has probably been misunderstood by its critics. Other Jesuits evangelized Paraguay in 1582, and pioneers in Canada added some rare stories of martyr-courage to the annals of missions. By the close of the 16th century a committee of cardinals was appointed under the name of the *Congregatio de propaganda fide* to give unity and solidity to the missionary work of the Roman Church. The scheme originated with Gregory XIII., but was given plenary authority by a bull of Gregory XV.

(2) *Protestant.*—Contrasted with the great missionary activity on the part of the Church of Rome, the Protestant Churches were backward in realizing the missionary implications of the faith. The opportunity for imperial expansion came to Spain and Portugal earlier than to England or Holland, and the Protestant Churches had to take time to define and consolidate their position. We see this in the instructions given by Edward VI. to the navigators of Sir Hugh Willoughby's fleet, in the efforts of Sir Walter Raleigh in Virginia, and in the expressed recognition, in the charter given to "the Governor and Company of Merchants of London trading with the East Indies" by Queen Elizabeth in 1600, of higher duties than those of commerce. When James I. granted letters patent for the occupation of Virginia it was directed that the "word and service of God be preached, planted and used as well in the said colonies as also as much as might be among the savages bordering among them."

In 1618 was published *The True Honour of Navigation and Navigators,* by John Wood, D.D., dedicated to the Governor of the East India Company, and about the same time appeared the famous treatise of Grotius, *De veritate religionis Christianae,* written for the use of settlers in distant lands. Dutch evangelists worked in Java, the Moluccas, Formosa and Ceylon.

The North American colonies received some attention, first from Archbishop Laud who designed a scheme for the establishment of a local episcopate, then during the Protectorate when a corporation for the propagation of the Gospel in New England was planned and renewed later in the Restoration period. Cromwell himself characteristically planned a council for the Protestant religion, to rival the Roman *Propaganda,* and to consist of seven councillors and four secretaries for different provinces. Among the most eminent of the missionaries of the New England corporation was the famous John Eliot who produced the Bible in the Indian language in 1661–64. Eliot received much assistance from the Hon. Robert Boyle, who gave other proof of his zeal for missionary work by contributing to the expense of publishing the four Gospels and the Acts of the Apostles in Malay. George Fox, the Quaker, wrote to "All Friends everywhere that have Indians or blacks, to preach the Gospel to them and their servants." Efforts were made by several bishops to develop the colonial church, supplemented by the work of Dr. Thomas Bray, who with a number of laymen founded the Society for the Promotion of Christian Knowledge and was later selected on the request of Maryland as commissary of the Bishop of London. His efforts were crowned in 1701 by the grant of letters patent under the great seal of England for the creation of a corporation under the name of the "Society for the Propagation of the Gospel in Foreign Parts."

On the Continent the first Protestant missionary enterprise was initiated by King Frederick IV. of Denmark who in 1705 founded a mission on the Coromandel coast of India, begun by those remarkable men Ziegenbalg, Plütschau and Christian Friedrich Schwartz, with whom the S.P.C.K. co-operated. The Moravians began in 1731 that astounding missionary career which has made them one of the great missionary churches of the world. Driven from Moravia by persecution, they had scarcely secured a place for themselves in Saxony before they formed the design of carrying the Gospel to the heathen of Greenland and of the West Indies. Within ten years they had established missions in the West Indies, South America, Surinam, Greenland, among the North American tribes, in Lapland, Tartary, Algiers, Guinea, the Cape of Good Hope and Ceylon.

The closing years of the 18th century and the early years of the 19th were marked by the foundation of several of the leading missionary societies of modern Protestant Christianity. The establishment of private societies not officially sponsored by the State and in most cases not officially supported by the Churches, is characteristic of this modern effort. William Carey, a Baptist cobbler in Northampton, and also a great linguist as well as a botanist and zoologist, published in 1792 his *Enquiry into the Obligations of Christians to use Means for the Conversion of the Heathens,* and the book marks a distinct point of departure in the history of Christianity. Under its influence twelve ministers at Kettering in October 1792 subscribed £13:2s:6d to begin the Baptist Society for Propagating the Gospel among the Heathen, and Carey left in 1793 for India. In 1795 the London Missionary Society was formed by a group of evangelical ministers of all denominations, particularly for work in the South Sea Islands.

The evangelical movement in the Church of England took missionary form in the Church Missionary Society, established in 1799 under the guidance of John Venn and Thomas Scott as "The Society for Missions to Africa and the East." This great society from its inception maintained cordial relations with the missionary societies of the Nonconformist Churches. In 1814 the Wesleyan Methodist Missionary Society was founded. In Scotland private missionary organizations in Edinburgh and Glasgow gave place to the organized work of the Church of Scotland, whose first missionary, sent out in 1829, was the famous Alexander Duff, the pioneer of the educational method in missions.

On the Continent of Europe there was a similar movement. The Basel Mission, which came to have large work on the Gold Coast of Africa and in India, was founded in 1815, drawing support from both southern Germany and Switzerland. Other German societies arose, such as the Leipzig, the Berlin and the Rhenish. The Netherlands Missionary Society (1797) in Holland began the evangelization of the Dutch Colonial possessions. The French a little later began their famous mission in South Africa.

In North America at the very end of the 18th century small societies were founded with a view to the evangelization of the Indians. The action of three students at Williams College in Massachusetts, who in 1806 formed themselves into a mission band, led to the formation of the American Board of Commissioners for Foreign Missions, an interdenominational society which like the London Missionary Society is now virtually, though not formally, a Congregationalist organization. The first offshoot from it was the American Baptist Missionary Union in 1814. The Methodist Episcopal Church founded its mission board, now the largest Protestant Missionary organization in the world, in 1819, and in 1837 the Presbyterians began a similar work.

No account of the stages by which the modern missionary movement developed would be complete without reference to two important features, which are to be taken into view along with the official work of the different denominational societies. First, there are the important bodies such as the Society for Promoting Christian Knowledge (1698), the Religious Tract Society of Scotland (1793), of London (1799), and America (1823), and most important of all, the great Bible Societies (*q.v.*)—the British and Foreign Bible Society (1804) and the American Bible Society (1816).

Secondly, there is the individual type of mission such as the China Inland Mission, founded by J. Hudson Taylor who went out to China in 1853; it has now over 1,000 missionaries there.

Recent Developments: Protestant. (1) *Great Britain.*—The eighties of last century marked a period of increased interest in missionary work throughout Great Britain. One of the

principal causes of this increased interest was the world-wide attention given to the life and work of David Livingstone and particularly to his death in 1873. In 1874 Bishop Hannington went to Africa and his murder in 1885 deeply touched the Christian conscience. In 1884-85 came the famous offer of service by the "Cambridge Seven," led by Stanley Smith and C. T. Studd. The offer for service in China on the part of these seven men gave an impetus to missionary interest in the Universities, not only in Great Britain but also in America, on the Continent and in the Dominions.

The principal instrument in the development of missionary interest among students has undoubtedly been the Student Volunteer Movement for Foreign Missions organized in 1886 in America and the Student Volunteer Missionary Union organized in 1892 in Great Britain.

Medical Missions have greatly developed and in certain countries, notably in Mohammedan lands and in such tracts as the North-West Frontier of India, are of singular value. In China the development of missionary medical training has been very noticeable and medical missions occupy an unusual place in relation to the medical profession.

Perhaps the most remarkable development of the missionary enterprise has been the great extension of women's work. It has only been in the last quarter of the nineteenth century that the missionary societies have engaged unmarried women to go out in any appreciable numbers. The larger denominations have developed their own Women's Auxiliaries (sometimes absorbing small voluntary societies). The Zenana Bible and Medical Mission was founded in 1861, and the Church of England Zenana Missionary Society in 1880.

(2) *Dominions.*—In Canada, Australia and New Zealand, the Protestant denominations all have regular organizations for foreign missions. The Anglicans of Canada have missionary work in India and in Japan, the Baptists in India, and the United Church of Canada (a union of Presbyterians, Methodists and Congregationalists) in India, China, Japan and Korea. The Presbyterians of Australia have missionary work in India, Korea and the South Seas, the Baptists in India, the Methodists in the South Seas. The Baptists and Presbyterians of New Zealand both have work in India. The Melanesian Mission associated with the names of Selwyn and Patteson is supported by the Anglican Churches in New Zealand and Australia. The London Missionary Society and the Church Missionary Society both have important auxiliaries in Australasia.

South Africa has a different problem. The Anglicans have in all their dioceses work among the African population. The Dutch Reformed Church is now one of the leading missionary churches.

(3) *Continental.*—The German Missions increased steadily until the World War. Of the Moravian Church we have already spoken. It has some two hundred and fifty missionaries working in Greenland, Labrador, Alaska, Central America, Tibet and among the Hottentots. The Basel Mission had extensive work on the Gold Coast of Africa, in the south-west of India, and in South China. The Berlin Missionary Society and the Rhenish Mission developed work in South Africa and China; the Hermannsburg Mission (Hanover) in South Africa and India; the Gossner Mission of Berlin among the aborigines of Chota Nagpur, India; and the Lutheran Leipzig Mission in South India. Other missions work in the South Seas. Two Missionary Societies work in the Dutch Colonies, an important Danish mission works in South India. The Swedes and Norwegians have increased their missionary activities in South Africa, Madagascar and India; the China Inland Mission has enlisted a number of Scandinavians.

(4) *America.*—One of the features of missionary work in the present century has been the growth of American missionary activity. At the present time American missions represent probably seventy per cent of the Protestant missionary work in the world. The large denominations have all vastly increased their work especially as the result of large appeals made immediately after the war. The Young Men's Christian Association, founded in England and now extending throughout the world, has reached its maximum influence in the United States and the Young Men's Christian Associations of India, China, Japan, South-eastern Asia and the Near East have all been greatly indebted to the foreign department of the American Y.M.C.A.

(5) *Christian Missions to the Jews.*—Missions to the Jews have been conducted by a few Societies. In 1926 two important conferences were held in Budapest and Warsaw attended by representatives of all the Protestant organizations in the world engaged in missionary work among the Jews. These conferences revealed the immensely wide dispersion of Jewry, and the small number of missionaries of any kind ministering to the Jews. Plans were made for the increase of efficiency.

(6) *General.*—One of the most notable developments of Protestant missionary work since 1910, the date of the World Missionary Conference held at Edinburgh, is the development of co-operation among Missionary Societies in Great Britain, America and on the Continent of Europe and on the part of the churches in the mission field. The Edinburgh Conference created widespread attention. It resulted in the establishment of the International Missionary Council, consisting of representatives of all the national missionary organizations.

The enlarged meeting of the International Missionary Council, held at Easter 1928 at Jerusalem, typified in its discussions many of the leading tendencies in modern missionary work. Attention was given both to such fundamental matters as the Christian Message, Christian Education, the growth of the Church and its relation to the missionary societies from the West, and also to such "secular" problems as race, industrialism, and rural development. Between a third and a half of the members were natives of the Oriental and African countries, and the reports of this gathering are an indispensable source of information regarding modern missionary movements.

Recent Developments: Roman Catholic.—The Roman Catholic Church at the beginning of the nineteenth century seems to have been not less stagnant in regard to foreign missions than were the Protestant churches. The nineteenth century however witnessed a great change. The revival was due in no small degree to the foundation in 1822 by a few earnest Catholics at Lyons of a Society called the Institute for the Propagation of the Faith. The income of this society in 1925 had risen to approximately £325,000. This Institute does not send out missionaries but makes grants to the various missionary groups. Roman missionary work is carried on by religious orders and missionary societies under the supreme direction of the Pope and the supervision of the *Congregatio de Propaganda Fide.* The Congregation holds supreme control over all foreign missions in non-Christian countries and over some parts of the Church in Christian countries whose governments are not Catholic, *e.g.*, the British Empire, America, Holland, Scandinavia, Greece and some parts of Germany and Switzerland. The non-Christian world is carefully mapped out among the different orders. The government of the various mission fields is principally carried on by Vicars Apostolic (*i.e.*, titular bishops acting as vicars or delegates of the Apostolic See) or Prefects Apostolic (*i.e.*, priests with similar powers, but without episcopal rank).

Two important encyclicals have been issued dealing with missionary work. Pope Benedict XV. in 1919 issued the encyclical *Maximum Illud* in which extensive directions were given for the conduct of missionary work, exaggerated expressions of nationalism were severely condemned and great emphasis was laid on the importance of developing a native clergy. Following upon this in 1926 six Chinese priests were consecrated bishops and in 1927 one Japanese priest. In 1926 Pope Pius XI. issued the encyclical *Rerum Ecclesiae* in which he developed the subject matter of *Maximum Illud,* pointing out the paucity of missionaries, the lack of native ministers and the urgent need for training colleges being established with a view to the equipment of native clergy including bishops. The Pope further urged all Catholics to support the Society of the Propagation of the Faith, the Society of Holy Childhood (for the supporting of orphans, etc.) and the Society of S. Peter (for training native priests), and all priests to join the *Unio cleri pro missionibus* (Missionary Clergy Union). He emphasized also the annual day of prayer appointed for the

penultimate Sunday in October. A great missionary exhibition was held at the Vatican during the Holy Year of 1925, and at the close of the Exhibition a museum of missions was established.

Orthodox Eastern Church.—When Ivan the Terrible (1533–84) began the great advance from Russia to Northern Asia, large numbers of missionaries accompanied the troops, and during the seventeenth century many thousands of Tartars were baptised, though most lapsed again to heathenism. Little was done until 1824 when John Veniaminov, later Archbishop Innocent, began a remarkable career of evangelistic activity. He founded missions in Alaska, the Aleutian Islands, Kamchatka and Eastern Siberia, and established the Orthodox Missionary Society at Moscow. In addition to nine separate missions in Siberia and six in European Russia, the Orthodox Church of Russia has had three foreign missions: in China, founded at Peking in 1714 in the face of Jesuit opposition; in Alaska and the Aleutian Islands; and in Japan. The last of these, established in 1863 by Bishop Nicolai, had very remarkable success, and a large Japanese Church was gathered, larger probably in proportion to the number of foreign workers than any other communion in Japan. The work of the Russian Orthodox Church has, however, suffered grievously since the War and the establishment of the Soviet Government, and the Orthodox Church in Japan has become considerably weakened.

HISTORY OF MISSION FIELDS

The South Seas.—Missionary work in the Pacific began with Magellan's visit to the *Philippines* in 1521. Roman Catholic missionary work was carried on from an early date in the *Caroline Islands* and others adjacent. Modern Protestant effort began with the sending of the London Missionary Society ship "Duff" in 1797 to *Tahiti*, the *Tonga* or *Friendly Islands* and the *Marquesas*. By 1815 idolatry was abolished in the larger islands of the Tahiti group. In the work of building up a Christian community the great leaders were William Ellis and John Williams; the latter established at Rarotonga a training school from which workers went as far as *Samoa* and *Fiji*, and was murdered at Erromanga in 1839. The London Missionary Society's work was notable for the evangelistic activity of its converts. The Wesleyans had great success in *Fiji* to which they came in 1834. The bulk of the natives of the Fiji group are now Christians.

The *Sandwich* or *Hawaiian Islands* were discovered by Captain Cook and work began in them in 1819 when the American Board of Commissioners for Foreign Missions sent missionaries. Great success was achieved and the work of the mission was handed over to the Hawaiian Evangelistic Association. Hawaiian missionaries went to the Marquesas and other islands in the Pacific.

Australasia.—Little success has been gained among the aborigines of Australia. In New Zealand much greater success was attained among the Maoris, among whom the Church Missionary Society began work in 1814. In 1833 Wesleyan missionaries reached the Islands; Bishop Selwyn was consecrated in 1841 and established in 1843 at Auckland a training institution not only for Maoris but for workers from other islands. More than half the Maori population is now Christian; the first Maori Bishop was consecrated in 1928.

John Patteson became the first Bishop of Melanesia in 1861. He transferred the training institute from Auckland, New Zealand, to the Norfolk Islands. It is part of the tragedy of his martyrdom that he was killed by natives who mistook him for one of the kidnapping traders to whose operations the islands owed so much of the decay of their life. The Church of England Melanesian Mission operates in the North New Hebrides, Banks Torres, Santa Cruz and the Solomon Islands.

In New Guinea the Gossner missionaries were the pioneers, followed by the Dutch who work in the Dutch part of the islands. Several German societies work in what was German New Guinea (now mandated territory), and in British New Guinea the London Missionary Society, the Australian Wesleyans and the Anglicans.

Work was established later in the islands of Micronesia, the Carolines, the Gilberts and Marshalls. The Philippine Islands are fields of Roman Catholic and American Protestant work.

Africa.—This continent is in every sense a modern mission field. Apart from North Africa, it is only within modern times that mission work has been carried on in the African continent.

North Africa.—The lands in which Augustine, Cyprian and Tertullian lived have long been occupied by Islam, and even now missionary work whether Protestant or Roman Catholic is weak. The North Africa Mission works mainly on medical lines. The Methodist Episcopal Church has work in Morocco. In the Sudan and right across to Northern Nigeria, missionary work is carried on by agencies such as the Sudan United Mission and the Sudan Interior Mission.

West Africa.—Mission work was begun in West Africa by the Society for the Propagation of the Gospel in 1752, and work has been carried on longer and has achieved greater results in West Africa than in any other part of the continent. The Church Missionary Society, the Wesleyans and the United Free Church of Scotland work on the Gold Coast, in Sierra Leone, Calabar and Nigeria. The Basel Mission had very extensive work on the Gold Coast up to the outbreak of the War, and have now returned to their field. The American Baptists and the Episcopalians work in Liberia, the American Presbyterians in the Cameroons, and the Congregationalists of America and Canada in Angola.

The Roman Catholic missions in West Africa are chiefly French organized by the Congregation of the Holy Ghost and the Lyons African Mission.

Central Africa.—In the interior of the continent the French and Belgium Protestant Churches have done some excellent work in the Congo, and the American Baptists, the Southern Presbyterians, the Methodists and the Disciples and a number of "faith" missions have developed the region. The English Baptist Mission on the Congo is the chief British mission there.

East Africa.—In Kenya the leading Protestant missions are those of the Church Missionary Society and the Church of Scotland Mission. The United Methodists also work in Kenya, while the Church Missionary Society has a large mission in Uganda. The Universities' Mission to Central Africa works in Zanzibar, Tanganyika (formerly German East Africa), and other parts of East Africa. Several German societies have done important work in Tanganyika.

South Africa.—The Moravians (1737) were the first to undertake missionary work in South Africa, but their work was soon stopped by the Dutch. The London Mission came in 1798 and in 1818 Robert Moffat, Livingstone's father-in-law, went to Bechuanaland. David Livingstone, one of the very small band of world-famous men, came to South Africa under the London Missionary Society, and dedicated a great life to the evangelization of Africa and the abolition of the slave trade.

Madagascar.—Work was begun in this island by the London Missionary Society in 1819, and it has since been developed by the Friends, the Society for the Propagation of the Gospel and the Norwegian Missionary Society. Since the French took control of the island, the Paris Evangelical Society has worked there.

The work of Protestant missions throughout Africa was comprehensively surveyed in a gathering held at Le Zoute in Belgium in September 1926.

India.—India remains the greatest mission field both in the extent of Christian work and in respect of the variety and difficulty of Christian work and in respect of the variety and difficulty of the issues which are presented there. The earliest missionaries to India, with the possible exception of Pantaenus of Alexandria (*c.* A.D. 180), were the founders of the Syrian Churches of Malabar. The traditional belief is that these Christians owe their origin to St. Thomas the Apostle, and although a Nestorian origin has been preferred by most historians, the Thomas legend has its defenders. The Jesuits came in the 16th century, the Dutch, the Danes, the Germans and the British as we have told above. William Carey, so far as Protestant missions are concerned, began a new era with his emphasis upon literary work, the translation of the Scriptures and the training of native workers. Carey and his two colleagues, Marshman and Ward, by 1834 when Carey died, had translated the Bible into 7 languages, and the New Testament into 23 more.

The methods of mission work in India most used are: (1) The

regular method of vernacular preaching carried on both by Indian preachers and by missionaries; (2) Education in all its grades from the village school through the middle school to the high school and the college. Christian education has reached women and girls in India in a way unequalled by any other agency; (3) Medical work: while medical work as an auxiliary of the Church has had triumphs everywhere, it is notable in India for its value among the *purdah* women, and on the North-west frontier where almost no other kind of work is possible; (4) The mass movement may almost be called a separate method. These movements of the outcasts have been especially large in the Punjab, the United Provinces, parts of western India, the Telegu country and Travancore. There have also been great ingatherings of the aborigines in Chota Nagpur and among the Khasis and Lushais in the Assam hills; (5) Christian Literature: more has been done in creating Protestant Christian literature in India than in most countries, but the supply is not adequate to the demand; (6) Special mention should be made of the special work conducted by the women's societies among *purdah* women in their homes, and in visiting schools and hospitals.

The great task presented by Indian Islam tends to be overshadowed by the needs of Hinduism. Converts from Islam in India have not been numerous, yet some leading Christians of northern India are converts or children of converts from Islam. Much more attention is now given to the study of Indian Islam.

It is well-known that in India, more perhaps than in any other country, the effects of Christian work are only partly seen in the numbers of the Christian communities. The Brahmo-Samaj, chiefly in Bengal, is a type of reformed Hinduism which owes much of its impetus to contact with Christianity. The Arya Samaj, mainly in North India, is an example of the opposite kind of reaction to contact with Christianity, *i.e.*, a return to an earlier Hinduism as the true Indian heritage. Nationalism has rehabilitated Hinduism in many minds, and nationalism together with the almost ineradicable pantheism of the Indian mind present a strong defence against the Christian evangelistic message. On the other hand there is widespread testimony to the admiration felt by educated Indians everywhere for the person of Jesus Christ.

The Christian community of India is estimated to number 5,939,212, of whom 2,242,798 are Protestant; 791,556 belong to the ancient Syrian churches, and 2,906,858 to the Roman Catholic Church. There are 48,787 Protestant Indian workers and 17,164 Catholic (1928).

China.—We have already mentioned the great missionary activity of the Nestorians. It was they who were the first missionaries to China, but their work and that of the Roman Church, begun as the result of Marco Polo's travels about 1290 faded away under the persecution of the Ming dynasty, which came into power about 1350. The next attempt was that of the French Jesuits following on the visit and death of Xavier. They advanced rapidly, especially after the accession in 1644 of the Manchu dynasty. The Orthodox Eastern Church came to Peking about the same time.

Modern missionary activity begins with Robert Morrison of the London Missionary Society, who reached Canton in 1807, and not being allowed to reside in China entered into the service of the East India Company. In 1829 the American Board sent their first representatives, and in 1836 Peter Parker began his famous medical mission. After the war of 1856 a measure of official toleration was obtained and the task of evangelizing the country was fairly begun. In 1877 the number of Protestant converts in the whole of China was reckoned at no more than 13,000, though Protestant missionaries had been seventy years in the country. Public feeling against foreigners was accentuated by the territorial aggression of the French, German, British and Japanese. There were anti-foreign outbreaks at different times but the great upheaval came in 1899–1900 when in what was known as the Boxer uprising 135 missionaries, 52 children and probably 16,000 Chinese Christians perished, often after torture and showing constancy and heroism never to be forgotten.

The Boxer rising was put down, and out of the agony of these years was born the new China, of which the history remains still to be written. The reforms of 1901–04, especially the decrees regarding education, contained within themselves a complete reversal of the traditional policy of China. A system of public instruction of the most extensive sort was drafted. Universities, technical schools and lower schools were designed, and young Chinese began to turn their faces towards the West.

Meanwhile the missionary societies had never slackened their efforts. Whereas in 1876 there were 289 mission schools with 4,909 pupils, in 1910 the numbers had risen to 3,129 schools with 79,823 scholars. American influence became particularly powerful, not least because the American government used part of the indemnity paid after the Boxer rising to provide scholarships to enable Chinese students to pursue their studies in America.

The recent developments in China have had a profound effect on missionary work. The Manchu dynasty was overthrown in 1911 by a revolution led by Sun Yat-sen. In 1925 he died and his book "The Three Principles" became the gospel of Chinese nationalism; the nationalist party dedicated itself to carrying out the purposes of the dead hero. The nationalist government of the South has made itself the *de facto* government of China and the whole future relationship of China to the western powers is the subject of international debate.

This entire series of political events has been reflected in the Chinese Church and every mission board in the world conducting work in China has been forced to review drastically its whole policy, particularly in regard to the relations between the missionaries and the Chinese Church. Already Chinese Christians have shown themselves able to take up work which missionaries were compelled to leave during the fighting, and especially in the work of the colleges and schools have shown both initiative and responsibility.

The growth of Christianity in China may be shown by the fact that in 1925 the total number of the Protestant Christian community in China was 795,095, and there were 27,133 Chinese evangelists, pastors, teachers and other workers. The Roman Catholic returns give 27,640 Chinese priests and lay helpers, 556,201 catechumens, the total community being much larger.

Japan and Korea.—Portuguese traders first brought the Christian faith to Japan in 1542, followed by Xavier in 1549. By 1581 there were 200 churches and 150,000 Christians. In 1594 there were one and a half million Christians. There followed a time of great persecution under Iyeyasu who in his second edict in 1614 forbade the entry of foreigners and extinguished Christianity by fire and sword.

The reopening of the country came in 1859, largely through American pressure, and in that year the Protestant Episcopal Church began work in Nagasaki. In 1868 the seclusion of Japan ended; financiers and engineers poured in from western Europe, and teachers, mainly missionaries, from America. In 1872 the first Japanese church was formed. In 1875 Joseph Neesima, converted by a Russian missionary and educated in America, founded the Christian Japanese College, the Doshisha, in Kyoto.

The war with China in 1894 initiated a time of intense national activity. Education and work for women made rapid advance and the work of missionaries, and especially that of Japanese ministers, prospered greatly. Christians more and more became prominent in public life.

In 1912 was held a conference of religions, when the government invited representatives of Shintoism, Buddhism and Christianity to meet and discuss the moral education of Japan. This recognition of Christianity as a religion tolerable in Japan marked in a way the beginning of a new epoch.

The Protestant community of Japan is about 165,000 (the Roman Catholics 80,000 and Orthodox 30,000) with 3,500 Japanese workers. It would be fair to say that Christians exercise an influence far greater than their numbers.

In Korea, early Roman Catholic Christianity introduced at the end of the 18th century was exterminated in 1864, but missionaries entered again in the 'eighties and the Methodist Episcopal Church, the Presbyterians of America, of Canada, and of Australia, and the Society for the Propagation of the Gospel have all developed work in the country. A Korean National Christian

Council has been formed, and the Korean Christian leaders are pressing for some attention to be given to the bearing of Christianity on economic and social issues.

South-east Asia.—Burma, although a part of the Indian Empire and ecclesiastically related with India and Ceylon, has many of the characteristics of South-east Asia. The largest mission in Burma is that of the American Baptists, founded by Adoniram Judson in 1813. The Society for the Propagation of the Gospel has a mission in Burma, and both societies have had much success with the Karens, a non-Burmese people of whom a considerable portion have now become Christian.

In Siam the American Presbyterians have had the field virtually to themselves.

In Tongking and Annam, French colonies, Roman Catholic missions are extensive and strong.

In the Malay States practically no work is done among the Moslems, but a good deal among the Indians and other immigrant people, largely by the Methodist Episcopal Church. In the Straits Settlements, the Society for the Propagation of the Gospel, the Methodist Episcopal Church, the English Presbyterians and the Church of England Zenana Missionary Society are all at work. In the Dutch Indies naturally the work has fallen to the Netherlands Missionary Society (1812) and other Dutch agencies, which have been highly successful. There is an important German Mission, the Rhenish, working among the Bataks of Sumatra. In Dutch Borneo, the Rhenish Society is making headway among the Dyaks, and in British Borneo and Sarawak the Society for the Propagation of the Gospel and the Methodist Episcopal Church. The total number of Christians in British Malaysia and the Dutch East Indies is about 857,800, including 60,000 Roman Catholics.

The Near East.—Few areas have undergone more startling changes than have taken place since the War in the Moslem lands of the Near East—Egypt, Turkey, Palestine, Syria, Arabia, Iraq and Persia.

The chief missions working in this area are the Church Missionary Society in Persia, Palestine and Egypt, the American Board in Turkey, the American Presbyterians in Persia and Syria and the American United Presbyterians in Egypt. There is also a mission of the American Reformed Church in Arabia in the Koweit region, and a mission of the United Free Church of Scotland near Aden. The establishment of well equipped colleges at Constantinople, Beirut, Smyrna, Cairo and other centres has been the distinguishing feature of the American mission policy in this area.

A Christian Council for Western Asia and Northern Africa was founded in 1926. The most effective co-operative work has been done in the production of Christian literature for Moslems.

Latin America.—The missionary societies of North America carry on much work in the southern continent, partly among the Indian population, partly among the nominally Catholic Spanish-speaking people. The intellectual life of the S. American universities is keen and deserves more attention than it receives at the hands of Europe. There are two British missions, the South American Missionary Society (Anglican) which works among the Indians and received the praise of Charles Darwin for its achievements among the Fuegians, and the Evangelical Union of South America.

SUMMARY

We may end this survey of missionary history by suggesting four reflections to which it leads. First, it is impossible to resist the impression that there is in the Christian faith, whether in its Protestant or its Catholic profession, an ineradicable conviction of universality. There is in spite of its unevenness a singular continuity in this Christian missionary effort. After every falling away there is a renaissance, as Christians recover fidelity to the mind of their Master. Second, the beneficence of the labours of missionaries can never be forgotten. In rescuing the oppressed, abolishing tyranny and superstition, spreading education, introducing medicine, raising the status of woman, protecting children, stimulating social reform, the world has never seen any service to compare with that of the Christian missionaries. Third, it is perhaps the greatest international enterprise in the world. The Churches of practically all the Western peoples have engaged in it, and now that the younger Churches in the mission-field are growing up, there is coming into being a literally world-wide Christian fellowship. Fourth, missionary work has added to the tale of human history some of the greatest of personalities. The names of a few have been given above.

The ultimate argument for Christian missions lies now, as it has always lain, in the conviction laid upon Christians that they owe to their Saviour a gift so precious that they cannot keep it to themselves. The modern world may find a secondary motive in the fact that there is arising in all countries the outline of a common (and largely secular) civilization, and that it is abundantly clear that the ancient religions are largely irrelevant to it. At the same time all history goes to show that no society can survive without a religious and moral basis, and it appears likely that mankind will more and more be driven to choose between secularism and the religion of Jesus.

Statistics.—Too much reliance should not be placed upon these, as the facilities for collecting figures vary enormously in the different countries, and different standards of valuation are used. In the World Missionary Atlas (1925) figures are given for Protestant missions which may be compared with those gathered in 1907.

Missionaries	1925	1907
Ordained men	7,625 3,644 North America 2,831 Britain and Dominions	5,735 1,980 British 1,911 U.S.A.
Unordained men	3,819 1,917 North America 1,146 Britain and Dominions	2,802 1,738 British 535 U.S.A.
Unmarried women	9,125 5,362 North America 3,018 Britain and Dominions	4,387 2,332 British 1,527 U.S.A.

Indigenous churches	1925	1907
Ordained workers	10,493	5,273
Communicants (full members)	3,614,154	1,817,450
Total Christian Community (Protestant)	8,342,378	4,361,138
Scholars (all types of schools)	2,440,148	1,302,905

Roman Catholic Missions.—The *Little Atlas of Catholic Missions* (1926) contains figures gathered for the Vatican Exhibition of 1925 and given in Arens' *Handbuch* (1925). They are compared here with figures for 1908:

	1925	1908
Foreign Priests	8,196	7,933
Native Priests	4,516	5,837
Foreign lay brothers	3,187	5,270 (total of foreign and native)
Native lay brothers	732	
Foreign Sisters	12,944	21,320 (total of foreign and native)
Native Sisters	11,158	
Native Catholics	11,956,160	7,441,215
Catechumens	1,534,446	1,517,909
Schools (upper and lower)	21,753	24,000

Bibliography.—The *Report of the World Missionary Conference* (1910) 9 vols. is still worth consulting. The *Complete Report of the Jerusalem Meeting of the International Missionary Council* (1928) is indispensable. Detailed facts and figures may be got from the *World Missionary Atlas* (2nd ed. 1925) for Protestant missions, and from the *Little Atlas of Catholic Missions* (Rome, 1925) for Roman Catholic missions. Other invaluable general works are Arens' *Handbuch der katholischen Missionen* (1925); Richter's *History of Protestant Missions in India* (2nd German ed., 1924); Richter's *Geschichte der evangelischen Mission in Afrika* (1922); Richter's *Das Werden der Christ-*

lichen Kirche in China (1925) Latourette's *History of Christianity in China* (1928); Moore's *The Spread of Christianity in the Modern World* (1919); *A History of Protestant Missions in the Near East* (1910). Of denominational histories may be mentioned Stock, *History of the Church Missionary Society* (1899); Myers, *Centenary Volume of the Baptist Missionary Society* (1892); Lovett's *History of the London Missionary Society* (1899); Findlay and Holdsworth's *History of the Wesleyan Methodist Missionary Society* (1924). Among older books are E. M. Bliss, *The Missionary Enterprise* (1908); E. Stock, *A Short Handbook of Missions* (1904); H. H. Montgomery, *Foreign Missions* (1904); T. Moscrop, *The Kingdom without Frontiers* (1910); S. L. Gulick, *The Growth of the Kingdom of God* (1897); G. Smith, *Short History of Christian Missions* (1897); G. Warneck, *Outline of a History of Protestant Missions* (1910). A complete bibliography appears in each number of the *International Review of Missions*, the organ of the International Missionary Council. (W. Pa.)

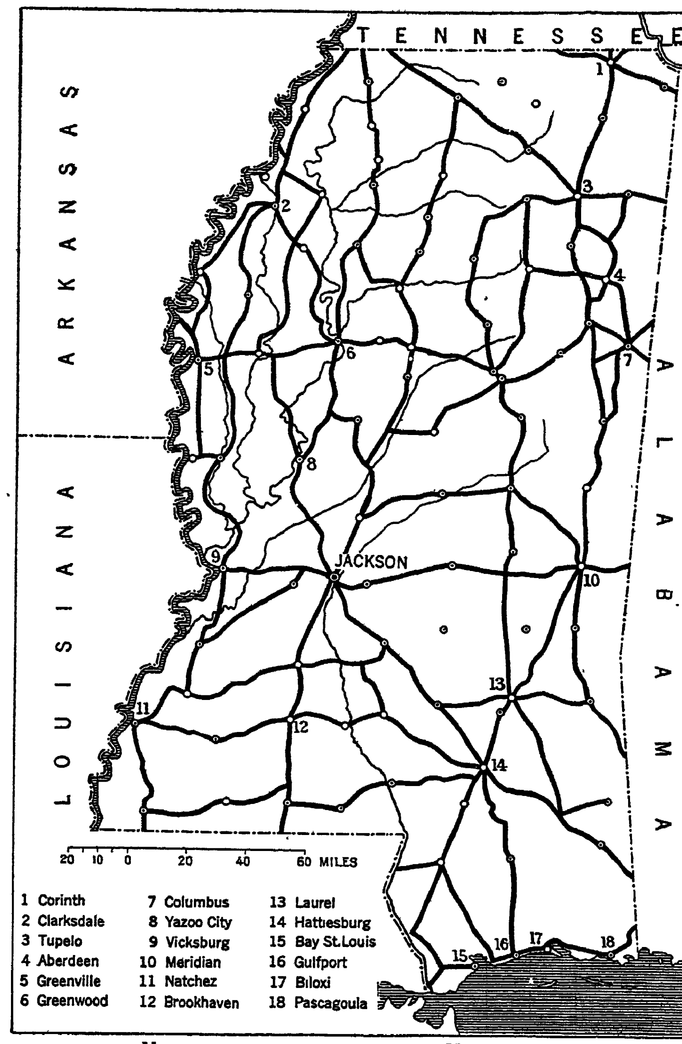
MISSISSIPPI (mĭs-ĭ-sĭp'ĭ), the "Magnolia State," a South Central State of the U.S.A., situated between 30° 13′ and 35° N. lat. and 88° 7′ and 91° 41′ longitude W. of Greenwich. The State is bounded N. by Tennessee, E. by Alabama, S. by the Gulf of Mexico and Louisiana, and W. by Louisiana, from which it is separated by the Pearl river and the Mississippi, and by Arkansas, from which it is separated by the Mississippi. The total area is 46,865 sq.m., of which 503 sq.m. are water surface.

Physical Features.—The greater part of the State lies in the Mississippi embayment of the Gulf coastal plain, the surface rising almost imperceptibly from the coast to the north-east. The highest elevations, about 800 ft. above the sea, are on the Pontotoc ridge in Tippah and Union counties in the north. The uplift of the State is enough to expose the formations of four distinct geological periods. In the extreme N.E. are found the oldest rocks in the State—lower Devonian and, not so old, an extension of the lower Carboniferous which underlies the Warrior coal-fields of Alabama. The Cretaceous region includes, with the exception of the lower Carboniferous, all that part of the State eastward of a line cutting the Tennessee boundary about 25 m. W., and drawn southward and eastward about 75 m., to the Alabama line. Deposits of the Tertiary period cover more than half the State, extending from the border of the Cretaceous westward nearly to the Yazoo delta and the Mississippi bottom, and southward to within a few miles of the Gulf coast. Seven formations, or groups, of the Tertiary strata have been distinguished in Mississippi. The older formation of the Quaternary period is the Lafayette, which immediately overlies all the Cretaceous groups except the prairies of the Selma chalk and all the Tertiary except the Porters Creek and Vicksburg formations and part of the Jackson. The second Quaternary formation is the Port Hudson, occurring within 20 m. of the Gulf coast, and, with alluvium, in the Yazoo delta. The Yazoo delta is a strip of bottom land between the Mississippi and Yazoo rivers, extending from N. to S. about 175 m., with an average width of more than 60 m. and covering an area of about 7,000 sq. m. With the exception of a few flat ridges running from N. to S., it is so low that, to protect it from overflows, it requires an unbroken line of levees averaging 15 ft. in height. Along the eastern border of this delta, and along the Mississippi itself, extends a belt of hills or bluffs cut by deep ravines. East of the belt are level or gently rolling prairies, and along the Gulf coast is a low, marshy tract.

The coast-line, about 85 m. long, is bordered by a beach of white sand, and broken by several small and shallow indentations, among which are St. Louis, Biloxi, Pascagoula and Point aux Chênes bays. Separated from it by the shallow and practically unnavigable Mississippi sound is a chain of low, long and narrow sand islands, the largest of which are Petit Bois, Horn, Ship and Cat.

The principal rivers are: the Mississippi on the western border, and its tributaries, the Yazoo and the Big Black; the Pearl and Pascagoula, which drain much of the southern portion of the State and flow into the Gulf; and the Tombigbee, which drains most of the north-eastern portion. The Pontotoc ridge separates the drainage system of the Mississippi from that of the Tombigbee. Extending from the north-eastern part of the State southward, this ridge divides in Choctaw county, the eastern branch separating the drainage basin of the Pascagoula from that of the Pearl, and the western branch separating the drainage basin of the Pearl from that of the Big Black and the Mississippi. The delta is drained chiefly by the Yazoo. A small area in the north-eastern corner is drained northward by the Tennessee and the Hatchie. Most of the rivers flowing into the Gulf are obstructed by sand-bars and navigable only during high water from January to April. Oxbow lakes and bayous are common only in the Delta.

Climate.—The southern latitude, the low elevation and the proximity to the Gulf of Mexico produce in southern Mississippi a



MAP SHOWING MAIN ROADS OF MISSISSIPPI

rather mild and equable climate, but to the northward the extremes increase. The normal mean annual temperature for the State is 64°, on the coast it is 67°, and on the northern border 61°. Annual precipitation for the State is about 51 in. (southern half, 54 in.; northern half, 49 in.). Nearly one-third of the rain falls in Jan., Feb. and March; July, also, is one of the wet months. The driest season is in Sept. and October. The prevailing winds are from the S.E.; but the rain-bearing winds chiefly from the S.W., and the high winds from the west and north-west.

The most fertile soil is the alluvium of the delta, deposited during the overflows of the Mississippi. Others that are exceedingly productive are the black calcareous loam of the prairies, the calcareous silt of the bluff belt along the eastern border of the delta, and the brown loam of the table-land in the central part of the State.

Government.—The chief special object of the present Constitution, adopted Nov. 1, 1890, was to preserve in a legal manner the supremacy of the whites over the ignorant negro majority. In addition to the ordinary suffrage qualifications of age and residence, the voter must have paid all taxes due from him for the two years preceding the election, and he must be able to read any section of the Constitution or "be able to understand the same when read to him, or give a reasonable interpretation thereof."

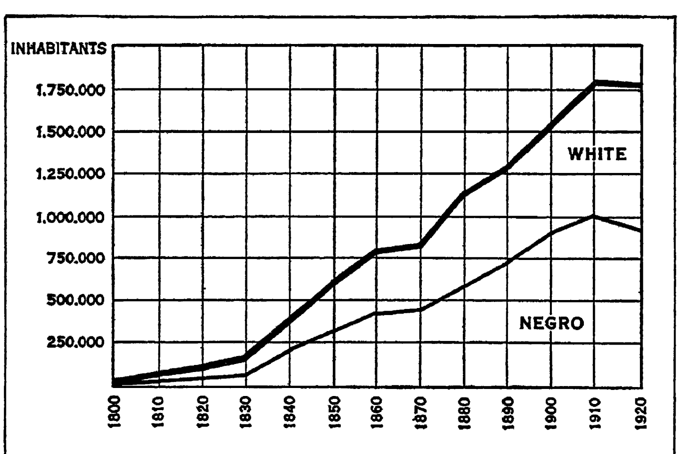
In 1916 the initiative and referendum were adopted by an amendment to the Constitution, thereby placing the Government more within the direct control of the people. Under its provisions, an initiative petition must be supported by 7,500 qualified electors, and a referendum petition by 6,000.

The chief executive constitutional officials are the governor, lieutenant governor, secretary of State, treasurer, auditor, attorney general and superintendent of education. All are chosen for terms of four years, and the governor, treasurer and auditor are ineligible for immediate re-election. The method of election is based in part upon the national presidential model. The governor is empowered to call extraordinary sessions of the legislature, to grant pardons and reprieves, and to exercise a power of veto which extends to items in appropriation bills. A two-thirds majority of the legislature is necessary to pass a bill over his veto.

The legislature consists of a senate and a house of representatives, chosen every four years. Since 1912, it has met in regular session biennially, and in extraordinary session whenever the governor has seen fit to call it. Revenue measures may originate in either house, but a three-fifths vote in each is necessary to their enactment.

The judiciary consists of a supreme court of six judges, 17 circuit courts, ten chancery courts, county courts and magistrate courts. The supreme court judges are elected for a term of eight years, and the circuit and chancery judges for four years. A majority of nine jurors may return a verdict in all civil cases in the circuit and chancery courts.

Population.—The population at selected census periods was: 8,850 in 1800; 40,352 in 1810; 606,526 in 1850; 1,131,597 in 1880; 1,551,270 in 1900; 1,797,114 in 1910; 1,790,618 in 1920; 2,009,821 in 1930. The census of 1920 showed a decrease of 6,496, or nearly ·4% from the figures for 1910. The negro population was 935,184, or 52·2% of the total, compared with 1,009,487, or 56·2% of the total in 1910. The foreign-born whites in 1920 numbered 8,019. The density was 38·6 per sq. mile. The seven cities having a population of more than 14,000 in 1930 were Jackson (48,282), Meridian (31,954), Vicksburg (22,943), Hattiesburg (18,601), Laurel (18,017), Biloxi (14,850) and Greenville (14,807).



GRAPH OF THE GROWTH OF POPULATION IN MISSISSIPPI, 1800–1920, SHOWING RELATIVE PROPORTIONS OF NEGRO AND WHITE AT EACH CENSUS

Finance.—The total receipts and disbursements for the fiscal year ended Sept. 30, 1925 were $17,731,150.70 and $17,756,116.18 respectively. The State indebtedness Oct. 1, 1925, consisted of $14,543,250 in outstanding State bonds.

Deposits in State banks are protected by a State guaranty fund. On June 30, 1925, there were 36 national banks and 323 State banks, with total resources and liabilities of $248,538,000. Deposits were $159,156,000.

Education.—Educational interests were almost entirely neglected during the colonial and Territorial periods. The first school established in the State was Jefferson college, now Jefferson Military college, near Natchez, Adams county, incorporated in 1802. Charters were granted to schools in Claiborne, Wilkinson and Amite counties in 1809–15, and to Port Gibson academy and Mississippi college, at Clinton, in 1826. The State established in 1819 the first educational institution which granted diplomas to women. The public school system was established in 1846.

Mississippi was the first State in the Union to establish, in 1884, a State-supported college for women. The lack of normal training for white teachers (from 1870 to 1904 there was a normal school for negroes at Holly Springs) continued until 1890, when a teachers' training course was introduced into the curriculum of the State University. There are separate schools for whites and blacks, with equipment and service approximately equal, although the whites pay about nine-tenths of the school taxes. The schools are subject to the supervision of a State superintendent of public education and of a board of education, composed of the superintendent, the secretary of State and the attorney general; and within each county, to a county superintendent and a county board of education. The schools are supported by a poll-tax, a dog-tax, by general appropriations, by local levies and by the Chickasaw school fund. An act of Congress of March 3, 1803, reserved from sale Section 16 of the public lands in each township for educational purposes.

A unique and distinctive educational and cultural State department was established in 1902 for the preservation and publication of the history of the State. The State department of archives and history is founded on the idea that the State owes a duty to its history. The department has issued a veritable library of Mississippi history, has created a beautiful State Hall of Fame, and has the best State Museum in the country.

An important development in education was the establishment in 1908 of county agricultural high schools. Every county may establish one for white children and one for negroes, or two counties may combine and create one set of schools for the two counties. These schools receive State aid based on the number of boarding pupils. The public school system was modernized and made uniform throughout the State by the school code of 1924.

The school population between five and 17 years of age, inclusive, in 1924, was 593,962. Of this number 560,971, or 94·4%, were in the public schools. High schools numbered 330 in 1925. The State institutions for higher education are: the University of Mississippi (chartered 1844; opened 1848), at University, near Oxford; the Agricultural and Mechanical college (opened 1880), at A. and M. College, near Starkville; the State College for Women (opened in 1885 as the Industrial Institute and College for Girls), at Columbus; the Alcorn Agricultural and Mechanical College for Negroes (1871; reorganized in 1878), at Alcorn; the State Teachers college, at Hattiesburg; the Delta State Teachers college at Cleveland; and many colleges not supported by the State. An agricultural experiment station, established in 1887 under the Hatch act, is at the Agricultural College near Starkville; and there are branch experiment stations at McNeill, Holly Springs and Stoneville.

Charities and Reformatories.—The charitable institutions of the State are supervised by separate boards of trustees appointed by the governor. Institutions maintained by the State are: the Mississippi Insane hospital, at Jackson; East Mississippi Insane hospital, at Meridian; the school and colony for feeble-minded, at Ellisville; Mississippi State Charity Hospital, at Jackson; South Mississippi Charity Hospital, at Laurel; Matty Hersee Hospital, at Meridian; the Tuberculosis Sanatorium, at Magee; the Jefferson Davis Beauvoir Memorial Home (for old soldiers), at Biloxi; and a school for the deaf and a school for the blind, at Jackson. State aid is given to the hospitals at Vicksburg and Natchez and also to 21 hospitals distributed over the State. The Mississippi Industrial and Training School for Delinquent and Abandoned Children was established at Columbia in 1916. The farm penitentiaries of the State are controlled by a board of three trustees elected by the people; they are managed by a superintendent appointed for a term of four years by the governor. The convict lease system was abolished by the Constitution of 1890, and State farms were purchased in Rankin, Hinds and Holmes counties, and later in Sunflower county.

Industry, Trade and Transport.—Agriculture is the leading

industry of the State, and cotton is the chief product. The total value for all farm crops produced in 1926 was estimated at $192,-758,000, and of this amount the cotton was valued at $112,000,000. Cotton is grown in every county of the State, but the large yields are in the delta (Bolivar, Coahoma, Washington, Yazoo and Leflore counties), and in Monroe, Lowndes and Noxubee counties on the Alabama border. The acreage of cotton in 1926 was 3,768,000; the yield was 1,930,000 bales, exclusive of linters (short lengths). The acreage of Indian corn in 1926 was 1,918,000 and the crop was 36,826,000 bushels. The only other cereal of economic significance was oats, which had a yield of 1,386,000 bushels. Dairying and early vegetable growing are rapidly becoming important industries.

BY COURTESY OF THE BUREAU OF RECLAMATION

A TURPENTINE FOREST, NEAR BUSSFIELD, MISSISSIPPI

In 1925, the number of farms was 257,228, of which 107,086 were operated by whites and 150,142 by negroes. There was a decrease both in the number of farms and the farm acreage as compared with 1920. There was a slight increase in the relative amount of tenantry during the period of 1920–25. Of the total number of farms in 1925, 80,808 were operated by owners and part owners, 175,742 by tenants, and 678 by managers. The live stock on the farms on Jan. 1, 1928, comprised 106,000 horses, 336,000 mules, 1,269,000 cattle and 878,000 swine.

Mississippi, in 1924, ranked second among the Southern States in lumber production, which in 1924 was valued at $92,033,335 and was the greatest in the history of the State, and turpentine and resin were produced to the value of $3,408,879. The legislature in 1924 passed a law tending to promote reforestation.

Fishing is a minor industry, confined for the most part to the Mississippi sound and neighbouring waters. The most valuable branches are the oyster and shrimp fisheries. In 1926, the production was 202,668 standard cases of canned oysters worth $966,521, and 163,962 standard cases of shrimps and crabs worth $850,770.

The mineral wealth of the State is very limited. Lack of mineral resources, especially of coal and iron, and of a good harbour, until the improvement of Gulfport, discouraged manufacturing.

The 1,705 industrial establishments operating within the State in 1925 gave employment to 55,171 wage-earners and had a product valued at $200,453,028. Compared with 1923 these figures show an increase in the number of industries and wage-earners and an increase of $22,381,870 in output. The chief products and their values were as follows: lumber and other timber products, $95,-734,039; cotton seed oil, cake and meal, $25,215,846; planing mill products, $14,656,705; cotton goods, $6,431,273; construction and repair done in steam railway shops, $6,264,710; wood preserving, $5,274,577; and turpentine and resin, $4,010,022. Laurel, Jackson, Meridian, Hattiesburg and Vicksburg were the industrial centres.

Except for the artificial harbour of Gulfport, the water along the Gulf coast is too shallow for any but small boats. The Gulf and Ship Island Railroad Company, with the co-operation of the U.S. Government, in 1901 began to dredge a channel 300 ft. wide and 19 ft. deep at mean low tide, and to construct an anchorage basin at Gulfport, ½ m. long by ¼ m. wide and 19 ft. deep. By June 1908, the maximum low water draft of the channel and the basin was 19 ft., but since that time it has been increased to 23 feet. Gulfport is the chief shipping point for Mississippi lumber and also exports much cotton. Along the western border of the State, the Mississippi river is navigable for river steamboats. The first railway in Mississippi was completed from Woodville, Miss., to St. Francisville, La., in 1837, but the State had suffered severely from the panic of 1837, and in 1850 it had only 75 m. of railway. In 1924 the total was 4,207 miles. There were 6,721 m. of highway under the control of the State highway department at the end of 1926. Of this total, 3,839 m. were classified as surfaced.

History.—At the beginning of the 16th century the territory included in the present State of Mississippi was inhabited by three powerful native tribes: the Natchez in the S.W., the Choctaws in the S.E. and centre, and the Chickasaws in the north. In addition, there were the Yazoos in the Yazoo valley, the Pascagoulas, the Biloxis and a few weaker tribes on the borders of the Mississippi sound. The history of Mississippi may be divided into the period of exploration (1540–1699), the period of French rule (1699–1763), the period of English rule (1763–81), the period of Spanish rule (1781–98), the territorial period (1798–1817), and the period of statehood (1817 *et seq.*).

Hernando de Soto (*q.v.*) and a group of Spanish adventurers crossed the Tombigbee river, in Dec. 1540, near the present city of Columbus, marched through the north part of the State, and reached the Mississippi river in what is now Tunica county, Mississippi, in 1541. In 1673 a French expedition, organized in Canada under Jacques Marquette and Louis Joliet, sailed down the Mississippi to the mouth of the Arkansas. Nine years later (1682) René Robert Cavelier, sieur de la Salle, reached the mouth of the river, took formal possession of the country which it drains, and named it Louisiana in honour of Louis XIV. The first European settlement in Mississippi was founded in 1699 by Pierre Lemoyne, better known as Iberville, at Ft. Maurepas (Old Biloxi) on the east side of Biloxi bay, in what is now Ocean Springs, Jackson county. The site proving unfavourable, the colony moved to Twenty-seven Mile Bluff, on the Mobile river, in 1702, and later to Mobile (1710). The oldest permanent settlements in the State are (New) Biloxi (*c.* 1720), situated across the bay from Old Biloxi and nearer to the Gulf, and Natchez or Ft. Rosalie (1716). During the next few years Ft. St. Peter and a small adjoining colony were established on the Yazoo river in Warren county, and some attempts at settlement were made on Bay St. Louis and Pascagoula bay. The efforts (1712–21) to foster colonization and commerce through trading corporations established by Antoine Crozat and John Law failed, and the colony soon came again under the direct control of the king. In 1729–30 the Natchez tribe destroyed Ft. St. Peter and some of the small outposts.

At the close of the Seven Years' war (1763) France ceded to Great Britain all her territory east of the Mississippi except New Orleans, and Spain ceded Florida to Great Britain. By a royal proclamation (Oct. 7, 1763) these new possessions were divided into East Florida and West Florida, the latter lying south of the 31st parallel and west of the Chattahoochee and Apalachicola rivers. Crown orders of 1764 and 1767 extended the limits N. to a line due E. from the mouth of the Yazoo at about 32° 28′ N. latitude. Under British rule there was an extensive immigration into this region from England, Ireland, Georgia, South Carolina and New Jersey. A settlement was made in 1772 by Richard and Samuel Swayze of New Jersey, 18 m. S.E. of Natchez and on the Big Black river 17 m. from its mouth; another in 1774 by Phineas Lyman (1716–74), of Connecticut; while settlements also were made by other "military adventurers," veterans of the Havana campaign of 1762. Spain took military possession in 1781, and in the Treaty of Paris (1783) both of the Floridas were ceded back to her. But Great Britain recognized the claims of the United States to the territory as far S. as the 31st parallel, the line of 1763. Spain adhered to the line of 1764–67, and retained possession of the territory in dispute. Finally, in the Treaty of San Lorenzo el Real (ratified 1796) she accepted the 1763 (31°) boundary, and withdrew her troops in 1798.

Mississippi Territory was then organized, with Winthrop Sargent as governor. The Territorial limits were extended on the N. to the State of Tennessee in 1804 by the acquisition of the west cessions of South Carolina and Georgia, and on the S. to the Gulf of Mexico by the seizure of West Florida in 1810–13, but were restricted on the E. by the formation of the Territory of Alabama in 1817. The Choctaws ceded their lands to the United States in 1820 and 1830, and the Chickasaws ceded theirs in 1832; and both tribes removed to the Indian Territory.

An enabling act was passed on March 1, 1817, and the State was formally admitted into the Union Dec. 10. The first State Constitution (1817) provided a high property qualification for governor, senator and representative, and empowered the legislature to elect the judges and the more important State officials. In 1822 the capital was removed to Jackson from Columbia, Marion county. The Constitution of 1832 abolished the property qualification for holding office and provided for the popular election of judges and State officials.

On the death of John C. Calhoun in 1850, the State, under the leadership of Jefferson Davis, began to rival South Carolina as leader of the Southern Constitutionalists in their defence of the rights of the States. There was a brief reaction: Henry Stuart Foote (1800–80), Unionist, was elected governor in 1851 over Jefferson Davis, the States' rights candidate, and in the same year a convention had declared almost unanimously that "the asserted right of secession . . . is utterly unsanctioned by the Federal Constitution." But the States' rights sentiment continued to grow.

An ordinance of secession was passed on Jan. 9, 1861, and the Constitution was soon amended to conform to the new Constitution of the Confederate States. During the Civil War battles were fought at Corinth (1862), Port Gibson (1863), Jackson (1863) and Vicksburg (1863). In 1865 President Johnson appointed as provisional governor William Lewis Sharkey (1797–1873), who had been chief justice of the State in 1832–50. A convention which assembled Aug. 14 recognized the "destruction" of slavery and declared the ordinance of secession null and void. The first meeting of the legislature after the war for southern independence was held Oct. 16, 1865, and at once enacted laws for the protection of the white people of the State, their homes and social order, laws which the North interpreted as an effort to restore slavery, but which, in fact were for the preservation of civilization. Under the reconstruction act of March 2, 1867, Mississippi with Arkansas formed the fourth military district, commanded successively by Generals E. O. C. Ord (1867), Alvan C. Gillem (1868) and Irvin McDowell (June–July 1868), and by Gillem (1868–69) and Adelbert Ames (1869–70). Under the latter the legally constituted civil officers of the State were ejected from office by military force.

The notorious "Black and Tan Convention" of 1868 adopted a Constitution which conferred suffrage upon the negroes, and by the imposition of test oaths disfranchised the leading whites. It was at first rejected at the polls, but was finally ratified in Nov. 1869 without the disfranchising clauses. The 14th and 15th amendments to the Federal Constitution were ratified in 1870, and the State was formally readmitted into the Union on Feb. 23 of that year.

From 1870 to 1875 the Government was under the control of "carpet-baggers," negroes and the most disreputable element among the native whites. Taxes were increased—expenditure increased nearly threefold between 1869 and 1871—and there was much official corruption; but the State escaped the heavy burden of debt imposed upon its neighbours, by reason of Constitutional inhibitions. The Democrats carried the legislature in 1875 and preferred impeachment charges against Gov. Adelbert Ames, who had been military governor (*see* above) and was a native of Maine, a graduate of the U.S. Military Academy (1861) and a soldier in the Union Army. The lieutenant governor, A. K. Davis, a negro, was impeached and removed from office; T. W. Cardoza, another negro, superintendent of education under Ames, was impeached on 12 charges of malfeasance, but was permitted to resign. Gov. Ames, when the impeachment charges against him were dismissed on March 29, 1876, immediately resigned. The whites maintained their supremacy and preserved their social system until the adoption of the Constitution of 1890 which disfranchised ignorance, venality and crime. The State has always been Democratic in national politics, except in the presidential elections of 1840 (Whig) and 1872 (Republican).

Mississippi has remained mainly agricultural in interest in spite of legislative encouragement to industry. The loss of life and property by successive floods of the Yazoo and the Mississippi rivers led to the provisions in the Constitution of 1890 establishing two great levee districts, the Yazoo-Mississippi delta and the Mississippi. Much had been done toward making the lowlands safe, but the unprecedented floods in the spring of 1927 proved the levees not sufficient.

A child labour law was passed in 1912. Under its provisions no child under 12 may be employed in any mill or factory and no child under 16 may be employed for more than eight hours per day. No employee is permitted to work in any mill or factory more than ten hours per day. The enforcement of this law is placed in the hands of the county health officer. The Torrens system of registration of land titles has been in force since 1915. A State highway commission was appointed in 1916.

Mississippi was the first State to ratify the 18th (Prohibition) amendment, doing so Jan. 8, 1918. The legislature, however, refused to ratify the 19th (woman suffrage) amendment in 1919, and it took no action on the proposed 20th amendment regarding child labour. The State flower is the magnolia and the State motto is *virtute et armis*. The State has a flag as the emblem of her sovereignty.

BIBLIOGRAPHY.—T. A. Owen, "A Bibliography of Mississippi," in the *Annual Report of the American Historical Association, 1899*, vol. 1 (1900); Dunbar Rowland, *Mississippi the Heart of the South*, two volumes of history and two of biography (1925), the only complete history of the State, based largely on original sources; J. F. H. Claiborne, *Mississippi as a Province, Territory and State* (Jackson, 1880), gives a good account of the period, 1699–1817; R. Lowry and W. H. McCardle, *History of Mississippi* (1893) and J. G. Baldwin, *The Flush Times of Alabama and Mississippi* (1898) are useful for local history; P. J. Hamilton's *Colonial Mobile* (1898) and *Colonization of the South* (1904) are of value for the French and English periods. J. W. Garner's *Reconstruction in Mississippi* (1902) is judicial, scholarly and readable. *See* also the *Publications of the Mississippi Historical Society* (Oxford, Miss., 1898 *seq.*); *Publications of the Department of Archives and History;* and the *Encyclopaedia of Mississippi History* (2 vol., Madison, Wisconsin, 1907), edited by Dunbar Rowland.

For administration *see* Henry L. Whitfield's *Know Mississippi* (1926) and the *Biennial Reports* of the the various State departments and institutions. For population, occupations, etc. consult the *Fourteenth United States Census*. Physical features are treated by E. N. Lowe, *Mississippi: Its Geology, Geography and Soils* (Mississippi geological survey, *Bulletin 12*) and in the reports of the *U.S. Geological Survey* (consult the various bibliographies). (D. R.)

MISSISSIPPI GULF COAST TO CHICAGO HIGHWAY (Magnolia Route), an American highway connecting Chicago with the Gulf of Mexico at Bay St. Louis, Miss., just east of New Orleans, La. It is about 1,050 m. long and the most direct road in this region. It runs almost due north and south and serves Terre Haute, Ind., Madisonville, Ky., Clarksville, Tenn., Tupelo, Laurel and Gulfport, Miss.

MISSISSIPPI RIVER (Algonquin, *Missi Sipi*, or "great river"), the central trunk of the great river system draining that part of the United States which lies between the Appalachian Mountains on the east and the Rocky Mountains on the west. Together with over 40 tributaries which are navigable for at least part of their courses it forms one of the great inland navigation systems of the world. Over 15,000 m. of waterway are capable of being used for commercial transport purposes. The entire area drained by the river and its tributaries is about 1,240,000 sq.m., or over one-third the area of the United States. Over this drainage area there is an average annual precipitation of 29·8 in., of which about one-fourth ultimately finds its way to the sea via the Mississippi. The total annual discharge at its mouth is estimated at 785,190,000,000 cu.yd., and the total amount of sediment carried into the Gulf annually is about 406,250,000 tons.

The Mississippi river rises in the lake region of northern Minne-

sota and flows in a southerly direction to the Gulf of Mexico. Its ultimate headspring has been found in Little Elk lake about 2,560 m. from its mouth, though the exact distance varies with a shifting river bed The river valley may be conveniently divided into the Upper Mississippi and the Lower Mississippi, the confluence with the Missouri, the longest tributary, being the dividing point. Like the Missouri and the Ohio, the Upper Mississippi may then be thought of as merely a chief tributary to the Lower Mississippi, and the contributions of the three most important branches may be compared as follows:—

River	Drainage area in sq.m.	Average annual rainfall	Per cent of rainfall draining off	Per cent of final discharge of Mississippi supplied
Missouri	530,000	20·9	15	14
Upper Mississippi	171,500	35·2	24	18
Ohio	202,000	41·5	24	31

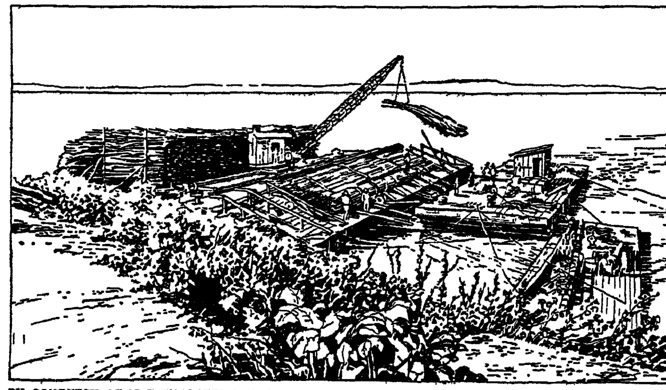
These three rivers thus represent 63% of the Mississippi's discharge at the Gulf. Below the mouth of the Ohio the chief tributaries are the Arkansas and Red rivers with extensive drainage basins (187,000 and 93,000 sq.m. respectively) and the St. Francis and Yazoo with much smaller basins, but with a far heavier rainfall, of which almost 75% finds its way to the Mississippi. The Missouri river flows 2,950 m. from the Rocky Mountains before it enters the Mississippi and, if to its length is added the 1,250 m. of the Lower Mississippi, the combination of the two forms the longest river in the world.

From its source at a comparatively slight elevation (1,670 ft. above sea-level) to its mouth the incline of the Mississippi river proper is gentle and almost uniform. Its upper course is through many marshes and lakes, and its valley south to the Falls of St. Anthony at Minneapolis is shallow and young, lying on a bed of glacial deposit through which it has cut but slightly. Entering the driftless area below the Falls of St. Anthony its trench becomes deeper and all the way to Cape Girardeau, Mo., its bed lies 400 to 600 ft. below the level of the surrounding prairies. This valley trench is 2 to 6 m. wide, with a comparatively level floor, and is bordered by abrupt bluffs, mostly wooded, but often crowned above their talus slopes with precipitous limestone and sandstone cliffs which add greatly to the beauty of the region.

This trench was cut in pre-glacial times, and its rock floor, as determined by well borings, was then 100 to 200 ft. below the present river bed and a little steeper in its incline toward the south. The outwash of glacial sand and gravel later filled the trench to, or slightly above, its present level. During the retreat of the ice the Mississippi carried a much greater volume of water than at present. Glacial Lake Agassiz in the valley of the Red river (of the North), with its natural northern drainage blocked by ice flowed southward through the Minnesota river into the Mississippi. Likewise the Great Lakes, their St. Lawrence outlet dammed, drained into the Mississippi; Lake Superior by the St. Croix river, Lake Michigan by the Illinois, and Lake Erie by the Wabash and other rivers.

From Cape Girardeau southward the highlands fall back to a much greater distance from the Mississippi and the river flows through an alluvial plain of its own making. Only at two points on the west—New Madrid, Mo., and Helena, Ark.—and at several points on the east—Columbus and Hickman, Ky., the Chickasaw bluffs and various localities between Vicksburg and Baton Rouge —do the hills approach the river banks. These places are important for they offer the chief sites for towns and cities. Elsewhere the river banks are unstable, for the river itself is constantly shifting—islands becoming peninsulas, peninsulas becoming islands, slight bends becoming in time long meanders, and these in turn becoming old river channels with crescent-shaped lakes as the river again cuts across its peninsula. From Cape Girardeau to the Gulf in a straight line is about 600 m., but by the windings of the Mississippi it is almost 1,700 m. From the Ohio to the head of the delta the river steadily diminishes in width from 1,500 to about 800 yd., but increases in depth from an average of 50 to over 100 feet.

As the river flows through its alluvial plain it builds natural embankments or levees along its immediate shore. These natural levees are higher than the remainder of the flood plain, the fall-away to the inland averaging 7 ft to the first mile. Often the bed of the river actually lies higher than the surrounding country. The natural levees have been supplemented by artificial levees which are relied upon to protect the country from floods. These serve for the lower floods, but there are few high floods where the bank is not cut and a crevasse opened at some weak spot through which the waters pour over the lowland plantations.



BY COURTESY OF THE ENGINEER DEPARTMENT, U.S. ARMY

REPAIRING A BREAK IN A LEVEE ON THE MISSISSIPPI RIVER

The levees cease with the arable lands, beyond which, in the delta, the land lies too low for cultivation. The delta, built up of the enormous amount of sediment brought down by the river, extends out into the Gulf in the pattern of a goose foot. Over this great mud plain, the river spreads, breaking up into branches or "passes," as they are locally known, each of which in turn extends far out into the water where it has built up its own smaller delta. On the farthest banks nothing grows except the tall reeds which give a little cohesion to the mud. There are five chief openings, South-west pass, South pass, South-east pass, North-east pass and Pass à l'Outre. At different times shifting conditions made steamers use first one pass and then another, but after 1878 engineering works made South pass the principal entrance.

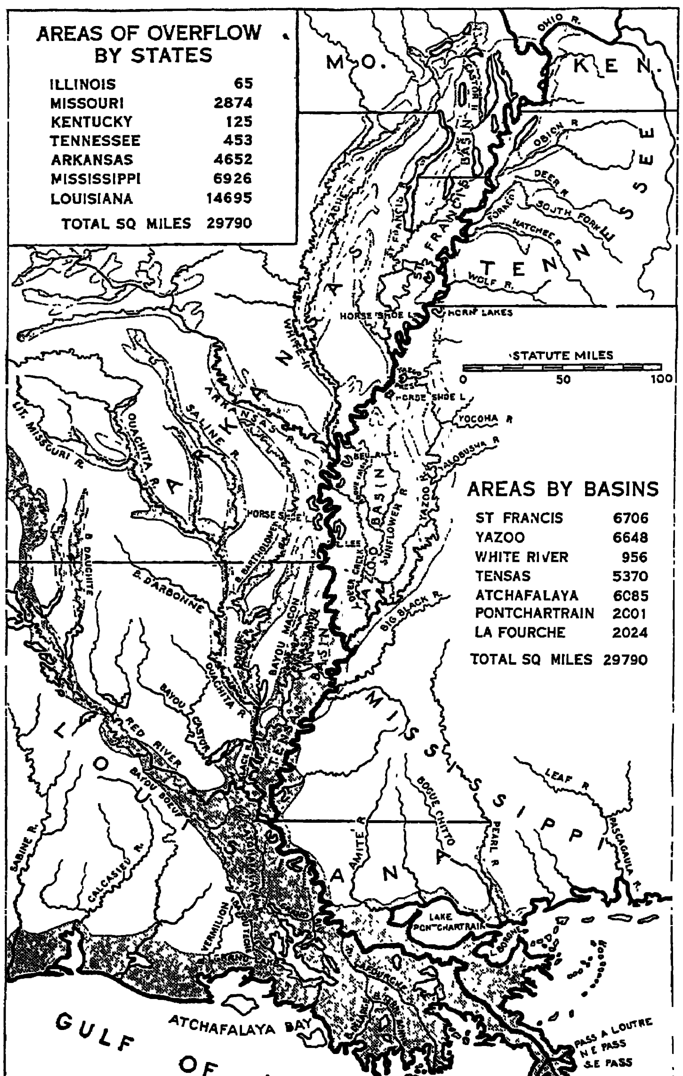
The volume of water carried by the Mississippi varies greatly with the seasons. Usually the river is lowest in early autumn and again in early winter. A minor rise in November is generally checked by the freezing of the upper tributaries. In January a rise again commences, as a consequence of early rains from the Gulf which sweep over the upper Ohio valley before the frost leaves the ground, and carry along with them the melting snows of the mountains. Unless the Ohio river contributes its general spring flood, it is rare that a large Mississippi flood follows. The Upper Mississippi has its heaviest rainfall in May and its waters and those of the Missouri do not reach Cairo at the mouth of the Ohio until the crest of the Ohio flood has passed. It is when the waters of the upper Mississippi are unusually early, or rainfall precipitates a second flood in the Ohio valley, so that the two crests meet, or one precedes but slightly and holds back the other, that a great flood occurs. The comparative height of floods is more accurately measured at Cairo than at lower points where the levels may be artificially affected by crevasse breaks. A height of 50 ft. or more above low water at Cairo generally results in a major flood which the levees are not capable of withstanding. Before the great flood of 1927 the record height was 54·69 ft. in 1913. The flood of 1927, the highest on record, registered 56·4 ft. at Cairo.

This great flood lasting more than six weeks with 47 recorded levee breaks, inundated about 28,000 sq.m. and submerged the homes of 750,000 people. Over 600,000 people were rendered destitute and were temporarily dependent upon the American Red Cross and other relief agencies for shelter, food and medical attention. Property and other flood losses were finally fixed at $355,147,000. Expenditures of the Red Cross were more than $14,000,000 and those of the Federal Government during the six

weeks were estimated at $5,000,000. As a result of the catastrophe, flood relief legislation by Congress became an urgent matter, and in Dec. 1927, President Coolidge submitted to that body the flood-control plan of Major-general Jadwin, chief of army engineers, calling for expenditures on the Lower Mississippi totalling $296,400,000. (X.)

ENGINEERING

The engineering of the Mississippi river has two purposes, viz., improvement of its navigation and control of its floods so as to protect the adjacent alluvial lands from overflows. Both the work for navigation and that for flood control have always been executed by U.S. army engineers. Until 1928, the Mississippi River Commission, composed of three army engineers and four civilians, directed the work which was executed under the supervision of engineer officers of the army. Since 1928 the commission



Map of areas along the Mississippi river subject to overflow

has directed the work as before but it has done so under the supervision of the chief of engineers of the army and the direction of the secretary for war. Some theories link the flood control structures and the navigation improvements together and claim that the control of floods causes the flood waters to improve navigation channels by their own action. It is true that bank revetments serve to prevent bank caving which keeps earth out of the river channel and also saves levees from caving into the river. These revetments, therefore, serve both navigation and flood control. However, although some structures serve both purposes, it is not proved that the flood waters themselves are forced to effect any material improvement of the navigable channel.

Navigation.—The Mississippi river has its source in numerous lakes in the northern part of Minnesota, its origin being traced to Little Elk lake. It flows in a southerly direction about 2,560 m. into the Gulf of Mexico. The navigation in the vicinity of the headwaters of the Mississippi has been improved by six reservoirs and by dredged cut-offs. The six reservoirs are, Winnibigoshish, Leech lake, Pokegama, Sandy lake, Pine river and Gulf lake. They have a combined storage capacity of 93,662,-093,290 cubic feet. The construction of the reservoirs has resulted in a greater channel depth and more uniform flow in the Mississippi river above Lake Pepin, 52 m. below St. Paul, Minn., and has made possible continuous navigation during the season on some stretches above St. Paul, where formerly it was subject to interruption on account of low water, and has assisted navigation at and immediately below St. Paul. Computations have indicated that under the system in operation in 1928 the reservoirs can produce an average increase in gauge height of 1·5 ft. at St. Paul during low-water season. The reservoirs also are of value in mitigating the effects of floods in the river above St. Paul.

Dredged cut-offs above Lake Pokegama and the partial closing of auxiliary channels by suitable dams have brought about the more rapid transmission of water from Lake Winnibigoshish and Leech lake reservoirs to the Pokegama distributing reservoir, and thus made it available for more prompt release there when needed. At the site of the Twin City lock and dam near Minneapolis, the discharge of the Mississippi varies from 1,000 to 54,000 second feet. The river in this section has an average slope of 5 ft. per mile and an average width of 700 feet. This lock and dam have extended navigation to the Washington Avenue bridge, Minneapolis, Minn., 1,944 miles above the mouth of the Mississippi with a low water depth of 6 feet. It will make possible the direct shipment of flour and grain from Minneapolis to the Gulf of Mexico by water and of coal and other bulky freight from down-river points to Minneapolis. The improvement has also made possible the development, under licence from the Federal Power Commission, of water-power with a maximum installed capacity of 18,000 horse power.

The project depth for the navigable channel of the Mississippi, from Minneapolis south to the northern boundary of the city of St. Louis is 6 feet. This stretch is improved principally by regulating works but it includes the Twin City lock and dam at Minneapolis, the lock and dams at Moline and at Smith island in the Rock Island rapids, the lock and dam at Keokuk, Ia., and a lock and dam under construction near Hastings, Minn. The distance from the head of navigation at Minneapolis to the mouth of the Missouri is 669 miles. From the mouth of the Missouri to the northern boundary of St. Louis it is 6 miles. The low water discharge at St. Paul, Minn., is 2,500 sec.ft., and above the mouth of the Missouri it is 20,000 second feet. The highwater discharge at Rock Island, Ill., is about 250,000 second feet. The current is gentle except on the Rock Island rapids, the average fall being 0·576 ft. to the mile; on the rapids 1·48 ft. to the mile. The width between banks varies from 1,000 ft. at St. Paul to about 5,000 ft. at the mouth of the Missouri river. The navigable channel throughout the 675 m. referred to above has been improved by regulating works, by dredging and by the locks and dams mentioned. The regulating works consist of spur dikes by which the low-water channel is made sufficiently narrow to force the low-water flow to scour its own channel 6 ft. deep. This low-water channel varies in width from 200 ft. to 1,400 ft. between the Illinois and Missouri rivers. The spur dikes have a crest elevation of 4 ft. above low water above Quincy, Ill., and 6 ft. above low water below Quincy to the Missouri river.

The spur dikes generally consist of piles of stone extending out from the banks either perpendicular to the bank or in some cases oblique to the bank. Where necessary the bank at the starting point of a dike is paved with riprap. The dikes in many cases are built of a layer of brush, then a layer of stone, until the desired height is obtained. In some cases dikes consist of two rows of piles tied together, with brush and stone in between. On

BY COURTESY OF (1) THE OFFICE OF CHIEF OF ENGINEERS, U.S WAR DEPARTMENT, (2, 3) U S ARMY AIR CORPS, OFFICIAL PHOTOGRAPH; PHOTOGRAPH, (4) EWING GALLOWAY

LEVEES AND FLOODED AREAS OF THE MISSISSIPPI RIVER

1. Land side of a levee when the Mississippi River is at high water. Seepage water goes through the levee, but a sub-dyke, built of sand bags, retards disintegration. A circle of sand is shown which encloses a sand boil. The head of water within the sand bags prevents the seepage water from transporting the sand out of the levee and consequently destroying it
2. Aeroplane view of the Mississippi River flood area at Melville, Louisiana, in May 1927
3. Another aeroplane view of the flood area
4. Revetment work in the lower Mississippi River carried on by U.S. Government engineers. Mat being woven. These mats are used in protecting the bank under water from erosion. Mattresses of willow and other timbers as well as slabs of concrete are used as revetments

the bottom there may be a mat through which the piles are driven. The regulating works are assisted in their action, where necessary, by dredging in order to maintain the low-water depth of 6 ft. throughout the navigable season. In a relatively few places rock excavation has been made to form the channel desired. The lock and dam at Keokuk as well as dry-dock, buildings, etc., were built by the Mississippi River Power Company and turned over to the Government free, in return for power rights given to that company. The dimensions of the lock in the clear are 380 by 110 ft. with a lift of 41 ft. at extreme low water. The dry-dock is 380 by 170 ft., with entrance gates 110 ft. wide.

From St. Louis, Mo., to Baton Rouge, La., the existing project provides for a channel not less than 300 ft. wide and 9 ft. in depth. This channel is to be secured and maintained by contraction works and by dredging. Below the mouth of the Missouri river, the banks of the Mississippi are not as stable as above the Missouri so that the type of regulating work used in the lower river generally is different from that used in the upper stretches of the river. From St. Louis to Cairo, Ill. (the mouth of the Ohio river) the Mississippi has been improved by spur dikes consisting of four rows of piles tied together, extending into the stream perpendicular to the banks. The banks at the bases of the spur dikes are revetted with riprap and mattresses for a distance of 100 ft. or more above and below. A mattress is placed on the bottom of the river through which the piles are driven. Brush or brush and stone are placed between the piles. The current is checked by the dike and deposit from the current builds up the structure. The contraction of the river by these works causes the necessary depth to be scoured in the channel between the outer ends of dikes or between the outer ends of dikes on one side and the bank of the river on the other side. Banks which thus form one side of the channel are made stable by mattresses below low water and paving on the bank above low water.

The above-described contraction works are aided and supplemented by dredging. During the low-water season suction dredges move from bar to bar and dredge out the navigable channel wherever it has shoaled to less than 9 ft. in depth. These dredges are generally self-propelling and have been developed to a very efficient status. Below the mouth of the Ohio river (Cairo, Ill.) dredging has been used in the past more than contraction works for the maintenance of channels, but contracting spur dikes and bank revetments are being extended southward so as to reduce the amount of maintenance by dredging that has been necessary in the past. As the Mississippi flows southward it becomes larger and larger from the inflow of tributaries, the maintenance of a low-water channel 9 ft. in depth becomes less and less difficult, and the places where either contraction works or dredging are necessary become farther and farther apart. From Baton Rouge to New Orleans, La., a channel depth of 34 ft. or more over a least width of several hundred feet has obtained naturally in the river, although there has been occasional shoaling to a depth between 28 and 34 ft. in one or two short stretches. The existing project for this stretch of the river (132 m. long) provides for a channel 35 ft. deep at low water and 300 ft. wide to be maintained by dredging. No work has been necessary so far to maintain this channel, and work will rarely be necessary.

From New Orleans, La., to the Head of the Passes (about 94 m.) through which the Mississippi flows into the Gulf of Mexico, the natural channel is generally sufficient for ocean-going vessels. Of the several outlets into the gulf, two, the South pass and the South-west pass, have been improved and require continuous improvement for navigation. The South-west pass is 19·8 m. long. It is improved by contraction works and dredging. The existing project provides for a channel 1,000 ft. wide and 35 ft. deep. The general plan of improvement provides for contracting the lower 8·3 m. of the pass to a width of 1,750 ft. by means of jetties, spur dikes, and inner bulkheads; for dredging the channel between the bulkheads and depositing the dredging material between the bulkheads and jetties; for dredging a channel through the outer bar inclining to the left of the jetty axis; for the construction of small revetted openings through the narrow portions of the banks of the pass for the purpose of strengthening these banks; for the closure of minor outlets; for the construction of sills to prevent the enlargement of gaps and other outlets; for dredging in the river at the Head of the Passes; and for other minor work. The jetties are composed of a substructure of brush mattresses surmounted with a superstructure of concrete or large riprap. Spur dikes are composed of cribwork of round piling filled with willows and stone or with a curtain of round piles along the upstream face.

The South pass (3 m. long and 750 ft. wide) has been improved by similar works and its navigable depth has been increased from 9 to 30 ft. at the mouth and from 13 to 36 ft. at the Head of the Passes so that larger and deeper draught vessels are permitted to enter.

Flood Control.—The lands bordering the course of the Mississippi river below the vicinity of Rock Island, Ill., some 1,550 m. above the mouth have always been subject to overflow from floods, and man has sought to protect these fertile lands and make use of them for agriculture without incurring the damage incident to overflows. From Rock Island south to Cape Girardeau, Mo., on the west side and to Cairo, Ill., on the east side (about 500 m.) the lands bordering the river, subject to overflow, are comparatively narrow, and their protection is not as vital as is the protection of the alluvial valley proper, south of Cape Girardeau. These comparatively narrow lands are generally from 3 to 5 m. wide, while the broad alluvial valley south of Cape Girardeau is some 50 m. wide and about 600 m. long in a direct line (1,000 m. by river).

From the earliest times protection against floods has been secured in varying degrees by levees along the river. The inhabitants first constructed their own local protection by throwing up earthen mounds around their individual plantations. Then there were combinations of owners and communities, which protected, by levees, larger areas. Levee districts were formed and chartered in each State until there were about 27 of these districts in the alluvial valley proper, in addition to those north of the valley. For many years the U.S. Government carefully refrained from accepting any responsibility for flood protection. Then in 1879, the Mississippi River Commission was formed by the Federal Government and charged with making surveys and studies of the Mississippi river. For years thereafter the primary function of the Federal work was the improvement of navigation with flood control incidental. It was claimed and assumed that the levees and bank revetment for flood control improved the navigable channel and that the United States had no responsibility except for this purpose. More recently legislative acts have frankly authorized Federal money to be spent for flood protection without regard to navigation.

For many years the funds of the United States could not be spent for levees unless local interests contributed a material proportion of the cost. Local contributions were turned over to Federal authorities who did the work. The local contributions to the work in the alluvial valley have been reduced until now local interests provide only rights of way for levees on the main river. North of the alluvial valley proper and on tributaries subject to backwater, local interests provide rights of way and contribute one third the cost. During the 30 years that the Federal Government has been actively engaged in improving the Mississippi river, many theories have been advanced for its improvement. These have always aimed at using the force of the water to accomplish the desired results. It cannot be denied that in certain ways this is possible and that to some extent it is practicable and has produced some desired results. But never have the results been as great as expected, nor have they been proved conclusively.

The theory which has had the most advocates, and which has been actually tried to the greatest extent is that of "levees only" or that an alluvial stream tends to make a channel to accommodate itself, that its confinement by levees would cause the flood waters to scour out a channel large enough to accommodate flood flows. The confinement of the waters of the Mississippi by levees has substantially raised the flood heights. Even if the "levees only" theory be correct, it does not solve the problem, because the

floods must be controlled before there has elapsed enough time for such a theory to work out. The water must be provided for now and after extreme stages are provided for, a possible future enlargement in size of channel is of little practical value. A gradual filling of the banks of the river between the levees and the growth of the islands in the river tend to counterbalance scour in the channel proper.

Several thousand cross-sections of the river measured from time to time do not show any material change in the channel itself. Although the confinement of the river between levees has caused large increases in flood heights, it has not caused as yet any cumulative changes in the elevation of the river bed itself. The bed and natural banks of the river are continually undergoing the local changes found in any alluvial stream subject to a widely varying discharge, but the gross effect of these changes on the discharge capacity of any considerable section of the river proper, since the construction of levees, is so small as to be less than the limits of accuracy of measurement. After a review of all the evidence, it is concluded that neither the levees nor the crevasses that have occurred in them have had any measurable effect on the capacity of the channel of the river itself to carry off flood waters.

It is not necessary to discuss the effect of a spillway system on the discharge capacity of the river. Before the construction of levees, water spilled generally over the banks in every flood. There is no evidence that spilling has yet permanently affected the regimen of the river. The river channel is made and maintained by the river flowing the year round below the bank-full stage. If the periods of overflow lasting only a limited time could be confined, they would not for an extremely long time, if at all, affect appreciably the results of the channel-forming processes operating continuously. Unproved theories concerning the river channel as affected by levees or relief spillways have no practical bearing on plans for flood relief.

Flood relief by means of reforestation or by reservoirs has no place in practical flood control for the alluvial valley of the Mississippi. Reforestation could not possibly have more than an incidental and very minor effect on reducing flood stages. When the Mississippi watershed was in its original state of virgin forests, there occurred floods probably as great as those of modern times. Reservoirs at the headwaters of all tributary streams would not store the water that falls in the valley itself. Reservoirs in the valley as well as at the headwaters would have an appreciable effect in reducing floods in the valley but their cost is prohibitive.

The practical way to provide for flood control of the Mississippi river is to permit the flood waters of excessive floods to spill out of the main channel at selected points when stages reach the danger point. Then this water must be allowed to flow to the Gulf of Mexico through the most efficient natural drainage basins. The overflows into these basins must be limited by natural ridges or by secondary levees whose location is determined on the economic basis of how much value they protect, after protection of life is provided for. The water within the river channel does no damage and flows to the gulf with the utmost efficiency because of its high velocities. It should be kept within the channel as long as possible. The excess above the safe-carrying capacity of the main channel must be spilled through safety valves.

Protection Planned.—The existing project adopted in 1928 provided for protecting the good lands bordering the Mississippi against the maximum flood predicted as possible. This flood was predicted by the best experts on the subject who said that it might occur on the average only once in two hundred years. It is a flood which, if confined, is computed to produce a stage of from 63 to 66 at Cairo, Ill. (corresponding to a discharge of from 2,250,000 to 2,450,000 sec.ft.); a stage if confined, of 74 at Arkansas City (corresponding to an outflow of about 2,850,000 sec.ft.), and a flood with a discharge at the mouth of Red river of about 3,000,000 second feet. Above Cairo, Ill., the project flood is to be confined between the river-side levees since it can be thus confined with levees not of excessive heights (about 20 ft.). Opposite Cairo, Ill., the river bank levee on the west side of the river is to be lowered to elevation corresponding to 55 on the Cairo gauge, and a new levee is to be constructed about 5 m. back at elevation corresponding to 60 on the Cairo gauge. With this set-back floodway available the stage of the project superflood will be held to one foot below the elevation of the top of the main line levees in this locality. From New Madrid south to the Arkansas river the superflood is to be confined within the river-side levees. Just below the Arkansas there is to be a fuse plug or relief levee some 35 or 40 m. in length with crown elevation generally about 3 ft. below the top of the river-side levee grades. This situation is to be brought about by leaving the present levee in the vicinity of Arkansas City at its existing height, from 35 to 40 m. in length, and raising all other levees 3 feet. The good lands in the Tensas basin on the west side are to be protected against water flowing over the top or through the fuse plug section by levees and natural ridges that will bound the Boeuf river bottom southwards to below Sicily island, where the backwater area at the mouth of the Red river begins. Below the mouth of Red river there will be another fuse plug section at the head of the Atchafalaya basin consisting of the existing levee at its present height. The main river levee lines other than the fuse plug section will be raised about 3 feet. In the Atchafalaya basin there will be protecting levees to confine the water to the lowlands and to protect the good lands. Just above New Orleans, near Bonnet Carre, there will be a controlled spillway emptying into a floodway about 5 m. long and some 1 to 2 m. wide which will empty into Lake Pontchartrain. The main river at Cairo will carry about 1,900,000 sec.ft. and the set-back floodway about 450,000 second feet. At Arkansas City the main river will carry about 1,950,000 sec.ft. and the balance will go down the Boeuf basin. At the latitude of the mouth of the Red River the main river will carry about 1,500,000 sec.ft. and the balance can go down the Atchafalaya basin. At Bonnet Carre 250,000 sec.ft. can be taken out of the main river leaving 1,250,000 sec.ft. to go by New Orleans at a stage of 20 or under.

The floodway from Cairo to New Madrid will have a minimum width of 5 miles. The width between the protecting levees in the Boeuf basin will be from 10 to 25 m. and in the Atchafalaya basin from 12 to 25 miles. The excess waters that will flow through the fuse plug sections and down the lowlands in the side basins will rarely, if ever, be as much as the amounts used in computing the protection to be provided in these basins. The levees that will protect the valley against the superflood will have a section that will be ample to include the line of saturation and will vary with the material and foundations in different localities. For loam (the predominating material) the section will generally have a river-side slope of 1 on $3\frac{1}{2}$, a crown of 10 ft. and a land side slope which will include a line of saturation, starting from the river-side slope at an elevation of 1 ft. below the crown elevation and running back with a slope of 1 on $6\frac{1}{2}$. The levees will vary in height generally from 20 to 25 ft., with greater heights where they cross depressions.

For the protection of the levees against caving banks the same kind of revetments that are used for navigation works are used. These are made either of brush or concrete. Below the low-water line a flexible mattress is sunk to lie on the sloping bottom. Above the low-water line the bank is paved with one man stone or concrete usually laid on a gravel base. The flexible mattresses are built on barges and slid into the water, where they are anchored over their location until they are sunk in place by dumping rock on them from barges. The banks above the mattresses are graded by hand or by hydraulic jet to the slope desired and then paved. The brush mattress consists of willows with diameters of from 1 to 4 in. woven with galvanized iron cable into facines and the facines are woven into a continuous mat all in one operation. The flexible concrete mats are of concrete slabs reinforced with galvanized wire and connected together by galvanized cable.

(E. JA.)

HISTORY

Hernando de Soto, an early Spanish explorer, discovered the lower course of the Mississippi river in 1541. The Spaniards

did not follow up his discovery and there is no further record of white men on the river for 132 years. In 1673 two French explorers, Louis Joliet (*q.v.*) and Father Marquette went from Lake Michigan by the Fox-Wisconsin river route to the Mississippi and were probably the first white men on the upper course. They voyaged south to the mouth of the Arkansas. In 1682 La Salle (*q.v.*) entered the Mississippi by the Illinois route and was the first to explore it southward to its mouth. There he took formal possession of the entire drainage basin of the Mississippi for France, naming it "Louisiana" in honour of Louis XIV. Under his orders Michel Accault voyaged northward from the mouth of the Illinois as far as the Falls of St. Anthony in Minnesota, thus completing for France the exploration of the greater part of the river. French settlements were founded at Cahokia and Kaskaskia, Illinois, *c.* 1700 and New Orleans, 1718.

By the treaty of Paris (1763) that part of the Mississippi valley east of the river (except the site of New Orleans on the east side of the river) was transferred from France to England, while the remainder of the valley was secretly ceded to Spain. The United States by the treaty (1783) at the close of the Revolutionary War secured title to the British portion. To the settlers already crossing the Alleghenies in great numbers the Ohio and Mississippi rivers furnished the most natural outlet for their products. Floating these down the river on rafts and flat-boats to New Orleans where they might be transferred to ocean vessels was much cheaper than carrying them overland across the mountains. To these settlers Spanish control of both sides of the river at New Orleans was a continual annoyance. A treaty with Spain in 1795 secured for Americans the right to deposit goods while they were awaiting transfer to ocean ships, but in 1802 the Spanish Intendant closed the river to all navigation by Americans. In the meantime Spain had transferred Louisiana to France. Indignation in the trans-Allegheny settlements was running so high that President Jefferson authorized Robert Livingston to treat with Napoleon in an effort to purchase enough territory to secure for the United States control of the outlets of the Mississippi. The unexpected result was the accession of the entire territory of Louisiana, comprising the entire western drainage basin of the river.

Early traffic down the Mississippi was mostly by barges or keel-boats, and the return trip was rarely attempted. However, the chief rush of immigration into the Mississippi valley luckily coincided with the introduction and development of the steamboat. Only four years after Fulton made his memorable journey up the Hudson river, the first steamboat came puffing down the Mississippi. Thirty years later the steamboat period was at its zenith; 30 years more and it had declined before the competition of east-west railways. This was a gay and colourful period in the history of the river, one which furnished later writers with many a theme for romance. It is impossible to overemphasize the concrete contribution made by the steamboat to the development of the Mississippi valley, for waiting for the completion of railways would have postponed its general settlement for a generation. Besides the numerous freight steamers the picturesque, well-equipped passenger steamers were a notable feature of the period.

During the Civil War the operations of the western division of the Union army were largely devoted to securing control of the Mississippi. Land operations from the north were supplemented by the brilliant naval operations of Farragut from the South, and finally, with the fall of Vicksburg and Port Hudson, the Confederacy was cut in two and President Lincoln was able to announce that "The Father of the Waters again goes unvexed to the sea." There was some revival of Mississippi commerce after the Civil War, but in addition to the increasing inroads of railways, it was checked by the bar at the mouth of the Southwest pass. Relief was obtained through the Eads jetties at the mouth of South pass in 1879, but still steamboat companies did not prosper.

Commerce.—Until recent years river transportation was in itself of secondary importance, but the river still served and will continue to serve in an important rôle as an effective check to high railway rates. For such non-perishable articles as steel and coal where bulk is large and delivery is not urgent, the river is again coming to the fore as a carrier. Traffic now takes the form of tugs which guide or tow trains of modern steel barges, one tug economically handling a load which would require 400 to 600 freight cars. During the World War the U.S. Government established a line of boats as a common carrier between St. Louis and New Orleans, which was after the war incorporated as the Inland Waterways Corporation. Though at first it was run at a loss it began in 1924 to produce a substantial profit. In 1926 the Mississippi carried a freight burden amounting to 691,637 tons on the upper river between Minneapolis and the Missouri, 1,005,979 tons between the mouths of the Missouri and Ohio rivers, 1,660,188 tons between the Ohio and Memphis, 4,792,780 tons between Memphis and Vicksburg and 11,074,488 tons from Memphis to New Orleans. Exports to foreign countries from the port of New Orleans amounted to 10,091,594 tons, imports to 5,654,859 tons, coastwise traffic to 766,883 tons. Together with internal receipts and shipments up the Mississippi, exports and imports of the port were valued at a grand total of $945,458,088.

Bibliography.—E. Parkman *La Salle and the Discovery of the Great West* (1907 ed.); J. D. Shea, *Discovery and Exploration of the Mississippi River* (1903 ed.); F. A. Ogg, *The Opening of the Mississippi* (1904); Mark Twain, *Life on the Mississippi* (1883); H. and E. Quick, *Mississippi Steamboatin'* (1926); C. E. Russell, *A Rafting on the Old Mississip'* (1928); J. Chambers, *The Mississippi River* (1910); L. Saxon, *Father Mississippi* (1927); R. M. Brown, "The Mississippi River from Cape Girardeau to the Head of the Passes," in *Bulletins of the American Geographical Society* (1902–03); J. L. Mathews, *Remaking the Mississippi* (1909); B. G. Humphreys, *Floods and Levees of the Mississippi River* (1914). Publications of the Minnesota, Wisconsin, Illinois, Missouri, Louisiana and Mississippi State Historical societies contain many historical articles. *See* also *Annual Reports of the Mississippi River Commission.*

MISSOLONGHI or **MESOLONGHI** (Μεσολόγγιον), the chief town of the province of Acarnania-and-Aetolia, Greece; on the N. side of the Gulf of Patras, about 7 m. from the coast; pop. (1928) 9,270; notable for the siege which Mavrocordato and Botzaris sustained in 1822 and 1823 against a Turkish army 11,000 strong, and for the more famous defence of 1825–26. Byron died here in 1824, and is commemorated by a cenotaph.

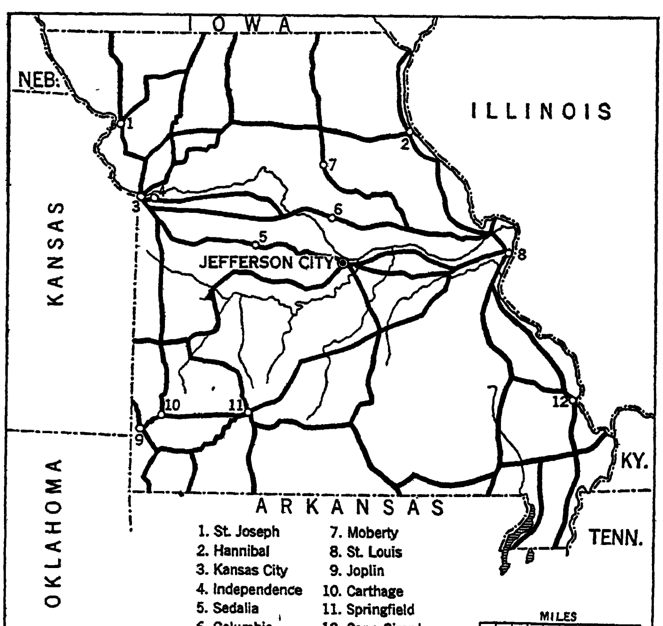
MISSOULA, a city of western Montana, U.S.A., on the Clark Fork of the Columbia river, at the mouth of the Bitter Root; the county seat of Missoula county, the seat of the State university, and the metropolis of the western part of the State. It is on Federal highways 10 and 93, and is served by the Chicago, Milwaukee, St. Paul and Pacific and the Northern Pacific railways. Pop. (1920) was 12,668 (86% native white); 1930 Federal census 14,657. The city lies on a broad plain (the bed of a glacial lake) 3,223 ft. above sea-level. The steep eastern wall of the valley is formed by Mount Jumbo and University mountain (Mount Sentinel), which rise abruptly over the city; and 5 or 6 m. to the west is the Bitter Root range. The university (opened in 1895) occupies a campus of 100 ac. at the foot of Mount Sentinel. Its property is valued at $2,250,000. The enrolment in 1927–28 was 2,272. Affiliated is the Montana School of Religion (organized 1924). On the Bitter Root river, 2 m. S.W. of the city, is Ft. Missoula, one of the important military posts of the mountain region; and 18 m. west is the Flathead Indian reservation. The city has railroad shops, an oil refinery and other manufacturing industries, with an output in 1925 valued at $3,870,703. The first settlement in this region was made in 1841, when Father De Smet founded the Mission of St. Mary where Stevensville now stands (30 m. S. of Missoula). The area now covered by Missoula county was included in the Territory of Oregon from 1848 to 1853, in the Territory of Washington from 1853 to 1863, in Idaho Territory for part of 1863 and of 1864, and became a part of Montana when that territory was organized in 1864. The city was founded in 1865 and incorporated in 1883. Settlers were so isolated that the result of the presidential election of Nov. 1856, was not known until the following April.

MISSOURI, popularly known as the "Show Me" State, occupies a central position in a group of 17 States which comprise

the great agricultural plain of the Mississippi valley. It is situated about 900 and 1,600 m. respectively from the Atlantic and Pacific coasts and approximately midway between Canada and the Gulf of Mexico. It is bounded on the north by Iowa; east by Illinois, Kentucky and Tennessee; south by Arkansas; and west by Oklahoma, Kansas and Nebraska. Its length from north to south, disregarding the St. Francois projection southward, is about 285 m., the width from west to east varies from 210 to 310 m., and the total area of the State is approximately 69,420 sq.m. of which approximately 693 are water surface. The State takes its name from its great river, the Missouri, which was named after a tribe of Indians who inhabited the country near the river mouth. The highest recorded elevation in the State is Taum Sauk mountain (1,750 ft.) in Iron county, and the lowest is on the flood plain of the Mississippi river in the south-east corner of Pemiscot county (229 ft.). The approximate mean elevation for the State is 800 feet.

Physiographic Regions.—Missouri is divided into four distinct physiographic regions: the old, glaciated and river plains, and the maturely dissected or Ozark highlands. The old plains region occupies about one-fifth of the area of the State, and is situated south of the Missouri river and west of the Ozark highlands. This topographic condition extends for a considerable distance into the adjoining States of Kansas, Oklahoma and Arkansas. It is underlain by shales, sandstones and limestones of Pennsylvanian and Mississippian age and is a region of topographic old age.

The glaciated plains occupy the major portion of the State north of the Missouri river. This region is underlain mainly by Mississippian and Pennsylvanian rocks and glacial and loessal deposits. Rocks belonging to earlier Paleozoic periods occur along the Missouri, Mississippi and other rivers. Pre-glacial features were similar to those now present in the old plains region. Post-glacial erosion has developed a topography characterized by extremely



MAP SHOWING THE MAIN ROADS OF MISSOURI

shallow valleys along the streams, and flattish inter-stream areas.

The river plains are flat areas varying in width from less than a mile to as much as 8 or 10 m. along the main streams, but in the south-eastern area the river plain is from 30 to 60 m. wide.

The Ozark highland, in Missouri, is a part of a highland area of considerable extent lying in the States of Illinois, Missouri, Arkansas and Oklahoma. It is underlain by pre-Cambrian igneous rocks and by sedimentary rocks ranging from Cambrian to Pennsylvanian in age, with Cambrian and Ordovician rocks underlying most of the region. Occupying in Missouri about two-fifths of the State, the Ozark highlands are distinguished by greater elevation and a more completely dissected surface. The general shape of the highland is an elongated dome, whose longer axis extends from the vicinity of St. Francois county south-westward across the State into north-central Arkansas. In the east is an area of granite knobs, peaks and ridges covering some 70 sq.m., commonly called the St. Francois mountains, which are only from 500 to 800 ft. above the adjacent valleys. In the south-western part the surface is rougher and more elevated continuing into Arkansas. The highlands are noted for their swift, clear streams abounding in game fish.

Climate.—The climate is characteristically "humid continental with long summers." As a rule the number of sunshine days is more dependable during each season than either rainfall or temperature. Summer months (June, July, August) have from 18 to 25 sunshine days, winter months (December, January, February) have from 12 to 18. The average winter temperature is 29° F. Summer average is 76° F. The yearly average of rainfall is 38 inches. Some 12 to 15 in. fall during spring in State-wide rains. Summer rain of about 7 in. is in showers. Autumn periods of four to six weeks of fine dry weather are common. Extended periods during autumn are calm. Extremely warm humid days in summer may result in destructive tornadoes. The growing season averages 178 days.

Geology.—The geological history of Missouri ranges from pre-Cambrian to the present time. The oldest known rocks, which are exposed in the south-eastern part of the State in the region of the St. Francois mountains, are of igneous and metamorphic origin and include granites, porphyries and schists. Their exact age is unknown. A long period of erosion followed their formation before the first advance of the Paleozoic seas in late Cambrian time. These Paleozoic seas spread around and upon the old pre-Cambrian igneous masses during their advances over the State, and their deposits represent every period of the Paleozoic era except the Permian. All of Missouri except a small area in the extreme south-eastern part and possibly a small area in the north-western part has probably been above the sea and subject to erosion since post-Pennsylvanian time, as no Mesozoic rocks have been found in the State and later marine deposits occur only in the south-eastern part. The presence of Cretaceous deposits in neighbouring States indicates, however, that late Mesozoic seas may have extended into south-eastern and north-western Missouri. Large glaciers advanced from the north late in Cenozoic time and extended south of the Missouri river. These glaciers modified the topography considerably and left a mantle of drift over the northern part of the State on their retreat.

Soils.—The soils of Missouri present a wide variation. The soils of the northern part of the State were derived mainly from glacial and wind-blown materials, with the greater relative amount of rich loessal soils along the Missouri and Mississippi rivers. The west-central part of the State is underlain mainly by residual soils derived from the weathering of limestones and shales but contains alluvial soils. The east-central and Ozark regions of Missouri are in the main stony and gravelly and best suited to the raising of live stock, but finer and more productive soils occur along the Mississippi and Missouri river valleys and in the smaller stream valleys. These soils are derived from the weathering of limestones, dolomites and igneous rocks of the Ozark region and from loessal and alluvial materials. The lowlands of south-eastern Missouri are underlain by loamy soils derived from water-deposited materials. The loams are of sand and clay, and when cleared of timber and well drained, are fertile.

Government.—Three Constitutions, framed by conventions in 1820, 1865 and 1875, have been adopted by the people of the State, and a fourth (1845) was rejected. A Constitutional Convention holding sessions during 1922–23 formulated and submitted to a special election on Feb. 26, 1924, 21 constitutional amendments, but all the more important proposals were rejected.

In addition there was the body chosen in 1861 to decide the question of secession, which retained supreme though irregular control of the State during the Civil War, and some of whose acts had the force of promulgated constitutional amendments. The present Constitution (that of 1875) was a notable piece of work

when framed. The term of the governor and other chief executive officers, which had been four years until the adoption of the Constitution of 1865, under which it was two years, was restored to the long term. Various effective checks were placed upon legislative extravagance, and upon financial, special and local legislation generally. Among reform provisions, common enough to-day, but uncommon in 1875, were those forbidding the general assembly to make irrevocable grants of special privileges and immunities; and permitting the governor to veto specific items in general appropriation bills. The grand jury was reduced to 12 members, and nine concurring may indict. The township system may be adopted by county option, but has not been widely established, though purely administrative (not corporate) "townships" are an essential part of State Administration. St. Louis and Kansas City have adopted their own charters under constitutional provision. An amendment (1908) provides for initiative and referendum; emergency measures, and appropriations for the State Government, for State institutions and for public schools are exempt from referendum. The referendum may be ordered by the legislature or by a petition signed by at least 5% of the legal voters in each of two-thirds (at least) of the congressional districts.

The executive and administrative department in 1927 consisted of a governor, lieutenant governor, secretary of State, attorney general, treasurer, auditor and superintendent of public instruction, all elected for four years, and 54 State boards, commissions, departments and bureaux.

The general assembly is composed of a senate of 34 members and a house of representatives of 150 members. Senators are elected every two years for a four-year term; representatives are elected for a term of two years. Regular sessions of the general assembly meet at Jefferson City, the capital, in odd-numbered years.

The supreme court, in certain cases holding sessions in two divisions, is composed of seven justices elected for a term of 10 years. There are three courts of appeals known as the St. Louis, Kansas City and Springfield courts of appeals. Each court consists of three judges elected for a term of 12 years, one being elected every four years. The State is divided into 38 circuit court districts. The bureau of labor statistics maintains free employment bureaux in St. Louis, Kansas City and St. Joseph.

Population.—The first census taken (1810) of that part of the upper Louisiana Territory which later became Missouri, showed a population of 19,783. The population at other selected censuses was as follows: 66,586 in 1820; 383,702 in 1840; 1,182-012 in 1860; 2,168,380 in 1880; 2,679,185 in 1890; 3,106,665 in 1900; 3,293,335 in 1910; 3,404,055 in 1920 and 3,629,367 in 1930 (April 1st) a gain of 225,312 or 6·6%. The percentage of urban population (in centres of 2,500 or more) increased from 42·5% in 1910 to 46·6% in 1920. Of the total urban population 79·7% in 1920 was in the three cities of St. Louis, Kansas City and St. Joseph. The rural population showed an absolute decrease in both 1910 and 1920. The population of the chief cities was:

Cities	1930	1920	Increase 1920-30	1910
St. Louis	821,960	772,897	6·3	687,029
Kansas City	399,746	324,410	23·2	248,381
St. Joseph	80,935	77,939	3·8	77,403
Springfield	57,527	39,631	45·2	35,201
Joplin	33,454	29,902	11·9	32,073

The density of population in 1930 was 52·8 per sq.m., as compared with 49·5 in 1920. Of the entire population in 1920 only 5·2% were negroes; this was the same relative position they held in 1900. The foreign-born population was relatively small—186,026 or 5·8% of the white population in 1920. The chief foreign groups were Germans (55,776), Russians (18,769), Irish (15,022), Italian (14,609), English (10,400). Early settlers were mainly from Kentucky, Tennessee, Virginia and the old slave States. After the Civil War, Northerners began to enter the State in large numbers.

Finances.—The revenue, inelastic through constitutional limitations,[1] proved increasingly inadequate until the unpaid current obligations in 1917 totaled over $2,000,000.

Attempts to secure relief for special purposes such as schools and good roads by constitutional amendments had all failed. The general assembly in 1917 passed new indirect taxes, a State income tax, a corporation franchise tax, a direct inheritance tax, a "soft" drink stamp tax and the wholesale liquor-dealers' licences, which yielded together nearly $2,400,000 in 1917–19. These taxes, excepting the liquor licences, yielded $7,847,875 in 1926. To secure greater uniformity in taxation and increase revenue, the basis of assessed valuation was raised in 1921 to 100% of actual value. This raised the assessed valuation from $2,694,567,461 in 1920 to $4,920,926,179 in 1921; the rate was lowered from $1.80 to $1.00 per $1,000 in the respective years. The chief sources of the State road fund in 1926 were: bonds, a gasolene tax ($6,006,934), Federal aid ($3,924,191) and motor vehicle licences ($3,774,941).

Education.—The idea of providing a university and free local schools as parts of a public school system occurs in the Constitution of 1820 (and in the acts of Congress that prepared the way for Statehood); but the real beginning of the system dates from the acts of 1835 and 1839. Not much progress was made, however, until a law was passed in 1853 providing for the formation of small school districts and another law requiring a fourth of the general yearly revenue of the State to be distributed among the counties for schools. This provision was made regularly after 1855 (save in 1861–67), and since 1875 has rested on a constitutional provision. In the years after 1887 one-third of the total revenue was appropriated for the support of public schools. This source of revenue amounted to $1,618,341 in 1910 and $3,-365,521 in 1926. To this must be added $187,040, the interest on the State's common school fund of $3,159,000. The permanent county, municipal and township school funds amounted, in 1925, to $12,720,879. Of the total revenue for the support of the public schools about 92% is derived from local taxation. The estimated total expenditure for public schools from State and local sources rose from $13,905,188 in 1910 to $49,970,000 in 1925; the per caput expenditure, in 1925, based on population aged 5–17 years inclusive, was $57.82. The public school enrolment in the above year was 735,589, with 103,221 in high schools. In 1924 there were 53,116 pupils enrolled in the private and parochial schools within the State. Negroes and whites are segregated in all schools.

Among institutions of higher learning the University of Missouri at Columbia is the chief one maintained by the State. It was opened to students in 1841, and received aid for the first time from the State in 1867. Women were first admitted to the normal department in 1869, to the academic department in 1870 and soon afterward to all departments. The university attendance in 1927 was in excess of six thousand. Teachers colleges are maintained as follows: at Kirksville (1870), at Warrensburg (1871), at Cape Girardeau (1873), at Springfield (1906), at Maryville (1906), and there is a normal department in connection with the Lincoln university, for negroes, at Jefferson City. Lincoln university (opened in 1866 as Lincoln institute) is for negro men and women. The basis of its endowment was a fund of $6,379 contributed in 1866 by the 62nd and 65th Regiments U.S. Coloured Infantry upon their discharge from the service. Privately endowed colleges within the State in 1928 included 16 senior colleges and universities. Among these schools the greatest is Washington university in St. Louis, opened in 1857.

Charities and Corrections.—The charitable and correctional institutions of the State include hospitals for the insane at Fulton, St. Joseph, Nevada and Farmington; a school for the blind at St. Louis; a school for the deaf at Fulton; a colony for the feeble-minded and epileptic at Marshall; a State sanitorium for tubercular patients at Mount Vernon; a home for neglected and dependent children at Carrollton; a Federal soldiers' home at St. James, and a Confederate soldiers' home at Higginsville; the penitentiary at Jefferson City; a training school for boys at Boon-

[1]The Constitution of 1875 limited the State revenue to $.20 on $100 assessed valuation with the added provision that when the assessed valuation of the State should reach $900,000,000 the rate should not exceed $.15 on $100 valuation.

ville; an industrial school for white girls at Chillicothe; and an industrial home for negro girls at Tipton.

Agriculture and Live Stock.—The State as a whole is devoted predominantly to agriculture, but it is no longer of chief economic importance. The total farm population in 1925 was 1,094,037 or 31·4% of the State's total population. Of the area of the State 74·2% was included, in that year, in farms (32,640,-893 ac.); and of this 15,278,436 ac. was classified as crop land. The number of farms had decreased from 277,244 in 1910 to 260,473 in 1925; the average number of acres per farm was 125·3. The number of farms operated by owners decreased during 1920–25 from 185,030 to 174,381; tenantry increased from 28·8% to 32·6% during the same period. The aggregate value of all farm crops in 1926 was $276,400,000 as compared with $307,-560,000 for the average for the period 1921–26. The table below gives the production and value of the chief crops in 1926:—

Crop	Acreage	Product	Value
Indian corn	6,404,000	174,189,000 bu.	$118,449,000
Tame hay	3,147,000	3,569,000 tons	48,181,500
Wheat	1,391,000	21,282,000 bu.	26,389,680
Oats	2,077,000	41,540,000 „	17,447,800
Potatoes	81,000	6,480,000 „	11,016,000
Cotton lint	434,000	104,160,000 lb.	10,416,000
Sorghum forage	140,000	434,000 tons	4,340,000
Apples	..	5,015,000 bu.	5,172,900

Indian corn and abundant grasses give to Missouri, as to the other central prairie States, a sound basis for her live stock interests. In 1926 the live stock dairy and poultry products marketed had an estimated value of $357,040,890. The aggregate total for all farm products in 1926, including farm and pasture crops, wood used on farms and all live stock products, was $679,641,260. Live stock on farms on Jan. 1, 1927 was valued at $210,552,800.

Mining.—Lead, clay products, cement, coal and building stone were the most important mineral products of Missouri in 1925. In lead production in 1924, Missouri ranked first among the States with a product of 189,929 short tons worth $30,388,640. The lead-producing area is confined mainly to two districts, Franklin, Jefferson and St. Francois counties in south-eastern and Barry, Greene, Jasper, Lawrence and Newton counties in south-western Missouri. The so-called "Joplin district" of south-western Missouri and south-eastern Kansas produces a considerable part of the zinc mined in the United States. Some silver is found in connection with zinc and lead mining. In 1925 the State ranked second as a producer of raw clays. There are unlimited supplies of clay, shale and limestone, the three essential constituents of Portland cement, and in its manufacture the State ranked sixth in 1925. The cement product for that year was 8,164,000 bbl. valued at $14,822,000. In 1924 the total value of stone quarried was $4,961,333, mainly limestone. Coal is produced over a large area; its production being reported from 27 different counties in the central, northern and western parts of the State. The coal production for 1924 was 2,480,880 short tons valued at $8,154,000. Missouri, in 1925 ranked first among the States as a producer of barytes ($725,000), chiefly from Washington county.

Manufactures.—In manufacturing and mechanical pursuits Missouri leads all States west of the Mississippi, California excepted. The State's manufacturing activity is greatly diversified as is shown by the 144 separate industrial groups identified by the 1925 census of manufactures. This census showed 5,114 industrial plants operating within the State, giving employment to 194,959 wage earners and having an annual product of $1,607,-161,018. Twelve industries in 1925 had a product valued at more than $30,000,000 each. Of the total output in 1925, over 77% were made up by the products of St. Louis, Kansas City and St. Joseph. The table in the next column gives the 10 leading industries, based on value, in 1925. One of the exclusive industries of the State is the manufacture of corncob pipes. Missouri produces practically the world's supply of these. The main industry is slaughtering and meat packing, for the State is in the centre of a hog-raising area.

Industry	Number of plants	Value
Slaughtering and meat packing (wholesale)	47	$175,392,412
Boots and shoes	68	124,327,761
Motor vehicles	11	113,130,501
Flour and grain mill products	241	82,442,041
Foundry and machine shop products	225	49,420,214
Bread and bakery products	582	49,384,309
Printing and publishing newspapers and periodicals	387	43,327,824
Men's clothing	96	39,356,064
Electric machinery and apparatus	54	39,130,533
Construction in steam railway repair shops	64	37,892,002

Commerce and Transportation.—In commerce as well as in manufactures St. Louis is first among the cities of the State, but Kansas City also is one of the greatest railway centres of the country, and the trade with the South-west, which St. Louis once held almost undisputed, has been greatly cut into by Kansas City, the ports on the Gulf and the rapidly growing cities of Texas. There is still considerable commerce on the Mississippi from St. Louis to New Orleans. In 1906–07 there was notable agitation for improvement of the Missouri from Kansas City to its mouth, 398 m. distant. Estimates were made in 1907 for 6 ft. and 12 ft. channels from Sioux City to Kansas City, and from Kansas City to the mouth of the river. The project for a 6 ft. channel 200 ft. wide from Kansas City to the mouth of the river was adopted by Congress in 1912; it has since been modified slightly. Between June 1910 and June 30, 1926, $13,339,079 were expended on the project. A 4 ft. channel was then open for the entire distance. Steam railway mileage increased until 1915 when there were 8,275 m. lying within the State; by 1925 the mileage had decreased to 8,051. In 1925 there were 19 electric railway companies operating 1,145 m. of track in Missouri.

The State highway system dates from the Hawes Act (1917), passed to take advantage of the Federal aid, and the Centennial Road Act (1921). The latter outlined the system and provided for the expenditure of a $60,000,000 bond issue approved by popular vote in 1920. Automobile licence fees and a gasolene tax provide additional funds. Of the total mileage of 7,640 under the highway department, on Dec. 31, 1926, 3,375·8 m. had been surfaced. New surfacing laid during 1926 amounted to 823 miles.

HISTORY

French and Spanish Régimes.—The first permanent settlements in Missouri, St. Genevieve (*c.* 1735), at the crossing to the lead district in south-east Missouri, and St. Louis (1764), the headquarters for the Missouri river fur trade, were settled from the Canadian-French villages across the Mississippi, from which there was a large migration after the establishment of English control in Illinois in 1765. The Spanish régime, established in Missouri in 1771, left few traces on population, language or customs. After 1796 American immigration was encouraged to gain strength against an apprehended British attack from Canada; when the American flag was raised at St. Louis in 1804, three-fifths of the 10,000 inhabitants of the region were Americans, chiefly log-cabin pioneers. The French were in the villages of St. Louis, St. Charles, St. Genevieve and New Madrid. Negro slaves, introduced before 1730, numbered about 1,500. Lead and food-stuffs went down the Mississippi and peltries to Montreal.

Early American Period.—Under the Americans all the Louisiana Purchase (*q.v.*) north of the present State of Louisiana was attached to Indiana Territory in 1804, organized as Louisiana Territory in 1805, and the name changed to Missouri in 1812. A legislature with elective lower house was granted in 1812, the upper house was made elective in 1816. In 1818 the legislature petitioned for Statehood and in 1821 Missouri was admitted to the Union as a slave State under the Missouri Compromise (*q.v.*). The Indians were never a serious problem in Missouri, although the Sac and Fox from the north-east drove the outlying pioneers into blockhouses along the Missouri and upper Missouri during the war of 1812; they surrendered their claims in 1815–16.

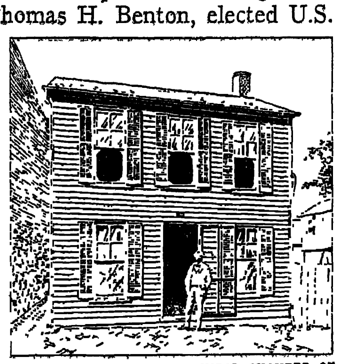
The population grew slowly until the great influx after 1815 to

the new areas along the upper Mississippi and the Boonslick country along the Missouri in the central part of the State. Of the 66,586 total population in 1820, nearly one-half were in these districts. In the succeeding decades the south-east filled in up to the Ozark section, the Missouri valley and the north-east were occupied until the two areas merged; the Platte Purchase in the north-west, annexed in 1837, filled up very quickly. The north-central section was settled later, in part from Iowa, while the south-west Ozark border lands, except around Springfield, and the Ozarks proper were sparsely settled even in 1860. Through 1850 the total population increased at the characteristic frontier rate, more than doubling in the '20s and '30s and increasing by three-fourths in each of the next two decades, reaching 1,182,012 in 1860. Until 1850 most of the settlers were of the Southern type, from Kentucky and Tennessee, or the back country of Pennsylvania, Virginia and the Carolinas. While Missouri had few plantations, the slave population kept proportional pace with the whites. Slavery was less economic than patriarchal.

The first steamboat reached St. Louis in 1816 and the Boonslick in 1819. The river transports carried out wheat, corn and meat products, as well as tobacco and hemp from the Missouri river counties, and the Missouri mule was early in evidence. St. Louis was the centre of the fur trade on the upper Mississippi and particularly on the Missouri; in the '20s the traders reached the Rocky Mountains and beyond. In the same decade began the overland trade with the Mexican hinterland at Santa Fe. When the Oregon trail was opened Missourians were the largest element of the early settlement in that territory; in the '40s began the exodus to California over the California trail. The starting point of these three transcontinental routes was at the great bend of the Missouri at Westport Landing (now Kansas City).

In 1831 the advance guard of the Mormons settled around Independence. As their numbers increased friction with the "Gentile" settlers developed and they were driven successively from Jackson and Clay counties. The legislature created a special county of Caldwell for them but with the arrival of their leader Smith and the main body of the church, they spread into the surrounding counties. In the end, in 1838–39, the antagonism became so acute that the militia were called out and after some skirmishing the Mormons withdrew to Nauvoo, Ill. (*q.v.*). Missouri furnished a large element in the early settlement of Texas. In the Mexican War Doniphan led a regiment of mounted militia to Santa Fe and went on to Chihuahua, finally reaching Taylor's army at the mouth of the Rio Grande. Two other Missouri regiments held Santa Fe throughout the war.

Early Politics.—In politics the national parties were organized slowly. The leading figure was Thomas H. Benton, elected U.S. senator in 1820 and re-elected until 1851. Missouri voted for Clay in 1824. In 1828 every county voted for Jackson, but not until 1836 was discipline and solidarity established in the Democratic Party. The Clay-Adams group supported candidates who were nominally Jackson men, but favoured the bank and the "American System" of Clay, thus electing Buckner senator (1830) and Ashley representative (1831–36). By 1839 the Whigs had developed a definite organization and party politics prevailed. The Whigs were to be found chiefly in St. Louis (the commercial element) and in the older richer slave-holding river counties; from 1836 to 1850 they were the minority party. Benton (*q.v.*) was defeated in 1851 but fought to regain control until his death in 1857, splitting the Democratic Party. Political confusion was increased in the '50s by the civil war in Kansas (*q.v.*) and the beginnings of the Republican Party.


BY COURTESY OF THE HANNIBAL CHAMBER OF COMMERCE
THE BOYHOOD HOME OF MARK TWAIN AT HANNIBAL, MISSOURI

During the decade 1850–60 St. Louis grew rapidly due to the development of the upper Mississippi country and the Southern trade; the Irish, German and free State immigration increased until these elements comprised two-sevenths of the total population in 1860. Slaves fell to one-tenth of the total population in this decade, the institution holding its own only in some 25 counties along the Mississippi and Missouri. Railway building was aided by State loans of over $23,000,000; and the Hannibal and St. Joseph was completed across the State. On the eve of the Civil War, Missouri was losing her Southern characteristics but the ruling classes had strong Southern traditions and sentiments, and the Benton fight had driven the Democratic leaders into a close alliance with the Southern wing of the party.

Civil War and Reconstruction.—In the presidential election of 1860, Douglas received the electoral vote of the State, the only one he carried in the Union. When the question of secession was submitted to the people in Feb. 1861, they elected a convention which voted 80 to 1 against immediate secession. But there was a very strong sentiment for compromise or even neutrality. The governer, Claiborne F. Jackson, indignantly repudiated Lincoln's call for troops, and intrigued to gain possession of the U.S. arsenal at St. Louis and to put the State on a war footing. Nathaniel Lyon and the Federal troops, with Blair's support, broke up an encampment of State militia at Camp Jackson, St. Louis, and began open hostilities with the driving of the governor out of Jefferson City. In August Lyon was defeated and killed by State and Confederate forces at Wilson's creek near Springfield, but next spring these forces were driven into Arkansas and defeated.

Meanwhile the convention re-assembled in 1861, ousted Governor Jackson and the legislature, and elected Hamilton R. Gamble provisional governor. Until his death in 1864 he maintained, with Lincoln's support, a loyal State Government accepted by the majority of Missourians, in the face of lack of funds and the impatience of Federal military authorities. In 1861 a minority of the fugitive legislature adopted an ordinance of secession and Missouri was admitted to the Confederacy. Gen. Frémont's emancipation proclamation issued at St. Louis in Aug. 1861 was promptly repudiated by Lincoln. However the convention after refusing Lincoln's plan of emancipation with compensation in 1863 enacted a plan of gradual emancipation. It also provided an oath of loyalty for officials and voters. Records show that 109,111 men were mustered into the Federal service while perhaps 50,000 served in the Confederate armies. In the election of 1864 the more radical elements swept the State and in 1865 a new convention abolished slavery immediately and without compensation. It also drew up a new Constitution which included an extremely rigorous test oath, covering in great detail all sympathy or indirect aid to the Confederacy, and imposed not only on voters but on professional men also. Although the latter sections were declared unconstitutional by the U.S. Supreme Court, the wholesale disenfranchisements and the rigid registration laws maintained the radicals in control until 1870. In that year Carl Schurz led a revolt of the more liberal Republicans and with the support of the reorganized Democratic Party elected B. Gratz Brown governor, repealing the test oaths. In 1872 the Democrats secured control of the State Government and retained it until 1908.

Economic and Industrial Progress.—Missouri emerged from this reconstruction period with a heavy debt, State and local, incurred in loans to the railroads and in war expenditures. The prostration of the South and the rise of Chicago injured St. Louis, while the prevailing economic depression was especially hard on the rural population. However, railways were extended, valuable zinc and lead deposits were discovered in south-west Missouri, and after 1880 the development of the South-western portion of the United States led to the rapid growth of Kansas City. Though hard hit in the panic of 1893, Missouri's economic and especially its industrial development since 1900 has been steady. Missourians were too interested in the reconstruction issues in the '70s to respond to the Granger movement, but the farmers' alliances of the '80s had a very large membership. Bryan and free silver swept the State in 1896 and 1900. Roosevelt, who endorsed many of the Populist ideals and appealed to the younger generation, carried Missouri in 1904, and Folk, the reform Democratic candidate, was elected governor. Since 1904 Missouri has

been a doubtful State politically, voting Republican in all presidential elections, including 1928, except 1912 and 1916, but frequently going Democratic in off-year State elections.

Bibliography.—For history: *see* W. B. Stevens, *Centennial History of Missouri* (1921); E. M. Violette, *History of Missouri* (1918); W. F. Switzler, *History of Missouri* (1879); Lucien Carr, *Missouri* (American Commonwealths Series, 1892); Louis Houck, *A History of Missouri* (1908); F. C. Shoemaker, *Missouri's Struggle for Statehood, 1804–21* (1916); W. M. Meigs, *Thomas Hart Benton* (1914); H. A. Trexler, *Slavery in Missouri* (1914); T. L. Snead, *The Fight for Missouri* (1886); W. Britton, *The Civil War on the Border* (1891–99, 3rd ed. of vol. i., rev. 1899); *Encyclopedia of the History of Missouri*, edit. by H. L. Conrad (1901); H. M. Chittenden, *History of Early Steamboat Navigation on the Missouri River* (1903); T. J. Scharf, *History of St. Louis City and County* (1883); R. S. Douglass, *History of Southeastern Missouri* (1912); and W. Williams, ed., *A History of Northwest Missouri* (1915). *See* also the volumes of *Missouri Historical Collections* (1880 *et seq.*) and of the *Missouri Historical Review* (Columbia, 1906 *et seq.*). On administration: the *Official Manual of the State of Missouri;* the reports of the various State officials, boards and departments; E. Fair, *Government and Politics in Missouri* (1922); and *Public Administration in Missouri* (issued as a bulletin of the State Teachers college, Kirksville, Mo.); *Political Science Series*, No. 1 (1923). For population, occupations, resources, etc., *see* the *Fourteenth United States Census;* the *Biennial Census of Manufactures;* the *U.S. Census of Agriculture;* and the *Missouri Red Book*, published annually by the State bureau of labour statistics. For physical features *see* E. B. Branson, "Geology of Missouri," *Univ. of Mo. Bulletin*, vol. xix., no. 15 (1918); M. F. Miller and H. H. Kruskopf, "The Soils of Missouri," *Bulletin 135*, Agricultural Experiment Station, Univ. of Mo. (1918); publications of the State bureau of geology and mines, including bulletins and reports of the Missouri Geological Survey (1853 *et seq.*) and publications of the U.S. Geological Survey, particularly *Bulletins* 132, 213, 267 and the *22nd Annual Report*, pt. ii.
(J. Vi.)

MISSOURI COMPROMISE, an agreement (1820) between the pro-slavery and anti-slavery factions in the United States, involving primarily the regulation of slavery in the public territories. A bill to enable the people of Missouri to form a state government, preliminary to admission into the Union, came before the House of Representatives on Feb. 13, 1819. An amendment offered by James Tallmadge (1778–1853) of New York, which provided that the further introduction of slaves into Missouri should be forbidden, and that all children of slave parents born in the state after its admission should be free at the age of 25, was adopted by the committee and incorporated in the Bill as finally passed (Feb. 17) by the house. The Senate refused to concur in the amendment and the whole measure was lost. During the following session (1819–20), the house passed a similar bill with an amendment introduced by John W. Taylor (1784–1854) of New York making the admission of the state conditional upon its adoption of a constitution prohibiting slavery. In the meantime the question had been complicated by the admission, in December, of Alabama, a slave state (the number of slave and free states now becoming equal), and by the passage through the house (Jan. 3, 1820) of a bill to admit Maine, a free state. The Senate decided to connect the two measures, and passed a bill for the admission of Maine with an amendment enabling the people of Missouri to form a state constitution. Before the bill was returned to the house a second amendment was adopted on the motion of J. B. Thomas (1777–1850) of Illinois, excluding slavery from the "Louisiana Purchase" north of 36° 30′ (the southern boundary of Missouri), except within the limits of the proposed state of Missouri. The House of Representatives refused to accept this and a conference committee was appointed. There was now a controversy between the two houses not only on the slavery issue, but also on the parliamentary question of the inclusion of Maine and Missouri within the same bill. The committee recommended the enactment of two laws, one for the admission of Maine, the other an enabling act for Missouri, without any restrictions on slavery, but including the Thomas amendment. This was agreed to by both houses, and the measures were passed, and were signed by President Monroe respectively on March 3/6, 1820. On the constitutional side the Compromise of 1820 was important as the first precedent for the congressional exclusion of slavery from public territory acquired since the adoption of the Constitution, and also as a clear recognition that Congress has no right to impose upon a state asking for admission into the Union conditions which do not apply to those states already in the Union. The compromise was specifically repealed by the Kansas-Nebraska bill of 1854.

See J. A. Woodburn, "The Historical Significance of the Missouri Compromise" in the *Annual Report of the American Historical Association* for 1893 (Washington, D.C.); Dixon, *History of the Missouri Compromise* (Cincinnati, 1899); Schouler's and McMaster's *Histories of the United States;* and *The Missouri Compromise and Presidential Politics, 1820–25,* from the letters of William Plumer, Jr., ed. E. S. Brown (St. Louis, 1926).
(W. R. Sm.)

MISSOURI PACIFIC LINES. The Missouri Pacific lines to-day comprise a system extending from St. Louis, Mo., west through Kansas City, north to Omaha and Lincoln, Neb., west of Kansas City to Pueblo, Colo., south-west from St. Louis through Little Rock and Texarkana, Ark., into Texas and south down the Mississippi valley to Memphis and New Orleans. They also include the Gulf Coast lines, which circle the Gulf of Mexico from New Orleans, through Beaumont, Houston, Galveston and Corpus Christi to Brownsville on the Rio Grande, as well as the International-Great Northern, which criss-crosses Texas in a great "X" from Fort Worth to Galveston and from Longview Junction to Laredo, through Austin and San Antonio.

In addition to these lines the Missouri Pacific owns a majority interest in the Texas and Pacific, which covers Texas from east to west, the line extending from New Orleans to El Paso, through the cities of Shreveport, Dallas and Fort Worth. The Missouri Pacific also owns jointly with the Western Pacific the Denver and Rio Grande Western.

The Missouri Pacific was originally known as the Pacific railway, construction of which was started at St. Louis on July 4, 1851. It was the first railroad constructed west of the Mississippi river. Later the Missouri Pacific formed the nucleus or basis of the transcontinental system the elder Gould undertook to assemble. The Missouri Pacific lines serve now virtually every portion of the Mississippi valley, west of the great river from Omaha south to the Gulf of Mexico and to the Rio Grande. In recent years the property has greatly developed. (L. W. B.)

MISSOURI RIVER, the principal western tributary of the Mississippi river, U.S.A. It is formed at Three Forks, in the Rocky Mountain region of south-western Montana, by the confluence of the Jefferson, Madison and Gallatin, thence it flows north into the plains, which it traverses in a course at first north-east, then east. Entering North Dakota, the river turns gradually to the south-east, then south, and again south-east, traversing both North and South Dakota. It forms the eastern boundary of Nebraska and, in part, of Kansas, and crosses Missouri in an easterly course to its junction with the Mississippi 17 m. above St. Louis, and 2,551 m. below the confluence of the three forks. The stream which is known as the Jefferson river in its lower course, Beaver Head river in its middle course and Red Rock creek in its upper course, is really the upper section of the Missouri; it rises on the border between Montana and Idaho, 20 m. W. of the western boundary of the Yellowstone National park, near the crest of the Rocky mountains, 8,000 ft. above the sea, and 394 m. beyond Three Forks, and with this and the Lower Mississippi the Missouri forms a river channel about 4,240 m. in length, the longest in the world. The Madison and Gallatin forks rise within the Yellowstone park, and the Yellowstone river, which is the principal tributary of the Missouri, traverses the park. The Missouri drains a basin having an area of about 580,000 sq.m., 2,550 sq.m. of which are in Canada.

Besides the Yellowstone and the three forks, there are the Platte, which rises in two large branches in Colorado, and the Milk, which rises in north-western Montana. The Kansas in Kansas, the James and Big Sioux in the Dakotas, and the Niobrara in Nebraska, are the principal tributaries wholly of the plains. In the mountain region the Missouri flows through deep canyons and over several cascades. Below Great falls the slower current is unable to carry all the silt brought down from the mountains and plains, and consequently a winding and unstable channel has been formed on deep deposits of silt. Bends in the river continue to develop by erosion until the neck between two of them is cut off, and in the process numerous islands, sand-

bars and crescent-shaped lakes are formed. Cottonwood, willow, cedar and walnut trees grow upon the banks that are for a time left undisturbed, but years later the eroding current returns to undermine these banks and the trees fall in and are carried down stream as snags, which are specially dangerous to navigation. The minimum discharge is 12,000 cu.ft. per sec. at Sioux City and 23,000 at Kansas City. The maximum discharge is about 200,000 cu.ft. per sec. at Sioux City and approximately 500,000 at Kansas City. The waters of the Missouri begin to rise in March, and a high water stage is reached in April, as a result of the spring rains and the melting snow on the plains; a second high stage is produced in June by the melting of the snow on the mountains. The fluctuation between extreme high and low water is 13·3 ft. at Pierre; 22·5 ft. at Sioux City; and at Kansas City 34·6 feet. The river is navigable to Fort Benton 2,285 m. above the mouth.

The mouth of the Missouri was discovered in 1673 by Marquette and Joliet, while they were coming down the Mississippi. Early in the 18th century French fur-traders began to ascend the river, and in 1764 St. Louis was established as a depôt; but the first exploration of the river, from its mouth to its headwaters, was made in 1804–05 by Meriwether Lewis and William Clark. Until many years later the commerce on the river was restricted to the fur trade, and was carried on with such primitive craft as the canoe, the pirogue, the bullboat, the mackinaw boat and the keelboat.

The first attempt to navigate the Missouri with steamboats was made in 1819. The American Fur company began to use steamers in 1830, and from then until the advent of railways the steamboat on the Missouri was one of the most important factors in the development of the North-west. The traffic was at its height in 1858, when no fewer than 60 regular packets were engaged in it, but its decline began in the following year with the completion of the Hannibal and St. Joseph railway to St. Joseph, Mo., and later on it had almost entirely disappeared. Various attempts have been made to revive river traffic in an effort to secure cheaper transportation for the valley.

The U.S. Congress has authorized the improvement of the Missouri for navigation, with a view to securing a navigable channel 6 ft. deep from the mouth to Sioux City, and for snagging, with some rock removal and bank protection to Fort Benton. The Government has spent about $26,000,000 on the section below Kansas City, about $3,000,000 on the section between Kansas City and Sioux City, and about $3,500,000 on the portion of the river above Sioux City. It is expected that a channel capable of being used for barge traffic will be available to Kansas City in 1930.

Bibliography.—F. V. Hayden, *Geological Report of the Exploration of the Yellowstone and Missouri Rivers* (Washington, 1869), *Profile Surveys of the Missouri River from Great Falls to Three Forks, Montana* (1914), which is *Water-Supply Paper,* No. 367, U.S. Geological Survey; J. V. Brower, *The Missouri River and its Utmost Source* (St. Paul, 1896); J. M. Hanson, *The Conquest of the Missouri* (1909); The *Annual Reports* of the Chief of Engineers, U.S.A.; H. M. Chittenden, *History of Early Navigation on the Missouri River* (1903); P. E. Chappel, *A History of the Missouri River* (Kansas City, 1905); C. P. Deatherage, *Steamboating on the Missouri River in the Sixties* (Kansas City, 1924). (E. Ja.)

MIST: *see* Fog.

MISTAKE, a misconception or error in thought or action. For its legal significance *see* Contract.

MISTLE THRUSH (*Turdus viscivorus*), a well-known European thrush, the largest found in Britain. The popular and specific names suggest that the bird eats mistletoe berries. The name is also spelt missel thrush. (*See* Thrush.)

MISTLETOE (*Viscum album*), a species of *Viscum,* of the family Loranthaceae (*q.v.*). The whole genus is parasitical, and contains about 20 species, widely distributed in the warmer parts of the old world; but only the mistletoe proper is a native of Europe. It forms an evergreen bush, about 4 ft. in length, thickly crowded with forking branches and opposite leaves, which are about 2 in. long, obovate-lanceolate in shape and yellowish-green; the dioecious flowers, which are small and nearly of the same colour but yellower, appear in February and March; the white berry when ripe is filled with a viscous semi-transparent pulp (whence bird-lime is derived). The mistletoe is parasitic both on deciduous and evergreen trees and shrubs. In England it is most abundant on the apple-tree, but rarely found on the oak. Poplars, willows, lime, mountain-ash, maples, are favourite habitats. The fruit is eaten by most frugivorous birds, and through their agency the plant is propagated. The sowing is effected by the bird wiping its beak, to which the seeds adhere, against the bark of the tree on which it has alighted. The viscid pulp soon hardens, affording a protection to the seed; in germination the sucker-root penetrates the bark, and a connection is established with the vascular tissue of the first plant. The plant is slow in growth but it is very persistent, its death being determined generally by that of the tree on which it has established itself. The mistletoe so extensively used in England at Christmas is largely derived from the apple orchards of Normandy, but some from the apple orchards of Herefordshire.

The American mistletoe (*Phoradendron flavescens*), very similar to the European mistletoe, occurs on deciduous trees, especially on tupelo and red maple, from central New Jersey to Missouri and southward to Florida, Texas and New Mexico. The larger western form (var. *macrophyllum*), growing in bushy clumps 2 ft. to 8 ft. in diameter, is parasitic chiefly on poplars and willows from Texas to central California. The common mistletoe (*P. villosum*) of the Pacific coast occurs chiefly on oaks from Oregon to southern California and Arizona. Within the same range three other mistletoes are found: the cypress mistletoe (*P. bolleana*), with pearl-like berries; the juniper mistletoe (*P. juniperinum*), with scale-like leaves, growing on junipers and incense cedars; and the mesquite mistletoe (*P. californicum*), with slender, pendulous branches, parasitic on mesquite, creosote-bush and cat's-claw.

MISTRAL, FREDERIC (1830–1914), Provençal poet, was born at Maillane (Bouches-du-Rhône) on Sept. 8, 1830. In the autobiographical sketch prefixed to the *Isclo d'or* (1876) he tells us, with great simplicity and charm, all that is worth knowing of his early life. His father was a prosperous farmer, and his mother a simple and religious woman of the people, who first taught him to love all the songs and legends of the country. In these early days on the farm he received those first impressions which were destined to constitute one of the chief beauties of *Mirèio*. In his ninth year Mistral was sent to a small school at Avignon, where he was very wretched at first, regretting the free outdoor life of the country. Gradually, however, his studies attracted him, above all the poetry of Homer and Virgil; and he translated the latter's first eclogue, showing his efforts to a young schoolfellow, A. Mathieu, who was destined to play a part in the foundation of the Félibrige. When Roumanille (*see* Provençal Literature) became an usher at Mistral's school, the two, fired by the same love of poetry and of their native Provençe, soon became close friends. Returning to Maillane (1847) he sketched a pastoral poem in four cantos (*Li Meissoun*). With all his love for the country, he soon realized that life on a farm did not satisfy his ambition. So he went to study law at Aix, where he contributed his first published poems to Roumanille's *Li Prouvençalo* (1852). He had become *licencié en droit* the year before, but now decided on a literary career. The Félibrige was founded in 1854, and five years later appeared *Mirèio,* the masterpiece not only of Mistral, but so far of the entire school. The tale itself was nothing—the old story of a rich girl and her poor lover, kept apart by the girl's parents. Mireille, in despair, wanders along a tract of country to the church of the Trois-Maries, in the hope that the latter may aid her. But the effort was too great: she sinks exhausted, and dies in the presence of her stricken parents and her frenzied lover. Into this simple web Mistral has woven descriptions of Provençal life, scenery, character, customs and legends that raise the poem to the dignity of a rustic epic that is unique in literature. There is no deep psychology in the characters, but then the people depicted are simple rustic folk, who wear their hearts on their sleeve. But *Calendau* (1867), the story of a princess held in bondage by a ruthless brigand, and eventually rescued by a youthful hero, is a comparative failure. The description of scenery is again masterly; but the old lore, which had charmed all readers in *Mirèio,* here becomes forced, not inevitable. The characters are mere symbols—indeed

the whole poem is obviously an allegory, the princess standing for Provence, the brigand for France and the young lover for the Félibrige. Mistral lavished enormous labour on this work, which probably accounts for its lack of spontaneity, as also for the love he bears it. In 1876 (the same year in which he married Mlle. Marie Rivière, of Dijon) was published the volume *Lis Isclo d'Or* —a collection of the shorter poems Mistral had composed from the year 1848 onwards. Here he is again at his very best. Old legends, *sirventes* (mostly, as in mediaeval times, poems with a tendency), and lyrics—all are admirable. Even the *pièces d'occasion* may be reckoned with the best of their kind. Two pieces, the *Coupe* and the *Princesse*, aroused violent controversy on their first appearance. They reproduce, in effect, the theme of *Calendau*, and Mistral was accused of trying to sow discord between the north and south of France. He was altogether innocent of such a design. *Nerto* (1884) is a charming tale of Avignon in the olden days, in which a girl's purity triumphs over her lover's base designs and leads him to nobler thoughts. The play *La Rèino Jano* (1890) is a complete failure, if judged from the dramatic standpoint: it is rather a brilliant panorama, a series of stage pictures, and the characters neither live nor arouse our sympathy. In the great epic on the Rhone (*Lou Pouèmo dou Rouse*, 1897) the poet depicts the former barge-life of that river, and intertwines his narrative with the legends clustering round its banks, and with a graceful love episode. For the first time he employs blank verse, and uses it with great mastery, but again the ancient lore is overdone. A splendid piece of work is *Lou Tresor dou Félibrige* (1886). In these two volumes Mistral has deposited with loving care every word and phrase, every proverb, every scrap of legend, that he had gathered during his many years' journeyings in the south of France. In 1904 he was awarded a Nobel prize for literature.

In 1906 he published a Provençal translation of *Genesis* and *Olivades*, in 1912, a collection of Provençal poems. His memoirs appeared, under the title *Mes Origines*, in 1906. He died at Maillane, near Marseilles, March 25, 1914.

An excellent literary appreciation of the poet is that by Gaston Paris, "Frédéric Mistral" (originally in the *Revue de Paris* [Oct. and Nov. 1894]; then in *Penseurs et Poètes* [Paris, 1896]). More elaborate accounts are Welter, *Frédéric Mistral* (Marburg, 1899); and Downer, *Frédéric Mistral* (New York, 1901), with a full bibliography.

See P. Brousse, *Frédéric Mistral* (1903); E. Lefèvre, *Bibliographie mistralienne* (1903); H. J. Boeken, *Frédéric Mistral* (1910); J. Brochet, *Frédéric Mistral* (1910); J. Charles-Roux, *Le jubilé de Fr. Mistral* (1912); E. Ripert, *La versification de Frédéric Mistral* (1917); P. Lasserre, *Frédéric Mistral* (1918); J. Vincent, *Frédéric Mistral: sa vie et son influence* (1918).

MISTRAL, a strong, dry, cold local wind which blows from the north-west on to the shores of the Gulf of Lion, where in winter the warm air usually has a lower barometric pressure than that over the colder lands to the north. The wind is experienced over the whole of the north-west Mediterranean coastal land, but is most marked in the district of the Rhone delta, the record at Marseilles being 175 days in the year. The blowing of the mistral is accompanied by cloudless skies, brilliant sunshine, intense dryness and piercing cold. With any increase of the atmospheric pressure differences it develops into a wind of great violence.

MISURATA, a town of Tripolitania, Italian North Africa, 137 m. E.S.E. of Tripoli by road and 122 by sea. Pop. (1927) about 10,000. Situated on the Great Syrtis it is the second city in Tripolitania, the seat of the commissioner of the eastern district, and manufactures carpets and reed mats. Its port, an open roadstead, lies 7 m. E. at the north end of the salt marsh (Sebcha) of Tauorga, described by Strabo as about 40 m. long and nine wide. During the World War it was the capital of the ephemeral republic of Tripolitania, under the bandit Ramadan Sceteui.

MITAU: *see* JELGAVA.

MITCHAM, a suburb of London, in Surrey, England, 10 m. S. of London Bridge by rail. Pop. of the urban district (1931) 56,856. Mitcham Common covers an area of 480 acres. The neighbourhood abounds in market gardens and plantations of aromatic herbs used for scents, essences and chemicals.

MITCHELL, DONALD GRANT (1822–1908), American author, was born in Norwich, Connecticut, on April 12, 1822. He graduated at Yale college in 1841 and studied law, but soon took up literature. Throughout his life he showed a particular interest in agriculture and landscape gardening, which he followed at first in pursuit of health. He produced books of travel, volumes of essays on rural themes, of which *My Farm of Edgewood* (1863) is the best, sketchy studies of English monarchs and of English and American literature, and a character-novel entitled *Dr. Johns* (1866), etc.; but he is best known as the author (under the pseudonym of "Ik. Marvel"), of essays contained in the volumes *Reveries of a Bachelor, or a Book of the Heart* (1850), and *Dream Life, a Fable of the Seasons* (1851).

MITCHELL, JOHN THOMAS WHITEHEAD (1828–1895), English Co-operator, was born at Rochdale on Oct. 18, 1828. He was an illegitimate child, greatly attached to his mother, who, to support them, kept a small beerhouse and later let lodgings to workmen. Not only did poverty make his schooling irregular, but at the age of 10 or 11 he worked in a cotton mill from 6 A.M. to 7 P.M. On Sundays he attended classes to improve his reading and writing and to obtain some knowledge of less elementary subjects. Later he was employed in the warehouse of a flannel mill at 16/– a week, rising to be manager. When he was 22 he became superintendent of the Milton Road Congregational Sunday school, an office he held throughout his life. Through discussions at the Sunday school his interest in co-operation was aroused; he joined the Rochdale Pioneers Co-operative Society in 1853, and served on its management committee for several years. In 1869, he was elected a director of the Co-operative Wholesale Society—started in 1863, and its future still uncertain.

Hitherto, the ideal of Co-operators had been that manufacture should be carried on in self-governing workshops, the profits being divided amongst the workers. But a new principle had been introduced by the device of "dividend on purchase." This brought success to the Rochdale Pioneers and a rapid increase in the number of retail co-operative societies, while productive workshops were continually failing. By this device, the surplus on trading was returned to the consumers, and profit-making was eliminated. A system was thus inaugurated in which the consumers organized distribution and production for use, to supply their own needs. Mitchell was the first to understand the possibilities of this system and something of its underlying theory (of which the full implications were first shown by Mrs. Sidney Webb in 1891), and he believed that it could become co-extensive with the nation. The success of this "Rochdale" system in England, largely due to Mitchell, has led to its being copied in 36 countries, and these national movements comprise now (1928) over 50,000,000 individuals. Mitchell was appointed chairman of the Co-operative Wholesale Society in 1874; his business ability steered the C.W.S. through serious difficulties in the '70s, and under his chairmanship a strong financial position was built up, large developments in banking and manufacture being initiated.

Mitchell never married and in his later years lived alone, looked after by a devoted neighbour—a man he had befriended on release from prison. His income from Co-operative work never exceeded £170 a year. This practical idealist had built up, through "voluntary socialism," a great inheritance for his fellows, and so lived for what he called "the good of the body politic."

For accounts of Mitchell see *C.W.S. Annual, 1896* (Manchester), P. Redfern, *John T. W. Mitchell* (Manchester, 1923); Mrs. Sidney Webb, *The Discovery of the Consumer* (1828).

MITCHELL, MARIA (1818–1889), American astronomer, was born on Nantucket, Aug. 1, 1818. Her astronomical work began as assistant to her father, William Mitchell, in making astronomical observations. On Oct. 1, 1847, she discovered a telescopic comet (seen by De Vico, Oct. 3, by W. R. Dawes, Oct. 7, by Madame Rümker, Oct. 11). In 1865 she became professor of astronomy and director of the observatory at Vassar college; and in 1888 professor emeritus. She made photographs of the sun and a special study of Jupiter and Saturn. She died at Lynn, Mass., on June 28, 1889.

See Phebe Mitchell Kendall, *Maria Mitchell: Life, Letters and Journals* (1896); *In Memoriam* (1889), by her pupil and successor at Vassar, Mary W. Whitney; and a sketch by her brother, Henry Mitchell (1830–1902), himself a well-known hydrographer, in the *Proceedings* of the American Academy of Arts and Sciences, vol. xxv. (1889–90), pp. 331–343.

MITCHELL, PETER CHALMERS (1864–), British zoologist, was born at Dunfermline on Nov. 23, 1864, and was educated at Aberdeen university, Christ Church, Oxford and at Berlin and Leipzig. From 1888 to 1891 he was university demonstrator in comparative anatomy at Oxford, and for the next two years was organizing secretary for technical instruction to the Oxfordshire County Council. He was later appointed lecturer in biology at Charing Cross hospital and at the London hospital, and in 1903 secretary to the Zoological Society of London. He also did much useful work as a member of the committees on fishery investigations and on sleeping sickness. During the World War he was attached to the Imperial General Staff and in 1918 acted as liaison officer to the War Office and to the British War Mission. He was elected F.R.S. in 1906.

His publications include *Outlines of Biology* (1894), *The Biological Problem of To-day* (1896), *T. H. Huxley* (1900), *The Nature of Man* (1904), *The Childhood of Animals* (1912), *Evolution and the War* (1915) and various papers in *The Anatomical Journal, The Quarterly Journal of Microscopical Science*, etc.

MITCHELL, SILAS WEIR (1829–1914), American physician and author, son of a physician, John Kearsley Mitchell, was born in Philadelphia, Feb. 15, 1829. He studied at the University of Pennsylvania and in 1850 received the degree of M.D. from Jefferson Medical College. From the time of his Civil War experience as an army surgeon he was interested in nervous diseases, soon becoming an international specialist particularly renowned for his use of the "rest cure." In 1863 he wrote a clever short story, combining physiological and psychological problems, entitled "The Case of George Dedlow," published in the *Atlantic Monthly*. Thenceforward Dr. Mitchell divided his attention between professional and literary pursuits. He wrote over 100 medical monographs and articles, the topics varying from the venom of poisonous snakes to neurasthenia. His *Wear and Tear, or Hints for the Overworked* (1871) might be classed as a best seller of its day; and *Fat and Blood* (1877) was translated into many languages. As a man of letters Dr. Mitchell wrote juvenile stories, several volumes of respectable verse, and prose fiction, perhaps the best being his historical novels *Hugh Wynne, Free Quaker* (1897), *The Adventures of François* (1898) and *The Red City* (1908). Mitchell died in Philadelphia, Jan. 4, 1914, the recipient of many academic and scientific honours. Mitchell's *Complete Poems* were published in 1914.

See Beverly R. Tucker, *S. Weir Mitchell* (1914), and Anna Robeson Burr, *Weir Mitchell: His Life and Letters* (1929).

MITCHELL, SIR THOMAS LIVINGSTONE (1792–1855), Australian explorer, was born at Craigend, Stirlingshire, Scotland, on June 16, 1792. In the Peninsular War, he surveyed battlefields. As surveyor-general of New South Wales, he made four exploring expeditions between 1831 and 1845, and discovered the Peel, the Namoi, the Gwyder and other rivers, traced the course of the Darling and Glenelg, and was the first to penetrate into that portion of the country which he named Australia Felix. In 1851 he was sent to report on the Bathurst goldfields, and in 1853 he again visited England and patented his boomerang propeller for steamers. He died at Darling Point, Sydney, on Oct. 5, 1855.

His works include: *Geographical and Military Surveying* (1827); *Three Expeditions into the Interior of East Australia* (1838); *Journal of an Expedition into the Interior of Tropical Australia* (1848); an *Australian Geography*, and a translation of the *Lusiad* of Camoens. During his tenure of office as surveyor-general he published a map of the settled districts of New South Wales.

MITCHELL, a city of South Dakota, U.S.A., 70 m. W. by N. of Sioux Falls, on the high banks of the crooked James river, at an altitude of 1,322 ft.; the county seat of Davison county. It is on Federal highways 16 and 37, and is served by the Chicago, Milwaukee, St. Paul and Pacific and the Chicago, St. Paul, Minneapolis and Omaha railways. Pop. (1920) 8,478 (91% native white); 1930 Federal census 10,942. It is the centre of a rich agricultural area and the seat of Dakota Wesleyan university (Methodist Episcopal: established 1885). Its unique "corn palace," redecorated annually with corn, grains and grasses, is the scene of a harvest festival during the last week in September. Mitchell was founded in 1879 and chartered as a city in 1883.

MITCHELL, MOUNT, a peak of the Black mountains, a short cross range extending north from the Blue Ridge through Yancey county, North Carolina, in 35° 45′ 53″ N. and 82° 15′ 55″ W. It is the highest (6,684 ft. above sea-level) peak in the United States east of the Mississippi river. In the same region there are about a dozen summits above 6,000 ft., the noblest of them being Blackstock Knob (6,386 ft.), Big Craggy Mount (6,068 ft.) and Balsam Cone (6,645 ft.). The mountains of North Carolina were not subject to glaciation and are, therefore, covered with a mantle of soil to the top, except for rocky precipices. They are covered with hardwood and pine forests in the lower elevations, and in the upper parts with an unbroken mantle of spruce and balsam fir.

For elevation in North Carolina see *Precise Triangulation, Traverse and Leveling in North Carolina* (1924), which is special publication No. 101 of the U.S. Coast and Geodetic Survey.

MITE, a name applied to an order of small Arachnida, and to a coin of slight value. The coin was originally a Flemish copper coin worth one-third or, a smaller fraction of the Flemish *penning*, penny. It is an expression in English for a coin of the smallest value, from its use in Mark xii., 43.

In zoology, "mite" is the name for minute members of the class Arachnida (*q.v.*), which, with the ticks (*q.v.*), constitute the order Acari. The word "mite," however, is merely a popular term and does not connote a natural assemblage. Mites are spread from the arctic to the antarctic hemisphere, and inhabit land, fresh-water and the sea. Many are permanent parasites; others for part of their life only. The largest species reach half an inch in length; while the smallest, the most diminutive Arthropoda, are invisible to the naked eye.

Mites are divided into a number of families. The Bdellidae (*Bdella*) are free-living with long antenniform palpi. The large tropical forms above mentioned belong to the genus *Trombidium* of the family Trombidiidae. They are covered with crimson velvety hairs. The legs are adapted for crawling and the palpi are raptorial. They are non-parasitic in the adult; but immature individuals of a British species (*Microtrombidium Autumnale*) are parasitic. (*See* HARVEST BUG.) The Tetranychidae are related to the last. A well-known example, *Tetranychus telarius*, spins webs and is sometimes called the money spider. The fresh-water Hydrachnidae are generally red or green and globular in shape. Their legs are furnished with long hairs for swimming. The red appears to be a warning colour. The marine Halacaridae creep on seaweeds and zoophytes. The Gamasidae are free-living with a thick exoskeleton, and allied to the ticks (*q.v.*). The Oribatidae or beetle-mites are non-parasitic, and go through remarkable metamorphoses. The Sarcoptidae are mostly parasitic. Some, however, live in decaying substances, the best known being the cheese-mite (*Tyroglyphus siro*). An allied species (*T. entomophagus*) damages collections of insects by destroying the specimens. They may be exterminated by benzine.

The mites are parasitic upon mammals and birds. They belong to the four families, Gamasidae, Trombidiidae (*vide supra*), Sarcoptidae and Demodicidae. Most of the Gamasidae are free-living. The family, however, contains an aberrant genus, *Dermanyssus*, of which one species, "red-mite," *D. gallinae*, is found in fowl-houses, dovecotes and bird-cages. During the day they lurk in cracks and emerge at night. They do much damage to the birds by sucking their blood and by depriving them of rest. Birds are also attacked by many species of Sarcoptidae (*Pterolichus* and *Analges*) living on and between the barbules of the feathers. They are apparently harmless. *Epidermoptes* occur on diseased fowls and live on the skin at the base of the feathers where they cause an accumulation of yellowish scales. *Cytolechus* lives in the connective tissue round the respiratory organs, or in the air sacs. They also penetrate to certain internal organs, and give rise to tubercle-like nodules.

The cutaneous mites mentioned above, merely suck the blood or feed upon the feathers, scurf and desquamating epidermis. Some species, however, give rise to a contagious disease known as scabies or mange. These mites belong to the Sarcoptidae and Demodicidae. A variety of species are responsible for Sarcoptic mange, *Sarcoptes mutans* producing it in the feet of birds.

Feather scabies of poultry is caused by *S. laevis*. Three genera of Sarcoptidae, namely *Sarcoptes, Chorioptes* and *Psoroptes* cause mange or scabies in mammals, the mange produced by *Sarcoptes* being the most serious, because the females of the species *scabiei*, burrow beneath the skin and are more difficult to kill. Their multiplication is very rapid. The numerous forms described from different mammals are probably all merely temporary varieties of a single species. Mange, if taken in time, can be cured by applications of sulphur ointment. *Demodex folliculorum* gives rise to "Demodecic or follicular mange," which is difficult to cure on account of the deep situation of the parasites. These infest the hair follicles and sebaceous glands in man and other animals. They differ from those previously noticed in the reduction of their legs and the elongation of the abdomen. They occur on domesticated animals, as well as on mice and bats.

The family Eriophyidae or gall-mites produce in plants results analogous to those produced in animals by Sarcoptidae and Demodicidae. As in the Demodicidae the abdomen is elongate, but the Eriophyidae differ from all other mites in having lost the last two pairs of legs. The best known of the excrescences or galls which they produce are the nail-galls of the lime caused by *Eriophyes tiliae*. Many species have been described. They inflict considerable loss upon fruit-growers by destroying the buds of the trees.

MITFORD, MARY RUSSELL (1787–1855), English novelist and dramatist, only daughter of Dr. George Mitford, or Midford, was born at Alresford, Hampshire, on Dec. 16, 1787. She retains an honourable place in literature as the authoress of *Our Village* (1824–32), a series of sketches of village scenes and characters unsurpassed in their kind, and as fresh as if they had been written yesterday. Miss Mitford lived in close attendance on an eccentric father, refused all holiday invitations because he could not live without her, and worked incessantly for him except when she broke off her work to read him the sporting newspapers. Her writing has the charm of perfectly unaffected spontaneous humour, combined with quick wit and real literary skill. Miss Mitford met Elizabeth Barrett (Mrs. Browning) in 1836, and the acquaintance ripened into a warm friendship. The strain of poverty began to tell on her work, for although her books sold at high prices, her income did not keep pace with her father's extravagances. In 1837, however, she received a civil list pension, and five years later her father died. A subscription was raised to pay his debts, and the surplus increased the daughter's income. She died at Swallowfield, near Reading, on Jan. 10, 1855. Her father was a curious character. He first spent his wife's fortune then the greater part of £20,000 which his daughter won in a lottery at the age of ten.

Miss Mitford wrote poems in the manner of Coleridge and Scott (*Miscellaneous Verses*, 1810, reviewed by Scott in the *Quarterly; Christine*, a metrical tale, 1811; *Blanche*, 1813). Several of her plays were produced with success, notably *Julian* (1823), *The Foscari* (1826), *Rienzi* (1828), and *Charles I.* (1834). *Belford Regis*, a novel idealizing Reading, was published in 1835.

Her *Recollections of a Literary Life* (1852) is a series of *causeries* about her favourite books. Her talk was said by her friends, Mrs. Browning and Hengist Horne, to have been even more amusing than her books, and five volumes of her *Life and Letters*, published in 1870 and 1872, show her to have been a delightful letter-writer; *see* L'Estrange, *Life of Miss M. Russell Mitford* with letters (3 vols., 1869); W. Roberts, *Mary Russell Mitford, Her Life and Friendship* (1913).

MITFORD, WILLIAM (1744–1827), English historian, born at Beaulieu, Hants, on Feb. 10, 1744, the son of a barrister. He was educated under William Gilpin at Cheam and at Queen's College, Oxford. He then read at the Middle Temple. After his marriage (1766) with Fanny Molloy he retired to Exbury, where he occupied himself with Greek language and literature. After his wife's death in 1776 he spent much time abroad. He sat in the House of Commons with intervals, from 1785 to 1818. Mitford died at Exbury on Feb. 10, 1827. In addition to his *History of Greece*, he published a few smaller works, the most important of which was an *Essay on the Harmony of Language*, 1774. The style of Mitford is natural and lucid, but without the rich colour of Gibbon. Mitford was an impassioned anti-Jacobin, and his partiality for a monarchy led him to be unjust to the Athenians, and the appearance of Grote's work eclipsed Mitford's *History*. Clinton, in his *Fasti hellenici*, charged Mitford with "a general negligence of dates," though admitting that in his philosophical range "he is far superior to any former writer" on Greek history.

MITHILA, an ancient kingdom of India, corresponding to that portion of Behar lying N. of the Ganges, with an extension into Nepal, where was the capital of Janakpur. Its early history is obscure, but it has always been noted for its peculiar conservatism and the learning of its Brahmans. Maithili is a dialect of Bihari, with an archaic grammar and literature of its own.

MITHRADATES, less correctly MITHRIDATES, a Persian name derived from Mithras (*q.v.*), the sun-god, and the Indo-European root *da*, "to give," *i.e.*, "given by Mithras." The name occurs also in the forms Mitradates (Herod. i. 110) and Meherdates (Tac. *Ann.* xii. 10). It was borne by a large number of Oriental kings, soldiers and statesmen. The earliest are Mithradates, the eunuch who helped Artabanus to assassinate Xerxes I. (Diod. xi. 69), and the Mithradates who fought first with Cyrus the Younger and after his death with Artaxerxes against the Greeks (Xen. *Anab.* ii. 5, 35; iii. 3, 1–10; iii. 4, 1–5), and is the ancestor of the kings of Pontus. The most important are three kings of Parthia of the Arsacid dynasty, and six (or four) kings of Pontus. There were also two kings of Commagene, two of the Bosporus and one of Armenia (A.D. 35–51).

Kings of Parthia.—MITHRADATES I. (Arsaces VI.), successor of his brother, Phraates I., came to the Parthian throne about 175 B.C. The first event of his reign was a war with Eucratides of Bactria, who tried to create a great Greek empire in the East. At last, when Eucratides had been murdered by his son about 150, Mithradates was able to occupy some districts on the border of Bactria and to conquer Arachosia (Kandahar); he is even said to have crossed the Indus (Justin 41, 6; Strabo xi. 515, 517; *cf.* Orosius v. 4, 16; Diod. 33, 18). Meanwhile the Seleucid kingdom was torn by internal dissensions, fostered by Roman intrigues. Phraates I. had already conquered eastern Media, about Rhagae (Rai), and subjected the Mardi on the border of the Caspian (Justin 41, 5; Isidor. *Charac.* 7). Mithradates I. conquered the rest of Media and advanced towards the Zagros chains and the Babylonian plain. In a war against the Elymaeans (in Susiana) he took the Greek town Seleucia on the Hedyphon, and forced their king to become a vassal of the Parthians (Justin 41, 6; Strabo xv. 744). About 141 he must have become master of Babylonia. By Diodorus 33, 18 he is praised as a mild ruler; and the fact that from 140 he takes on his coins the epithet *Philhellen* (W. Wroth, *Catalogue of the Coins of Parthia*, p. 14 *seq.;* till then he only calls himself "the great king Arsakes") shows that he tried to conciliate his Greek subjects. The Greeks, however, induced Demetrius II. Nicator to come to their deliverance, although he was much pressed in Syria by the pretender Diodotus Tryphon. At first he was victorious, but in 138 he was defeated. Mithradates settled him with a royal household in Hyrcania and gave him his daughter Rhodogune in marriage (Justin 36, 1, 38, 9; Jos. *Ant.* 13, 5, 11; Euseb. *Chron.* I. 257; Appian *Syr.* 67). Shortly afterwards Mithradates I. was succeeded by his son Phraates II., the real founder of the Arsacid Empire.

MITHRADATES II. the Great, king of Parthia (*c.* 120–88 B.C.), saved the kingdom from the Mongolian Sacae (Tochari), who had occupied Bactria and eastern Iran, and is said to have extended the limits of the empire (Justin 42, 2, where he is afterwards confused with Mithradates III.). He defeated King Artavasdes of Armenia and conquered seventy valleys; and the prince Tigranes came as hostage to the Parthians (Justin 42, 2; Strabo, xi. 532). In an inscription from Delos (Dittenberger, *Or. gr. inscr.* 430) he is called "the great King of Kings Arsakes." He also interfered in the wars of the dynasts of Syria (Jos. *Ant.* xiii. 14, 3). He was the first Parthian king who entered into negotiations with Rome, then represented by Sulla, praetor of Cilicia (92 B.C.).

MITHRADATES III. murdered his father Phraates III. about 57 B.C., with the assistance of his brother Orodes. He was made king of Media, and waged war against his brother, but was soon

deposed on account of his cruelty. He took refuge with Gabinius, the Roman proconsul of Syria. He advanced into Mesopotamia, but was beaten at Seleucia by Surenas, fled into Babylon, and after a long siege was taken prisoner and killed in 54 by Orodes I. (Dio Cass 39, 56; Justin 42, 4; Jos *Bell.* i. 8, 7 *Ant.* 14, 6, 4).

A Parthian king Mithradates, who must have occupied the throne for a short time during the reign of Phraates IV., is mentioned by Jos. *Ant.* xvi. 8, 4, in 10 B.C.; another pretender Meherdates was brought from Rome in A.D. 49 by the opponents of Gotarzes, but was defeated (Tac. *Ann.* xi. 10, xii. 10 *sqq.*). The name of another pretender Mithradates (often called Mithradates IV.) occurs on a coin of the first half of the 2nd century, written in Aramaic accompanied by the Arsacid titles in Greek (Wroth, *Catal. of the Coins of Parthia*, p. 219); he appears to be identical with Meherdotes, one of the rival kings of Parthia who fought against Trajan in 116; he died in an attack on Commagene and appointed his son Sanatruces successor, who fell in a battle against the Romans (Arrian *ap.* Malalas, *Chron.* pp. 270, 274) (ED. M.)

Kings of Pontus.—The kings of Pontus were descended from one of the seven Persian conspirators who put the false Smerdis to death. (*See* DARIUS I.) According to Diodorus Siculus, three members of his family—Mithradates, Ariobarzanes, Mithradates—were successively rulers of Cius on the Propontis and Carinē in Mysia. The last of these was put to death in 302 B.C. by Antigonus, who suspected him of having joined the coalition against him. He was succeeded by his son Mithradates I. or III. (if the two dynasts of Cius be included[1]), the founder κτίστης of the Pontic kingdom, although this distinction is by some attributed to the father. Warned by his friend Demetrius, the son of Antigonus, that he was threatened with the same fate as his father, he fled to Paphlagonia, where he seized Cimiata, a fort at the foot of the Olgassys range. Being joined by the Macedonian garrison and the neighbouring populations, he conquered the Cappadocian and Paphlagonian territories on both sides of the Halys and assumed the title of king. Before his death he further enlarged Pontic Cappadocia. He was succeeded by Ariobarzanes, who left the throne to MITHRADATES II. (*c.* 256–190, according to Meyer, *Mithradates II. and III.*), a mere child. Early in his reign the Gauls of Galatia invaded his territory. Mithradates was at the battle of Ancyra (*c.* 241), in which he assisted Antiochus Hierax against his brother Seleucus Callinicus, in spite of the fact that he had married the daughter of the latter with Greater Phrygia as her dowry. His two daughters, both named Laodice, were married, one to Antiochus the Great, the other to his cousin Achaeus, a dynast of Asia Minor. He unsuccessfully attacked Sinope, which was taken by his successor Pharnaces, the brother (not the son) of MITHRADATES III. (169–121), surnamed *Philopator, Philadelphus* and *Euergetes.* According to Meyer, however, there were two kings (Mithradates IV. *Philopator* and V. *Euergetes*). He was the first king of Pontus to recognize the suzerainty of the Romans, of whom he was a loyal ally. He assisted Attalus II. of Pergamum to resist Prusias II. of Bithynia; furnished a contingent during the Third Punic War; and aided the Romans in obtaining possession of Pergamum, bequeathed to them by Attalus III., but claimed by Aristonicus, a natural son of Eumenes II. Both Mithradates and Nicomedes of Bithynia demanded Greater Phrygia in return for their services. It was awarded to Mithradates, but the senate refused to ratify the bargain on the ground of bribery. For several years the kings of Pontus and Bithynia bid against each other, till in 116 Phrygia was declared independent, although in reality it was treated as part of the province of Asia. Mithradates appears to have taken it without waiting for the decision of the senate. He invaded Cappadocia, and married his daughter to the young king, Ariarathes Epiphanes; bought the succession from the last king of Paphlagonia, and obtained a kind of protectorate over Galatia. He was a great admirer of the Greeks, who called him Euergetes; he removed his capital from Amasia to Sinope, and bestowed liberal gifts upon the temples of Delos and Athens. At the height of his power he was assassinated by his courtiers during a banquet in his palace at Sinope.

[1]There is much difference of opinion in regard to the kings of Pontus called Mithradates to the accession of Mithradates Eupator. Ed. Meyer reckons five, T. Reinach three.

MITHRADATES VI. *Eupator,* called the Great, a boy of eleven, now succeeded his father. Alarmed at the attempts made upon his life by his mother, he fled to the mountains and was for many years a hunter. In 111 he returned to Sinope, threw his mother into prison, and put his younger brother to death. Having thus established himself on the throne, he turned his attention to conquest. In return for his assistance against the Scythians, the Greeks of the Cimmerian Bosporus and the Tauric Chersonese recognized his suzerainty. He occupied Colchis, Paphlagonia and part of Galatia; set his son Ariarathes on the throne of Cappadocia and drove out Nicomedes III., the young king of Bithynia. The Romans restored the legitimate kings, and, while apparently acquiescing, Mithradates made preparations for war. He had long hated the Romans, who had taken Phrygia during his minority, and he aimed at driving them from Asia Minor. The cause of rupture was the attack on Pontic territory by Nicomedes at the instigation of the Romans. Mithradates, unable to obtain satisfaction, declared war (88 B.C.). He rapidly overran Galatia, Phrygia and Asia, defeated the Roman armies, and ordered a general massacre of the Romans in Asia. He sent large armies into European Greece, and his generals occupied Athens. But Sulla in Greece and Fimbria in Asia defeated his armies in several battles; the Greek cities were disgusted by his severity, and in 84 he concluded peace, abandoning all his conquests, surrendering his fleet and paying a fine of 2,000 talents. During what is called the Second Mithradatic War, Murena invaded Pontus without any good reason in 83, but was defeated in 82. Hostilities were suspended, but disputes constantly occurred, and in 74 a general war broke out. Mithradates defeated Cotta, the Roman consul, at Chalcedon; but Lucullus worsted him, and drove him in 72 to take refuge in Armenia with his son-in-law Tigranes. After two great victories at Tigranocerta (69) and Artaxata (68), Lucullus was disconcerted by mutiny and the defeat of his lieutenant Fabius. (*See* LUCULLUS.) In 66 he was superseded by Pompey, who completely defeated both Mithradates and Tigranes. The former established himself in 64 at Panticapaeum, and was planning new campaigns against the Romans when his own troops revolted, and, after vainly trying to poison himself, he ordered a Gallic mercenary to kill him. So perished Rome's greatest enemy in Asia Minor. His body was sent to Pompey, who buried it in the royal sepulchre at Sinope.

Ancient authorities have invested Mithradates with a halo of romance. His courage, his bodily strength and size, his skill in the use of weapons, in riding, and in the chase, his speed of foot, his capacity for eating and drinking, his penetrating intellect and his mastery of 22 languages are celebrated to a degree which is almost incredible. With a surface gloss of Greek education, he united the subtlety, the superstition, and the obstinate endurance of an Oriental. He collected curiosities and works of art; he assembled Greek men of letters round him; he gave prizes to the greatest poets and the best eaters. He spent much of his time in practising magic and it was believed that he had so saturated his body with poisons that none could injure him. He trusted no one; he murdered his mother, his sons, the sister whom he had married; to prevent his harem from falling to his enemies he murdered his concubines, and his followers were never safe.

See T. Reinach, *Mithridate Eupator* (1890; Ger. trans. by A. Goetz, 1895, with the author's corrections and additions); also E. Meyer, *Geschichte des Königreichs Pontos* (1879).

MITHRAS (MITHRES, MITHRA), a god, mentioned in Sanskrit and Old Persian documents and thus probably older than the separation of the Iranian stock from the Aryan invaders of India. (*See* INDIA, *History;* PERSIA, *History.*)

History.—Although mentioned by Greek writers, particularly of Hellenistic date, as an important Persian deity, his history is obscure. In Zoroastrianism as we know it, he is simply a *Yazata,* a kind of angel, a power of light who fights on the side of Ahura-Mazda. This warlike characteristic he seems always to have retained. But other evidence exists to show that his position remained higher than this would indicate. Names compounded of his (*e.g.,* Mithradates) are common among Orientals of various epochs; his festival, the Mithrakana, (sixteenth day of the seventh month; both month and day were especially sacred to him) was

brilliant, and modified forms of it survived to Muslim times.

His cult naturally spread with the Persian conquests, and in particular, he reached the Euphrates valley, where he was so long settled that several Greek and Roman writers speak of him as an Assyrian god. Another branch of his cult, of some importance for later developments, was established in Cilicia; but for some reason he never penetrated to the western parts of Asia Minor till late times, about the beginning of the Christian era. Naturally, the concept of him was modified by contact with foreign cults, and in particular, he tended to be identified, or at least brought into close association with, the Sun. Perhaps as a result of the accretion of foreign worshippers, his cult took on, if it did not already possess, the form of a mystery, with more or less definite grades of initiation and ceremonials of purification, penance and so forth, appropriate to such a worship.

Mithraism was first transmitted to the Roman world during the 1st century B.C. by the Cilician pirates captured by Pompey. As late as the time of Augustus it was but little known in Roman territory, and gained a firm foothold in Italy only gradually, as a result of Rome's increasing hold upon Asia.

Towards the close of the 2nd century the cult had begun to spread rapidly through the army, the mercantile class, slaves and actual propagandists, all of which classes were largely composed of Asiatics. It throve, especially among military posts, and in the track of trade, notably at ports. The German frontiers afford most evidence of its prosperity. Rome itself was a favourite seat of the religion. From the end of the 2nd century the emperors encouraged Mithraism, because of the support which it afforded to the divine right of monarchs. The Persian belief that the legitimate sovereign reigned by the grace of Ormazd, whose favour was made manifest by the sending of the *Hvarenō*, a kind of celestial aureole of fire, resulted in the doctrine that the sun was the giver of the *Hvarenō*. Mithras, identified with Sol Invictus, thus became the giver of authority and victory to the imperial house.

The beginning of the downfall of Mithraism dates from A.D. 275, when Dacia was lost to the empire. The aggression of Christianity also was now more effective. The emperors, however, favoured the cult, which was the army's favourite until Constantine destroyed its hopes. The reign of Julian and the usurpation of Eugenius renewed the hopes of its devotees, but the victory of Theodosius (394) may be considered the end of its existence. It still survived in certain cantons of the Alps in the 5th century, and clung to life with more tenacity in its Eastern home.

Sources, Remains, Ritual.—The sources of present knowledge regarding Mithraism consist of the Vedas, the Avesta, the Pahlevi writings, Greek and Latin literature and inscriptions, and the cult monuments. The last include (a) some hundreds of sculptures, (b) numerous chapels, which are grottoes (*spelaea*) underground, or imitations thereof in masonry. The average grotto held from fifty to a hundred persons. The size of the sanctuaries, however, was compensated for by their number.

The typical bas relief, which is found in great abundance in the museums of Europe, invariably represents Mithras, under the form of a youth with conical cap and flying drapery, slaying the sacred bull, the scorpion attacking the genitals of the animal, the serpent drinking its blood, the dog springing towards the wound in its side, and frequently, in addition, the Sun-god, his messenger the raven, a fig-tree, a lion, a ewer, and torch-bearers. The relief is in some instances enclosed in a frame of figures and scenes in relief. The smaller reliefs Cumont arranges in two groups; (1) Infinite Time (*Zrvan Akarana*) called in Greek κρόνος, identified by theorists of that day with χρόνος; in Latin, Saturnus; Tellus and Atlas supporting the globe, representing the union of Earth and Heaven; Oceanus; the Fates; Infinite Time giving into the hand of his cessor Ormazd the thunderbolt, the symbol of authority; Ormazd struggling with a giant of evil—the Mithraic gigantomachy. (2) The birth of Mithras; then the god nude, cutting fruit and leaves from a fig-tree in which is the bust of a deity, and before which one of the winds is blowing upon Mithras; the god discharging an arrow against a rock from which springs a fountain; the bull in a small boat, near which again occurs the figure of the animal under a roof about to be set on fire by two figures; the bull in flight, with Mithras in pursuit; Mithras bearing the bull on his shoulders; Helios kneeling before Mithras; Helios and Mithras clasping hands over an altar; Mithras with drawn bow on a running horse; Mithras and Helios banqueting; Mithras and Helios mounting the chariot of the latter and riding over the ocean.

These documents Cumont interprets tentatively as follows. The head of the divine hierarchy of Mithras was Infinite Time; Heaven and Earth were his offspring, and begat Ocean. From Heaven and Earth sprang the remaining members of a circle analogous to the Olympic gods. Ahriman was also the son of Time. Mithras was the most important member of the circle, the mediator between man and the supreme god.

The Mithras legend has been lost, and can be reconstructed only from the sculptures. Mithras was born of a rock, the marvel being seen only by certain shepherds, who brought gifts and adored him. Chilled by the wind, the new-born god went to a fig-tree, partook of its fruit, and clothed himself in its leaves. He then undertook to vanquish the beings already in the world, and rendered subject to him first the Sun, with whom he concluded a treaty of friendship. Next, he captured the sacred bull which had been created by Ormazd. This by order of the Sun, who sent his messenger the raven, he reluctantly sacrificed. From the dying animal sprang the life of the earth, although Ahriman sent his emissaries to prevent it. The soul of the bull rose to the celestial spheres and became the guardian of herds and flocks under the name of Silvanus. Mithras was through his deed the creator of life. Meanwhile Ahriman sent a terrible drought upon the land. Mithras defeated his purpose by discharging an arrow against a rock and miraculously drawing the water from it. Next Ahriman sent a deluge, from which one man escaped in a boat with his cattle. Finally a fire desolated the earth, and only the creatures of Ormazd escaped. Mithras, his work accomplished, banqueted with the Sun for the last time, and was taken by him in his chariot to the habitation of the immortals, whence he continued to protect the faithful.

As regards the organization of Mithraism, S. Jerome (*Epist.* 107, 2) and inscriptions preserve the knowledge that the mystic, *sacratus*, passed through seven degrees, which probably corresponded to the seven planetary spheres traversed by the soul in its ascent; *Corax*, Raven; *Cryphius*, Hidden (κρύφιος) (cryphus, the mss. corrected by Hilberg from inscr.; the initiate was perhaps veiled). *Miles*, Soldier, signifying the holy warfare against evil in the service of the god; *Leo*, Lion, symbolic of the element of fire; *Perses*, Persian (*cf.* the Christian use of "Israel," "Zion," etc.) *Heliodromus*, Courier of the Sun; *Pater*, Father, a degree bringing the mystic among those who had the general direction of the cult for the rest of their lives.

Of the seven degrees, those mystics not yet beyond the third, *Miles*, were not in full communion, and were called ὑπηρετοῦντες (servants); while the fourth degree, *Leo*, admitted them into the class of the fully initiate, the μετέχοντες (participants). No women were connected with the cult. A sacred communion of bread, water and possibly wine, compared by the Christian apologists to the Eucharist, was administered to the mystic who was entering upon one of the advanced degrees.

The Mithraic priest, *sacerdos* or *antistes*, was sometimes also of the degree of *pater*. Tertullian (*De praescr. haeret.* 40) calls the chief priest *summus pontifex*, probably the *pater patrum* who had general supervision of all the initiates in one city, and states that he could marry but once. According to the same author, there were Mithraic, as well as Christian, *virgines et continentes.* Each day of the week was marked by the adoration of a special planet, the sun being the most sacred of all.

The Mithraic community of worshippers, besides being a spiritual fraternity, was a legal corporation enjoying the right of holding property, with temporal officials at its head, like any other *sodalitas*. The cult was supported mainly by voluntary contribution. An abundance of epigraphic evidence testifies to the devotion of rich and poor alike.

Moral Influence.—Like all the mystery religions (*see* MYSTERY) of that day, Mithraism attracted neophytes by claiming to

possess ancient and divine wisdom and by holding out hopes of a blessed immortality in union with a god. But it would seem, in addition, to have had a high moral standard. The "soldier" of Mithras, like the "soldier" of Christ, was a warrior on the side of good against evil. While observing ritual, he had also to be morally pure and upright. Those who were so, might hope to regain, by successive degrees (corresponding according to the popular astrological doctrine, to the seven planets), the original beatitude of the soul; the wicked fell to the portion of Ahriman.

Relation to Christianity.—The most interesting aspect of Mithraism is its antagonism to Christianity. Both religions were of Oriental origin; they were propagated about the same time, and spread with equal rapidity on account of the same causes, viz., the unity of the political world and the debasement of its moral life. The points of collision were especially at Rome, in Africa, and in the Rhône Valley, and the struggle was the more obstinate because of the resemblances between the two religions, which were so numerous and so close as to be noticeable as early as the 2nd century, causing mutual recrimination.

The fraternal spirit of the first communities, and their humble origin; the connection of their central figures with the Sun; the legends of the shepherds with their gifts and adoration; the flood, and the ark; the representation in art of the fiery chariot; the drawing of water from the rock; the use of bell and candle, holy water and the communion; the sanctification of Sunday and of the 25th of December; the insistence on moral conduct, the emphasis placed upon abstinence and self-control; the doctrine of heaven and hell, of primitive revelation, of the mediation of the Logos emanating from the divine, the atoning sacrifice, the constant warfare between good and evil and the final triumph of the former, the immortality of the soul, the last judgment, the resurrection of the flesh and the fiery destruction of the universe—are some of the resemblances which, whether real or only apparent, enabled Mithraism to prolong its resistance to Christianity. At their root lay a common Eastern origin rather than any borrowing.

Neither these resemblances, many of which can be found in all the mystery cults, nor the approach made by Mithraism to becoming a universal religion, should be exaggerated. As regards the latter, it could never have been really universal, for it apparently quite excluded women; also, it was a compromise with polytheism, and, as such, weaker than its uncompromising rival. Moreover, like all the other mystery-cults, it had as its central figure a mythical, not a historical personage. Many elements of it passed into Manichaeism, which seems to have provided a half-way house for those who were not prepared to accept the Christian theology in its entirety.

BIBLIOGRAPHY.—Chief work, F. Cumont, *Texts et Monuments figurés relatifs aux Mystères de Mithra*, 2 vols. (Brussels, 1896, 1899, bibliography). Shorter works by same author, art. MITHRAS in Roscher's *Lexikon; Les religions orientales dans le paganisme romain* (1907).

MITOSIS, a process of nuclear division. *See* CYTOLOGY.

MITRA, RAJENDRA LALA (1824–1891), Indian Orientalist, was born in a suburb of Calcutta on Feb. 15, 1824, of a respectable family of the Kayasth or writer caste of Bengal. In 1846 he was appointed librarian of the Asiatic Society, and to that society the remainder of his life was devoted—as philological secretary, as vice-president, and as the first Indian president in 1885 Apart from very numerous contributions to the society's journal, and to the series of Sanskrit texts entitled "Bibliotheca indica," he published three separate works: (1) *The Antiquities of Orissa* (2 vols., 1875 and 1880), illustrated with photographic plates, in which he traced back the image of Jagannath (Juggernaut) and also the car-festival to a Buddhistic origin; (2) a similarly illustrated work on *Bodh Gaya* (1878), the hermitage of Sakya Muni, and (3) *Indo-Aryans* (2 vols., 1881), a collection of essays dealing with the manners and customs of the people of India from Vedic times. He received the honorary degree of LL.D. from the University of Calcutta in 1875, the companionship of the Indian Empire when that order was founded in 1878, and the title of raja in 1888. He died at Calcutta on July 26, 1891.

MITRE, BARTOLOMÉ (1821–1906), Argentine statesman, soldier, author, journalist and president of the republic, was born in Buenos Aires on July 26, 1821, the son of an Argentine army officer. While still a youth his political views caused him to seek refuge in Montevideo, and he spent the next 15 years in exile, serving in the sieges of Montevideo in 1838 and 1843–46 as captain and lieutenant-colonel, commanding the government artillery in Bolivia, 1847–48, and editing *El Mercurio* in Valparaiso, Chile, 1848–49, until his opposition to the government compelled him to leave that country. In 1852 he returned to Argentina and commanded the Uruguayan artillery in the battle of Monte Caseros (Feb. 3, 1852) where Gen. Urquiza overthrew the dictator Rosas. Elected deputy to the provincial legislature of Buenos Aires, he led the opposition to Urquiza's Federal plan of Government, was appointed provincial minister of war in 1853 and in 1860 governor of the province. In 1859 the estrangement between Buenos Aires and the Confederation resulted in war. Mitre, commanding the provincial forces, was beaten in the battle of Cépeda (Oct. 22, 1859) and Buenos Aires was incorporated into the confederation, but in 1861 he defeated Urquiza in the battle of Pavón (Sept. 17), definitively establishing the hegemony of Buenos Aires; and after a short period as president *ad interim*, he became constitutional president on Oct 7, 1862. Under his leadership Argentina made great progress. He impressed the authority of the national government upon the provincial *caudillos*, reorganized the finances, improved international relations and fostered public works, means of communication, immigration and industries. When, in 1865, Argentina joined Brazil and Uruguay in the War of the Triple Alliance against Paraguay (1865–70), Mitre, now a general, was for a time in command of the allied troops. Soon after the conclusion of his presidential term in 1868, he was elected to the senate, and in 1872–73 filled a special diplomatic mission to Brazil and Paraguay. A candidate for the presidency in 1874, upon his defeat he headed an unsuccessful revolt, but he continued to have great political influence and in 1891 was a third time candidate for the presidency; he withdrew his name, however, and not long afterwards retired from political life. He died in Buenos Aires on Jan. 18, 1906.

Mitre's activities were never restricted to those of soldier and statesman. Aside from his journalistic career, which included the ownership of *La Nación*, one of the most important newspapers in Spanish-America, his contributions to philology and history proved him one of the outstanding intellectual men of the continent. His works include: *Rimas* (Paris, 1854); *Historia de Belgrano* (Buenos Aires, 1887); *Historia de San Martin* (Buenos Aires, 1890); *Lenguas americanas* (La Plata, 1894). His private library, at the time the finest in Spanish-America, he presented as a gift to the State.

See J. Victorica, *Urquiza y Mitre* (B.A., 1906); *Enciclopedia Universal Ilustrada* (Barcelona, 1917?); R. Bazán de Cámara, *Estudio sobre la personalidad del general Mitre* (B.A., 1921); R. Rivarola, *Mitre . . . 1852–62* (B.A., 1921); R. Rojas, *Bartolomé Mitre* (Inter-America, Eng. ed. Dec. 1921, Feb. 1922). (W. B. P.)

MITRE, a liturgical head-dress of the historic churches, generally proper to bishops. The word is derived through the Latin from the Greek μίτρα, a head-band or head-dress.

In the Roman Catholic Church its actual form is that of a sort of folding cap consisting of two halves which, when not worn, lie flat upon each other. These sides are stiffened, and when the mitre is worn, they rise in front and behind like two horns pointed at the tips. From the lower rim of the mitre at the back hang two bands (*infulae*), terminating in fringes. In the Roman Catholic Church mitres are divided into three classes: (1) *Mitra pretiosa,* decorated with jewels, gold plates, etc.; (2) *Mitra auriphrygiata,* of white silk, sometimes embroidered with gold and silver thread or small pearls, or of cloth of gold plain; (3) *Mitra simplex,* of white silk damask, silk or linen, with the two falling bands behind terminating in red fringes. Mitres are the distinctive head-dress of bishops; but the right to wear them, as in the case of the other episcopal insignia, is granted by the popes to other dignitaries. Bishops alone, including of course the pope and his cardinals, are entitled to wear the *pretiosa* and *auriphrygiata;* the others wear the *mitra simplex.*

Origin and Antiquity.—The origin and antiquity of the episcopal mitre have been the subject of much debate. Some have

claimed for it apostolical sanction and found its origin in the liturgical head-gear of the Jewish priesthood. Such proofs as have been adduced for this view are, however, based on reading a special meaning into words (*mitra, infula,* etc.) used by early writers. With the episcopal mitre the Jewish *miznephet,* translated "mitre" in the King James Version (Exod. xxviii. 4,36), has nothing to do, and there is no evidence for the use of the former before the middle of the 10th century even in Rome, while elsewhere it does not make its appearance until the 11th.

The first trustworthy notice of its use is under Pope Leo IX. (1049–54). This pope invested Archbishop Eberhard of Trier, who had accompanied him to Rome, with the Roman *mitra,* telling him that he and his successors should wear it *in ecclesiastico officio* (*i.e.,* as a liturgical ornament) according to Roman custom, in order to remind him that he is a disciple of the Roman see (Jaffé, *Regesta pont. rom.,* ed. Leipzig, 1888, No. 4158).

From Leo IX.'s time papal grants of the mitre to eminent prelates became increasingly frequent, and by the 12th century it had been assumed by all bishops in the west, with or without papal sanction, as their proper liturgical head-dress. From the 12th century, too, dates the custom of investing the bishop with the mitre at his consecration.

It was not till the 12th century that the mitre came to be regarded as specifically episcopal, and meanwhile the custom had grown up of granting it *honoris causa* to other dignitaries besides bishops. (*See* ABBOT.)

Mitres were also sometimes bestowed by the popes on secular sovereigns. In the coronation of the emperor, more particularly, the mitre played a part. According to the 14th Roman *ordo,* of 1241, the pope places on the emperor's head first the *mitra clericalis,* then the imperial diadem.

Development of Form.—The original form of the mitre was that of the early papal tiara (*regnum*), *i.e.,* a somewhat high conical cap. The stages of its general development from this shape to the high double-horned modern mitre are clearly traceable though it is impossible exactly to distinguish them in point of date. The most characteristic modifications may be said to have taken place from the 11th to the middle of the 13th century. About 1100 the conical mitre begins to give place to a round one; a band of embroidery is next set over the top from back to front, which tends to bulge up the soft material on either side; and these bulges develop into points or horns. Mitres with horns on either side seem to have been worn till the end of the 12th century. The custom was, however, already growing up of setting horns over the front and back of the head instead of the sides, and with this the essential character of the mitre during the middle ages, was established.

In most of the reformed churches the use of mitres was abandoned with that of the other vestments. They have continued to be worn, however, by the bishops of the Scandinavian Lutheran churches. In the Church of England the liturgical use of the mitre was discontinued at the Reformation, but was revived in the latter part of the 19th century, and is now fairly widespread.

In the Orthodox Eastern Church the mitre is proper only to bishops. Its form differs entirely from that of the Latin Church. In general it rather resembles a closed crown, surmounted by a cross. In Russia the cross usually lies flat, only certain metropolitans, and by prescription the bishops of the eparchy of Kiev, having the right to have the cross upright. In the Armenian Church priests and archdeacons, as well as the bishops, wear a mitre. That of the bishops is of the Latin form, a custom dating from a grant of Pope Innocent III.; that of the priests, the *sagvahart,* is not unlike the Greek mitre. In the Syrian Church only the patriarch wears a mitre, which resembles that of the Greeks. The *biruna* of the Chaldaean Nestorians, on the other hand, worn by all bishops, is a sort of hood ornamented with a cross. Coptic priests and bishops wear the *ballin,* a long strip of stuff ornamented with crosses, etc., and wound turban-wise round the head; the patriarch of Alexandria has a helmet-like mitre, the origin of which is unknown, though it perhaps antedates the appearance of the *phrygium* at Rome. The Maronites, and the uniate Jacobites, Chaldaeans and Copts have adopted the Roman mitre.

The mitre was introduced into the Greek rite only after the capture of Constantinople by the Turks (1453).

See J. Braun, S.J., *Die liturgische Gewandung,* pp. 424–498 (1907). The question of the use of the mitre in the Anglican Church is dealt with in the *Report of the Sub-committee of the Convocation of Canterbury on the Ornaments of the Church and its Ministers* (1908). *See* also the bibliography to the article VESTMENTS.

MITROVICA, a town of Croatia Slavonia, Yugoslavia. Pop. (1921) 11,848. It is a flourishing river port, and one of the principal markets of Croatia Slavonia for pigs and sheep, for which three fairs are held annually. Cattle and horses are also reared. Mitrovica occupies the site of Sirmium, the chief city of Lower Pannonia, and many Roman remains have been discovered. The emperor Probus (232–282) was born and buried at Sirmium, where according to some authorities the emperor Marcus Aurelius (121–180) also died. It became an episcopal see about 305, and was united with the diocese of Bosnia in 1773. The city was sacked by the Huns in 441, and by the Turks, who destroyed all its ancient buildings, in 1396 and 1521.

MITSCHERLICH, EILHARDT (1794–1863), German chemist, was born on Jan. 7, 1794 at Neuende near Jever, Oldenburg, where his father was pastor. He was educated at Jever and went to Heidelberg in 1811; he devoted himself to philology, and gave special attention to the Persian language. Mitscherlich resolved to study medicine in order that he might enjoy that freedom of travel usually allowed in the East to physicians. He began at Göttingen with the study of chemistry, and this so arrested his attention that he gave up the idea of a journey to Persia. From his Göttingen days dates the treatise on certain parts of Persian history, compiled from mss. in the university library and published in Persian and Latin in 1814, under the title *Mirchondi historia Thaheridarum historicis nostris huiusque incognitorum Persiae principum.* In 1818 he went to Berlin and worked in the laboratory of H. F. Link (1767–1851). There he made analyses of phosphates and phosphites, arsenates and arsenites, confirming the conclusions of J. J. Berzelius as to their composition; bis observation that corresponding phosphates and arsenates crystallize in the same form was the germ from which grew the important theory of isomorphism which he communicated to the Berlin academy in Dec. 1819. Shortly afterwards he went to Stockholm and studied under Berzelius; he returned to Berlin in 1821, and in the summer of 1822 he delivered his first lecture as extraordinary professor of chemistry in the university, where in 1825 he was appointed ordinary professor. He died at Schönberg, near Berlin, on Aug. 28, 1863.

In the course of Mitscherlich's crystallographic investigations he observed that the rhombohedral angles in the case of calcspar varied with the temperature, and that crystals, when heated expand unequally in the direction of dissimilar axes. His investigation (also in 1826) of the two crystalline modifications of sulphur brought to light the fact that certain substances could exist in different crystalline forms, a property which Mitscherlich called dimorphism. He obtained selenic acid in 1827 and showed that its salts are isomorphous with the sulphates, while a few years later he proved that the same thing is true of the manganates and the sulphates, and of the permanganates and the perchlorates. He prepared benzene sulphonic acid (1833), nitrobenzene (1834) and investigated the relation of benzene to benzoic acid and to other derivatives (1835). In 1829–30 he published his *Lehrbuch der Chemie,* which embodied many original observations. His interest in mineralogy led him to study the geology of volcanic regions, and he tried to devise a theory of volcanic action. He did not, however, publish any papers on the subject, though after his death his notes were arranged and published by Dr. J. L. A. Roth in the *Memoirs* of the Berlin Academy (1866).

Mitscherlich's published papers are chiefly to be found in the *Abhandlungen* of the Berlin academy; in the *Annalen der Physik und Chemie* (ed. J. C. Puggendorf, Halle, 1790, etc.); and in the *Annales de chimie et de physique* (1816, etc.). The 4th edition of the *Lehrbuch der Chemie* was published in 1844–47, a 5th was begun in 1855 but was not completed. His *Gesammelte Schriften* were edited by A. Mitscherlich in 1896, who also published *Erinnerung von Eilhardt Mitscherlich* (1894). *See* also A. D. von Hofmann, *Chemische Erinnerungen* (1882).

MITTAG-LEFFLER, MAGNUS GÖSTA (1846–1927), Swedish mathematician, was born at Stockholm on March 16, 1846. He studied at Uppsala and later became lecturer at the University of Uppsala (1872–77), professor at Helsingfors (1877–81), and finally professor at Stockholm, being rector of the University in 1886, 1891 and in 1893. Mittag-Leffler found the *Acta Mathematica* in 1883, set up an editorial staff from the four Scandinavian countries, gained the patronage of Oscar II. of Sweden, and acted as chief editor for 45 years. This journal was international. As a mathematician, Mittag-Leffler made a number of contributions to analysis. He worked on the general theory of functions and gave a proof of Cauchy's theorem. He also dealt with the problem of the analytic representation of a one-valued function; in connection with this there is the well known Mittag-Leffler theorem. A good deal of his researches laid the foundation of later work by other mathematicians. Mittag-Leffler was the recipient of numerous honours both at home and abroad and was an honorary member of many societies. He died at Stockholm on July 7, 1927.

See notice by Nörlund in *Acta Mathematica.*

MITTWEIDA, a town of Germany in the republic of Saxony, on the Zschopau, 12 m. by rail N. of Chemnitz on the railway to Döbeln and Riesa. Pop. (1925) 19,278. It has cotton spinning and weaving mills. Other industries are the making of furniture, machinery, cigars and leather.

MIVART, ST. GEORGE JACKSON (1827–1900), English biologist, was born on Nov. 30, 1827, in London. In 1851 he was called to the bar, but devoting himself to scientific studies, he was appointed lecturer at St. Mary's Hospital medical school in 1862, and from 1874 to 1877 was professor of biology at the short-lived Catholic University College, London. In 1871 his *Genesis of Species* brought him into the controversy then raging round the theories of Darwin, and ultimately led to his estrangement from both Darwin and Huxley. Though admitting evolution in general, Mivart emphasized the distinction between organic and inorganic matter, minimized the importance of natural selection, and, especially in his *Nature and Thought* (1882) and his *Origin of Human Reason* (1889), denied the evolution of the human intellect. Some articles published in the *Nineteenth Century,* while he was professor of the philosophy of natural history at Louvain, advocated the claims of science even where they seemed to conflict with religion, and were placed on the *Index.* Other articles in January 1900 led to his excommunication by Cardinal Vaughan, with whom he had a curious correspondence vindicating his claim to hold liberal opinions while remaining a Catholic. Shortly afterwards he died, in London, on April 1, 1900.

Besides the above named works, Mivart wrote: *Lessons in Elementary Anatomy* (1873), *Man and Apes* (1873), *The Common Frog* (1874) and *The Cat: an Introduction to the Study of Back-boned Animals* (1881)—all of which exhibit his scientific powers. A complete list of his publications is in the *Dict. Nat. Biog.*

MIXE-ZOQUE, a stock of Mexican Indians, in the region of the Isthmus of Tehuantepec, between long. 92° and 96°, nowhere reaching the sea. The Mixe are to the west, the Zoque to the east. The two languages are related, but seem distinct from Zapotecan, Nahuan and Maya. Mixe and Zoque were regarded as sturdy but backward people by their ancient neighbors. The Popoloco of Puebla and Tapachula of the Guatamalan frontier seem to belong to them linguistically. The 1895 census enumerated 28,000 Mixe and 12,000 Zoque.

MIXTEC, a people occupying much of the western half of the State of Oaxaca, Mexico. With the Zapotec and several smaller groups, they are considered to form the Zapotecan linguistic family. They participated to some degree in the higher civilization of ancient Mexico, and made fine polychrome pottery. They were conquered by the Aztecs. In 1895, 146,000 Indians spoke Mixtec.

MIXTURES, PROPERTIES OF: *see* CHEMISTRY.

MIZPAH. There are several places of this name in the Old Testament. (1) Mizpah of Gilead, where Jacob was reconciled to Laban, and Jepthah encamped before attacking the Ammonites. It is supposed to be identical with Ramoth Gilead. (2) Mizpah of Benjamin, where the Hebrews assembled preliminary to the annihilation of the Benjamites (Judges xx., 1); Samuel made it his headquarters (1 Sam. vii., 5). Fortified by Asa it became the seat of the viceroy Gedaliah and the scene of his murder. Although recently an identification with Tell-en-Nasbeh has been suggested, Nebi Samwil is the traditional and generally accepted site. A crusaders' church (1151), later converted into a mosque, is built over the traditional tomb of Samuel. It was destroyed by the shelling of the Turkish army in their efforts to drive from it the British troops (Nov. 27–30, 1917). (3) A territory near Mt. Hermon (Josh. xi., 3). (4) A town in the tribe of Judah (Josh. xv., 38). (5) Mizpah of Moab, where David interviewed the king of Moab and found a place of refuge for his parents (1 Sam. xxii., 3).

See W. J. Phythian-Adams, "The Mizpah of 1 Sam. vii., 5"; *Journ. Pal. Orient. Soc.* 3 (1923) 13 *seq.* (=Tell-en-Nasbeh); W. F. Albright. "The Site of Mizpah in Benjamin": *Revue Biblique* 33 (1924) 637 *seq.* (Nebi Samwil).

MIZRAIM, the biblical name for Egypt (Gen. x. 6, 13). The apparently dual termination (Heb. *Miṣrayim*) may be due to a misunderstanding or may refer to Upper and Lower Egypt as two entities in one. There is an alternative poetical form Māṣōr (2 Ki. xix. 24, etc.). In Isa. xi. 11 the name is distinct from Pathros or Upper Egypt, and includes some of Lower Egypt.

But C. T. Beke, as long ago as 1834, in his *Origines biblicae* concluded that "Egypt" in the Old Testament sometimes denotes a district near Midian and the Gulf of 'Akaba; and this view restated quite independently by Hugo Winckler on later evidence (1893) has been the subject of continued debate. Egypt is known to have laid claim to the southern half of Palestine from early times, and consequently the extension of the name of Egypt beyond the limits of Egypt is inherently probable (so especially Ezek. xx. 36). For example, Hagar, as the ancestress of Ishmaelite tribes, may not have been an "Egyptian" in the strict ethnical sense. Besides this Mizraim the Old Testament knows of another. In 1874 E. Schrader pointed out that the Assyrians locate a Muṣri (*i.e.,* Mizraim) to the north of Palestine and this land presumably is referred to in 2 Ki. vii. 6 (mentioned with the Hittites), and again in 1 Ki. x. 28 *seq.,* 2 Chron. i. 16 *seq.,* where the word for "droves" (Heb. *m-ḳ-v-h*) conceals the land of Kuë (Cilicia). The situation of this Muṣri is disputed, some authorities even placing it east of the Tigris.

MLADÁ BOLESLAV, a beautiful old town in Bohemia, Czechoslovakia, on the Jizera, a right-bank tributary of the Elbe, dating from the 10th century. Its old walls and towers harmonize with a picturesque setting but nevertheless the town is a brisk centre of trade and an important railway junction with sugar refineries and soap and candle factories. It has many fine old ecclesiastical buildings, some of them with a history closely associated with the Bohemian Brethren for whom the town was the metropolis; the tomb of Johann August, the celebrated bishop of their Order is in the Church of St. Maria. Pop. (1921) 17,237.

MNEMONICS, the general name applied to devices for aiding the memory. Such devices are also described as *memoria technica.* The principle is to enable the mind to reproduce a relatively unfamiliar idea, and specially a series of dissociated ideas, by connecting it, or them, in some artificial whole, the parts of which are mutually suggestive. Among the most famous examples of metrical mnemonics are the "gender rhymes" of the Latin grammars, the hexameter lines (especially that beginning "Barbara Celarent") invented by logicians (for a list *see* Baldwin's *Dict. of Philos.,* vol. ii., s.v. "Mnemonic Verses"), the verse for remembering the number of days in the months ("Thirty days hath September, April, June and November"). Other devices are numerous.

Systems.—Mnemonic devices were much cultivated by Greek sophists and philosophers, and are repeatedly referred to by Plato and Aristotle. In later times the invention was ascribed to the poet Simonides, perhaps for no other reason than that the strength of his memory was famous. Cicero, who attaches considerable importance to the art, but more to the principle of order as the best help to memory, speaks of Carneades (or perhaps Char-

mades) of Athens and Metrodorus of Scepsis as distinguished examples of the use of well-ordered images to aid the memory. The Romans valued such helps as giving facility in public speaking. The method used is described by the author of *Rhet. ad Heren.*, iii. 16–24; *see* also Quintilian (*Inst. Or.* xi. 2), whose account is, however, obscure. In his time the art had almost ceased to be practised. The Greek and Roman system of mnemonics was founded on the use of mental places and signs or pictures, known as "topical" mnemonics. The most usual method was to choose a large house, of which the apartments, walls, windows, statues, furniture, etc., were severally associated with certain names, phrases, events or ideas, by means of symbolic pictures; and to recall these it was only necessary to search over the apartments of the house till the particular place was discovered where they had been deposited by the imagination. In accordance with this system, if it were desired to fix an historic date in the memory, it was localized in an imaginary town divided into a certain number of districts, each with ten houses, each house with ten rooms, and each room with a hundred quadrates or memory-places, partly on the floor, partly on the four walls, partly on the roof. Thus, if it were desired to fix in the memory the date of the invention of printing (1436), an imaginary book, or some other symbol of printing, would be placed in the thirty-sixth quadrate or memory-place of the fourth room of the first house of the historic district of the town. Except that the rules of mnemonics are referred to by Martianus Capella, nothing further is known regarding the practice of the art until the 13th century. Among the voluminous writings of Roger Bacon is a tractate *De arte memorativa.* Raimon Lull devoted special attention to mnemonics in connection with his *ars generalis.* The first important modification of the method of the Romans was that invented by the German poet Konrad Celtes, who, in his *Epitoma in utramque Ciceronis rhetoricam cum arte memorativa nova* (1492), instead of places made use of the letters of the alphabet. About the end of the 15th century Petrus de Ravenna (b. 1448) awakened such astonishment in Italy by his mnemonic feats that he was believed by many to be a necromancer. His *Phoenix artis memoriae* (Venice, 1491, 4 vols.) went through as many as nine editions, the seventh appearing at Cologne in 1608. An impression equally great was produced about the end of the 16th century by Lambert Schenkel (*Gazophylacium,* 1610), who taught mnemonics in France, Italy and Germany, and, although he was denounced as a sorcerer by the university of Louvain, published in 1593 his tractate *De memoria* at Douai with the sanction of that celebrated theological faculty. The most complete account of his system is given in two works by his pupil Martin Sommer, published at Venice in 1619. In 1618 John Willis (d. 1628?) published *Mnemonica; sive ars reminiscendi* (Eng. version by Leonard Sowersby, 1661; extracts in Feinaigle's *New Art of Memory,* 3rd ed., 1813), containing a clear statement of the principles of topical or local mnemonics. Giordano Bruno, in connection with his exposition of the *ars generalis* of Lull, included a *memoria technica* in his treatise *De umbris idearum.* Other writers of this period are the Florentine Publicius (1482); Johann Romberch (1533); Hieronimo Morafiot, *Ars memoriae* (1602); B. Porta, *Ars reminiscendi* (1602).

In 1648 Stanislaus Mink von Wenussheim or Winckelmann made known what he called the "most fertile secret" in mnemonics —namely, the use of consonants for figures, so as to express numbers by words (vowels being added as required); and the philosopher Leibnitz adopted an alphabet very similar to that of Winckelmann in connection with his scheme for a form of writing common to all languages. Winckelmann's method, which in fact is adopted with slight changes by the majority of subsequent "original" systems, was modified and supplemented in regard to many details by Richard Grey (1694–1771), who published a *Memoria technica* in 1730. The principal part of Grey's method (which may be compared with the Jewish system by which letters also stand for numerals, and therefore words for dates) is briefly this: "To remember anything in history, chronology, geography, etc., a word is formed, the beginning whereof, being the first syllable or syllables of the thing sought, does, by frequent repetition, of course draw after it the latter part, which is so contrived as to give the answer. Thus, in history, the Deluge happened in the year before Christ two thousand three hundred forty-eight; this is signified by the word Del-*etok,* Del standing for Deluge and *etok* for 2348." To assist in retaining the mnemonical words in the memory they were formed into memorial lines, which, however, being composed of strange words in difficult hexameter scansion, are by no means easy to memorize. The vowel or consonant, which Grey connected with a particular figure, was chosen arbitrarily; but in 1806 Gregor von Feinaigle, a German monk from Salem near Constance, began in Paris to expound a system of mnemonics, one feature (based on Winckelmann's system) of which was to represent the numerical figures by letters chosen on account of some similarity to the figure to be represented or some accidental connection with it. This alphabet was supplemented by a complicated system of localities and signs. Feinaigle, who apparently published nothing himself, came to England in 1811, and in the following year one of his pupils published *The New Art of Memory,* which, beside giving Feinaigle's system, contains valuable historical material about previous systems. A simplified form of Feinaigle's method was published by Aimé Paris (*Principes et applications diverses de la mnémonique,* 7th ed., Paris, 1834), and the use of symbolic pictures was revived in connection with the latter by a Pole, Antoni Jaźwiński, of whose system an account was published by the Polish general J. Bem, under the title *Exposé général de la méthode mnémonique polonaise, perfectionnée à Paris* (Paris, 1839). Various other modifications of the systems of Feinaigle and Aimé Paris were advocated by subsequent mnemonists, among them being the *Phrenotypics* of Major Beniowsky, a Polish refugee, the *Phreno-Mnemotechny* (1845) of François Fauvel Gouraud, the *Mnemotechnik* of Karl Otto Reventlow (generally known as Karl Otto), a Dane, and the *Mnemotechny* of the American Pliny Miles.

The more complicated mnemonic systems have fallen almost into complete disuse; but methods founded chiefly on the so-called laws of association (*see* Association of Ideas) have been taught with some success in Germany by, among others, Hermann Kothe, author of *Lehrbuch der Mnemonik* (2nd ed., Hamburg, 1852), and *Katechismus der Gedächtnisskunst* (6th ed. by Montag, Leipzig, 1887); and Hugo Weber-Rumpe, author of *Mnemonische Zahlwörterbuch* (Breslau, 1885) and *Mnemonische Unterrichtsbriefe* (1887–1888); in England by Dr. Edward Pick, whose *Memory and the Rational Means of Improving it* (5th ed., 1873) and *Lectures on Memory Culture* (1899) obtained a wide circulation. Passing over the work of William Day (*New Mnemonical Chart and Guide to the Art of Memory,* 1845), Rev. T. Brayshaw (*Metrical Mnemonics,* a very rare work), Fairchild and W. Stokes, the next name of any importance is the Rev. J. H. Bacon, a pupil of Edward Pick. His book (*A Complete Guide to the Improvement of the Memory,* 3rd ed., rev. 1890) contains a good summary of the history of mnemonics and a very reasonable account of the principles; it gains in value by its comparative simplicity. More or less successful systems were issued by Lyon Williams (1866), T. Maclaren (1866), Thomas A. Sayer (1867), Rev. Alexander Mackay (1869), George Crowther (1870), F. Appleby (1880), John Sambrook, who made use of similarities in sounds (gun, 1; Jew, 2), the French scientist Abbé Moigno, J. H. Noble and Allan Dalzell. Considerable interest was roused both in London and in America by the controversy which raged round the system of "Alphonse Loisette," who taught his "art of never forgetting" successively in London and Washington. It claimed to be original in system, but was attacked in England by F. Appleby and in America by George S. Fellows, and is generally regarded as both unoriginal and inferior on the whole to preceding systems (for the litigation in America see *e.g.,* Part II. of Middleton's *Memory Systems,* pp. 96 *sqq.*). An interesting work (*Memoranda mnemonica*) was published by James Copner in 1893, containing a system based partly on the use of letters for figures and words for dates, as well as a large number of rhymes for remembering facts in biblical, Roman, Greek and English history. He made use of Grey's system, but endeavoured as far as possible to invent, where necessary, words and terminations

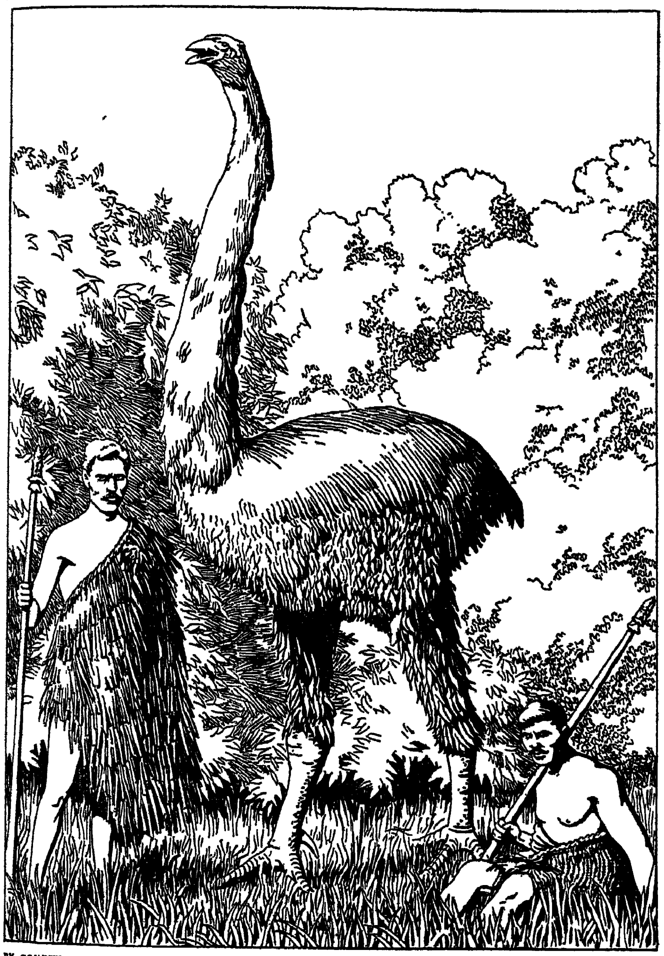
which in themselves had some special fitness in place of Grey's monstrosities. More complicated systems are the *Keesing Memory System* (Auckland, 1896), the Smith-Watson *System of Memory and Mental Training* (Washington), and the Pelman memory system.

Bibliography.—A large number of the works referred to in the text contain historical material. Among histories of the subject, see C. F. von Aretin, *Systematische Anleitung zur Theorie und Praxis der Mnemonik* (Sulzberg, 1810); A. E. Middleton, *Memory Systems, Old and New* (espec. 3rd rev. ed., New York, 1888), with bibliography of works from 1325 to 1888 by G. S. Fellows and account of the Loisette litigation; F. W Colegrove, *Memory* (1901), with bibliography, pp. 353–361. (J. M. M.)

MNESICLES, the architect of the great Propylaea of the Athenian Acropolis, set up by Pericles about 437 B.C.

MOA, the Maori name of the extinct Ratite birds, comprising the New Zealand group *Dinornithes* (*see* Bird and Ratitae). In the North Island the moas seem to have died out some 500–700 years ago, soon after the arrival of the Maoris. In South Island they lingered much longer, possibly even down to the time that Captain Cook visited New Zealand. Numerous bones have been found in caves and swamps.

The wings and shoulder-girdle, except for a few vestiges in one species (*Anomalopteryx dromaeoides*), had entirely disappeared.



BY COURTESY OF THE NEW ZEALAND HIGH COMMISSIONER

THE MOA (DINORNIS MAXIMUS), NOW EXTINCT, RECONSTRUCTED TO SHOW ABSENCE OF WINGS AND GREAT SIZE COMPARED WITH A MAORI WARRIOR, NEW ZEALAND

There is no trace of a keel on the sternum. The hind limbs were very strong and ended in four toes. The bill was short and stout and the feathers had a large after-shaft. The moas varied from the 12ft. high *Dinornis maximus* to the size of a turkey. Their affinities are with the Australian Ratites, especially with the kiwis. Moas are known only as far back as the Pliocene, and seem to have been herbivorous.

MOAB, the name of an ancient people of Palestine who inhabited a district east of the Jordan and the Dead sea, lying north of Edom and south of Ammon (*q.v.*). The national traditions of the Israelites (*see* Jews) recognize a close relationship between Moab and Ammon, "sons" of Lot, and the "brothers" Esau (Edom) and Jacob (Israel), and Moab is represented as already a powerful people when Israel fled from Egypt (Exod. xv. 15). It was supposed that Moab, having expelled the aboriginal giants, was in turn displaced by the Amorite king Sihon, who forced Moab south of the Arnon (Wadi Mōjib, a natural boundary) and drove Ammon beyond the Jabbok. The Israelites at Kadesh, almost at the gate of the promised land, incurred the wrath of Yahweh, and, deterred by a defeat at Hormah from pursuing their journey northwards, chose another route (Num. xiv. 40–45; contrast xxi. 1–3). A great detour was made round by the south of Edom (Num. xiv. 25, xxi. 4; Judges xi. 18), and the people reached Pisgah in Moab (Num. xxi. 16–20; *cf.* Deut. iii. 27, xxxiv. 1), or, according to another view, passed outside Moab until they reached the border of Sihon's kingdom (Num. xxi. 13, 26; Judges xi. 17 *seq.*). The late list in Num. xxxiii. even seems to assume that the journey was made from Kadesh across the northern end of Edom. Apparently no fixed or distinct tradition existed regarding the journeys; and it is extremely probable that some of the most characteristic features of the narratives belong to much later periods than the latter half of the second millennium B.C., the age to which they are ascribed (*e.g.*, the poem on the fall of Heshbon, Num. xxi. 27–30).

The history of the "brothers" Moab and Ammon was bound up with that of Judah and Israel respectively and depended, to a considerable extent, upon these two and their mutual relations. Jephthah (*q.v.*), one of the Israelite "judges," delivered Gilead from Ammon, who resumed the attack under its king Nahash, only to be repulsed by Saul (*q.v.*). Ehud (*q.v.*) of Benjamin or Ephraim freed Israel from the Moabite oppression. To the first great kings, Saul and David, are ascribed conquests over Moab, Ammon, and Edom. The Judaean David, for his part, sought to cultivate friendly relations with Ammon, and tradition connects him closely with Moab. His son Solomon contracted marriages with women of both states (1 Kings xi. 5, 7), thus introducing into Jerusalem cults which were not put down until almost at the close of the monarchy (2 Kings xxiii. 13). In the 9th century B.C. the two states appear in a more historical light, thanks to the Assyrian records and a lengthy Moabite inscription.

This latter inscription, now in the Louvre, was found at Dhībān, the biblical Dībōn, in 1868. It contains a record of the successes gained by the Moabite king Mesha against Israel. Omri (*q.v.*) had previously seized a number of Moabite cities north of the Arnon, and for 40 years the Moabite national god Chemosh was angry with his land. At length he roused Mesha; and Moab, which had evidently retreated southwards towards Edom, now began to take reprisals. "The men of Gad had dwelt in the land of Ataroth from of old; and the king of Israel built Ataroth for himself." Mesha took the city, slew its people in honour of Chemosh, and dragged before the god the altar-hearth (or the priests?) of D-v-d-h (apparently a divine name, but curiously similar to David). Chemosh next roused Mesha against the city of Nebo. It fell with its thousands, for the king had "devoted" it to the deity ʿAshtar-Chemosh. Yahweh had been worshipped there, and his . . . (?vessels, or perhaps the same doubtful word as above) were dragged before the victorious Chemosh. With the help of these and other victories (at Jahaz, Aroer, etc.), Moab recovered its territory, fortified its cities, supplied them with cisterns, and Mesha built a great sanctuary to his god. The inscription enumerates many places known elsewhere. (Isa. xv.; Jer. xlviii.), but, although it mentions the "men of Gad," makes no allusion to the Israelite tribe Reuben, whose seat lay in the district (Num. xxxii.; Josh. xiii. 15–23; *see* Reuben). The revolt will have followed Ahab's death (*see* 2 Kings i. 1) and apparently led to the unsuccessful attempt by Jehoram to recover the lost ground (*ibid.* iii.).

Moab thus retained its independence, even harrying Israel with marauding bands (2 Kings xiii. 20), while Ammon was perpetrating cruelties upon Gilead (Am. i. 13 *sqq.*). But under Jeroboam II. (*q.v.*) Israelite territory was extended to the Wadi of the ʿArabah or wilderness (probably south end of the Dead sea), and

again Moab suffered. If Isa. xv. *seq.* is to be referred to this age, its people fled southwards and appealed for protection to the overlord of Edom (*see* Uzziah). During the Assyrian supremacy its king Salamannu paid tribute to Tiglath-Pileser III., but joined the short-lived revolt with Judah and Philistia in 712. When Sennacherib besieged Jerusalem in 700, Kamus (Chemosh)-nadab also submitted; and subsequently both Esarhaddon and Assur-bani-pal received tribute from the Moabite king Muṣuri ("the Egyptian"). During the reign of Assur-bani-pal Moab helped to repulse the invasion of the Nabayati and nomads of Kedar, a movement which made itself felt from Edom nearly as far as Damascus. It had its root in the revolt of Shamash-shum-ukin of Babylonia, and, coming at a time immediately preceding the disintegration of the Assyrian empire, had important consequences for Judah and the east of the Jordan.

Later, Moab joined the coalition against Babylonia (Jer. xxvii. 3), and if it is condemned for its joy at the fall of Jerusalem (Isa. xxv. 9 *seq.;* Jer. xlviii.; Ezek. xxv. 8–11; Zeph. ii. 8–10), it harboured fugitive Jews (Jer. xl. 11): the dates of the most significant passages are unfortunately uncertain. If Sanballat the Horonite was really a native of the Moabite Horonaim, he finds an appropriate place by the side of Tobiah the Ammonite and Gashmu the Arabian among the strenuous opponents of Nehemiah. Still later we find Moab part of the province of Arabia in the hands of fresh tribes from the Arabian desert (Jos. *Ant.* xiii. 13, 5); and, with the loss of its former independent power, the name survives merely as a type (Dan. xi. 41).

As Mesha's inscription proves, Moab had reached a high state of civilization by the 9th century B.C. Its language differed only dialectically from Hebrew; its religion and culture were very closely akin to the Israelite. The relation of Chemosh, the national god, to his "children" (Num. xxi. 29) was that of Yahweh to Israel (Judges xi. 24). Apart from the religious cult suggested in the name Mount Nebo, there were local cults of the Baal of Peor and the Baal of Meon; and Mesha's allusion to ʻAshtar-Chemosh, a compound deity, has been taken to point to a corresponding consort whose existence might naturally be expected upon other grounds (*see* Astarte). The fertility of Moab, the wealth of wine and corn, the temperate climate, and the enervating heat supply conditions which directed the form of cult. Nature-worship, as in Israel, prevailed, and the impure rites of Shittim and Baal-Peor (Num. xxxi. 16; Ps.cvi. 28) would not materially differ from practices which Israelite prophets condemn. The kinship of Israel with the external states (Moab, Edom, and Ammon) is entirely justified. It extends intermittently throughout the history. But Israel remained a great power while Moab disappeared. It is true that Moab was continuously hard pressed by desert hordes; the exposed condition of the land is emphasized by the chains of ruined forts and castles which even the Romans were compelled to construct. But the explanation is to be found within Israel itself, and especially in the work of the prophets.

Bibliography.—*See* the articles on Moab in Hastings' *Dict. Bible* (W. H. Bennett), *Ency. Bib.* (G. A. Smith and Wellhausen); also the popular description by Libbey and Hoskins, *Jordan Valley and Petra* (1905), and the invaluable works of Brünnow and A. von Domaszewski, *Die Provincia Arabia* (1904–5), and A. Musil, *Arabia Petraea* (1907–08). For the Moabite inscription of Mesha *see* G. A. Cooke *North Semitic Inscriptions* pp. 1–14, and the articles "Mesha" in *Ency. Bib.* (S. R. Driver) and "Moab" in Hastings' *Dict. Bible* (W. H. Bennett). (S. A. C.)

MOʻALLAQĀT (or Muʻallaqāt). *Al-Moʻallaqāt* is the title of a group of seven longish Arabic poems, which have come down to us from the time before Islam. The name signifies "the suspended" (pl.), the traditional explanation being that these poems were hung up by the Arabs on or in the Kaʻba at Mecca. Against this we have the testimony of the grammarian Nāḥḥās (d. A.D. 949), who says in his commentary on the Moʻallaqāt: "As for the assertion that they were hung up in [*sic*] the Kaʻba, it is not known to any of those who have handed down ancient poems." (Ernst Frenkel, *An-Nāḥḥās' Commentar zur Muʻallaqa Imruul-Qais* [Halle, 1876], p. viii.) This cautious scholar is unquestionably right in rejecting a story so utterly unauthenticated.

That a series of long poems was *written* at all at that remote period is improbable in the extreme. Up to a time when the art of writing had become far more general than it was before the spread of Islam, poems were never—or very rarely—written, with the exception, perhaps, of epistles in poetic form. The diffusion of poetry was exclusively committed to *oral* tradition. The legend that the poems were written in gold evidently originated in the name "the golden poems" (literally "the gilded"), a figurative expression for excellence. We may interpret the designation "suspended" on the same principle. It seems to mean those (poems) which have been raised, on account of their value, to a specially honourable position.

The selection of these seven poems can scarcely have been the work of the ancient Arabs at all. It is much more likely that we owe it to some connoisseur of a later date. Now Nāḥḥās says expressly: "The true view of the matter is this: when Ḥammād ar-Rāwiya (Ḥammād the Rhapsodist) saw how little men cared for poetry, he collected these seven pieces, urged people to study them, and said to them: 'These are the [poems] of renown.'" And this agrees with all our other information. Ḥammād (who lived in the first three quarters of the 8th century A.D.) was perhaps of all men the one who knew most Arabic poetry by heart. The recitation of poems was his profession. To such a rhapsodist the task of selection is in every way appropriate; and it may be assumed that he is responsible also for the somewhat fantastic title of "the suspended."

There is another fact which seems to speak in favour of Ḥammād as the compiler of this work. He was a Persian by descent, but a client of the Arab tribe, Bakr ibn Wāil. For this reason, we may suppose, he not only received into the collection a poem of the famous poet Ṭarafa, of the tribe of Bakr, but also that of another Bakrite, Ḥārith, who, though not accounted a bard of the highest rank, had been a prominent chieftain; while his poem could serve as a counterpoise to another also received—the celebrated verses of Ḥārith's contemporary ʻAmr, chief of the Taghlib, the rival brethren of the Bakr. ʻAmr praises the Taghlib in glowing terms: Ḥārith, in a similar vein, extolls the Bakr—ancestors of Ḥammād's patrons. The collection of Ḥammād appears to have consisted of the same seven poems which are found in our modern editions, composed respectively by Amra'al-Qais, Ṭarafa, Zuhair, Labīd, ʻAntara ibn Shaddād, ʻAmr ibn Kulthūm, and Ḥarith ibn Ḥilliza. These are enumerated both by Ibn ʻAbd-Rabbihi, and, on the authority of the older philologists, by Nāḥḥās; and all subsequent commentators seem to follow them. We have, however, evidence of the existence, at a very early period, of a slightly different arrangement. Certainly we cannot now say, on the testimony of the *Jamharat ash'ār al ʻArab*, that two of the most competent ancient authorities on Arabic poetry, Mofaḍḍal (d. *c.* 790) and Abū ʻUbaida (d. A.D. 824, at a great age), had already assigned to the "Seven" (viz. "the seven Moʻallaqāt") a poem each of Nābigha and Aʻshā in place of those of ʻAntara and Ḥārith. For meanwhile it has been discovered that the compiler of the above-mentioned work—who, in order to deceive the reader, issued it under a false name—is absolutely untrustworthy. But the learned Ibn Qotaiba (9th century A.D.), in his book *Of Poetry and Poets,* mentions as belonging to the "Seven" not only the poem of ʻAmr, which has invariably been reckoned among the Moʻallaqāt (ed. de Goeje, p. 120), but also a poem of ʻAbīd ibn Abraṣ (*ibid.* 144). In place of which poem he read this we do not know; and we are equally ignorant as to whether he counted other pieces than those indicated above among the seven.

Now Nābigha and Aʻshā enjoyed greater celebrity than any of the poets represented in the Moʻallaqāt, with the exception of Amra'al-Qais, and it is therefore not surprising that scholars, of a somewhat later date, appended a poem by each of these to the Moʻallaqāt, without intending by this to make them an integral part of that work. This is clear, for instance, from the introductory words of Tībrīzī (d. A.D. 1109) to his commentary on the Moʻallaqāt. Appended to this he gives a commentary to a poem of Nābigha, to one of Aʻshā, and moreover one to that poem of ʻAbīd which, as we have just seen, Ibn Qotaiba had

counted among the seven. It is a pure misunderstanding when Ibn Khaldūn (*loc. cit.*) speaks of *nine* Moʿallaqāt; and we ought hardly to lay any stress on the fact that he mentions not only Nābigha and Aʿshā, but also ʿAlqama, as Moʿallaqa-poets. He was probably led to this by a delusive recollection of the Collection of the "Six Poets," in which were included these three, together with the three Moʿallaqa-poets, Amra'al-Qais, Zuhair and Ṭarafa.

The lives of these poets were spread over a period of more than a hundred years. The earliest of the seven was Amra'al-Qais (*q.v.*), regarded by many as the most illustrious of Arabian poets. His exact date cannot be determined; but probably the best part of his career fell within the midst of the 6th century. He was a scion of the royal house of the tribe Kinda, which lost its power at the death of King Ḥārith ibn ʿAmr in the year 529. (See *Tabari's Geschichte der Perser und Araber . . . übersetzt von Th. Nöldeke* [Leiden, 1879], p. 171.) The poet's royal father, Ḥojr, by some accounts a son of this Ḥārith, was killed by a Bedouin tribe, the Banū Asad. The son led an adventurous life as a refugee, now with one tribe, now with another, and appears to have died young. The anecdotes related of him as well as his poems, imply that the glorious memory of his house and the hatred it inspired were still comparatively fresh, and therefore recent. A contemporary of Amra'al-Qais was ʿAbīd ibn Abraṣ, one poem of whose, as we have seen, is by some authorities reckoned among the collection. He belonged to the Banū Asad, and is fond of vaunting the heroic deed of his tribe—the murder of Ḥojr—in opposition to the victim's son, the great poet.

The Moʿallaqa of ʿAmr hurls defiance against the king of Ḥira, ʿAmr son of Mundhir, who reigned from the summer of 554 till 568 or 569, and was afterwards slain by our poet. (*See* Nöldeke's *Tabarī*, pp. 170, 172.) This prince is also addressed by Ḥārith in his Moʿallaqa. Of Ṭarafa, who is said to have attained no great age, a few satirical verses have been preserved, directed against this same king. This agrees with the fact that a grandson of the Qais ibn Khālid, mentioned as a rich and influential man in Ṭarafa's Moʿallaqa (v. 80 or 81), figured at the time of the battle of Dhū-Qār, in which the tribe Bakr routed a Persian army. This battle falls between A.D. 604 and 610.

The Moʿallaqa of ʿAntara and that of Zuhair contain allusions to the feuds of the kindred tribes ʿAbs and Dhobyān. Famous as these contests were, their time cannot accurately be ascertained. But the date of the two poets can be approximately determined from other data. Kaʿb, son of Zuhair, composed first a satire, and then, in the year 630, a eulogy on the Prophet; another son, Bujair, had begun, somewhat sooner, to celebrate Mahomet. ʿAntara killed the grandfather of Aḥnaf ibn Qais, who died at an advanced age in A.D. 686 or 687; he outlived ʿAbdallāh ibn Ṣimma, whose brother Duraid was a very old man when he fell in battle against the Prophet (early in A.D. 630); and he had communications with Ward, whose son, the poet ʿOrwa, may perhaps have survived the flight of Mahomet to Medina. From all these indications we may place the productive period of both poets in the end of the 6th century.

To the same period appears to belong the poem of ʿAlqama, which, as we have seen, Ibn Khaldūn reckons amongst the Moʿallaqāt. This too is certainly the date of Nābigha, who was one of the most distinguished of Arabic poets. For in the poem often reckoned as a Moʿallaqa, as in many others, he addresses himself to Noʿmān, king of Ḥīra, who reigned in the two last decades of the 6th century. The same king is mentioned as a contemporary in one of ʿAlqama's poems.

The poem of Aʿsha, sometimes added to the Moʿallaqāt, contains an allusion to the battle of Dhū Qār (under the name "Battle of Ḥinw," v. 62). This poet, not less famous than Nābigha, lived to compose a poem in honour of Mahomet, and died not long before A.D. 630.

Labīd is the only one of these poets who embraced Islam. His Moʿallaqa, however, like almost all his other poetical works, belongs to the Pagan period. He is said to have lived till 661, or even later; certainly it is true of him, what is asserted with less likelihood of several others of these poets, that he lived to a ripe old age.

The seven Moʿallaqāt, and also the poems appended to them, represent almost every type of ancient Arabian poetry in its excellences and its weaknesses. In order rightly to appreciate these, we must translate ourselves into the world of the Bedouin, and seek to realize the peculiar conditions of his life, together with the views and thoughts resulting from those conditions. In the Moʿallaqa of Ṭarafa we are repelled by the long, anatomically exact description of his camel; but such a description had an extraordinary charm of its own for the Bedouins, every man of whom was a perfect connoisseur on this subject down to the minutest points; and the remaining parts of the poem, together with the other extant fragments of his songs, show that Ṭarafa had a real poetic gift. In the Moʿallaqāt of ʿAmr and Ḥārith, for the preservation of which we are especially grateful to the compiler, we can read the haughty spirit of the powerful chieftains, boastfully celebrating the splendours of their tribe. These two poems have also a certain historical importance. The song of Zuhair contains the practical wisdom of a sober man of the world. The other poems are fairly typical examples of the customary *qaṣīda*, the long poem of ancient Arabia, and bring before us the various phases of Bedouin life.

It is a phenomenon which deserves the fullest recognition, that the needy inhabitants of a barren country should thus have produced an artistic poetry distinguished by so high a degree of uniformity. Even the extraordinary strict metrical system, observed by poets who had no inkling of theory and no knowledge of an alphabet, excites surprise. In the most ancient poems the metrical form is as scrupulously regarded as in later compositions. The only poem which shows unusual metrical freedom is the song of ʿAbīd. It is, however, remarkable that ʿAbīd's contemporary Amra'al-Qais, in a poem which in other respects also exhibits certain coincidences with that of ʿAbīd (No. 55, ed. Ahlwardt), allows himself considerable licence in the use of the very same metre—one which, moreover, is extremely rare in the ancient period. Presumably, the violent deviations from the *schema* in ʿAbīd are due simply to incorrect transmission by compilers who failed to grasp the metre. The other poems ascribed to ʿAbīd, together with all the rest attributed to Amra'al-Qais, are constructed in precise accord with the metrical canons. It is necessary always to bear in mind that these ancient poems, which for a century or more were preserved by oral tradition alone, have reached us in a much mutilated condition. Fortunately, there was a class of men who made it their special business to learn by rote the works either of a single poet or of several. The poets themselves used the services of these rhapsodists (rāwī). The last representative of this class is Ḥammād, to whom is attributed the collection of the Moʿallaqāt; but he, at the same time, marks the transition of the rhapsodist to the critic and scholar. The most favourable opinion of the rhapsodists would require us to make allowance for occasional mistakes: expressions would be transposed, the order of verses disarranged, passages omitted, and probably portions of different poems pieced together. It is clear, however, that Ḥammād dealt in the most arbitrary fashion with the enormous quantity of poetry which he professed to know thoroughly. The seven Moʿallaqāt are indeed free from the suspicion of forgery, but even in them the text is frequently altered and many verses are transposed. The loose structure of Arabic poems was extremely favourable to such alterations. Some of the Moʿallaqāt have several preambles: so, especially, that of ʿAmr, the first eight verses of which belong not to the poem but to another poet. Elsewhere, also, we find spurious verses in the Moʿallaqāt. Some of these poems, which have been handed down to us in other exemplars besides the collection itself, exhibit great divergences both in the order and number of the verses and in textual details. This is particularly the case with the oldest Moʿallaqa—that of Amra'al-Qais—the critical treatment of which is a problem of such extreme difficulty that only an approximate solution can ever be reached. The variations of the text, outside the Moʿallaqāt collection, have here and there exercised an influence on the text of that collection. It would be well if our manuscripts at least gave the Moʿallaqāt in the exact

form of Ḥammād's days. The best text—in fact, we may say, a really good text—is that of the latest Mo'allaqa, the song of Labīd.

The Mo'allaqāt exist in many manuscripts, some with old commentaries, of which a few are valuable. They have also been several times printed. Especial mention is due to the edition of Charles (afterwards Sir Charles) Lyall with the commentary of *Tibrīzī* (Calcutta, 1894). Attempts to translate these poems, verse for verse, in poetical form, could scarcely have a happy result. The strangeness, both of the expression and of the subjects, only admits of a paraphrastic version for large portions, unless the sense is to be entirely obliterated. An attempt at such a translation, in conjunction with a commentary based on the principles of modern science, has been made by the present author: "Fünf Mo'allaqāt übersetzt und erklärt," in the *Sitzungsberichte der kais. Akad. d. Wiss. in Wien. Philos.-hist. Classe*. Bde. cxl.–cxiv. A supplement to this is formed by an article, by Dr. Bernh. Geiger, on the Mo'allaqa of Ṭarafa, in the *Wiener Zeitschrift für die Kunde des Morgenlands*, xix. 323 *sqq*. *See* further the separate articles on the seven poets. (Th. N.; X.)

MOAT, a depression surrounding a castle, city wall or other fortification, usually, but not always, filled with water. The existence of a moat was a natural result of early methods of fortification by earthworks, for the ditch produced by the removal of earth to form a rampart made a valuable part of the defence system. When, in the middle ages, earthworks gave way to masonry walls, the moat was retained, and became even more valuable than before, as it prevented moving towers or battering rams from being brought up to the ramparts until the moat had been filled. With the development of fire-arms the moat lost much of its importance, but was occasionally retained into the 18th century, as an obstacle against infantry attacks. Dry moats or ditches, as parts of modern earthworks, still occur spasmodically. (*See* Castle, Fortification and Siegecraft. For a thorough consideration of mediaeval moats, *see* Viollet-le-Duc, *Dictionnaire Raisonné*, articles "Architecture Militaire" and "Château.")

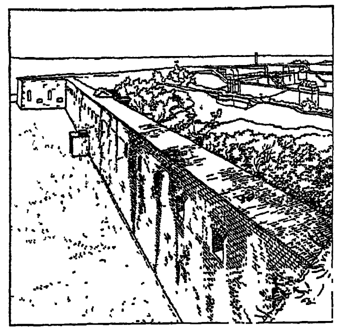
MOBERLY, GEORGE (1803–1885), English divine, was born on Oct. 10, 1803, and educated at Winchester and Balliol college, Oxford. He was head master of Winchester from 1835 to 1866. Mr. Gladstone made him bishop of Salisbury in 1869. Though Moberly left Oxford at the beginning of the Oxford movement, he formed an intimate friendship with Keble. In 1872 he astonished his High Church friends by joining in the movement for the disuse of the damnatory clauses in the Athanasian Creed. His chief contribution to theology is his Bampton Lectures of 1868, on *The Administration of the Holy Spirit in the Body of Christ*. He died on July 6, 1885.

His son, Robert Campbell Moberly (1845–1903) became regius professor of pastoral theology at Oxford. He contributed to *Lux Mundi* (1889), and wrote *Atonement and Personality* (1901).

MOBERLY, a city of Randolph county, Missouri, U.S.A., 135 m. N.W. of Saint Louis; on Federal highways 24 and 63, and served by the Missouri-Kansas-Texas and the Wabash railways. Pop. (1920) 12,808 (91% native white); and was 13,772 Federal census 1930. It is a shipping point for farm produce, live stock, wool, hides and hardwood lumber, and has a number of manufacturing industries, including a shoe factory, hosiery mills, a cheese plant and large repair shops of the Wabash company (established in 1872), with an output in 1925 valued at $4,133,565. Coal is mined in the vicinity. Moberly was platted in 1866; became the county seat in 1868; and a city in 1873.

MOBILE, a city of south-western Alabama, U.S.A., at the head of Mobile bay on the Gulf of Mexico (30 m. long and 8 m. wide); county seat of Mobile county. It is on Federal highways 45 and 90; has a municipal airport; and is served by the Alabama, Tennessee and Northern, the Gulf, Mobile and Northern, the Louisville and Nashville, the Mobile and Ohio and the Southern railways, and by 40 ocean steamship lines and the barges of the Inland Waterways Corporation (Mississippi-Warrior Service). Pop. (1920) 60,777 (39% negroes); and was 68,202 Federal census 1930, with an additional 15,000 in adjacent suburbs, making the total for the metropolitan area about 85,000.

Mobile is the only seaport of Alabama, and until 1900 was its largest city. It occupies 20 sq.m. of a sandy plain. The Cochrane bridge and causeway, 10·5 m. long (completed 1927) crosses the delta of the Mobile river and the headwaters of the bay, providing an uninterrupted passage by highway over the Old Spanish trail from Florida to California. The land-locked fresh water harbour, formed by the lower 5 m. of the Mobile river, is connected with the Gulf by a 30 ft. channel and has ample anchorage. To June 30, 1926, the Federal Government had spent $10,352,265 (spread over a century) in deepening the harbour and channel, which originally had a usable depth of only 5·5 feet. Extensive docks and terminal facilities (completed 1928) have been built by the State at a cost of $10,000,000. The U.S. quarantine station occupies Sand island, at the entrance to the river. Pinto and Blakely islands, opposite the city, are occupied by dry-docks and ship-building yards, coaling stations and oil-tank farms. The U.S. Steel Corporation owns large tracts of land at Chickasaw, and other industrial developments fringe the north-west boundary of the city. Five miles west is Spring Hill college, founded (1830) and conducted by Jesuits. There are 18th century buildings in the city, many residences of both ante-bellum and modern construction. The city's assessed valuation for 1927 was $54,041,849. Since 1911 it has had a commission form of government. Mardi Gras has been celebrated annually since 1830.



BY COURTESY OF THE MOBILE CHAMBER OF COMMERCE

OLD FORT GAINES, AT THE ENTRANCE TO MOBILE BAY

The harbour traffic in 1926 was 3,193,166 tons, valued at $121,878,580, of which $37,058,400 represented exports (mainly raw cotton, lumber and timber, iron and steel products) and $9,224,134 imports (largely sodium nitrate, bananas, manganese and manganese ore and molasses). Garden truck and small fruits are the leading money crops of the region. Over 2,000 carloads of cabbage and $1,000,000 worth of satsuma oranges and pecans are shipped annually, and the county boasts a "cabbage patch" of 500 acres. The output of the manufacturing industries was valued at $30,913,553 in 1927. Bank debits in 1926 aggregated $469,888,000.

Mobile was founded in 1702 and was the capital of the French province of Louisiana until 1720. The name was taken from the Mobile or Maubila Indians, who then occupied the region. By the Treaty of Paris (1763) Mobile was ceded to Great Britain; in 1780 it was captured by a Spanish force; in 1813 it was seized for the United States by Gen. James Wilkinson, and in Aug. 1814 Gen. Andrew Jackson made it his headquarters, resisting an attack (Sept. 15) by the British on Ft. Bowyer at the mouth of the bay. After the War of 1812 American immigrants rapidly changed the French character of the place. A town charter was received from the territorial legislature of Mississippi in 1814; a city charter from the first State legislature of Alabama, in 1819. Throughout the 19th century it was the commercial metropolis of Alabama and Mississippi. Cotton exports increased from 7,000 bales in 1818 to 450,000 in 1840 and 1,000,000 in 1861.

During the Civil War Mobile was an important port of the Confederacy. Despite a Federal blockade begun in 1861, trade with the West Indies and Europe was kept up by a line of swift vessels. In 1864 Admiral Farragut entered the channel, captured the Confederate ironclad ram "Tennessee," destroyed one gunboat and drove another aground, losing the Federal monitor "Tecumseh." Ft. Gaines, on Dauphin island, surrendered on August 7; Ft. Morgan, on Mobile Point, on August 23. In the spring of 1865 Gen. E. R. S. Canby laid siege to Ft. Blakely and Spanish Fort, on the east side of the bay. After 25 days the forts, and then the city, were evacuated, and the Federal forces entered the city on April 12. In 1879, in consequence of railway losses and the financial disturbance of 1873, the municipality became bankrupt. Its charter was vacated; trustees acting under the chancery court were appointed; and a temporary municipal government, called the Port of Mobile, was established. In 1887 the city of Mobile was again chartered. A hurricane on Sept. 27, 1906, destroyed

property valued at over $5,000,000.

MOBILIZATION, the preparation of an army for active service (from Latin *mobile* and French *mobile*), and its passage from a peace to a war footing. It is of vital importance that the period of mobilization shall be as short as possible, as victory in the first battles and even the results of the whole war may be jeopardized by any avoidable delay in this process. Thus every army is constantly endeavouring to speed up its mobilization by providing for contingencies. On the issue of the order much has to be done. Reservists have to be called up, clothed, armed and equipped, fed and sent to the units into which they are to be incorporated. Arms, ammunition, equipment, vehicles and stores not issued in peace time but necessary in war have to be provided and distributed; and any similar material in possession of units but not required for active service or defective must be returned to store or replaced. Special promotions and appointments must be made and notified; a number of new units and formations will have to be raised and fitted out; and everything must be ready by the time appointed for each unit to commence its move to its concentration area or port of embarkation in accordance with the time-table drawn up in peace time. All this complicated process requires a complete programme for each formation and unit, showing what is to be done on each day of the mobilization period; these programmes are revised at frequent intervals and subjected to partial tests. (*See* also ARMY.)

MÖBIUS, AUGUST FERDINAND (1790–1868), German astronomer and mathematician, was born at Schulpforta on Nov. 17, 1790. At Leipzig, Göttingen and Halle he studied for four years, and in 1815 became professor of astronomy at Leipzig, being chosen director of the university observatory, which was erected (1818–1821) under his superintendence. He died on Sept. 26, 1868. His doctor's dissertation, *De computandis occultationibus fixarum per planetas* (Leipzig, 1815), established his reputation as a theoretical astronomer. *Die Hauptsätze der Astronomie* (1836), *Die Elemente der Mechanik des Himmels* (1843), may be noted amongst his other purely astronomical publications. His labours in pure mathematics appear for the most part in *Crelle's Journal* from 1828 to 1858. These papers are chiefly geometrical, many of them being developments and applications of the methods laid down in his great work, *Der barycentrische Calcul* (Leipzig, 1827), which, as the name implies, is based upon the properties of the mean point or centre of mass. (*See* ALGEBRA: *Universal.*) This work abounds in suggestions and foreshadowings of some of the most striking discoveries in more recent times—such, for example, as are contained in H. Grassmann's *Ausdehnungslehre* and Sir W. R. Hamilton's *Quaternions.* Möbius was a leader in the introduction of the powerful methods of modern projective geometry.

His *Gesammelten Werke* were published at Leipzig, (4 vols., 1885–1887).

(2) Theodor, son of the last-named, Scandinavian authority, born at Leipzig, June 22, 1821. Among many papers and writings, his *Catalogas librorum islandicorum et Norvegicorum aetatis mediae* (1856) and *Verzeichnis der auf dem Gebiet der altnordischen Sprache und Literatur 1855 bis 1879 erschienenen Schriften* (1880) as keys to Scandinavian bibliography, and his *Edda-Ausgabe* as a text-book, are perhaps the most valuable to students. He died in Leipzig, April 25, 1890.

MOCATTA, FREDERICK DAVID (1828–1905), English Jewish philanthropist, was a member of the London financial firm, Mocatta and Goldsmid, but retired from business in 1874 and devoted himself to works of public and private benevolence.

He first began to give his attention to the better housing of the working classes, and the administration of charity in such a manner as not to demoralise the poor. He literally supported almost every hospital in London.

Mocatta did much to promote education, especially that of the Jewish poor, and he encouraged Jewish literature and research. Besides this he was a patron of learning and himself an author of historical works, the chief of which was *The Jews and the Inquisition.* On occasion of his 70th birthday, he was presented with a testimonial from more than 200 philanthropic and literary institutions. The Anglo-Jewish Historical Exhibition (1887) owed its inception to him. He bequeathed his fine library to the Jewish Historical Society of England, of which he was at one time president. This library formed the basis of the collections which are now included in the Mocatta Library and Museum, founded in his memory, and located at the University of London (University College, Gower Street).

See *Trans. Jewish Hist. Soc. Eng.* vol. v.

MOCCASIN, a shoe made of deerskin or other soft leather. It is made in one piece; the sole is soft and flexible and the upper part is often adorned with embroidery, beading or other ornament. It is the footwear of the North American Indian tribes and is also worn by hunters, traders and settlers. In botany, the lady's slipper is known in the United States as the "moccasin flower."

MOCCASIN SNAKE (*Ancistrodon piscivorus*), a venomous viviparous aquatic snake of the southern United States, also called cottonmouth (from the white rim round its mouth) and water moccasin. It belongs to the pit-viper family, Crotalidae (*see* SNAKES), which also includes the rattlesnake (*q.v.*). The moccasin may reach four feet in length. It feeds largely on frogs and fishes and is one of the most deadly of American snakes. The allied copperhead (*q.v.*) is sometimes called the upland moccasin. It has a more northerly range. Moccasins are coloured dark olive-brown above, and yellowish-brown below, with dark bars and blotches. They are darker than the copperhead, being without the bright tints of the latter. The top of the head is mostly covered with scales like those of the back, instead of large regular plates as in the case of harmless snakes. The head is flat and broad. The water moccasin is mimicked by the harmless false moccasin (*Natrix*), a smaller water-snake with a narrow and less triangular head and a double row of scales on the underside of the tail.

MOCENIGO, the name of a noble and ancient Venetian family which included many doges, statesmen and soldiers. TOMMASO MOCENIGO (1343–1423) commanded the crusading fleet in the expedition to Nicopolis in 1396, and also won battles against the Genoese. While Venetian ambassador at Cremona he was elected doge (1414), and he escaped in secret, fearing that he might be held a prisoner by Gabrino Fondolo, tyrant of that city. He made peace with the Turkish sultan, but when hostilities broke out afresh his fleet defeated that of the Turks at Gallipoli. During his reign the patriarch of Aquileia was forced to cede his territories to the republic (1420), which also acquired Friuli and Dalmatia. Tommaso greatly encouraged commerce, reconstructed the ducal palace and commenced the library. PIETRO MOCENIGO, doge from 1474 to 1476, was one of the greatest Venetian admirals, and revived the fortunes of his country's navy after the defeat at Negropont in 1470. In 1472 he captured and destroyed Smyrna. He then defeated the Turks who were besieging Scutari and died of an illness contracted there. GIOVANNI MOCENIGO, Pietro's brother, doge from 1478 to 1485, fought against Mohammed II. and Ercole I., duke of Ferrara, from whom he recaptured Rovigo and the Polesine. LUIGI MOCENIGO was doge from 1570 to 1577. During his reign Venice lost the fortresses Nicosia and Famagosta in Cyprus. He took part in the battle of Lepanto, but after the loss of Cyprus he was forced to make peace with the Turks and to hand them back his conquests. ANDREA MOCENIGO, who flourished in the 15th and 16th centuries, was a senator of the republic and a historian; he composed a work on the league of Cambrai entitled *Belli memorabilis Cameracensis adversus Venetos historiae libri vi.* (Venice, 1525). Another LUIGI MOCENIGO was doge from 1700 to 1709, and his brother SEBASTIANO from 1722 to 1732. ALVISE MOCENIGO (1701–78), who was doge from 1763 until his death, restricted the privileges of the clergy, and in consequence came into conflict with Pope Clement XIII.

MOCHA STONE, a variety of chalcedony containing infiltrated dendritic oxides of manganese and iron which give it the appearance of containing vegetable remains. Most of the mocha stones of commerce are obtained from India, being found among the agate pebbles due to the disintegration of the trap rocks of the Deccan. Artificial stones are produced at Oberstein.

MOCKING-BIRD, popular name of birds belonging to the American family *Mimidae* including also the thrashers (*q.v.*). The northern mocking-bird (*Mimus polyglottus*) inhabits the southern part of U.S.A., visiting the north in summer and breeding, though rarely, in New England. West of the Alleghanies it is less numerous, though occurring in suitable localities across to the Pacific. The mocking-bird has a fine song of its own and, in addition, has a remarkable power of mimicry.

It is greyish-brown above and dull white below. The nest is often placed close to houses and is a careless structure. Three to six blue-green eggs, spotted with light brown, are laid. The great enemies of the mocking-bird are snakes, which eat both eggs and young; but the parents show great courage in defence of their home and often drive off the intruder.

Some 12 or 14 other species of *Mimus* occur, mostly in S. America. The catbird (*Dumatella carolinensis*) is another ally; it too has both a fine song and the power of mimicry. It is sooty-grey and has a wide range on the continent and extends to Bermuda.

MOCK ORANGE, the name given to various species of syringa (*q.v.*), especially to those with highly fragrant flowers, and also to the Missouri gourd or calabazilla (*Cucurbita foetidissima*), of the south-western United States, because of the resemblance of the globular fruit to small oranges. The leaves of the latter were used medicinally by the Spanish-Californians.

MOCOAN, a linguistic stock of South American Indians, whose name is derived from the Mocoas, one of its best-known tribes. The Mocoan tribes occupied a small territory on the eastern slope of the Cordillera Oriental in southern Colombia, directly east of Pasto, on the sources of the Putumayo river and between it and the upper Caqueta. Little or nothing of the character and culture of these tribes is known.

See A. F. Chamberlain, "Sur Quelques familles linguistiques . . . de l'Amerique du Sud" (*J. Soc. Americanistes de Paris* [n.s.], vol. vii. pp. 179–202).

MODELS AND MODEL-MAKING. The making of models is one of the oldest hobbies of mankind. The Egyptians, for instance, believed that the human spirit, after death, was capable of travelling on land, but required assistance across the waters of the Nile, so they buried with their dead a model boat called a "Spirit Ship" to assist the soul across the river.

An early model dealing with steam is described by Hero of Alexandria, about A.D. 120. A reconstruction of this model is in the South Kensington museum, London, and consists of a boiler with a flat top supported by a frame over a wood fire. The top of the boiler has a hollow ball mounted between two pivots, one of which acts as a steam-pipe leading through the boiler. On opposite sides of the ball are two nozzles bent at right angles so that when steam is generated and passes into the atmosphere it causes the ball to revolve rapidly. An early model-maker was the famous James Watt. He was born in 1736 and spent some of his early days in improving the model of a Newcomen engine which formed part of the Glasgow college equipment, from which experiment we gained the first practical steam engine. Later, William Murdock, who invented gas lighting, joined James Watt, and the experimental locomotive which Murdock built in 1786 was probably the first model locomotive in existence. It had a cylinder $\frac{3}{4}$ in. diameter.

Models are now commonly used for the demonstration of patents, inventions and experimental work both by engineering firms and private inventors. A few of the leading uses may be here enumerated. (1) For instructional purposes by schools, railway companies, technical colleges, physical laboratories, Admiralty, War Office and other Government departments. (2) For exhibition and publicity purposes, accurate reproductions to scale make it possible to show an article in precise detail within a limited space. Complete scale models are made for shipping companies and for engineering exhibitions. Sectional models are often made to explain internal constructions and the operation of special details. Architects now make extensive use of models for housing details, town-planning, suggestions for extensions to factories, the laying out of estates and the rearrangement of transport facilities. The law courts also make use of models in legal disputes about ancient lights or disagreements about extensions to buildings. Railway and motor-car accidents are modelled to show the positions of the trains or vehicles involved. (3) Last, but not least, there is the use of models for the instruction and amusement of the young, in the form of model railways, model power boats, sailing yachts and other high-class toys, in which scientific data play an important part.

Model-making as a hobby is almost peculiar to the British Isles and has many enthusiastic adherents, as witness the annual exhibitions held in London where amateur-made models are entered for competition. The production of scale models is almost exclusively in the hands of very small groups of craftsmen, in some cases working in their own homes or in small workshops; the chief reason being that very little machinery is required. The work demands great personal skill, repetition being almost unknown.

The commercial production of models on a large scale is mainly carried on in England, America and Germany; several firms in these countries give employment to 100 or 200 workpeople; one British firm, established at Northampton, covers the whole range of model-making, from the mass production of popular models to elaborate scale models costing hundreds of pounds each.

In addition to firms who devote themselves exclusively to model-making as a business, many of the leading engineering and shipbuilding companies have established model or experimental workshops where the new ideas are worked out in miniature. The South Kensington science museum, and other institutions have workshops where exhibits are made and repaired.

One of the finest examples of recent model-making, to which hundreds of craftsmen and artists contributed, was the Queen's doll's house designed by Sir Edward Lutyens. It represents the amenities of domestic life in the present century and is built to a scale of 1 in. to the foot. When shown at the Wembley Exhibition, it was seen by hundreds of thousands. In centuries to come this model, protected under its glass cover, will visualise civilization at the outset of the 20th century. (W. J. B.-L.)

MODENA (ancient *Mutina*), city, Emilia, Italy, capital of the province of Modena and seat of an archbishop, 31 m. E.S.E. of Parma by rail. Pop. (1921) 61,763 (town); 83,663 (commune). It lies in a damp, low plain on the south side of the Po valley, between the Secchia to the west and the Panaro to the east. Some main streets follow lines of canals, which still (now covered) traverse the city. The observatory stands 135 ft. above sea-level. The fortifications, converted into promenades, give the city an irregular pentagonal contour. Within are various open areas—the spacious Ippodromo, the public gardens, the Piazza Grande, and the Piazza Reale. The Via Aemilia passes obliquely through the city, from east to west.

Begun by Countess Matilda of Tuscany (1099), after designs of Lanfranc, and consecrated in 1184, the Romanesque cathedral (S. Geminiano) has a lofty crypt under the choir, three eastern apses, and a façade with sculptures of the 12th century. The graceful bell-tower, erected in 1224–1319, named La Ghirlandina from the bronze garland surrounding the weathercock, is 282 ft. high; in the basement may be seen the wooden bucket captured by the Modenese from the Bolognese in the affray at Zappolino (1325) (*see* Tassoni's *Secchia Rapita*). S. Giovanni Decollato contains a *Pieta* in painted terra-cotta by Guido Mazzoni (1450–1518). The so-called Pantheon Estense (the church of S. Agostino), is a baroque building by Bibbiena. San Pietro and San Francesco have terra-cottas by Begarelli (1498–1565).

The extensive ducal palace, from the designs of Avanzini (1651–1679), and finished by Francis Ferdinand V., with a fine courtyard, contains the military school. The Albergo delle Arti, built by Duke Francis III., accommodates the Museo Lapidario (Roman inscriptions, etc.); the valuable archives, the Biblioteca Estense, the Museo Civico, with palaeo-ethnological and archaeological collections; a collection of textile fabrics, and the picture gallery, presented to the city by Francis V. and since augmented by the Campori collection. The town hall dates from 1194. The university (783 students) is mainly medical and legal with a faculty of physical and mathematical science.

Commerce is chiefly agricultural. Modena is the point at which

the railway to Mantua and Verona diverges from that between Milan and Bologna, and has several branches to neighbouring places. It is also the starting-point of a once important road over the Apennines to Pistoia by the Abetone Pass, and of a canal by the Panaro and Po to the sea.

The old abbey of Nonantola (752) some 6 m. to the N. has a fine Romanesque church and valuable treasury and archives.

Modena is the ancient *Mutina* in the territory of the Boii, which became Roman in 215–212 B.C. The Roman town lay south-east of the modern; its north-western wall is marked by the Corso Umberto I.; but the Roman level is 15 to 20 ft. below the modern. Its territory was conterminous with that of Bononia and Regium, and to the south it extended to the summit of the Apennines. Marcus Brutus, lieutenant of Lepidus, held it against Pompeius in 78 B.C., and in 44 B.C. the place was successfully defended by D. Brutus against Mark Antony. The ravages of Attila and Lombard attacks ruined it, but about the close of the 9th century it was restored by its bishop, Ludovicus.

In the wars between Frederick II. and Gregory IX. it sided with the emperor. In 1288 Obizzo d'Este became its lord. Constituted a duchy in 1452 in favour of Borso d'Este, and enlarged and strengthened by Hercules II., it became the ducal residence on the incorporation of Ferrara with the States of the Church (1598). Francis III. (1698–1780) gave the city many public buildings. Hercules III. (1727–1803) saw his states transformed by the French into the Cispadine Republic, and died at Treviso. In 1814 his eldest son, Francis IV. received back the *Stati Estensi* and ruled them despotically. Francis Ferdinand V., succeeded in 1846, and on August 20, 1859, the representatives of Modena declared their territory part of the kingdom of Italy, and their decision was confirmed by the plebiscite of 1860.

MODERATOR, a judge or umpire, one who acts the part of mediator, and so a term used of the person chosen to be president of a meeting (as in America, of a town meeting). In the Universities both of Oxford and Cambridge, it is still used of the officers appointed to preside over certain examinations; but the best-known use of the word is in the Presbyterian churches; the name is applied to the minister elected to preside over ecclesiastical meetings or assemblies, as the synod, presbytery or general assembly (*see* PRESBYTERIANISM).

MODERN ARCHITECTURE, 18TH AND 19TH CENTURIES. This article deals with the development of architecture in Europe and America during the last two centuries prior to the general use of skeleton construction and design characteristic of it. (*See* ARCHITECTURE.) Certain European developments during the 18th century are also treated in this work in the articles BAROQUE ARCHITECTURE and RENAISSANCE ARCHITECTURE. Contemporary architecture is treated in this work under a number of headings which are given in the article ARCHITECTURAL ARTICLES.

CONTINENTAL EUROPE

Continental architecture from the end of the 15th to the beginning of the 19th century presents a continuous development on the lines of the Renaissance. But Renaissance is here used only for the first phase of the epoch, embracing about a century and a half. The ensuing stage, extending to the first decades of the 18th century, is termed *baroque*. The style of the following period is called *rococo*. From about 1770 the so-called *neo-classicism* dominates most European countries.

Development.—Architectural development from the time of the Renaissance takes very different forms in the different countries. This difference can be traced to the different character within each country of the Renaissance itself (*see* RENAISSANCE ARCHITECTURE). In Italy the Renaissance was never an established and defined style and it rapidly passes over to the daring expressive forms and the grandiosity of the baroque. In France, the style of the Renaissance, cultivated by academic tradition, pervades monumental French architecture right up to the time of Napoleon. Whereas in Italy the Renaissance is a direct reaction against the Gothic style, in France it stands in many ways as the heir of this style. The architecture of Spain also early acquired a characteristic style, which has never entirely disappeared. The Moorish influence allied itself easily and organically with the Gothic style and also became a welcome element in the baroque. The architecture of Central Europe is less determined in character. The ornamentation of the German Renaissance contains a seed of the turgidity of the baroque. North Germany is influenced by Holland, whose architecture adheres to the Italian Renaissance, especially as it has been developed by Palladio. Belgium stands under the influence of Spain, Italy, or France, each in turn. The architecture of the northern countries reflects their isolated position. In Denmark the Renaissance is dependent on Dutch, and in Sweden mostly on north German models. The latter country came into closer contact with the rest of Europe during the latter part of the 17th century and acquired a monumental architecture, which is specially allied to the Roman high Renaissance.

At the beginning of the 18th century Russia remained culturally and artistically isolated, the upper classes importing foreign—Italian, German or French—architects. (*See* RUSSIAN ARCHITECTURE.)

EIGHTEENTH CENTURY

In Italy the first phase of the 18th century is on the whole an echo of the 17th. A few characteristic buildings from this time, however, deserve mention: La Superga at Turin by Juvara (1685–1735), Fontana di Trevi in Rome by Salvi (1699–1751), and the façade of the Lateran basilica in Rome by Galilei (1691–1737). Galilei received his training in England and was obviously influenced by Wren. Italian architecture is already under the restraining influence of other countries.

During the 17th century France developed her academic classical style of buildings, which bears the name of Louis XIV. At the beginning of the 18th century comes a certain stagnation, although, during the whole of the century, France still sets the fashion for the rest of the Continent.

The changes of style, however, affect the exterior architecture —which on the whole still follows the academic pattern—less than the interior. The regency period marks a relaxation in the severe etiquette of Louis XIV. It aims at pleasantness, ease, and domestic comfort. The foremost French architects during this time are Oppenort (1672–1742) and de Cotte (1656–1735).

The Rococo Style with its peculiar ornamentation, developed from baroque and oriental—especially Chinese—art, has a typical exponent in Meissonier (1693–1750). Boffrand (1667–1754) is more refined, and in his private palaces, such as the Hôtel de Montmorency, he has created the ideal of a comfortable and distinctive dwelling. But although the rococo originated in France, it was of relatively short duration there, and its influence on architecture was limited. As early as 1732 signs of new ideals of style appear in the competition for the façade of the St. Sulpice church in Paris, in which Servandoni (1695–1766) carried off the prize with a project in "Palladio style" in competition with Meissonier's project in sumptuous rococo. It is significant that both of these men of extremes came from the Italian school

When the classicism of Servandoni made its appearance, it was a unique occurrence in French architecture and is perhaps, rather the expression of a theatre-painter's fantasy than the severe work of an architect. The struggle against the rococo style was soon in full swing, supported by such theorists as Blondel and Laugier. In 1737 Soufflot (1709–80) created an important building of classical inspiration—the Hôtel-Dieu in Lyons—and met with such success that he was called to Paris and entrusted with the building of the St. Geneviève church (Pantheon). This building, which testifies to a profound knowledge of Greek (Paestum) and Roman antique as well as of Italian high Renaissance, ushers in the eclecticism which prevailed in the 19th century. Ange Jacques Gabriel (1710–82) works more in conformity with French tradition in his buildings, such as the École militaire and Garde meubles (Place de la Concorde) in Paris, and in the Petit Trianon, near Versailles. Gabriel's interiors show the developed Louis XVI. style, and correspond, to a certain extent, to the English Adam style, but are more soft in their echo of the rococo.

In Germany, which long suffered from the consequences of the

devastating religious wars, the art of monumental architecture was developed later than in France. In the south, as well as in Austria, however, a lively building activity arose during the latter part of the 17th century. In Vienna and Salzburg Johan Bernhard Fischer von Erlach (1650–1723) created monumental buildings and churches, the most remarkable of which is the St. Karl Borromäus church in Vienna. In the pleasure palace of Belvedere in Vienna, erected for Prince Eugene, Johann Lukas von Hildebrandt (1666–1745) produced a work of art which exercised a deciding influence on Austrian and south German taste. A magnificent example of the Austrian baroque ecclesiastical architecture is the convent of Melk, built by Jakob Prandauer. The small St. Johann Nepomuk church in Munich, erected in 1733 by the brothers Asam, is an interesting example of the south German baroque. There is also the magnificently appointed residence for the Prince Bishop built by Johann Balthasar Neumann (1687–1753) at Wurzburg.

While the architecture of south Germany thus emanates from Italy, that of north Germany is dependent upon Dutch models. Building activity in north Germany was practically stagnant until the beginning of the 17th century, when the talented architect and sculptor Andreas Schlüter (1664–1714) was entrusted with the rebuilding of the royal castle in Berlin, a task continued by Johann Friedrich von Eosander (1670–1729). Prussia comes into close contact with French culture in the middle of the 17th century, and Georg Wenceslaus Knobelsdorf (1699–1753) was entrusted with the building of the city castle and the French church at Potsdam; the architecture of both is severely classical. During the latter part of the 18th century, French influence becomes more and more prominent in Germany. The so-called "Zopfstyle" appears as a mixture of French Louis XVI. and German baroque style. The most typical exponent of this early classicism is Carl von Gontard (1736–1802).

In the Netherlands artistic development came to a standstill after an extraordinarily flourishing period during the preceding centuries. As early as in the 18th century Holland developed in its churches that severe planning and sober appointments which have since become so common. Belgium came more and more under French influence during the 18th century, and therefore came under the influence of the French neo-classicism during the latter part of the century.

In Spain, at the beginning of the 18th century, Don José de Churriguera (1650–1723) developed the Spanish high baroque, with its sumptuous decoration and strange mixture of styles, which has been named *Churrigueresque* (*q.v.*).

Portugal during the 18th century concentrated its strength on a gigantic building, the Mafra castle, which, from an artistic point of view, however, does not justify the enormous cost of its erection.

Amongst the Scandinavian countries Sweden played a prominent rôle in the architectural history of the baroque period, especially through the activity of the Tessin family of architects. Nikodemus Tessin, the younger, created in the royal palace of Stockholm perhaps the most perfect building of the time emanating from the school of the Roman Renaissance. Later the Swedish art of building approached closer to French models.

NINETEENTH CENTURY

Politically the period of the French Revolution ushers into view a totally new epoch in the history of the Continent. The rupture is less evident in the history of art. Apparently the severe novantique, which characterizes the period following the Revolution, is a direct continuation of the classicism of the last phase of *l'ancien régime*. In reality, however, the Revolution introduced into this field also a totally new conception, which becomes ever more apparent during the 19th century. This is the eclecticism founded on archaeological studies. There is a fundamental difference between the conception of architecture of this new period and that of the Renaissance. Whilst the masters of the Renaissance and their successors gained inspiration for *new creation* from the classical architecture, the architecture of the 19th century is principally imitative and its highest aspiration is to come as close to the architectonic creations of past times as possible, but not to surpass or transpose them. This imitation is not limited to the antique only, but seeks its models amongst all the building styles of earlier times. The eagerness for archaeological research becomes wedded to romanticism, which in its literary enthusiasm for old times is blind to the requirements of the present day.

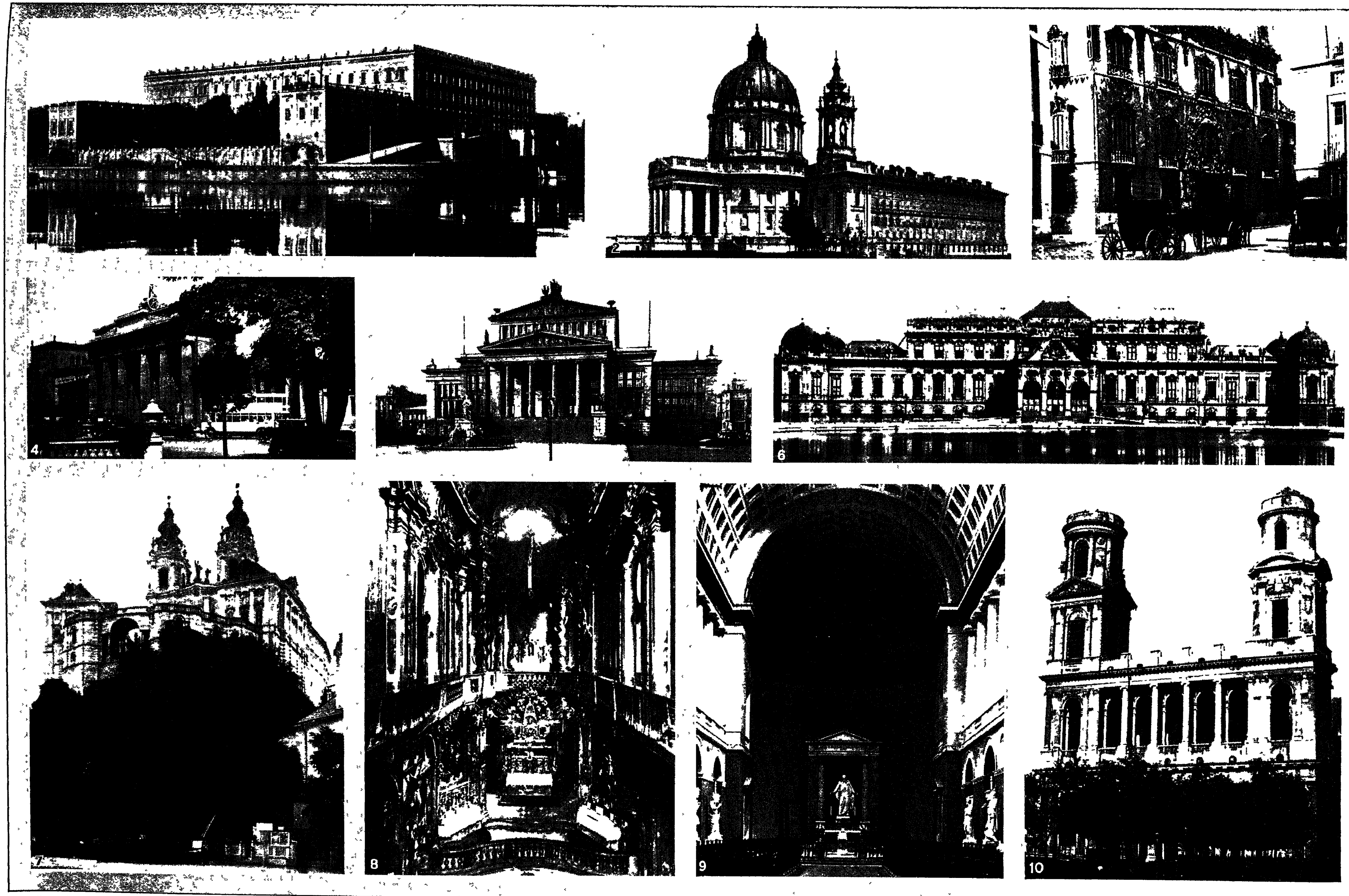
So far as architecture is concerned, therefore, the 19th century is full of interesting suggestions and experiments, but on the whole it is barren. A contribution during this century, however, which is decisive for the future, is the increasing development of the *technique* of building. By the middle of the century, iron made its appearance as a material with properties revolutionizing the art of building, and a short time thereafter came cement, a new and extremely easily worked building material; finally these materials were combined into reinforced concrete, a combination which seems to herald a complete revolution in architecture.

During this period the lead in architectural development on the Continent passed more and more from France to Central Europe. France, however, still retained her reputation as the keeper of the academic architectonic traditions, and in reality she still retained the lead at the beginning of the century. The architecture of the Napoleonic empire, or the so-called Empire style, is predominantly decorative in character. It does not aim in the first place at the solution of a certain practical building problem, but at the creation of a monument for the glorification of the empire. Just as Napoleon based his court ceremonials on Roman models, so these monuments seek to emulate the antique, whether they appear in the form of a "temple of glory," such as the Madeleine church, or as triumphal arches. However, in the latter erections and especially in l'Arc de Triomphe de l'Étoile by Jean François Chalgrin (1739–1810) can be traced the last appearance of the noble tradition of French classical architecture (Porte St. Denis by François Blondel, etc.).

The leading architects of the Napoleonic era and the architects mostly employed by the court were Charles Percier (1764–1838) and Pierre Fontaine (1762–1853). The works of these two collaborators show that they were influenced by the Adam brothers and, like them, they have made their works known in wide circles by their brilliant books of engravings. They have exercised a strong influence on the contemporary Continental taste especially by their designs for interior decoration and furniture. The style created by Percier and Fontaine rules in France on the whole up to the middle of the 19th century, but it is occasionally modified under the influence especially of Italian Renaissance, as shown by the St. Vincent-de-Paul church by Jacob Ignaz Hittorf (1792–1867).

The German nation was naturally qualified, by its peculiar combination of naïve eagerness for exact research work and dreamy enthusiasm, to acquire both the romanticism and the archaeological novantique. There appeared in the person of J. J. Winkelmann (1717–68) a—for that time—extraordinarily learned student of the history of antique art. Greek classicism was also soon developed in German architecture, and from the beginning of the 19th century received strong impulses. The Brandenburger Tor in Berlin by Karl Gotthard Langhans (1733–1808) is the most typical example of this severe classicism, and, in Karlsruhe, Freidrich Weinbrenner (1766–1826) created a number of artistically important buildings in the same spirit. Finally, Karl Friedrich Schinkel (1781–1841), a many-talented architect, transposed with uncommon independence and a rich imagination the classical ideals. His best known works are the royal theatre and the old museum in Berlin, the Niccolai church in Potsdam, and the Werder church in Berlin. With the last-mentioned building, Schinkel originated the new Gothic style, which afterwards became so popular in church architecture. South Germany possessed in Leo von Klenze a kindred spirit to Schinkel. The best known works by Klenze are the Glyptotheca and the Propylées in Munich and the Hermitage museum in St. Petersburg (Leningrad).

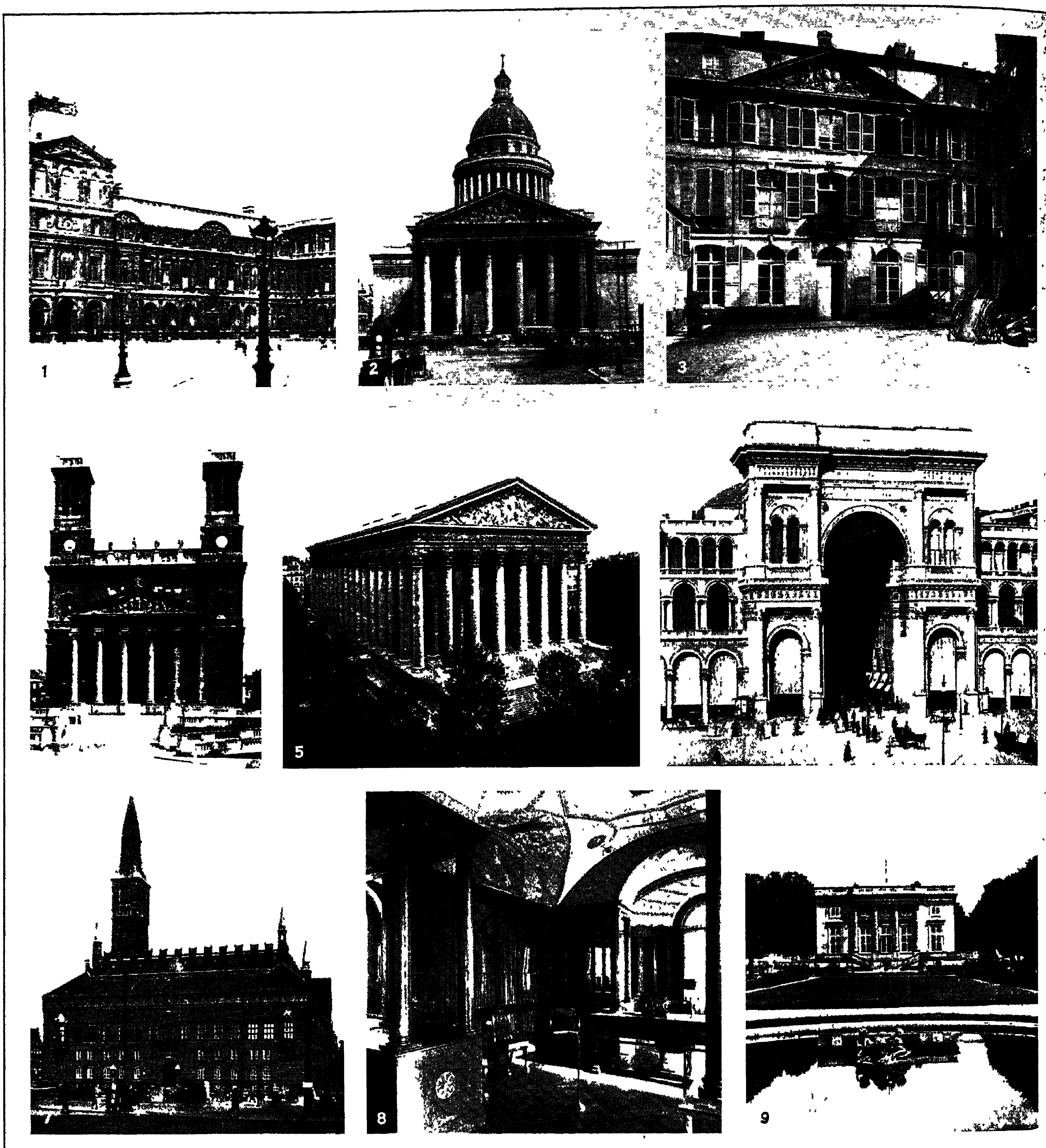
In the other countries of Europe the new classicism followed the development in the leading ones. Italian architects, as we have already pointed out, have been actively instrumental in bringing about the victory of classicism. The architect and engraver



BY COURTESY OF (4, 8) THE REICHSZENTRALE FUR DEUTSCHE VERKEHRSWERBUNG, (7, 9) F. R. YERBURY; PHOTOGRAPHS, (1, 2, 3, 5, 6) E N A , (10) COLLECTION ARCHIVES PHOTOGRAPHIQUES

18TH AND 19TH CENTURY CONTINENTAL ARCHITECTURE

1. The Royal Palace, Stockholm. Nikodemus Tessin the Younger, architect
2. The Basilica of Superga, Turin. F. Juvara, architect
3. Palacio del Marques de los Aguas, Valencia. Rovira, architect
4. Brandenburger Tor, Berlin. K. G. Langhans, architect
5. The Schauspielhaus, Berlin
6. Schloss Belvedere, Vienna; German and Austrian. Lucas von Hildebrandt, architect
7. The Convent at Melk, Austria; German and Austrian. Jakob Prandauer, architect
8. Interior of St. Johann Nepoumuk, Munich. The Asam Brothers, architects
9. The Church of Our Lady, Copenhagen
10. Façade of St. Sulpice, Paris. Servandoni, architect



BY COURTESY OF (7) F. R. YERBURY; PHOTOGRAPHS (1, 2, 3, 4, 5, 8, 9) COLLECTION ARCHIVES PHOTOGRAPHIQUES, (6) ALINARI

17TH, 18TH AND 19TH CENTURY CONTINENTAL ARCHITECTURE

1. Louvre, Paris, Pavillon de Sully, 17th century
2. Panthéon, Paris, built 1755–81. Jacques Germain Soufflat, architect
3. Hôtel de Montmorency, 18th century, French. Germain Boffrand, architect
4. St. Vincent-de-Paul, Paris, 19th century. Example of modification of the style of Charles Percier and Pierre Fontaine (*see* fig. 8) under the influence of the Italian Renaissance. Jacques Ignatz Hittorf, architect
5. Church of the Madeleine, Paris, 1804. Designed by Pierre Vignon in imitation of an octastyle peripteral Roman temple, 350 feet by 147 feet. The building stands on a podium 23 feet high
6. Galleria Vittorio Emanuele II., Milan, Italy, 19th century. Giuseppe Mengoni, architect
7. Town Hall, Copenhagen, 19th century. Marten Nyrop, architect
8. Library in the Château Malmaison, France, 19th century. Percier and Fontaine, architects
9. Petit Trianon, Versailles, France, 18th century. Erected by Louis XV. for Madame Dubarry, and later a favourite residence of Marie Antoinette. The entrance façade is a typical example of the late French Renaissance style. Ange Jacques Gabriel, architect

Giov. Battista Piranesi (1720–78), with his excellent reproductions of the buildings of the antique and the Renaissance periods, has had a great influence on the direction of taste Giuseppe Valadièr (1762–1839) was active as an archaeologist and architect in a severe classical spirit during the Napoleonic era. At this time the building of theatres received an extraordinary amount of attention in Italy, Teatro della Scala in Milan by Giuseppe Piermarini (1734–1808) and Teatro St. Carlo in Naples by Antonio Niccolini being striking examples. The most characteristic ecclesiastical buildings of this time are the church in Possango by Antonio Selva (1753–1819), and the St. Francesco di Paolo in Naples by Pietro Bianchini.

During this time Denmark was artistically the leading country in Scandinavia and had excellent representatives in Christian Fredrik Hansen (1756–1845) and Michael Gottlieb Bindesböll (1800–56) of the refined, national new Danish classicism. Hansen's leading works were Christiansborg castle in Copenhagen (destroyed by fire) and Vor Frue church in Copenhagen. In Thorwaldsen's museum Bindesböll created an original and beautiful monument to the most celebrated sculptor of his time in northern Europe. The Dane Theophil Hansen (1813–91), who built the university in Athens and the house of parliament in Vienna, won international fame.

The Later 19th Century.—Continental architecture presents a varied picture during the latter part of the 19th century. The fashionable styles succeeded each other rapidly and academical architectonic education was mainly concentrated on imparting to the pupil an easy proficiency in the use of all these so-called "historical styles." This schematic doctrine of styles is the product of one-sided and to some extent imperfect knowledge of the history of architecture. Through its self-sufficient belief in its capability to judge what is right and suitable in each style, it has caused great and irreparable damage in the restoration of old buildings, a favourite occupation of the period.

The inability of the 19th century to solve its building problems in an independent manner is probably partly explained by the furious tempo at which building activity developed during this time. The larger towns especially grew with a speed hitherto undreamed of, and during the latter part of the century the problems of town planning therefore became acute. The 19th century did considerable preparatory work in this field, of which we are now enjoying the fruits. Many building problems arose which demanded an architecture of a totally different kind from the traditional. This was especially the case with industrial buildings, the great stores, railway stations, bridges, and skeleton buildings of many kinds. It is only in a few cases that the 19th century can show final solutions in these spheres, but by zealous experiments the way was nevertheless prepared for a new and more homogeneous art of building. At the exhibitions, which were so usual in this century, there was a great predilection for the new technical creations, and these exhibitions have therefore given interesting examples of what technique has been able to accomplish at different times.

Only a few of the great number of architects active during this time can be mentioned here. France has in Viollet-le-Duc (1814–79) a prominent representative of the scientific art of restoration, who occupies a leading position on the Continent. Charles Granier (1825–98) created a sumptuous edifice in the great opera house in Paris, which aroused enormous admiration amongst contemporaries. The Eiffel tower, erected by Gustave Eiffel for the Paris exhibition in 1889, has met with more criticism but has perhaps exercised a deeper influence on subsequent architecture. Germany has a refined and independent architect in Gottfried Semper (1803–79), who works in the spirit of the Renaissance. Alfred Messel (1853–1910) shows in his buildings, such as Wertheim's stores in Berlin, a free adaptation of historical styles to modern purposes. In Italy—roused to new life by her political independence—a lively building activity was developed during the latter part of the 19th century. The Galleria Vittorio Emanuele by Giuseppe Mengoni (1820–77) is a characteristic example of the generously planned Italian building projects. At the turn of the century representatives appeared in Austria, Holland and Switzerland of new tendencies, which, however, were not fully developed until the 20th century. Denmark still retained its leading position amongst the Scandinavian countries. This country, by maintaining a sound and moderate tradition, forms a point of departure for the national re-creation of architecture which is taking place in the northern countries at the beginning of the 20th century. The town hall in Copenhagen by Martin Nyrop (1849–1921) is the best example of this style.

See W. H. Ward, *The Architecture of the Renaissance in France* (1912); R. T. Blomfield, *A History of French Architecture, 1494–1774* (1921); P. Franke, *Die Entwicklungsphasen der Neueren Baukunst* (1914); J. Burckhardt, *Geschichte der Renaissance in Italien* (5th ed., 1912); G. von Bezold, *Die Baukunst der Renaissance in Deutschland, Holland, Belgien, und Dänemark* (1908); G. A. Platz, *Die Baukunst der Neuesten Zeit* (1927); Le Corbusier, *Towards a New Architecture* (trans. from 13th French ed., 1927); Robertson and Yerbury, *Examples of Modern French Architecture* (1928); Hajos, E. M. and Zahn, *Berliner Architektur der Nachkriegszeit* (1928); *Encyclopédie de L'Architecture, Construction Modernes*, vol. i. (1928); Mieras and Yerbury, *Modern Dutch Architecture of the 20th Century* (1926); Stahl, Fritz, *Neue Werkkunst German Bestelmeyer* (1928). (H. Ah.)

ENGLAND

The architecture of England during the 18th century covers a longer period than commonly supposed. It begins with the school of Sir Christopher Wren and his contemporaries (*see* RENAISSANCE ARCHITECTURE) and extends to the period of the Regency. Resting upon the broad foundation prepared in the late 17th century it became subject to many external influences but in general remained constant to the classicism of the age. The classic viewpoint may be said to have dominated all the arts and to this cause can be attributed the remarkable consistency of style which is the chief characteristic of the buildings of the time. Between the years 1700–1800 the population increased from five to eleven millions, steam-power was harnessed and commerce was almost quadrupled. The impetus given to architecture began with the Revolution of 1688, when direct governance fell into the hands of the Whig Party. From thence onwards statesmanship became more closely allied with commercial advantage, the nation changed its chief industry from agriculture to manufacture and a redistribution of the people was in progress. Throughout the period architects appear to have expressed the new conditions with due regard to the spirit of the age. Broadly speaking the buildings group into two main divisions, *i.e.*, monumental and domestic. In the main the tendencies were academic, and were related to similar impulses then in action on the Continent. English architecture, however, developed its own characteristics. The architects were continually seeking fresh inspiration from Italy and, at a later date, Greece. While this is true of the monumental aspect of certain buildings, the repose which is the chief attribute of the domestic architecture can be traced more directly to the Anglo-Dutch tradition instituted by Wren. In addition, craftsmanship based upon mediaeval practice, and the persistence of regional traits, gave added piquancy to the vernacular style. It was not until the close of the first quarter of the 19th century that the old system began to be crushed out. On the monumental side the completion of St. Paul's cathedral and Greenwich hospital in the reign of Queen Anne, and the building of several new churches, terminated the immediate influence of Wren and Hawksmoor. Then ensued a transference of architectural energy to the erection of princely mansions in town and country expressing the sound status of the leaders among the Whig Party.

Sir John Vanbrugh, famed as a dramatic author, now came into prominence as an architect. To his care had been entrusted the naval buildings at Plymouth dock. He found further scope for his theories of vast scale at Castle Howard, Blenheim palace and Seaton Delaval. Vanbrugh was influenced not only by the work of Sir Christopher Wren but by contemporary French work, and the designs of Daniel Marot. His pupil Thomas Archer created St. Philip, Birmingham, and the temple at Wrest park, Bedfordshire. Vanbrugh forms the chief link between the school of Wren and the coterie of early 18th century architects who favoured the style of Palladio, and the revival of the style initiated in the previous century by Inigo Jones. James Gibbs is another link. In this case the Palladian influence is carried on to the work of

Sir William Chambers. Gibbs is renowned for the church of St. Martin-in-the-Fields and the Radcliffe library at Oxford, as well as for country and town houses. By the year 1730, building on the great scale had definitely turned to Palladian and Roman doctrines. William Kent was engaged on Holkham hall, Norfolk, and Devonshire house, London. The amateur had entered the lists, and the earl of Burlington was looked upon as the chief patron of the arts. The extent of the revived Palladian movement can be judged from the character of the villa at Chiswick (1729, a modification of the Villa Capra, Vicenza), Mereworth castle, Kent, Houghton hall, Norfolk (the seat of Sir Robert Walpole), and Prior park, Bath, by John Wood.

The fashion of the "Grand Tour" and the acquisition of antique statuary both contributed to the passion for authentic classicism, and it was not long before architects followed in the steps of the rich patrons to Rome. Henceforword two factors determined the status of an architect, *i.e.*, travel in Italy and the publication of a work on architecture. The folio works edited by Leoni, Ware, Gibbs and Chambers had the immediate effect of reducing architectural design to a mere repetition of rules. Another influence was the founding of the Society of Dilettanti which resulted in the extension of classical research to Greece. While the building of great palaces belongs more especially to the first half of the century, the practice was continued to the end of the period. In the works of Sir Robert Taylor, Robert and James Adam, Sir William Chambers and Carr of York is evidenced an extension of private palace building on a diminished scale. In this regard the Palladian type can be regarded as dominant.

Types of Buildings.—The social conditions of the period are reflected in the development of town planning (*see* Town and City Planning), more especially in the Squares of London, the stately streets of Bath and the New Town of Edinburgh. Although the bulk of early 18th century architecture consisted of private mansions there was also scope for new types of public buildings (*see* Governmental Architecture), of which in London the Bank of England, designed by Sampson and later remodelled by Sir Robert Taylor and Sir John Soane, was the chief. Other official buildings include the Mansion house, by Dance the Elder; the Admiralty, Whitehall, by Ripley; the Horseguards, by Kent; and South Sea house. In various cities outside London town halls were built, as at Liverpool (1754) by John Wood, Bristol, Doncaster, Warwick and Salisbury. The Georgian theory of civics included hospitals such as St. Bartholomew's, by James Gibbs, St. Luke's by George Dance the younger, prisons such as Newgate, guildhalls and lawcourts. The principal Government buildings were erected in the second half of the century. The exponent of the matured Roman Palladian style was Sir William Chambers, a worthy associate of Reynolds and Dr. Johnson. The design of Somerset house ranks among the first works of the second half of the period in London. For this building Chambers evolved a majestic river frontage rising by terraces direct from the water line. The detail shows the influence of contemporary French taste, particularly the works of Neufforge and Gabriel. Broadly speaking the work of James Gibbs can be regarded as the basis upon which the Chambers manner was modelled. Robert Adam, in collaboration with his brother James, contributed an elegant rendering of classical detail for his graceful designs, but by contrast with the works of Sir William Chambers the buildings he erected are effeminate. In the hands of Carr of York, James Gandon and Harrison of Chester the Roman Palladian expression was continued. Dublin owes its monumental buildings chiefly to Gandon. These latter include the Customs house, the Four Courts and the Kings Inns. Following the leading architects a host of lesser men were adding to the pronounced classicality. Architectural taste was influenced by the publication of folio volumes of designs, Builders' Guides, and other works related to architecture, which had the beneficial effect of restraining eccentricity. The whole tendency towards standardization exactly suited the requirements of the time.

Decline of Palladianism.—Towards the close of the century the Roman Palladian school showed signs of abating interest. True, its principles had been vindicated by the younger Dance in the design of Newgate, but newer forces were becoming active. Architects and patrons now took notice of Greek detail and paid attention to "Stuarts Athens." The Brothers Adam had already exploited Greek detail, for stucco enrichments, but it was left to Henry Holland to imitate a formal Graeco-Roman manner. The most original designer, however, was Sir John Soane. Soane began by following the work of the Adam brothers; he had been employed in the offices of Dance and Holland; later, acting on the advice of Sir William Chambers, he gave attention to the designs of Piranesi. When Soane was commissioned to rebuild the Bank of England he revolutionized the older school of thought by evolving detail for which there was no precedent.

Reviewing the monumental character of English architecture, from the period of Vanbrugh to that of Soane, it becomes clear that the academic issues had been taken to a point beyond which it was impossible to go. At the end of the 18th century the modern spirit was in the ascendant. The example of the French Revolution, the rise of trade and the emergence of a vigorous middle class, pointed the way to vaster developments. Soane had almost prophetic vision, and he became professor of architecture at the Royal academy, training many private pupils. In the first quarter of the 19th century there ensued a further merging of Palladian tendencies with Greek detail. The "metropolitan improvements," engineered by John Nash and the Committee of Taste, were for the most part stuccoed conventions.

NINETEENTH CENTURY

The 19th century from first to last was a period of style exploitation and pictorial experiment. The reason for the change is associated with the enormous development of manufactures. At the close of the reign of George IV. the country had passed from agriculture to intensive industry. Town life formed a magnet denuding the country-side of its rural population. The middle classes had become firmly established and participated in national affairs. The problems of housing and cheap food were foremost. It is not surprising, therefore, that the traditional handicrafts lost caste. The new economic conditions demanded mass production, the old values deteriorated, and revivals of historical styles became inevitable. The growth of cities, seaports and manufacturing centres, called for buildings of complex character. The administration of the country required public edifices (*see* Governmental Architecture), education needed schools, religion appealed for new churches and conventicles (*see* Religious and Memorial Architecture). Civil engineering, at first associated with docks, highways and railroads, led to the rise of a coterie of engineers, among whom Rennie and Telford were prominent.

From 1800 to 1830 the art of architecture in many particulars fulfilled the moods of the late 18th century. There was an extension of the Greek school, which had been adumbrated as early as 1770. But the ambitions of the classicists, who had developed a bias towards academic Greek, were in process of being checked by the romantic group, who favoured revived Gothic. Although the "battle of the styles" was never brought to a conclusion, classic remained in the ascendant. On the classic side the stimulus of Greek, Roman and Italian motives continued almost *pari passu* with the revival of English and French Gothic. At the time of the Great Exhibition of 1851 the divisioning was definite. On this showing one aspect of early Victorian art can be traced to the influences in vogue at the time of the Regency. After 1851 the classic school had recourse to emulation of contemporary French Neo-Grec, to imitation of old Italian models and later to revivals of the domestic architecture current in the reigns of Queen Elizabeth and Queen Anne. The interest aroused in 18th century social life, especially by the writings of Thackeray, foreshadowed the Georgian revival characteristic of the last decade of the 19th century. Little more than 50 years separates the "artistic '80s" from the period of the "metropolitan improvements" which were the triumph of Nash and the Committee of Taste. From 1840 onwards the development of lithography, engraving and photography made familiar to all classes the pictorial qualities of historical architecture.

Steel and Tradition.—Among the Victorian architects the

BY COURTESY OF (6) THE DIRECTOR OF GREENWICH HOSPITAL, (7) F R. YERBURY, PHOTOGRAPHS, (1, 5, 8, 9, 11) FRITH AND COMPANY, LTD, (2) HARVEY BARTON, (3) STEWART BALE, (10) UNDERWOOD PRESS SERVICE, (12) D MCLEISH

BRITISH ARCHITECTURE OF THE 18TH AND 19TH CENTURIES

1. The four Courts, Dublin, (1776–86), James Gandon, arch't. 2. Bank of England Buildings, Bristol (1844), Prof. C. R. Cockerell, arch't. 3. St. George's Hall, Liverpool (1839), H. L. Elmes, arch't. 4. Town Hall, Halifax (1862), Sir Charles Barry, arch't. 5. The Radcliffe Camera, Oxford (1739–49), James Gibbs, arch't. 6. Greenwich Hospital, London (1617–1814); commenced by Inigo Jones, completed by Wren and others. 7. St. Martin's-in-the-Fields, London (1722), James Gibbs, arch't. 8. Somerset House, London (1776–86), Sir William Chambers, arch't. 9. Harewood House, near Harrogate (1760). "Carr of York," arch't. 10. View from the choir of the new nave of St. Saviour's Cathedral, Southwark, built in 1891–96 from designs by Sir Arthur Blomfield. 11. Truro Cathedral, begun in 1880. J. L. Pearson, arch't. 12. Dorchester House, Park Lane, London (1851), Lewis Vulliamy, arch't

aim was to compete with the masterpieces of the past and to reconcile the age of steel with the time honoured styles. The use of cast iron and steel as a basis for construction enabled greater spans to be attempted. Such frameworks gave scope to engineers, and called for ingenious veneerings of historical detail. Apart from the Crystal palace, and the iron and glass vaults over railway stations, the result was one-sided. The feverish craze for pictorial accomplishment obscured the benefits of structural statement. So far as monumental and civic buildings were concerned architects based their projects upon Greek, Roman and Italian prototypes. The exponents of Greek were H. W. Inwood. who designed St. Pancras Church, London, to include features from the Erectheum and the Tower of the Winds; William Wilkins, who contributed University college, London; Sir Robert Smirke, who designed the British Museum, and the post office; and Decimus Burton, who designed the screen at Hyde park corner, and the Athenaeum club. George Basevi favoured the Graeco-Roman style, his chief work being the Fitzwilliam Museum, Cambridge. The finest classic building of the first half of the century, St. George's hall, Liverpool, was erected by Harvey Lonsdale Elmes; this building, conceived on Graeco-Roman lines, owes its detail to the skill of Professor C. R. Cockerell.

Neo-Grec.—By the year 1850, more enlightened theories were in the ascendant; it was realized that neither academic Roman nor Greek entirely suited civic art. Fresh inspiration came from the Neo-Grec revival which was being pursued in France, under the leadership of Louis Duc, and Labrouste, and in Germany under Schinkel. As a style neo-grec found a worthy exponent in Prof. Cockerell, whose researches in Greece and Italy fitted him to combine academic knowledge with respect for the works of Wren and the whole gamut of the English classical tradition. Cockerell's buildings include the Taylor Institution, Oxford, the Sun Fire Office, London, branches of the Bank of England at Liverpool, Manchester, Bristol and Plymouth, and the remodelling of Soane's attic storey to the Bank of England in Threadneedle street.

Italianate.—Another section of the classic school entered upon an Italianate phase. For example Sir Charles Barry favoured astylar façades. His designs for the Travellers club, the Reform club and Bridgewater house, London, were thought to be admirably suited to their several purposes. Other exponents of the Italian school were Sir James Pennethorne, Philip Hardwick and Sir Gilbert Scott. This coterie designed, respectively, the Geological museum, London, the Great Hall at Euston station, London, and the Government offices, Whitehall, London, comprising the home, colonial, foreign and India offices. Another Italianate building, Dorchester house, London, designed by Lewis Vulliamy, as frankly a copy of the Villa Farnesina, Rome; much of the interior decoration was contributed by Alfred Stevens.

Later Developments.—In the second half of the 19th century the development of commerce demanded newer types of warehouses, banks, assurance offices and town halls. As a result the Italian style gained fame. Two other buildings remain to be considered; *i.e.*, the Science college, South Kensington, and the Albert hall, London. These buildings, conjointly the work of Capt. Fowke, Gen. Scott and various architectural assistants, are good examples of ordered but free classic. In the work of "Greek" Thomson and Hibbert of Preston, there is evidence of a later revival of Neo-Grec. A freer version of monumental classic begins with the work of Norman Shaw, James Brydon, John Belcher and Sir Reginald Blomfield. From thence to the present time the tendency has been towards classical scholarship combined with invention. In this the influence of the Ecole des Beaux Arts (*see* ARCHITECTURAL EDUCATION), is paramount.

The Gothic Revival.—The beginnings of revived Gothic can be traced to the 18th century. The founding of the Society of Antiquaries, the monthly periodical magazines and the curious taste of Horace Walpole at Strawberry Hill prepared the way for Fenthill and the remodelling of Windsor castle. In the late 18th century many cathedrals and churches became the subject of churchwarden repair. From 1800 onwards the subject of mediaeval art forms the background of fashionable novels; Jane Austen touches upon Gothic art in *Northanger Abbey*, and later Sir Walter Scott, Goethe and Victor Hugo made the subject popular. The mediaeval movement also found support at the hands of the Church. As a result, by the middle of the 19th century, there ensued a phase of church restoration and building based upon an analytical study of authentic examples of Gothic Architecture.

The subject of Gothic art also claimed exponents among the acknowledged leaders of the classic school. For example, Professor Cockerell designed Lampeter college, and Sir Charles Barry, beginning with Birmingham grammar school (1833) gave Gothic verticality to the classic plan of the palace at Westminster. In this design Barry was assisted by Augustus Pugin whose extraordinary knowledge of Gothic detail was unrivalled. Indeed, Pugin, who held almost fanatical views on the subject of what he termed the "Christian" style, was the moving spirit in the Gothic revival. His own work included 65 churches in the United Kingdom. His chief work is St. Georges cathedral, Southwark. Philip Hardwick, whose fame rests upon the classic hall at Euston station, was responsible for the eminently successful hall and library at Lincolns Inn. Both Sir Charles Barry and Philip Hardwick favoured a modern version of Tudor Gothic; other revivalist architects at the time concentrated upon Early English or Decorated Gothic (*see* GOTHIC ARCHITECTURE). The work of Sir Gilbert Scott covers the period 1846–77; he built St. Giles, Camberwell; St. Mary Abbotts, Kensington; St. Mary's cathedral, Edinburgh; St. Pancras station, London; Glasgow university and many other large buildings. He was concerned with the restoration of many old churches, and has been censured for the design of the Albert memorial. William Butterfield and W. Burgess gave their attention to colour, and sought to modernize the Gothic spirit. Burgess designed his own dwelling, Tower House, Melbury road, Kensington; and he left innumerable designs for furniture. In the career of G. E. Street is evidenced the ultimate phase of the revivalist movement; the Royal Courts of Justice, London, 1874–82, rank as the last attempt to apply Gothic to a great public building; Street was conversant with Continental Gothic, and although he was cramped by an awkward site in Fleet street, and suffered interference from the lawyers, he overcame many difficulties. The work of John Loughborough Pearson is exemplified in the following London churches: St. John, Red Lion Square; St. Augustine, Kilburn; and the Catholic Apostolic church, Maida Hill; in addition to extensive repairs at Westminster abbey, Pearson designed Truro cathedral, a building which suffers from diminutive scale but whose details are faultless.

Out of the ruck of revivalism the practice of Gothic art emerged into a clarified atmosphere. A new coterie consisting of James Brooks, G. Gilbert Scott, J. Oldrid Scott, G. F. Bodley, John Bently and Sir Arthur Blomfield, became responsible for a series of churches and college additions of great merit. Even towards the close of the 19th century revived Gothic had not lost caste. At the hands of J. D. Sedding, H. W. Wilin and Leonard Stokes, the tradition was continued with varying success. The new Cathedral at Liverpool by Sir Giles Gilbert Scott is to be considered a fitting climax to the Gothic movement. This building, begun in 1903, is remarkable for its masterly plan and monumental character. The great double transepts, the mighty scale and the simple detail, contrasted with the beauty of the Lady Chapel, form an ensemble exactly suited to the magnificent site.

BIBLIOGRAPHY.—Colin Campbell, J. Woolfe and J. Gandon, ed., *Vitruvius Britannicus* (1715–71); I. Jones, *The Designs of Inigo Jones*, (1727); J. Gibbs, *Book of Architecture* (1728); R. and J. Adam, *Works in Architecture* (1778–1822); G. H. Birch, *London Churches of the XVII.th and XVIII.th Centuries* (1896); J. Belcher and M. E. Macartney, *Later Renaissance Architecture in England* (1897, 1901); R. Blomfield, *A History of Renaissance Architecture in England* (1897); A. E. Richardson and C. Lovett Gill, *London Houses from 1660 to 1820* (1911); A E. Richardson, *Monumental Classic Architecture in Great Britain and Ireland* (1914); T. A. Gotch, *The English Home from Charles I. to George IV.th* (1918); A. Bolton, *The Architecture of R. and J. Adam* (1922); A. E. Richardson and H. D. Eberlen, *The Smaller English House of the Later Renaissance, 1660–1830* (1925). (A. E. R.)

AMERICA

On the founding of the British colonies in the wilderness of North America the first dwellings were like the "frail houses," made of wattle, clay and thatch, which still sheltered the farm labourers and copyholders in England. The first church at Jamestown was "set upon cratchets"—forked sticks set in the ground —"covered with rafts, sedge and earth." Such primitive shelters were the "English wigwams" of early chroniclers, by no means like those of the Indians. At Plymouth and elsewhere, lines of stakes or hewn planks were driven into the ground to make "palisaded houses." The log-house, of horizontal logs notched together at the corners and chinked with clay, was unknown in England, and was brought in by the Swedes of the Delaware, to whom it had been the ordinary form of dwelling at home. Its suitability to conditions in the densely forested new country soon led to its adoption by the English colonists, and it later became the typical form of frontier dwelling.

Meanwhile, soon after the first settlement, the building of frame houses had begun, few at first, for the leaders. The filling of the "half-timber" frames with wattle or cat-and-clay was soon found inadequate to withstand the severe climate, and was covered with weather boards, as used in Kent. Thirty years after the settlement the ordinary farmer or artisan had such a house of a single room below, a storey and a half in height; the divine or magistrate, one of two storeys and a half, with two rooms to a floor, and often with a "lean-to" extension at the rear. Glass windows now became common, chimneys of masonry replaced those of clay, and shingle roofs rapidly took the place of thatch. The general dearth of lime made it difficult to build with brick or stone, and these were but gradually adopted, except in Pennsylvania, where lime and a fine ledge stone were both abundant.

The artistic character of the 17th century buildings in America remained that of rural England at the time the colonists left, a simple Jacobean style in which mediaeval survivals predominated. Steep gabled roofs, leaded casement windows, high, clustered chimney stacks and exposed construction are characteristic elements of the effect. In the more elaborate wooden houses of New England, the upper storeys often overhung the lower, as in the old English houses of timber. Among the finest examples surviving are the House of the Seven Gables in Salem and the Parson Capen house (1684) in Topsfield, Mass. In the early plantation houses of Virginia there were more ambitious attempts at a Jacobean character: Bacon's Castle (before 1676) with cross-shaped plan and with curved and stepped gables; Fairfield (now destroyed) with the H plan traditional in England under Elizabeth and James I.

In the South, loyal to the Established Church, the churches continued the type of late Gothic English parish church with a square tower at the west. The earliest of them, at Jamestown and Smithfield, still had projecting buttresses and traceried windows. In New England the Puritan meeting-house followed the scheme of the dissenting chapel, with pulpit on one of the long sides, galleries around the other three. They were of the utmost plainness, strongly framed, with roof on curved braces, as we see in the "Old Ship" at Hingham, Massachusetts.

Eighteenth Century.—The opening of the 18th century brought the adoption of the forms of academic architecture, introduced in England by Jones and Wren (*see* RENAISSANCE ARCHITECTURE). While retired farmhouses still kept the high gable and other features surviving from the middle ages, the houses of leaders such as Keith and Logan in Pennsylvania, Hancock in Boston, or William Byrd in Virginia showed the classic cornice, the mantelpiece framed by mouldings or the adornment of doorways by the classic orders. The abundant forms of the Baroque (*see* BAROQUE ARCHITECTURE) appeared in the scrolls of the pediments which crowned doorway and overmantel, while the classic spirit of order and repose brought in the balanced plan and the continuous horizontal cornice all about the lowered roofs. At first there was great simplicity in the wall surfaces, which relied only on uniformity, proportion and the fine texture of brick, ledge-stone, clapboard or shingle.

By the middle of the century there was some attempt at more monumental treatment, even in the house. Tall pilasters marked the corners and the centres, or stood all about. In a few houses on the eve of the Revolution—Drayton's Palace and the Brewton House in Carolina, Monticello, the home of Jefferson, and Lansdowne, that of Gov. John Penn—storeyed porticos rose one above another at the front.

This trend toward a modest grandeur was more clearly evident in the churches. Those of the Church of England in the colonial capitals, like St. Philip's and St. Michael's in Charleston, Christ church in Philadelphia and King's chapel in Boston. These had columned interiors and steeples like those of Wren's churches in London; some even had the great external portico brought in by Gibbs' St. Martin in the Fields.

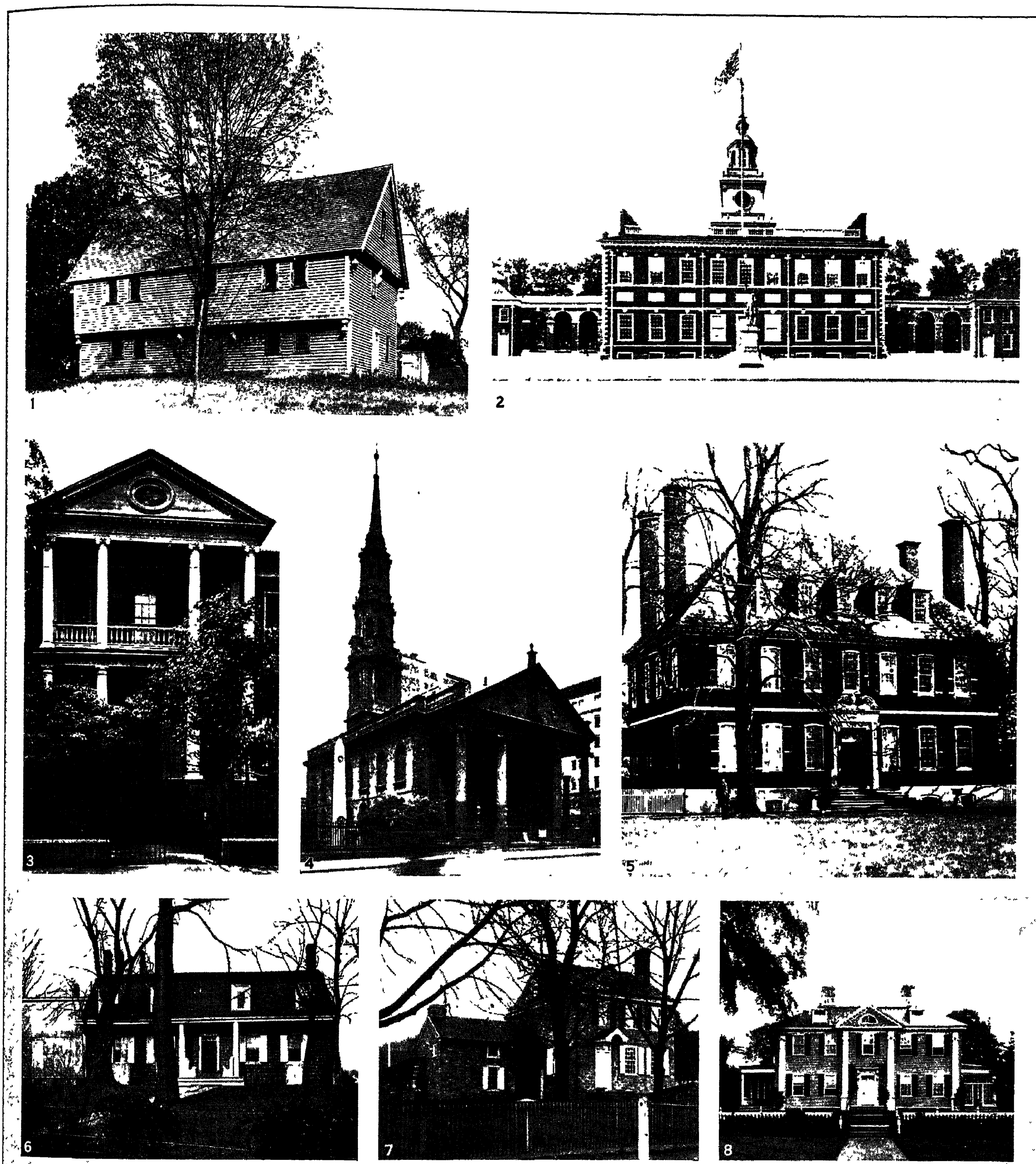
With the increasing power of the colonial assemblies, public buildings began to assume importance and pretentions. Independence hall, the old Pennsylvania State house, stands as the type of the earlier ones, still half-domestic in character. The painter Smibert in Faneuil hall at Boston and the gentleman-amateur Peter Harrison in the town hall at Newport, with their arched and pilastered fronts, set new standards of conformity to the old world.

In the domestic interiors (*see* INTERIOR DECORATION) just before the Revolution the Chippendale vogue brought in the *rocaille* ornament of Louis XV., appearing in the carving of chimney-pieces, the ornamentation of plaster ceilings with delicate leafage and tattered shell, as at the Phillipse Manor in Yonkers, at Westover on the James River and elsewhere.

These were mansions in which the ideal was conformity to current English usage, and the achievement was comparable to that of the smaller houses of gentlemen in the English shires. Far more racily American were the provincial types of the byroads, lagging behind the march of progress. The wooden New England farmhouse with its roof extended to the northern storms by a long lean-to and rambling sheds, the "Dutch colonial" type about New York with low gambrel roof and wide overhanging eves; the Pennsylvania houses of stone, hooded, perhaps, above the lower storey, the cottages of rural Virginia with their tall chimneys and detached outbuildings, are vernacular or dialect types purely American in their development.

More distinct still are the stone houses of the French in Quebec, the stuccoed and whitewashed walls of the few Spanish buildings in Florida, the French and Spanish buildings of Louisiana, with their formal ordonnance, the Spanish missions of the south-west. Here, after beginning with structures of the simplest adobe, the Jesuits brought in, at the missions of San Antonio, some of the fire of Churriguerra; the Franciscans of California carried on a chastened Spanish tradition into the 19th century.

The Revolution brought new problems and new ideals. A new type of legislative building was to be created; institutional buildings had to be reformed in accordance with democratic and humanitarian principles. There was the wish to throw off provincial dependence on British style, yet to retain the respect of foreign observers. Jefferson (1743–1826) established the new artistic direction when, long before Napoleon's Madeleine, he chose the Maison Carrée as the model for the Virginia capitol (1785). The architecture of the early Republic was turned into a classical and monumental channel. In building the new city of Washington (1791 ff.) for the Federal Government great efforts were made to surpass the colonial capitals. L'Enfant (1754–1825), a French engineer, laid out the town on suggestions from Versailles, Hallet, a French architect of the highest professional training, created the type of modern legislative building with wings for the two chambers and with a tall central dome. Hoban (*c.* 1762–1831) an Irish master-builder, modelled the president's house, the White House, on the great British Georgian mansions, and Jefferson gave it, during his presidency, the tall circular portico to the river. In New York Mangin, another Frenchman, gave the design for the City Hall (1803–12) a work purely Gallic; in Boston, Bulfinch (1763–1844), a native amateur, soon to become professional, suggested the fronts of the Place de la Concorde beneath the dome of his



BY COURTESY OF (8) THE ESSEX INSTITUTE, PHOTOGRAPHS (1) COPR THE TOPSFIELD HISTORICAL SOCIETY, (5) H. P. COOK

AMERICAN ARCHITECTURE IN THE 17TH AND 18TH CENTURIES

1. Parson Capen house (1683), Topsfield, Mass. Example of the more elaborate wooden house of New England of the 17th century, in which the upper storeys overhung the lower
2. Independence Hall, the old Pennsylvania State house, at Philadelphia. Type of the earlier American public building
3. Portico of the Brewton house, Charleston, South Carolina, built in the middle of the 18th century; showing the attempt at more monumental treatment
4. St. Paul's Chapel, New York city (1764–66, steeple, 1794). McBean, architect
5. Westover on the James River, Virginia (1730). In mansions of this character the ideal was conformity with the current English style
6. Brinckerhoff House, Hackensack, New Jersey
7. Washington's Headquarters at Valley Forge, near Philadelphia
8. John Vassell (Longfellow) House, Cambridge, Mass. (1759)

BY COURTESY OF (2) THE ESSEX INSTITUTE, (4) THE PUBLIC LIBRARY, BOSTON; PHOTOGRAPHS, (3) ROGER MILLEN, (6) EWING GALLOWAY

AMERICAN ARCHITECTURE IN THE 18TH AND 19TH CENTURIES

1. The Manning House, Providence, R.I.
2. John Reynolds (Morris) House, Philadelphia, 1768
3. Monticello, Albermarle County, Virginia. Home of Thomas Jefferson, 1769–1809. The monumental portico, which was sponsored by Jefferson, was a type used widely in the architecture of the South of this period
4. Public Library of the City of Boston, 1888–95. McKim, Mead and White, architects
5. Wainwright building (steel frame), St. Louis, 1890. Louis Sullivan, architect
6. Trinity Church, Copley Square, Boston, 1872–77. H. H. Richardson, architect

State house (*see* Governmental Architecture).

In domestic architecture the modern comfort invented under Louis XV. came in at the same time with the classic style. The oval salon *à la française* was adopted in the White House and the homes of many leaders in politics and fashion. In the North it was the delicate Adam versions of classical ornament which prevailed in the houses of Bulfinch, McIntire, McComb and Thornton; south of the Potomac the monumental portico sponsored by Jefferson at Monticello and the University of Virginia (1817–1825) adorned the great houses of the Piedmont.

Greek Revival.—The Greek revival came hard on the heels of the Roman. The leader was Benjamin Henry Latrobe (1766–1820) who had learned his Greek details in England but got his stimulus toward bodily imitation of the temple from the American laymen and amateurs, now filled with a sophomoric enthusiasm for antiquity. His Bank of Pennsylvania (1799) was the beginning, his Bank of the United States (1819–24), now the Philadelphia Custom House, an imitation of the Parthenon, was the culmination of the movement. His pupils Mills and Strickland rang the changes on the classical motives, as in Mills' great colonnade of the Treasury, and his Washington monuments in Baltimore (1815 ff.) and Washington (1836 ff.), a great Doric column (antedating the similar monuments abroad) and a vast obelisk. Churches and houses likewise followed the type of the temple, which became a single unconditional ideal for all classes of buildings. The white porticos rose alike in the whaling ports of New England, on the banks of the Delaware, the Potomac and the distant Ohio, and on the borders of the Great Lakes and the Gulf. Their tradition lingered until the Civil War.

Gothic Revival.—In the '30s it was already beginning to be undermined by the growth of romanticism. Jefferson and Latrobe had already toyed with the Gothic as an alternative. Downing, the landscape gardener, and Davis, his architect collaborator, used it with greater conviction. Newcomers from England like Richard Upjohn (1802–1878) designer of Trinity church in New York, brought a new knowledge and competence. The enthusiasm of Ruskin made a Victorian Gothic universal in churches, and drew civil architecture into the Gothic orbit. Later disciples of romanticism like Cram and Goodhue added the element of craftsmanship, on the stimulus of William Morris.

Eclecticism.—Meanwhile the widening historical horizon had evoked in America, as in Europe, a general eclecticism, a choice of many styles but half understood. The brilliance of the Second Empire gave vogue to the mansard roof; the influx of the Germans brought the floridity of the northern Renaissance; the Centennial Exposition, the English Queen Anne. For a moment in the '80s Henry Hobson Richardson (1838–1886) carried all before him with his free and virile version of southern Romanesque, first embodied in Trinity Church in Boston. Richard Morris Hunt (1827–1895), who had led the way to study at the École des Beaux Arts, introduced its system of instruction (*see* Architectural Education), and adopted the style of the Valois châteaux in his great Fifth avenue houses and country palaces, like Biltmore, N.C., for the new American plutocracy. While suggestions from early American buildings were taken up by McKim and others who inaugurated a Colonial revival, and the local traditions of Florida suggested to Carrère and Hastings a Spanish style, many of the students returning from Paris remained faithful to the style of the Louis.

Steel.—In the midst of these historical reminiscences science and industrialism were evoking new materials and modes of construction. The fruitful exploitation of iron came, along with the elevator, in the high office buildings, which the absence of legal restrictions allowed to rise on the preferred urban sites. At first these were amorphous structures of self-supporting external masonry walls, interior columns of cast iron, and beams of rolled iron, as in that of *The World* in New York, over 300 ft. As they grew higher and higher, the thickening of the walls compromised the rental value of the lower storeys. In the Home Insurance building designed by William LeBaron Jenny in Chicago in 1883, the idea came of supporting the walls, as well as the floors, on the frame. Soon the structural type was crystallized by the adoption of a steel frame, riveted throughout. The last hindrance to ascent was swept away, the skyscraper appeared. (*See* Architecture.)

The idea of finding in this new structural development the key to a new and modern style grew out of the rationalistic architectural theory of Viollet-le-Duc and Semper. It was Louis Sullivan (1856–1924), of Chicago, who had the creative imagination to clothe the steel frame of the high building in new functional form. Its loftiness he accented by vertical lines replacing the old wall surfaces of masonry. His Wainwright building in St. Louis, designed in 1890, was the manifesto of a new school, and had an influence far beyond his own partisans.

Neo-classicism.—Against Sullivan's equation of beauty with truth, his structural emphasis, the New Yorkers led by Charles Follen McKim (1847–1909) and Stanford White (1853–1906) sought to re-establish the independence of art through abstract beauty of form. Like worshippers of form in many earlier periods, they turned again to the Roman alphabet, but their work is not to be regarded merely as one more historical revival among many. They reaffirmed a unity of style, as well as a unity in the single work, ignoring the temptation to characterize and differentiate minor elements. The long unbroken fronts of McKim's Boston library (designed in 1888), with its uniform arcades, was the first work in this vein to seize public attention.

The cohorts of function and of form met on the battlefield of the Chicago World's Fair in 1893. The Westerners, with one exception lost themselves in a variety of historical reminiscences. Sullivan, in his Transportation building, glowing with colour and gold, sought to create a new expressive idiom of detail and ornament, but he stood alone. The Eastern men made common cause in unifying their buildings about the Court of Honour. The sheds of steel and wood disappeared behind ordered white colonnades whose justification lay only in their own harmony. The cumulative effect was overwhelming, and was deeply branded on the memory of the nation.

In the remaining years of the decade its whole architecture turned again to classic unity of form, finding a sanction in the works from the formative period of the Republic. The great formal groups for Columbia and New York universities, dominated by their domed libraries, recalled Jefferson's initiative at the University of Virginia. The banks reverted to the models of Latrobe; the triumphal arch and column were revived as types of monuments. Domestic architecture followed Colonial or Italian suggestions, with gardens (*see* Landscape Architecture) once more formal in design. With the plans for the improvement of Washington, developing the neglected conceptions of L'Enfant, at the turn of the century, the artistic ideals of the founders were re-established. (For current work *see* Architecture.)

Bibliography.—Books concerned with the whole history of American architecture are: L. Mumford, *Sticks and Stones* (1924); T. F. Hamlin, *The American Spirit in Architecture* (1926); T. E. Tallmadge, *The Story of Architecture in America* (1927); F. Kimball, *American Architecture* with full bibliography (1928). For the earlier period *see* W. R. Ware, ed., *The Georgian Period* (Boston, 1898–1902); A. Embury, *Early American Churches* (New York, 1914); F. Kimball, *Domestic Architecture of the American Colonies* (New York, 1922). For the contemporary period *see* J. Gréber's *L'architecture aux États-Unis* (1920); W. Hegemann and E. Peets, *American Vitruvius* (1920), and G. H. Edgell, *American Architecture of To-day* (1928).

(F. Ki.)

MODERNISM. This term has been used since the second decade of the twentieth century (at least as early as 1914) to describe the form which the Broad Church or Liberal Church Movement has taken in the Church of England. The word Modernism had been used on the Continent during the pontificate of Leo XIII. as the designation of a neo-scholastic movement in the Roman Catholic Church which was condemned by the Encyclical *Pascendi* in 1907. The English movement, although in its philosophy and theology it differs widely from Roman Modernism, yet has affinities with it both in its causes and aim, and has been influenced in some measure by such Roman Catholic Modernist writers as George Tyrrell, F. von Hügel and Alfred Loisy. For instance English Modernists have no difficulty in accepting for themselves Tyrrell's description of Modernism:

"I think that the best description of Modernism is that it is the desire and effort to find a new theological synthesis, consistent with the data of historico-critical research. . . . By a Modernist I mean a churchman of any sort who believes in the possibility of a synthesis between the essential truth of his religion and the essential truth of modernity."

The following accounts of it by five writers intimately connected with the activities of the English Modernist Movement present it fairly:

"Modernism is based upon evolution in science and the critical method in history: and it demands, not that the great truths of the Christian religion shall be given up, but that they shall be considered afresh in the light of growing knowledge, and re-stated in a way suitable to the intellectual conditions of the age."

"Modernism seeks to combine in a higher unity the two ways of looking at Christian history, the evolutional and the inspirational." (Professor Percy Gardner.)

"Modernism is the attempt of the modern spirit, acting religiously, to refashion Christianity, not outside, but inside, the warm limits of the ancient churches, to secure not a reduced, but a transformed Christianity." (Mrs. Humphry Ward.)

"I do not disclaim the term Modernist. The name describes justly what I aim at being. I aim at thinking the thoughts and speaking the language of my own day, and yet, at the same time, keeping all that is essential in the religion of the past." (Canon William Sanday.)

"Modernism is only the altogether praiseworthy attempt on the part of a group of thinkers to present Christian truth in terms of modern knowledge. We do not to-day travel by coach, or wear jerkins, or speak the language of Chaucer, or believe that the earth is the centre of the solar system. Why in matters theological should we be forced to think in terms of bygone centuries? Woe betide the Church that shuts its eye to God's gift of new knowledge." (Canon Vernon Storr.)

"Modernism is not a religion: it is a defence of religion, and of the Christian Religion." (Dr. R. W. Macan.)

The enormous advances made, not only in natural and physical science during the last seventy years, but in literary and historical criticism of the Bible, the history and psychology of religion, anthropology and history, have rendered much of the traditional Christian doctrine untrue in its form, but some of it also untrue in fact. English Modernists, who believe in the essential truth of the Christian Religion and in the indispensable services which the Christian Church, the historic *organon* of that religion, can perform in the spheres of both personal culture and social evolution, desire to win the Church authorities to the difficult and courageous policy of openly rejecting false tradition, however venerable, and discarding ancient formulae, where repugnant to modern thought and feeling, in favour of teaching which seeks to express the truth of fact and faith in harmony with modern knowledge, conviction, and aspiration.

The Modernist regards his task as twofold:—

(1) The presentation of essential Christian truth in the light of modern knowledge and in such a way that it does not conflict with it:

(2) The conversion of the authorities and adherents of the Church to the acceptance, authorization and propagation of Christian doctrine in this new form.

Bishop Barnes F.R.S. has hailed Professor F. J. A. Hort of Cambridge as "the Father of English Modernism." In that case he was its posthumous father as it is only in the Appendix to his *Hulsean Lectures* published in 1893, after his death, that his Modernism is clearly seen. Hort there affirms that

"Christianity is not a uniform and monotonous tradition, but is to be learnt by the successive steps of life." "Criticism is not dangerous save when it is merely the tool for reaching a result, believed on the ground of speculative postulates."

"There can be no surer sign of decrepitude and decay in faith than a prevalent nervousness about naming and commending reason."

Hort indicates what he regards as the right line of advance:

"It is vain to uphold either (on the one hand) a merely humanitarian theology: all study of nature dissolves it: an enlarged study of and care for humanity dissolves it hardly less: (or) on the other hand, a merely pantheistic theology in combination with a humanitarian morality or anthropology. Both the pantheistic and the humanitarian factors are needed in theology and in morality alike, and for the union of both. No evidence of the super-mundane God can have any power if we fail to discern the radiations of transmitted and derivative deity as the luminous and vital tissue of finite things."

English Modernism differs mainly from the older Broad or Liberal Churchmanship in being less individualist and less Erastian. It conceives of the Christian Religion as best realising its beneficent purpose for humanity through the operation of the Church, and therefore holds that it is the duty of the individual Christian to live in and work through the Church, which although it can often best serve the highest interests by closely co-operating with the State, is yet essentially independent of it should the State's policy be in conflict with Christian principles. The Modernist's ideal is not "a free Church in a free State," but "a Christian Church in a Christian State."

The English Modernist differs mainly from the Roman Modernist in being neither pantheistic in his theology, nor pragmatist in his philosophy: neither does he identify the Christ with the Catholic Church. The English Modernist is one with the Roman Modernist in his plea for the continuous development of Christian theology based on the truth-seeking interpretation of an enlarging Christian experience, and in the demand that scientific methods and historical criticism must be used to the full in the elucidation and presentation of Christian doctrine.

Modernism claims to offer three great advantages over Traditionalism which are as much in harmony with essential Christianity as with the modern mind. It satisfies the modern Christian's intellect by giving him freedom of research; his conscience by giving him freedom to teach the truth as he learns it: his heart by admitting to Christian fellowship all who call Jesus Lord. Modernism claims to be in harmony with the fundamental character of the English Church and should assist that body to realise its function as the reunion-centre of a reformed and progressive Christendom.

In Convocation in 1914 Bishop Hicks of Lincoln said: "I believe the men who may be called English Modernists are not unsettling the faith, but interpreting it, and making it clear to the modern man, and within a generation they will be looked back to as men who helped to build the faith of the English Church." The chief English Modernist society is "The Modern Churchmen's Union for the advancement of Liberal Religious Thought," founded in 1898. Its organ is *The Modern Churchman,* a monthly magazine, founded in 1911.

The United States.—In America the term Modernism is used in a somewhat different sense from the way it is used in England. Full treatment of the controversy in America between the Fundamentalist and Modernist groups is given in the article FUNDAMENTALISM AND MODERNISM.

BIBLIOGRAPHY.—A. Fawkes, *Studies in Modernism* (1913); H. Handley, *Theological Room* (1914); C. H. S. Matthews, *Faith or Fear* (1916); C. W. Emmet, *Conscience, Creeds and Critics* (1918); M. G. Glazebrook, *The Faith of a Modern Churchman,* 2nd ed. (1918); C. H. S. Matthews, *Faith and Freedom* (1919); W. Sanday, *Divine Overruling* (1920); and *The Position of Liberal Theology* (1920); H. Rashdall, *Jesus Human and Divine* (1922); J. M. Sterrett, *Modernism in Religion* (1922); R. D. Richardson, *The Causes of the Present Conflict of Ideals in the Church of England* (1923); Leighton Parks, *What is Modernism?* (1924); M. Pryke, *Modernism as a Working Faith* (1925); E. W. Barnes, *Should such a Faith offend?* (1927); J. F. Bethune-Baker, *The Ways of Modernism* (1927); P. Gardner, *Modernism in the English Church* (1927); H. D. A. Major, *English Modernism, its origin, method, aims* (1927) (gives a full bibliography). (*See* also, ROMAN CATHOLIC CHURCH; ENGLAND, CHURCH OF.)

(H. D. A. M.)

MODERN TENDENCIES IN APPLIED ART. No exact date can mark the beginning of the modern movement in applied art. Whenever men grew tired of reproducing the decorative formulae of the periods preceding the industrial revolution and turned to the creation of new forms and new motives, then and there were the beginnings. One might point to the porcelain table service of Felix Bracquemond exhibited at the Paris exhibition of 1867 as a very early appearance, but in reality this was but the application to western forms of Japanese motives, then just brought to the attention of artistic Europe.

On the other hand, it would hardly be correct to mention William Morris as a precursor of the modern movement, inasmuch as his valiant struggle was not aimed against the old forms but against the machine and commercialism, and his own creations were always a reflection of the mediaeval spirit. The influence of Morris on later developments, however, was very great, if indirect. In the first place it was largely through his teachings

and example that the English Arts and Crafts movement came into being, and although the underlying principles and motives of this revival did not make for modernism as conceived to-day, many things were produced by the craft-workers that were essentially of this spirit, especially in woodwork, ceramics and embroidery. Furthermore, it was the ideals of the Morris group and the English artist craftsman that perhaps more than any other influence inspired the beginnings of the true modern movement in Vienna and southern Germany.

The first definite appearance of creations in the intention now identified as modern, would seem to have occurred at Paris in the decade of the '80s in the field of the smaller crafts, particularly in ceramics and glass. The French had long been acquainted with Japanese prints and pottery, but it was not until the '90s that Chinese ceramics of the Tang and Sung periods became known. Certain craftsmen became filled with intense desire to discover the secret of the glazes of these wares and after much labour and research success crowned the efforts of Carriès and Chaplet. Delaherche continued these studies and shortly began to produce the remarkable series of sober, rich, deep-toned stoneware of the high fire kiln that have marked his long career. Rejecting all ornamentation and relying on the manifold decorative glaze effects produced at high temperatures, he initiated the triumph of *grès au grand feu* that has remained ever since the high and characteristic achievement of French ceramics. The work of these craftsmen, together with that of Dalpayrat and Lachenal attracted great attention and favourable comment at the International Exposition of 1889 in Paris. Side by side with these ceramic triumphs was the glass of Emile Gallé of Nancy. Gallé, an artist of versatile talent, had been experimenting for many years with various glass-techniques, all of which relied upon the material itself for decorative effect. (*See* GLASS, MODERN, EUROPEAN for work of Gallé.)

The buildings of the Exposition were also a very distinct expression of modernism. The genius of the architects, through appropriate use of iron, concrete, glass and terra cotta, produced a number of delightful creations in form and colour, which were at the same time dignified and imposing. It is in the decade of the '90s, however, that the modern movement becomes widespread in western Europe. To try to establish priority among these developments would be a fruitless task and one that would inevitably lead to controversy. Nevertheless, it is clear that important activities in the field of decoration and furniture design were occurring very early in Brussels. Here, in 1894, took place an exhibition of the so-called "Free Aesthetics," among whom were Henry van de Velde, Victor Horta, S. van Rysselberghe, Serrurier-Bovy and Paul Hankar. First among these in genius for design and later influence was van de Velde. Educated as a painter, he early found the brush inadequate as a means of expressing his reactions towards contemporary life and turned to the design of furniture and household decoration. At heart a believer in functional design and sound construction, he was at first caught in the mesh of the curved line, then almost universally in vogue, and evolved a peculiar whiplash curve, which he designated "the line of force."

In 1895 van de Velde exhibited four complete rooms in the establishment that had just been opened by S. Bing in Paris. These rooms were shown two years later at the Art Exhibition at Dresden and made a profound impression upon German craftsmen and designers.

Van de Velde was soon commissioned to construct the Folkwang Museum in Hagen, Westphalia, and the completion of this interesting building in 1902 served to cement his position in Germany as a leader in the new movement. Meanwhile the grand duke of Weimar, whose ambition was to improve artistic instruction in his country, offered this task and problem to van de Velde, who accepted and installed his studio in the art school later known as the "Bauhaus." Here he continued to exercise an important influence on the decorative arts of Germany until the outbreak of the World War. His work in Germany culminated in the beautiful and severe theatre built for the "International Art Exposition" at Cologne in 1914.

The first fruition of van de Velde's ideas, however, was not in Germany, but in Paris. There in 1895, Bing, who had for many years maintained a shop for the sale of Japanese prints and other examples of Oriental art, set up an establishment, *L'art nouveau,* for the display of modern art. At first the work of various artists and craftsmen was assembled, but finding harmonious ensembles impracticable in this way, Bing secured the services of a corps of designers, among whom were E. Colonna, De Feure and Gaillard engaged in production. As has been noted above, four rooms of van de Velde were exhibited here in 1895 and the characteristic curve originated by the Belgian was adopted by Bing as the peculiar motive for *l'art nouveau.* At this time French furniture exhibited a mixture of influences: English arts and crafts, reminiscences of Eastlake, naturalistic decoration and above all a welter of curved lines generally awkward and clumsy. This latter chaos the workers of Bing crystallized into a style by the adoption of the whiplash curve. It was a motive far too subtle to be handled successfully by any except highly talented designers, but it was exactly such individuals that the "Etablissement Bing" had employed, and some of the productions of Colonna and Gaillard stand to-day as unchallenged masterpieces of design—masterpieces in which a highly artificial motive was used to produce creations of much charm, that were at the same time guilty of no structural enormities.

L'art nouveau was the sensation of the Paris International Exposition of 1900. Its success was its undoing. The new motives became at once the vogue, with the result that manufacturers in large numbers hastened to gain profit from their popularity. To give the new quality to their production, they called upon designers of all degrees of capacity. Consequently motives requiring the hand of a master were soon vulgarized and cheapened and the whole movement reduced to absurd and fantastic exaggerations. *L'art nouveau* was but an episode in the modern movement—a brilliant episode, but one based on a decorative motive and not on sound considerations of the vital tendencies of modern life. It had no organic relations with function or structure and from its nature was destined to a short life. At this exposition also Louis Tiffany of New York exhibited his creations in "Favrille-glass" of which the beautiful and subtle colour effects, often iridescent, attracted wide attention.

The jewelry of René Lalique was also one of the features of 1900. Employing novel and richly-coloured materials and all the resources of the carver, engraver, and enameller, this prolific artist exhibited numberless examples of brooches, necklaces, combs and other dress ornaments that ran the entire gamut of the curved line and made of jewellery a charming decorative adornment rather than a mere exhibit of costly gems.

One must also note the remarkable efflorescence of the French poster that occurred at a somewhat earlier period. Six artists, Chéret, Grasset, Toulouse, Lautrec, Steinlen and Mucha, captivated the interest of the entire world and carried the art of the poster to a point not since surpassed. (*See* POSTER.)

In 1910 there was an important exhibit of the work of Munich artists and designers at the *salon d'automne* in Paris. Viewed from the standpoint of to-day the displays were not brilliant nor wholly consistent, but they were in a number of cases marked by simplicity of structure and of practical quality, at that time rare in the French designs, and they undoubtedly brought to French artists a needed sobering and fresh consideration of fundamentals.

To bring the picture of the movement into perspective it is necessary to turn to the earlier developments in Germany and Vienna. In the years before 1900 furniture and decoration in Germany that did not follow the old lines showed a mixture of influences: traces of the *Alt-Deutsch* of the '70s and '80s; adaptations of the English arts and crafts, particularly of the Glasgow school, and some reflection of the curves of van de Velde. In 1899 the grand duke of Hesse-Darmstadt invited the Viennese architect Josef M. Olbrich to come to Darmstadt and design the houses of an artists' colony in the suburb of Mathildenhöhe. These houses together with an exhibition-building were for the most part built in the following year, and a number of artists, among whom were Peter Behrens, Hans Christiansen, Ludwig Habich and Patriz Huber, became members of the colony. The

houses exhibited much variety and novelty of design and while free from conventional architectural motives were marked by sobriety and fineness of proportion.

The first exhibit of the artistic creations of the colony was held in 1901 and showed many interesting experiments in modernism. Other influences quickly made themselves felt. In 1898 the grand duke had invited the English architect Baillie-Scott, a foremost exponent of the arts and crafts revival, to decorate two rooms in his palace. The designs of this artist for furniture and house decoration quickly became popular all over Germany. Many examples of his furniture were made and sold in the Wertheim department store in Berlin.

It is quite beyond the limitations of this article to make more than a reference to the development of German architecture in the years between 1900 and the World War. Suffice it to say that the talent of Olbrich, Messel, Peter Behrens and many others created in their buildings during this period the only unified architectural expression in Europe worthy of being called a modern style. The influence of this architectural development was felt and is still felt strongly not only all over Germany, but in the countries of Central and Southern Europe.

The quality that distinguished the German movement from that in all other countries was its widespread organization and the encouragement received from powerful official and industrial agencies. Prominent among the organizations that championed the new movement was the *Deutsche Werkbund,* founded in 1908. Its aims were to ennoble industrial work, to bring about co-operation between art and industry and the work of the artisans by means of instruction, of propaganda and of common action in situations where it was appropriate. Towards 1910 it numbered 732 members, of whom 360 were artists, 267 industrialists and business men, and 105 amateurs and officials of museums and other interested persons. The *Werkbund* aimed at bringing together all the active forces in the art industries and in trade and commerce. It carried out its programme by such methods as exhibitions, lectures, and publications.

The General Electric Company developed an artistic department with Peter Behrens as counsellor. The great printing companies studied the work of talented typographic artists to improve the character of type and to develop new styles in posters, placards and head lines. The publishers of art periodicals lent themselves industriously to the exposition of the new movement. Many of the large department stores erected new buildings in the modern spirit. Those of Wertheim at Berlin and Tietz at Düsseldorf were especially noteworthy. The *Werkbund* pushed to the front those architects who were foremost in the new movement for the design of municipal architecture, such as city halls, railway stations, theatres, and markets. Other organizations were developed, such as the *Deutsche Werkstätten für Handwerkskunst* in Munich. This organization dealt with all phases of decoration and applied art, making inexpensive furniture in quantity at its model factory at Hellerau and finer cabinet work at Munich.

Vienna contributed a very interesting chapter to the modern movement. Here in 1896 was organized the *Secession* as a protest against the academic quality in the arts. The society was dedicated to the purpose of bringing to Vienna from the outside world all healthy influences making for modernism. Prominent among the founders were Gustav Klimt, Josef Hoffmann, Alfred Roller, Koloman Moser, F. Andri and Josef Olbrich, who built the *Secession* building in 1898. At the second exhibition of the Society in 1898 were shown examples of applied arts from England and France, and for many years the annual exhibitions welcomed the work of the pioneers in modernism from all European countries. In the expansion of the applied arts that followed the organization of the *Secession* movement, the influence of the English arts and crafts, as expressed by C. R. Ashbee, Voysey, and Baillie-Scott, and that of the Glasgow school headed by Mackintosh, was very great.

In 1903, the *Wiener Werkstätte* was organized through the financial assistance of Fritz Waerndofer. For two years the society co-operated with the *Secession,* but in 1905 established an independent existence with Josef Hoffmann as the guiding influence. The *Werkstätte* developed a business organization, employing its own designers and craftsmen and maintaining workshops for the fabrication of products. It aimed at introducing artistic furnishings into everyday life and at bringing about closer relations between art and industry.

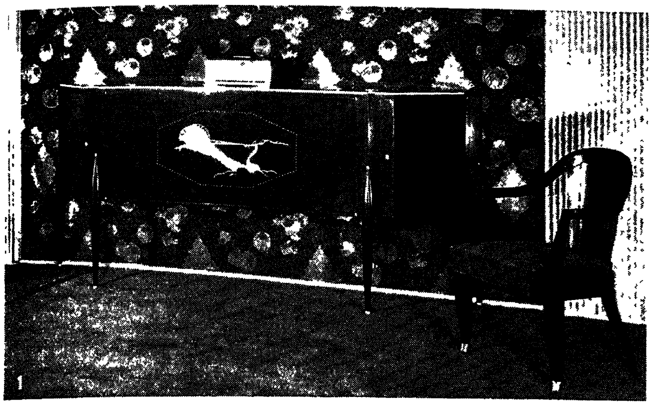
Many of the products of the Viennese artists exhibit a naïve, playful, and charming character that well reflects the atmosphere of the city. Especially typical of this kind of work are the bright-glazed, low-fired figurines by Vally Wieselthier, Susi Singer, Herta Bucher, and others. Leather goods and printed textiles have always been noteworthy among the products of this city, and they have received delightful expression at the hands of modern artists. One of the exquisite achievements of Viennese art is the engraved glass of J. and L. Lobmeyr. This firm has employed the foremost artists available in Central Europe to design the forms and decoration of their products, and has brought to their execution the highest type of technical skill.

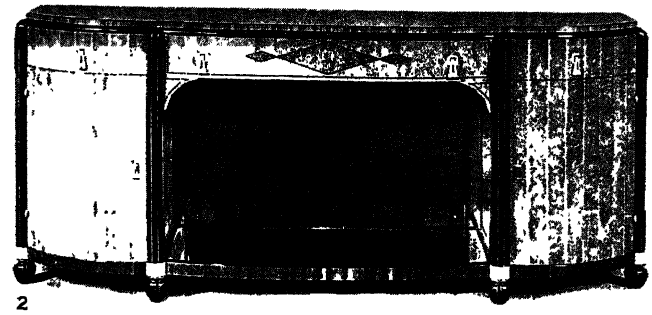
Architects from the first exercised a strong influence upon the modern movement in Vienna. In 1895 *Modern Architecture* appeared, written by the architect Otto Wagner, a professor in the Vienna Academy. It was the first appearance of the new doctrines and the younger architects rallied to their support. Among Wagner's students were many notable men. First among these was Josef Olbrich, a man of many talents, who, as noted before, built the artists' colony in Darmstadt and exercised a profound influence on German design in the early years of the present century. Another of Wagner's pupils was Josef Hoffmann, who in 1899 became professor in the *Kunstgewerbe Schule* in Vienna. While first of all an architect who has designed many buildings in the suburbs of Vienna and other places in Europe, he is also an artist craftsman with an intimate knowledge of processes and the possibilities of materials. For 25 years he has devoted a large part of his time and energy to applied art, in which field he has been for long the recognized leader of the modern Viennese school. In 1908 Hoffmann built the Stocklet house at Brussels, which remains to-day, in its interior design and furnishings the most important residence the modern style has yet produced. Hoffmann designed the house to express the owner, a wealthy banker possessing an extraordinary collection of oriental and occidental applied art. He employed vigorous rectangular forms to suggest power, and precious and beautiful marbles to give an atmosphere of richness. The walls of the dining-room were decorated by notable mosaics designed by Gustav Klimt.

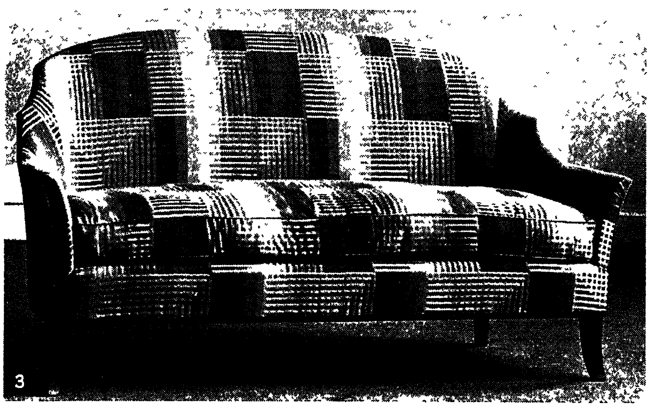
In this modern development of Viennese applied art a very important influence was exerted and is still exerted by the *Kunstgewerbe Schule* which early attracted to its staff many of the most talented and creative spirits of the time and which has for 30 years placed great emphasis upon original design through actual craft work. As can be seen, the Viennese movement has been led by a group of highly trained and cultivated persons who have guided its course within sophisticated channels, but running through its manifestations is constantly discernible a warm strain which reflects the manifold racial qualities of the peoples comprising the former Austrian Empire.

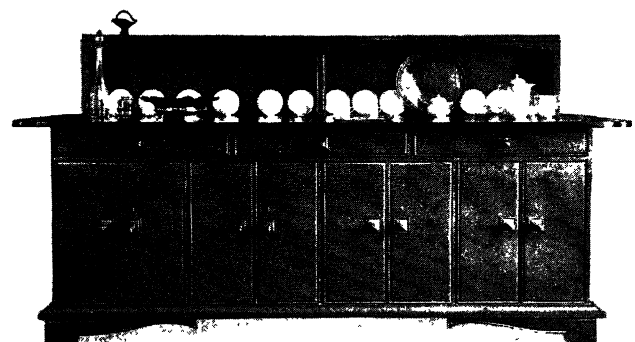
Any reference to modern tendencies would be incomplete without mention of the ceramics of Copenhagen and the organization of industrial art matters in Sweden. The firms of Bing and Grondahl and the Royal Copenhagen Porcelain Factory have since their inception made most earnest efforts to combine multiproduction with the highest artistic quality. Great variety of character and technique characterizes the products of these establishments, some of which follow the lines of 19th century traditions, while others embody the spirit of modernism in a marked degree. The same energetically progressive attitude is found in several smaller establishments in Denmark where the individuality of the artist plays an even larger part to the advantage of the production.

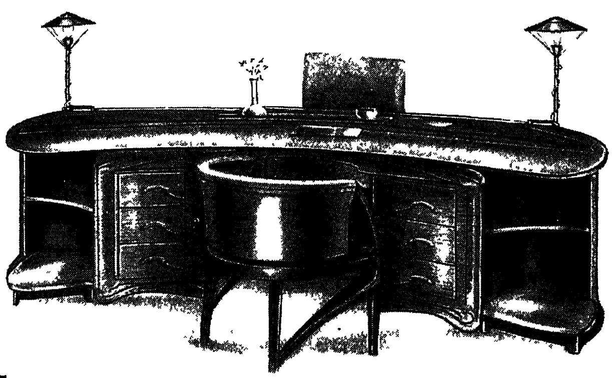
Sweden has for many years enjoyed the advantage of an association (*Svenska Slöjdforeningen*) which has rendered substantial assistance to manufacturers and craftsmen in promoting higher standards of work. The products of Orrefors Bruks well illustrate the situation. Upon request of this establishment the

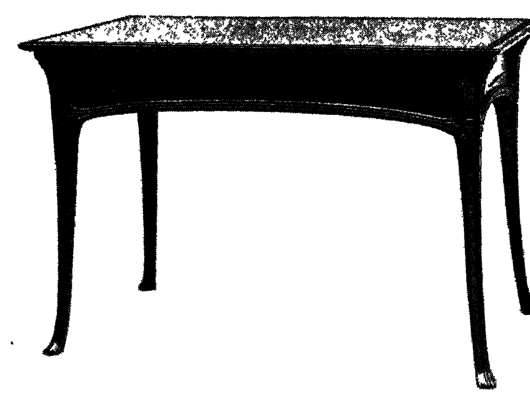

1

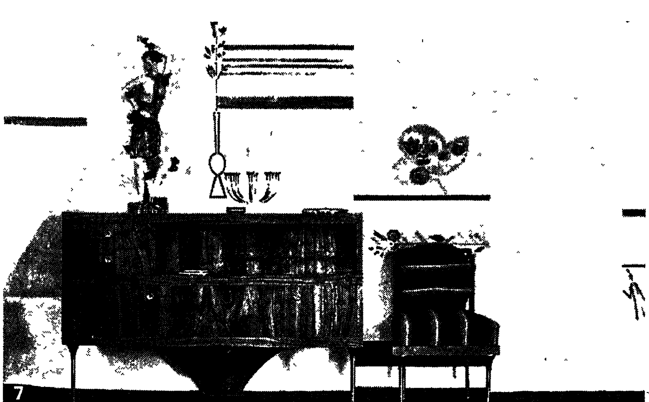

2


3


4


5


6


7


8

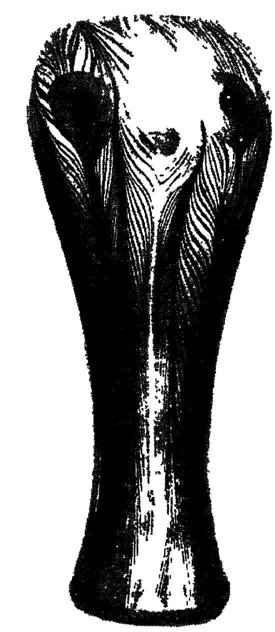
BY COURTESY OF (1) LORD AND TAYLOR, (2) W. AND J. SLOANE, (3) EUGENE SCHOEN, INC., (6) THE METROPOLITAN MUSEUM OF ART, NEW YORK

MODERN DESIGN IN FURNITURE

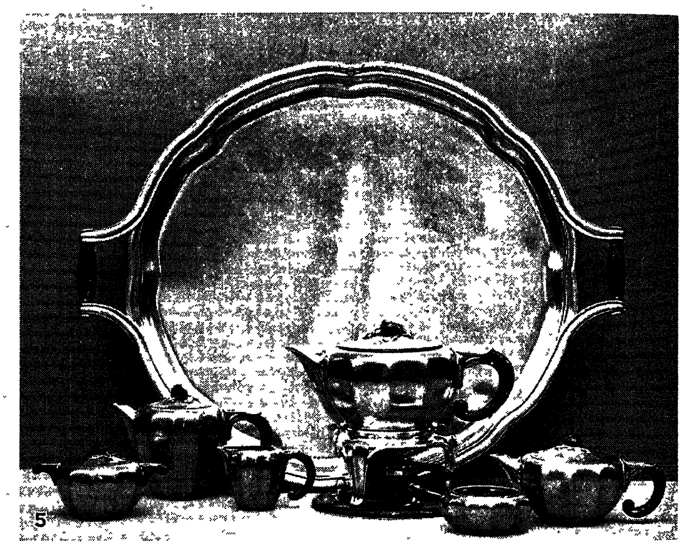
1. Elements of a dining-room by E. J. Ruhlmann, Paris, in the Lord and Taylor furniture exposition of 1928 in New York city. 2. Buffet of mahogany with burl veneers of rare woods by W. and J. Sloane, New York. Contemporary. 3. Sofa designed by Eugene Schoen, New York, with rayon silk upholstery. Contemporary. 4. Buffet by Professor Richard Riemerschmid, Germany. 1921. 5. Desk by Henry van de Velde, Brussels. 1899. 6. Table of rosewood designed by Ed. Colonna in 1900 for the Etablissement Bing, Paris. 7. Tea room designed by Professor Josef Hoffmann, Vienna. Contemporary. 8. Twin beds by John Widdicomb Company, Grand Rapids, Michigan


1

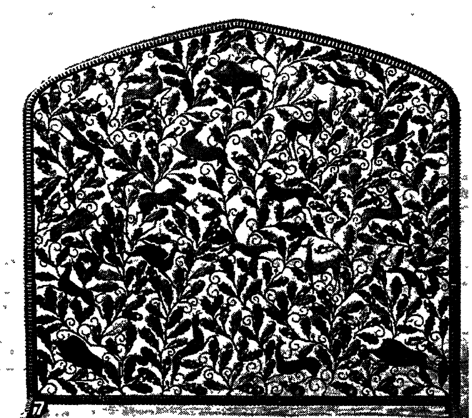
2

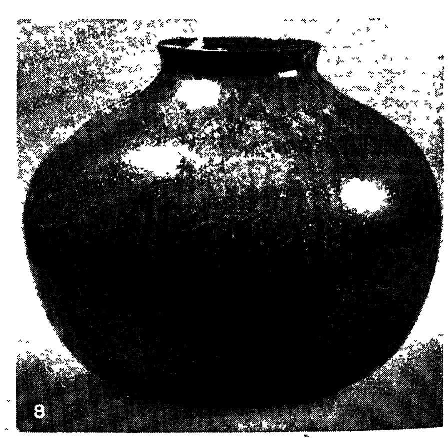

3


4


5


6


7


8

BY COURTESY OF (3) TIFFANY STUDIOS, (4, 8) ROBERT W. DE FOREST, (5) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (6) HOHENZOLLERN-KUNSTGEWERBEHAUS, BERLIN; PHOTOGRAPH, (2) COPR. H. BONNAIRE

MODERN TENDENCIES IN ART OBJECTS AND POSTER

1. Porcelain vase with brown underglaze overrun with mauve coloured slip by Mrs. A. A. Robineau, Syracuse, New York. Contemporary. 2. Poster by Jules Chéret, France. (1891). 3. Favrile glass vase by Louis Tiffany of New York (1898). 4. Stoneware jar and plate by Emile Decoeur, France. Contemporary. Lent to the Metropolitan Museum of Art by Robert W. de Forest. 5. Tea service, silver and lapis lazuli, by Jean Puiforcat, France. Contemporary. 6. Ornamental comb by René Lalique, France. (About 1900). 7. Firescreen, "The Forest," executed by Edgar Brandt, France. Contemporary. 8. Stoneware vase by Auguste Delaherche, France. Contemporary

association recommended the employment of two artists, Simon Gate and Edward Hald. Within a few years the genius of these two men has brought the engraved glass of Orrefors to a well deserved world-wide reputation.

The World War brought all European art activities to a standstill. In Central Europe these have only of recent years been slowly resumed. France, the first to recover industrially, addressed herself to the effort to gain recognition in the international market as the exponent of the modern movement. Apparently resolved no longer to rest content with individual initiative and enterprise she has endeavoured to organize the activities in this field. For one thing instruction in the modern spirit of design is now offered in all the schools of applied art throughout the republic.

In the last decade each of the large department stores, Bon Marché, Galeries Lafayette, Printemps, and the Louvre, has inaugurated a special department offering all kinds of material conceived in the modern spirit, and has placed at the head of this department an individual of talent and reputation in this field. Each of these directors is furnished with a staff of designers and personally designs or superintends the design in his own studio of much of the material offered by his department. This development has had an important commercial result, inasmuch as it has popularized the movement by bringing its productions within the reach of the ordinary purse, whereas the modern creations up to a few years ago were to a large extent *objets de luxe* available only to the wealthy.

Another organized body of considerable importance is that of the *Société des Artistes Décorateurs,* who hold a salon embracing the field of the industrial arts each spring and autumn in the Grand Palais. For years this society has admitted to its expositions only works conceived in the modern spirit, and has refused place to all objects distinctly based upon the old styles. In the same direction is the important influence of the *Musée des Arts Décoratifs* and the *Musée Galliéra,* which hold frequent temporary expositions.

Finally, as the culminating recognition of a national attitude, France organized and carried through the International Exhibition of Modern Decorative and Industrial Arts in 1925. Perhaps the most important lesson to be derived from the exhibition was that which must be studied in all manifestations of modernism if the movement is to survive as a salutary influence in contemporary life, viz., that the only expressions in this new mode which are significant and which will serve to carry forward the level of applied art are those which conform to the age-old requirements of good design and at the same time possess those qualities which are in sympathy with the needs and taste of their times. Novelty for novelty's sake, queerness and freakishness of form that violate the demands of function and structure, are but the effort of mediocre designers to attract attention. These represent the incubus that holds back the movement, and that must be discounted to gauge its true meaning and possibilities. Much of the material shown at the exhibition was of this character. In each division there was to be found the work of only a few individuals possessed of sufficient culture, talent and understanding to interpret the tendencies of their times in forms both old in quality and yet new in spirit. If the modern movement is to be a real evolution it is obviously only the work of such men that is significant, and it is their creations that must be examined rightly to appraise its nature and its tendencies. That leadership of a high order was in evidence in the French section of the exhibition is hardly to be disputed. Whether the rank and file of French producers will take their cue from these sources or continue to follow after mere novelty remains to be seen.

Germany since the war has been gradually resuming interest in modernism. The heavy and awkward character often to be seen in the earlier ventures has very largely disappeared and the productions of many establishments, particularly those of the *Deutsche Werkstätte* of Munich and Hellerau, are marked with fine sobriety, simplicity and good taste together with moderate cost. The German schools of industrial art play a very important part in the present day situation. Often directed by men of exceptional talent, they are almost as a unit emphasizing design in the new spirit and adding to this thorough and intensive constructive processes.

In England a number of individuals, whose initial devotion was to the arts and crafts, have continued their creative work into later times and have made valuable contributions to modern design. One establishment, Heal and Son, under the direction of Ambrose Heal, has served as a connecting link between the two periods and in its productions during the last 30 years has presented a continuous picture of the highest expression of English modernism. This firm has not only exhibited a fine sanity and purity of taste in its own furniture, but it has constantly presented and encouraged the best efforts of English manufacturers and craftsmen in many other branches of applied art. This is particularly true of ceramics, in which field the products of the great English potteries as well as those of individual craftsmen have been given prominent place.

After the scant display of modern furniture at the Paris exhibition of 1925, English manufacturers showed rather surprising activity which in three years resulted in an exhibition of a dozen furnished rooms in London, some of which displayed a sound grasp of the true spirit of modernism and attained a high degree of artistic taste.

A factor of most promising character has arisen in the progress of English applied arts, in the form of the Design and Industries Association, founded during the World War by a group of educators, designers, craftsmen and manufacturers. The rational and progressive attitude of the Association towards industrial art has already made an impression upon public thought and has achieved certain distinct influences upon production.

In the United States the development of modernism has been marked in a few lines, but it is very uneven when the whole field is considered. In the design of the tall office building in the large cities America has evolved a distinct modern type. In a situation in which many well equipped minds are working on the same problem—a problem involving for its solution the adjustment of rigid requirements of many kinds—social, physical, legal, economic and aesthetic—a result has been arrived at which, if it cannot be termed a style, is at least characterized by very definite and uniform tendencies and very modern qualities. Considered purely from the aesthetic side, these buildings show an increasing subordination of surface ornament and reliance upon fineness of line, mass and proportion, and the dignity of plain surfaces.

In the United States as in every other Western country, woman's outdoor dress is the most significant of all expressions of modern taste. Such dresses, compared with those of 35 years ago show a remarkable and rapid evolution. In response to the modern demands for greater freedom and more natural living, feminine costume has passed from an extreme of complexity and artificiality to an extreme of simplicity of which no one can gainsay the aesthetic advantage. (*See* DRESS, *Modern.*)

The more sober coloured winter street dress reflects the same qualities as those represented by other modern creations, viz., elimination of artificial ornament, emphasis upon functional form and tendency towards quiet spaces that gain interest from the material itself. These are qualities fundamental to modern design, but by themselves they are obviously not enough to express completely this age, with its speed, its innovations, its unconventionality, intellectual activity and new ideas. On this side modern life craves fantasy, novelty and fine colour and it is woman's dress that has first of all responded to this desire in the warm weather street and sport clothing of recent years.

This demand for strong beautiful colour and playful fantasy, felt more and more by Western peoples ever since the first vision of the Russian ballet, is one that extends to almost all phases of decoration (hangings, furniture stuffs, murals, floor and wall coverings and graphic advertising) and that brings with it an increasing problem of composition in a difficult field.

To sum up the general situation one might venture to state that wherever natural forces, such as social ideals, emulation, competition or seasonal demands, make for frequent changes

and adjustments, there one finds highly developed critical taste on the part of the consumer, continuous artistic progress and inevitable acceptance of the principles underlying modern design.

Where these forces are either wanting or relatively weak, and this applies in large degree to all our household furnishings, progress is much slower and much more dependent upon the chance of leadership. Inasmuch as a transition epoch from its very nature can produce but few leaders with the ability and vision to interpret the needs and tendencies of their time in forms of beauty, a manifest critical need of this period is for public discrimination as to what is sound and fundamental in contemporary design and what is merely casual and novel.

It is still too early to forecast with any certainty the ultimate significance of these developments of the last 30 years, but it is difficult to escape the conclusion that the essential qualities that are increasingly apparent in the best of present day applied art are too much a part of the vital and organic tendencies of modern times to be ephemeral.

See Arts and Crafts; Architecture, and cognate articles; Glass; Gems in Art; Potteries and Porcelains, and the bibliographies thereto. (C. R. R.)

MODES, ECCLESIASTICAL. The scales of early ecclesiastical music are not those used in the classical music of modern times. They form a series of eight, differing from one another not merely in pitch but in character. (*See* Harmony; Plainsong.)

MODESTINUS, HERENNIUS, a celebrated Roman jurist, who flourished about 250 B.C. He appears to have been a native of one of the Greek-speaking provinces, probably Dalmatia, and was a pupil of Ulpian. In Valentinian's *Law of Citations* he is classed with Papinian, Paulus, Gaius and Ulpian. He is mentioned in a rescript of Gordian in the year 240 B.C. No fewer than 345 passages in the *Digest* are taken from his writings.

MODESTO, a city of central California, U.S.A., 90 m. E. by S. of San Francisco, in the northern end of the San Joaquin valley, on the Tuolumne river; the county seat of Stanislaus county. It is on the Pacific highway, has a municipal airport and is served by the Santa Fe, the Southern Pacific and the Western Pacific railways, and by auto-stages and motor-truck lines. Pop. (1920) 9,241 (88% native white); in 1930 it was 13,842. Modesto is in the midst of 400,000 ac. of irrigated land, supplied with abundant water and power from the Don Pedro dam, hydro-electric plant, and storage reservoir in the foot-hills. Dairy and poultry products, forage crops, vegetables (notably beans), peaches, grapes, melons and a great variety of other fruits and nuts are produced in the county to the value of $40,000,000 annually. The city cans 750,000 cases of fruits and vegetables a year, and its co-operative creamery, with a membership of 2,000 dairymen, makes 5,000,000 lb. of butter and 5,000,000 lb. of skim-milk powder. The city's assessed valuation of property for 1927 was $14,087,865. Bank clearings in 1927 totalled $136,416,764. Modesto was planned in 1870 and incorporated in 1884. In 1893 the La Grange diverting dam on the Tuolumne river was completed, and after ten years' delay, due to litigation, water was turned into the ditches in 1903, and the transformation of the district from a vast wheat-field to a region of diversified agriculture began. The Don Pedro storage dam was completed in 1923. Between 1900 and 1920 the population increased nearly fivefold. Since 1911 the city has had a commission form of government.

MODICA, a town of Sicily, in the province of Syracuse, 57 m. W.S.W. of Syracuse by rail and 33 m. direct. Pop. (1921) 55,817 (town); 60,192 (commune). It lies on a hill between two valleys, which was the site of the Sicel town of Motyca, while the modern part of the town extends along the river Mauro, an inundation of which did much damage in September 1902. Six miles south-east is the valley of the Cava d'Ispica, with hundreds of grottoes cut in its rocky sides, some Sicel tombs, but mostly catacombs or tombs of the early Christian and Byzantine periods, or cave-dwellings of the latter age.

MODILLION, in architecture, the enriched block or horizontal bracket generally occurring in rows under the corona, or projecting portion and above the bed-mould of the Corinthian cornice. (*See* Order.)

MODJESKA, HELENA (1844–1909), Polish actress, daughter of a musician, Michael Opido, was born at Cracow on Oct. 12, 1844. After her marriage, to a Pole named Modrzejewski, she joined a company of strolling players. In 1868 she married Count Bozenta Chlapowski, a Polish politician and critic, and then began to act at Warsaw, where she remained for seven or eight years. Her chief tragic rôles were Ophelia, Juliet, Desdemona, Queen Anne in *Richard III.*, Louisa Miller, Maria Stuart, Schiller's Princess Eboli, Marion Delorme, Victor Hugo's Tisbé and Slowacki's Mazeppa. In comedy her favourite rôles were Beatrice in *Much Ado About Nothing,* and Donna Diana in the Polish translation of an old Spanish play of that name. Madame Modjeska also played in modern pieces by Legouvé, Dumas, father and son, Augier, Alfred de Musset, Octave Feuillet and Sardou. In 1876 she went with her husband to California, where they settled on a ranch. This enterprise was a failure, and Modjeska returned to the stage. She appeared in San Francisco in 1877, in an English version of *Adrienne Lecouvreur.* She continued to act principally in America, but was also seen from time to time in London and elsewhere in the United Kingdom, her repertory including several Shakespearian rôles and a variety of emotional parts in modern drama. She died on April 9, 1909, at her home near Los Angeles, California.

See Mabel Collins, *The Story of Helena Modjeska* (London, 1883), and the (autobiographical) *Memories and Impressions* (New York, 1910).

MODJESKI, RALPH (1861–), American engineer, was born at Cracow, Poland, Jan. 27, 1861, his mother being the actress, Helena Modjeska. He graduated at the École des Ponts et Chaussées, Paris, with high honours, and settled in the United States. From 1892, he practised as consulting bridge engineer at Chicago and as a designer and builder of bridges he did distinguished work. Among his best known bridges are the Government bridge over the Mississippi at Rock Island; the McKinley bridge at St. Louis; the bridges over the Mississippi at Thebes (Ill.) and at Memphis (Tenn.); the Northern Pacific bridge over the Missouri at Bismarck (N.D.); also bridges over the Columbia and Willamette rivers in Oregon. He was a member of the Quebec bridge commission, and consulting engineer for the Ohio river bridge at Metropolis (Ill.), for the Chicago, Burlington and Quincy Railroad, and the Thames river bridge at New Haven (Conn.), for the New York, New Haven and Hartford Railroad. He was chosen chief engineer and chairman of the board of engineers of the Philadelphia-Camden bridge over the Delaware river, which, on its completion, in 1926, was the longest suspension bridge in the world. He was appointed chief engineer of the proposed bridge over the Mississippi river at New Orleans for the Public Belt Railroad of New Orleans, also for the bridges over the Atchafalaya river at Melville (La.), for the Texas and Pacific Railway.

MÖDLING is a popular summer resort for the Viennese and lies at the entrance to the Brühl valley, Lower Austria. In addition to the numbers of tourists attracted by its iron and sulphur baths it has important assets in its considerable iron and metal industries and shoe factories. Pop. (1923), 18,695.

MODOC, a tribe which formed the southern portion of the so-called Lutuami group, the Klamath constituting the northern and larger portion. Between them the two tribes held the Klamath lake basin, and are scarcely distinguishable in speech or customs. The Klamath were wholly in Oregon, the Modoc partly in California. Modoc means south. In 1873 part of the Modoc attempted to reoccupy lands they had ceded to the Government, defied the troops, and for three months stood off several companies of soldiers from their refuge in the broken Modoc lava beds. In the course of negotiations Gen. Canby was murdered by treachery, for which the Modoc leader, Kintpuash or Captain Jack, and several companions were later hanged. The whole hostile force numbered only 200, including women and children; part of the Modoc and all the Klamath remained peaceable. The present population of the Modoc and Klamath jointly is 1,100.

See A. S. Gatschet, *The Klamath Indians* (1891); J. Curtin, *Myths of the Modocs* (1912).

MODULATION, in music, signifies the passing from one key to another. The term "transition" is also used, though principally to designate very brief and transient modulations to keys not dwelt in. Modulation is of various kinds, as "natural" when the change is to one or other of the "relatives" of the original key; "extraneous" when it is to keys other than relative, *i.e.*, more remote; or "enharmonic" when it is effected by a change of notation. Modulation constitutes one of the greatest resources of music as we know it and is employed by modern composers to an ever-increasing extent. (*See* ENHARMONIC; KEY; HARMONY.)

Modulation, as the term is used in radio, is the process whereby the frequency or amplitude of a wave is varied in accordance with a signal wave. A modulator is a device to effect the process of modulation. It may be operated by virtue of some non-linear characteristic and also by a controlled variation of some circuit quantity.

MODULE, in architecture, any unit adopted for measuring the relative proportions of the different parts of a building or decorative form. The term is relative only; the module chosen may vary infinitely in actual dimension. The module chosen by Vitruvius (iv., 3) for determining the proportions of a classic order (*q.v.*) was half the bottom diameter of a column. This module is sub-divided in various ways by different authorities; Vitruvius usually used six sub-divisions; in the later Renaissance, in the effort to obtain the most accurate proportions, the sub-divisions were sometimes increased to as many as 30. A new system of modules has recently come into vogue in all sorts of artistic criticism, based on the relations of the diagonal of a rectangle to its sides. With scales of relative value so established, it has been claimed that the proportions of many beautiful objects can be determined. This view is much contested and is at the basis of one of the greatest controversies in current art criticism. The term module is also applied in hydraulics (*q.v.*) to a device for regulating the supply of water from an irrigation channel.

MOERIS, AELIUS, Greek grammarian, surnamed *Atticista* ("the Atticist"), probably flourished in the 2nd century A.D. He was the author of an extant list of Attic forms and expressions (Ἀττικαὶ λέξεις), accompanied by the Hellenistic parallels of his own time, the differences of gender, accent and meaning being clearly and succinctly pointed out.

Editions by J. Hudson (1711); J. Pierson (1759); A. Koch (1830); I. Bekker (1833); with Harpocration.

MOERIS, LAKE OF, the history of the lake which once occupied a considerable area of the Fayûm depression, and which to-day is represented by the shallow Birket Qarun, has been much elucidated by the geological and archaeological work which has been recently carried out in the desert margin of the depression. From the results obtained it would appear that in later palaeolithic times the lake level reached a point about 130 feet above sea-level, or about 280 feet above the present lake. During neolithic times the level fell slowly for about 140 feet, though there were occasional interruptions when it remained at one level long enough to allow formation of beaches which can still be traced. Throughout this period primitive settlements occupied its shoreline, and down to early dynastic times the level does not seem to have varied greatly. Later however through the dynastic period the level of the lake fell slowly as a result probably of climatic conditions of greater aridity, though the fall was retarded from time to time as the volume of surplus water brought in from the Nile in order to irrigate the cultivated lands was greater or less.

The cultivated lands above the level of the lake which were irrigated from the Nile were some of the most fertile in Egypt so long as the supply canals from the river were maintained in good order, though this doubtless varied with the political conditions of Egypt. The Egyptian name of the lake was Shei, "the lake," later Piôm, "the sea" (whence Fayûm); Teshei, "the land of the lake," was the early name of the region. At its capital Crocodilopolis and elsewhere the crocodile god Sobk (Suchus) was worshipped. Senwosrê II. of the XIIth Dynasty built his pyramid at Illahun. Amenemhêt III. built his near Hawara, and the vast labyrinth attached to it was probably his funerary temple. This king was afterwards worshipped in more than one locality about the lake under the name Marres (his praenomen Nemarē) or Peremarres, *i.e.*, Pharaoh Marres. In the reign of Ptolemy Philadelphus veterans from the Syrian War were settled in the "Lake" (Λίμνη), and the latter quickly became a populous and very fertile province. Strabo's account of the Lake of Moeris must be copied from earlier writers, for in his day the outflow had been stopped probably for two centuries, and the old bed of the lake was dotted with flourishing villages to a great depth below the level of the Nile. Large numbers of papyri of the Ptolemaic and Roman periods have been found in and about the Fayûm, which continued to flourish through the first two centuries of the Roman rule. The level of the lake varies from year to year with the amount of irrigation water which reaches it from the Nile. Its average level is now about 147 ft. below sea-level.

See W. M. F. Petrie, *Hawara Biahmu and Arsinoe* (1889); R. H. Brown, *The Fayûm and Lake Moeris* (1892); B. P. Grenfell, A. S. Hunt and D. G. Hogarth, *Fayûm Towns and their Papyri* (1900); H. J. C. Beadnell, *The Topography and Geology of the Fayûm Province of Egypt* (Cairo, 1905); G. Caton Thompson and E. W. Gardner, *Geog. Journ.* (1929). (F. LL. G.)

MOESIA, a district inhabited by a Thracian people, bounded on the south by the mountain ranges of Haemus and Scardus, on the west by the Drinus, on the north by the Danube and on the east by the Euxine. Some, however, place the boundary much farther west. Each was governed by an imperial consular legate and a procurator. It corresponded in the main to modern Serbia and Bulgaria. In 75 B.C., C. Scribonius Curio, proconsul of Macedonia, penetrated as far as the Danube, and gained a victory over the inhabitants, who were finally subdued by M. Licinius Crassus, grandson of the triumvir and also proconsul of Macedonia, during the reign of Augustus *c.* 29 B.C.; the country, however, was not organized as a province until the last years of the reign. Originally one province, under an imperial legate (who probably also had control of Achaea and Macedonia), it was divided by Domitian into Upper and Lower Moesia, the western and eastern portions respectively, divided from each other by the river Cebrus. As a frontier province, Moesia was strengthened by stations and fortresses erected along the southern bank of the Danube, and a wall was built from Axiopolis to Tomi as a protection against Scythian and Sarmatian inroads. After the abandonment of Dacia (*q.v.*) to the barbarians by Aurelian (270–275) and the transference of its inhabitants to the south of the Danube, the central portion of Moesia took the name of Dacia Aureliani. The Goths, who had already invaded Moesia in 250, hard pressed by the Huns, again crossed the Danube during the reign of Valens (376), and with his permission settled in Moesia. But quarrels soon took place, and the Goths under Fritigern defeated Valens in a great battle near Adrianople (378). These Goths are known as Moeso-Goths, for whom Ulfilas made the Gothic translation of the Bible. In the 7th century Slavs and Bulgarians entered the country and founded the modern kingdoms of Serbia and Bulgaria.

BIBLIOGRAPHY.—J. Marquardt, *Römische Staatsverwaltung,* i. 301 (1881); T. Mommsen, *Provinces of the Roman Empire* (1886). For ancient authorities, see *Orosius,* v. 23; *Dio Cassius,* li. 25, 27.

MOFAḌḌALĪYĀT, strictly MUFAḌḌALĪYĀT, an anthology of ancient Arabic poems, which derives its name from al-Mufaḍḍal, son of Muḥammad, son of Ya'lā, a member of the tribe of Ḍabba, who compiled it some time between A.D. 762 and 784 in the latter of which years he died. Al-Mufaḍḍal was a contemporary of Ḥammād ar-Rāwiya and Khalaf al-Aḥmar, the famous collectors of ancient Arab poetry and tradition, and was somewhat the junior of Abū 'Amr ibn al-'Alā, the first scholar who systematically set himself to preserve the poetic literature of the Arabs. He died about fifty years before Abū 'Ubaida and al-Aṣma'ī, to whose labours posterity is largely indebted for the arrangement, elucidation and criticism of ancient Arabian verse; and his anthology was put together between fifty and sixty years before the compilation by Abū Tammām of the *Ḥamāsa* (*q.v.*).

Al-Mufaḍḍal was a careful and trustworthy collector both of texts and traditions, and is praised by all authorities on Arabian

history and literature as in this respect greatly the superior of Ḥammād and Khalaf, who are accused (especially the latter) of unscrupulous fabrication of poems in the style of the ancients. He was a native of Kūfa, the northernmost of the two great military colonies founded in 638 by the caliph 'Omar for the control of the wide Mesopotamian plain. In Kūfa and Baṣra were gathered representatives of all the Arabian tribes who formed the fighting force of the Islamic Empire, and from these al-Mufaḍḍal was able to collect and record the compositions of the poets who had celebrated the fortunes and exploits of their forefathers. He, no doubt, like al-Aṣma'ī and Abū 'Ubaida, also himself visited the areas occupied by the tribes for their camping grounds in the neighbouring desert; and adjacent to Kūfa was al-Ḥīra, the ancient capital of the Lakhmid kings, whose court was the most celebrated centre in pre-Islamic Arabia, where, in the century before the preaching of the Prophet, poets from the whole of the northern half of the peninsula were wont to assemble.

The date of al-Mufaḍḍal's birth is unknown; but he lived for many years under the caliphs of the Omayyad line until their overthrow by the 'Abbasids in 749. In 762 he took part in the rising led by Ibrāhīm ibn 'Abdallāh ibn al-Ḥasan, the 'Alid, called "The Pure Soul," against the caliph al-Manṣūr, and after the defeat and death of Ibrāhīm was cast into prison. Al-Manṣūr, however, pardoned him, and appointed him the instructor in literature of his son, afterwards the caliph al-Mahdī. It was for this prince that, at al-Manṣūr's instigation, al-Mufaḍḍal compiled the *Mufaḍḍalīyāt.*

The collection, in its present form, contains 126 pieces of verse, long and short; that is the number included in the recension of al-Anbārī, who had the text from Abū 'Ikrima of Ḍabba, who read it with Ibn al-A'rābī, the stepson and inheritor of the tradition of al-Mufaḍḍal. We know from the *Fihrist* of Muḥammad an-Nadīm (A.D. 988) that in his time 128 pieces were counted in the book; and this number agrees with that contained in the Vienna ms., which gives an additional poem, besides those annotated by al-Anbārī, to al-Muraqqish the Elder, and adds at the end a poem by al-Ḥārith ibn Ḥilliza. The *Fihrist* states (p. 68) that some scholars included more and others fewer poems, while the order of the poems in the several recensions differed; but the correct text, the author says, is that handed down through Ibn al-A'rābī. It is noticeable that this traditional text, and the accompanying scholia, as represented by al-Anbārī's recension, are wholly due to the scholars of Kūfa, to which place al-Mufaḍḍal himself belonged.

The collection is one of the highest importance as a record of the thought and poetic art of Arabia during the time immediately preceding the appearance of the Prophet. Not more than five or six of the 126 poems appear to have been composed by poets who had been born in Islām. The great majority of the authors belonged to the days of "the Ignorance," and though a certain number (*e.g.*, Mutammim ibn Nuwaira, Rabī'a ibn Maqrūm, 'Abda ibn aṭ-Ṭabīb and Abū Dhu'aib), born in paganism, accepted Islām, their work bears few marks of the new faith. The ancient virtues—hospitality to the guest and the poor, profuse expenditure of wealth, valour in battle, faithfulness to the cause of the tribe—are the themes of praise; wine and the game of *maisir,* forbidden by Islām, are celebrated by poets who professed themselves converts; and if there is no mention of the old idolatry, there is also little spirituality in the outlook on life. The 126 pieces are distributed among 68 poets, and the work represents a gathering from the compositions of those who were called *al-Muqillūn,* "authors of whom little has survived," in contrast to the famous poets whose works had been collected into *dīwāns.* At the same time many of them are extremely celebrated, and among the pieces selected by al-Mufaḍḍal several reach a very high level of excellence. Such are the two long poems of 'Alqama ibn 'Abada (Nos. 119 and 120), the three odes by Mutammim ibn Nuwaira (Nos. 9, 67, 68), the splendid poem of Salāma ibn Jandal (No. 22), the beautiful *nasīb* of ash-Shanfarā (No. 20), and the death-song of 'Abd-Yaghūth (No. 30). One of the most admirable and famous is the last of the series (No. 126), the long elegy by Abū Dhu'aib of Hudhail on the death of his sons; almost every verse of this poem is cited in illustration of some phrase or meaning of a word in the national lexicons. Only one of the poets of the *Mo'allaqāt* (*see* MO'ALLAQĀT), al-Ḥārith, son of Ḥilliza, is represented in the collection. An interesting feature of the work to be noted is the treatment in it of the two poets of Bakr ibn Wā'il, uncle and nephew, called al-Muraqqish, who are perhaps the most ancient in the collection. The elder Muraqqish was the great-uncle of Ṭarafa of Bakr, the author of the Mo'allaqa, and took part in the long warfare between the sister tribes of Bakr and Taghlib, called the war of Basūs, which began about the end of the 5th century A.D. Al-Mufaḍḍal has included ten pieces (Nos. 45–54) by him in the collection, which are chiefly interesting from an antiquarian point of view. It is probable that the compiler set down all he could gather of this ancient author, and that his interest in him was chiefly due to his antiquity. Of the younger Muraqqish, uncle of Ṭarafa, there are five pieces (Nos. 55–59). The only other authors of whom more than three poems are cited are Bishr ibn Abī Khāzim of Asad (Nos. 96–99) and Rabī'a ibn Maqrūm of Ḍabba (Nos. 38, 39, 43 and 113).

The *Mufaḍḍalīyāt* differs from the *Ḥamāsa* in being a collection of complete odes (*qaṣīdas*), while the latter is an anthology of brilliant passages specially selected for their interest or effectiveness, all that is prosaic or less striking being pruned away. It is of course not the case that all the poems of al-Mufaḍḍal's collection are complete. Many are mere fragments, and even in the longest there are often *lacunae*; but the compiler evidently set down all that he could collect of a poem from the memory of the *rāwīs,* and did not, like Abū Tammām, choose only the best portions. We are thus presented with a view of the literature of the age which is much more characteristic and comprehensive than that given by the brilliant poet to whom we owe the *Ḥamāsa,* and enables us to form a better judgment on the general level of poetic achievement.

The *Mufaḍḍalīyāt* is not well represented by mss. in the libraries of the West. There is an imperfect copy of the recension of al-Marzūqī (died 1030), with his commentary, in the Berlin collection. A very ancient fragment (dated 1080) of al-Anbārī's recension, containing five poems in whole or part, is in the Royal Library at Leipzig. In the British Museum there is a copy made about a century ago for C. J. Rich at Bagdad of a ms. with brief glosses; and at Vienna there is a modern copy of a ms. of which the original is at Constantinople, the glosses in which are taken from al-Anbārī, though the author had access also to al-Marzūqī. In the mosque libraries at Constantinople there are at least five mss.; and at Cairo there is a modern copy of one of these, containing the whole of al-Anbārī's commentary. In America there are at Yale University a modern copy of the same recension, taken from the same original as the Cairo copy, and a ms. of Persian origin, dated 1657, presenting a text identical with the Vienna codex. In recent years a very interesting ms., probably of the 6th century of the Hegira, but not dated, has come to light. It purports to be the second part of a combination of two anthologies, the *Mufaḍḍalīyāt* of al-Mufaḍḍal and the *Aṣma'īyāt* of al-Aṣma'ī, but contains many more poems than are in either of these collections as found elsewhere. The commentary appears to be eclectic, drawn partly (perhaps chiefly) from Ibn as-Sikkīt (died 858), and partly from Abū-Ja'far Aḥmad ibn 'Ubaid ibn Nāṣih, one of al-Anbārī's sources and a pupil of Ibn al-A'rābī; and the compilation seems to be older in date than al-Anbārī, since its glosses are often quoted by him without any name being mentioned. This ms. (which is the property of Mr. F. Krenkow of Leicester) appears to represent one of the recensions mentioned by Muḥammad an-Nadīm in the *Fihrist* (p. 68), to which reference has been made above.

In 1885 Professor Heinrich Thorbecke began an edition of the text based on the Berlin codex, but only the first fasciculus, containing forty-two poems, had appeared when his work was cut short by death. In 1891 the first volume of an edition of the text, with a short commentary taken from al-Anbārī, was printed at Constantinople. In 1906 an edition of the whole text, with short glosses taken from al-Anbārī's commentary, was published at Cairo by Abū Bakr b. 'Omar Dāghistānī al-Madanī; this follows

generally the Cairo codex above mentioned, but has profited by the scholarship of Professor Thorbecke's edition of the first half of the work. A complete edition of al-Anbārī's text and commentary, with a translation of the poems by Sir C. J. Lyall appeared in 1919. (C. J. L.)

MOFFAT, ROBERT (1795–1883), Scottish Congregationalist missionary to Africa, was born at Ormiston, Haddingtonshire, on Dec. 21, 1795, of humble parentage. He began as a gardener, but in 1814 when employed at High Leigh in Cheshire, offered himself to the London Missionary Society, and in 1816 was sent out to South Africa. After spending a year in Namaqua Land, with the chief Afrikaner, whom he converted, Moffat returned to Cape Town in 1819 and married Mary Smith (1795–1870), the daughter of a former employer. In 1820 Moffat and his wife left the Cape and proceeded to Griqua Town, and ultimately settled at Kuruman, among the Bechuana tribes living to the west of the Vaal river. Here he worked as a missionary till 1870, when he reluctantly returned finally to his native land. He made frequent journeys into the neighbouring regions as far north as the Matabele country. The results of these journeys he communicated to the Royal Geographical Society (*Journal* xxv.–xxxviii. and *Proceedings* ii.), and when in England on furlough (1839–1843) he published his well-known *Missionary Labours and Scenes in South Africa* (1842). He translated the whole of the Bible and *The Pilgrim's Progress* into Sechwana. Moffat was builder, carpenter, smith, gardener, farmer, all in one, and by precept and example he succeeded in turning a horde of bloodthirsty savages into a "people appreciating and cultivating the arts and habits of civilized life, with a written language of their own." David Livingstone was his son-in-law. He died at Leigh, near Tunbridge Wells, on Aug. 9, 1883. *See* also LIVINGSTONE, DAVID.

See *Lives of Robert and Mary Moffat*, by J. S. Moffat (1885); and C. S. Horne, *The Story of the L.M.S.* (1894).

MOFFAT, burgh and parish, Upper Annandale, Dumfriesshire, Scotland. Pop. (1931), 2,006. It is situated 21 m. N.N.E. of Dumfries and 63 m. by the L.M.S. line from Edinburgh and Glasgow. It has been famous for its sulphur and saline waters since the middle of the 18th century, and is a popular holiday resort. The spa lies a mile to the north of the town, and there are also spas at Hartfell (3½ m. N.) and Garpel (2 m. S.W.). Dumcrieff House, 2 m. S.W., the seat of Lord Rollo, was the home of Macadam, the road-builder.

MOFFAT TUNNEL, begun in 1923 and completed in 1928, is 6·2 m. long and pierces the continental divide 50 m. west of Denver, Colo., at an elevation of about 9,200 ft. above sea-level. The 16′×24′ tunnel, which provides for a single track standard gauge railroad, was driven parallel with and 75 ft. to the north of an 8′×8′ water tunnel with which it is connected at about 1,500 ft. intervals by cross cuts. It rises on a grade of 0·3% from the eastern entrance toward the centre and then descends on 0·8% and 0·9% grades to the western entrance.

The railway tunnel eliminated about 30 m. of 4% grades over Rollins' pass, reduced the maximum grade of the Denver and Salt Lake railway from 4% to 2%, and the maximum curvature from 16% to 12%. About 173 m. of the distance between Denver and Salt Lake City will eventually be saved. The water tunnel transports water for municipal and agricultural purposes in and around Denver from the western slope of the divide, and is designed to carry 450,000 gal. per minute. It is estimated that this water will add about 100,000 ac. of productive land to the territory adjacent to Denver. The tunnel is administered by the Moffat Tunnel Commission, and cost $15,470,000.

MOGADOR (*Es-Sueira*), the most southern seaport on the Atlantic coast of Morocco, in 31° 50′ N., 9° 20′ W., chief town of the *contrôle civil* of Chiadma. The town stands from 10 to 20 ft. above high water on a projecting ridge of calcareous sandstone. In certain states of wind and sea it is turned almost into an island, and a sea-wall protects the road to Saffi. On the land side stretch miles of sand-dunes studded with broom, and beyond, the argan forests, distinctive of southern Morocco. Approached from this side the city bursts on the view like a mirage between sky and sea. It is the best planned and cleanest town in the empire. The harbour is well sheltered from all winds except the south-west, but escape is difficult with the wind from that quarter, as the channel between the town and Mogador Island is narrow and hazardous. Pop. 18,401, of whom 9,836 are Muslims, 7,730 Jews, 835 Europeans. It is one of the towns of Morocco in which Jews are most numerous. Trade reaches 121 millions of francs (imports 59 millions, exports 62 millions). The share of France is 70 millions, that of Great Britain 31 millions, that of the United States 5 millions.

A place called Mogador is marked in the 1351 Portulan of the Laurentian library, and the map in Hondius's *Atlas minor* shows the island of Mogador, *I. Domegador;* but the origin of the present town is much more recent. Mogador was founded by Mohammed ben Abd Allah in 1760, and completed in 1770. The Portuguese called it after the shrine of Sidi Megdul, which lies towards the south half-way to the village of Diabat, and forms a striking landmark for seamen. In 1844 the citadel was bombarded by the French.

See A. H. Dyé, "Les Ports du Maroc," in *Bull. Soc. Geog. Comm. Paris* (1908), xxx. 313 *sqq.*, and British Consular reports.

MOGILA, PETER (*c.* 1596–1647), metropolitan of Kiev from 1632, belonged to a noble Wallachian family. He studied for some time at the university of Paris, and became a monk in 1625. He is known as the promoter of the *Orthodox Confession*, drawn up at his instance by the Abbot Kosslowski of Kiev, approved at a provincial synod in 1640, and accepted by the patriarchs of Constantinople, Jerusalem, Alexandria and Antioch in 1642–1643, and by the synod of Jerusalem in 1672. (*See* ORTHODOX EASTERN CHURCH.)

There are numerous editions of the *Confession* in Russian; it has been edited in Greek and Latin by Panagiotes (Amsterdam, 1662), by Hofmann (Leipzig, 1695), and by Kimmel (Jena, 1843), and there is a German translation by Frisch (Frankfort, 1727).

MOGILEV, a former government of western Russia now in the Ukrainian S.S.R. (*q.v.*).

MOGILEV ON THE DNIEPER, a town of the White Russian S.S.R., in 53° 55′ N., 30° 18′ E., on a hilly site on both banks of the river, and on the railway. Pop. (1926) 46,562. It has flour mills, a smelting industry, leather and tobacco manufactures and a brewery. It trades in corn, salt, sugar and fish from the south. It has an ancient Tatar tower, a 17th century church, a cathedral built for the Roman Catholics and one built for the Greek Orthodox church by Catherine II. of Russia and Joseph II. of Austria in 1780.

Mogilev is mentioned in the 14th century as a dependency of the Vitebsk, or of the Mstislavl principality. At the beginning of the 15th century it became the property of the Polish kings. But it was continually plundered—either by Russians, or by Cossacks. In the 17th century its inhabitants, who belonged to the Orthodox Greek Church, suffered much from the persecutions of the United Greek Church. In 1654 it surrendered to Russia, but in 1661 the Russian garrison was massacred by the inhabitants. In the 18th century the town was taken several times by Russians and by Swedes, and in 1708 Peter the Great ordered its destruction by fire. It was annexed to Russia in 1772. Near here the French under Davoût defeated the Russians under Bagration on July 23, 1812. It was the scene of much strife in the 1917–20 period.

MOGILEV ON THE DNIESTER (MOGILEV-PODOLSK), a town of the Ukrainian S.S.R., on the left bank of the river in 48° 27′ N., 27° 45′ E. Pop. (1926) 22,271. The former trade of the town along the Dniester has been checked by the state of armed neutrality existing at present between Russia and Rumania on the question of Bessarabia. It has several flour-mills, a distillery, a sugar refinery and a chalk factory. Mogilev, named in honour of the Moldavian hospodar Mohila, was founded by Count Potocki about the end of the 16th century. Owing to its situation on the highway from Moldavia to the Ukraine, at the passage across the Dniester, it developed rapidly. For more than 150 years its possession was disputed between the Cossacks, the Poles and the Turks. It remained in the hands of the Poles, and was annexed to Russia in 1795. It suffered much during the war and civil war of 1914–20.

MOGUL, MOGHAL, or **MUGHAL,** the Arabic and Persian form of the word Mongol, applied to the Mohammedan empire in India, which was founded by Baber. In consequence the name is applied to all Mohammedans from the countries on the west and north-west of India, except the Pathans. The Great Mogul is the name given to the Mogul emperors of Delhi.

MOHÁCS, a Hungarian town on the right bank of the Danube, acts as a market for the vineyards and agricultural produce of the fertile alluvial lands of the district. It also engages in the working up of flax, hemp and wool, milling and brewing. The town is famous in history as the site of two fateful battles for the control of the route between the river and the Mecsek mountains. In the first (Aug. 29, 1526), the Turks annihilated the Hungarian army but in the second (Aug. 12, 1687), they were decisively defeated by the Austrians. Pop. (1920) 15,864.

MOHAIR, the hair of a variety of goat originally inhabiting the regions of Asiatic Turkey of which Angora is the centre, whence the animal is known as the Angora goat.

The typical mohair fibre is 7 to 8in. long, very lustrous owing to its physical structure (which although akin to wool is different in that the wool scales are only indicated instead of being fully developed, while the fibre is always solid), $\frac{1}{800}$ to $\frac{1}{800}$ of an inch in diameter, of a soft elastic handle, and usually of a clear white transparent colour. The staples of which the fleece is formed should be uniform in length and clearly defined, naturally lending themselves to a good "spin"—a difficult attainment in the case of mohair (*see* WOOLLEN MANUFACTURE). There are many varieties of mohair, and in Constantinople, the centre of the Turkish mohair trade, a large variety of fleece is recognized.

Owing to the demand for raw material exceeding the supply, from 1820 onwards there has been a great deal of crossing of the well bred Angora with the common kind of goat: in fact, it has been said that by 1863 the original Angora had practically disappeared. The growing demand for mohair further resulted in attempts on a commercial scale to introduce the goat into South Africa—where it was crossed with the native goat—the United States, Australia, and later still New Zealand. Perhaps the introduction of the Angora into Australia and New Zealand may in part be due to its value as a scrub and blackberry browser.

The manufacture of fabrics from mohair—as in the case of alpaca and cashmere—was in the first instance due to the genius of the rearers of the goat. It would, indeed, be interesting to know if the present day mohair goods—often styled "alpacas"—really had their origin in the earlier products of Asia Minor. That fabrics of mohair were in use in England early in the 18th century is obvious from Pope's allusion:—

> "And, when she sees her friend in deep despair,
> Observes how much a chintz exceeds mohair."

Raw mohair was first exported from Turkey to England about 1820, and from that date onwards marked strides were made in its manufacture into useful yarns and fabrics. England has always had, and still maintains, supremacy in this manufacture. The larger part of both the Turkish and Cape clips is at least converted into yarn in Yorkshire mills. Quantities of these yarns are also woven into dress goods, dust cloakings, pile fabrics, imitation furs, etc., in Yorkshire, but even greater quantities of mohair yarn are exported to Russia, Germany, Austria, etc., to be converted into astrakhans, ordinary braids, brush braids, etc. In the first decade of the 20th century the mohair braid trade received a blow from the introduction of artificial silk.

The history of the introduction of the Angora goat from Asia Minor into the other countries mentioned is as follows. In 1838 pure-bred Angoras were introduced into Cape Colony. These pure-bred goats crossed with the common goat laid the basis of the Cape flocks. In 1856–57 other importations of pure-bred goats were made. From 1868 to 1897 further importations were made, but these were not of the pure-bred goat. The introduction of Angoras into the United States took place in 1849. Other importations of goats from Asia Minor were made between 1857 and 1880, and interchanges of blood also took place between the United States and Cape Colony. Between 1856 and 1875 some 300 goats were introduced into Australia. It seems that Australia may yet find the Angora goat an important asset.

MOHAMMED or **MUḤAMMAD** or **MAHOMET,** founder of the religious system called in Europe Mohammedanism, and by himself Islam or Ḥanifism. He died, according to the ordinary synchronism, on June 7, 632 (12 Rabia, A.H. 11), and his birthday was either 63 or 65 years earlier. A member of the tribe Koreish, and son of Abdullah and his wife, Aminah, Mohammed is said to have been a posthumous child who, after the early death of his mother, was brought up first by his wealthy grandfather, ʿAbd al-Moṭṭalib, and then by his poorer uncle, Abū Ṭalib. In his youth he seems to have visited the desert to acquire the habits and the language of the Bedouins, and also to have accompanied Meccan traders to Syria and south Arabia, and perhaps to Egypt and Mesopotamia. His career as a caravan conductor probably terminated with his marriage to Khadija, daughter of Khuwailid, whom tradition represents as a wealthy widow, 15 years his senior and 40 years of age at the time of the union. After his marriage, Mohammed appears to have been a partner in a shop in Mecca which sold agricultural produce.

The Prophet's Call.—Meanwhile he had acquired a reputation for great practical wisdom, though his education seems to have been only such as was normal in the case of the better families of his community. The word *ummī,* literally "popular" or "plebeian" (according to one etymology), applied to him in the Koran. is said to mean "one who can neither read nor write," a supposition which enters into the doctrine of the miraculous nature of the Koran. But the word may mean "Meccan," *i.e.,* native of "the Mother of the Villages" (*Umm al Qura*); and it is probable that he could both read and write, but unskilfully.

At the time of his aspiration to become the legislator or mouthpiece of the Deity, Arabian paganism in the north had gradually come under the Christianizing influence of the Byzantine empire, and in the south had fallen successively under Jewish, Abyssinian and Persian influence. In so far as Mohammed formulated a definite notion of his work, it was probably the restoration of the religion of Abraham, or (as the Koran calls him) Ibrahim. Though we have no reason for supposing the name of Abraham or Ishmael to have been known in Mecca generally before Mohammed's time, the biblical ethnology was not apparently questioned by those who were told of it, and there are stories, not necessarily apocryphal, of precursors of Mohammed going abroad in search of the "religion of Abraham." One feature of that system, associated in the Bible with the name of Ishmael as well, was circumcision, which was actually observed by the Meccan tribes, though with technical differences from the Jewish method; the association of monotheism with it would seem reasonable enough in view of Jewish traditions, such as Mohammed may have heard on his travels; why the doctrine of the future life should be coupled with it is less clear.

As it was obvious that the claim to be God's mouthpiece, whether directly or through the intermediary of the angel Gabriel, was to claim autocracy, Mohammed employed the utmost caution in his mode of asserting this claim. For three years his followers were a secret society; and this period appears to have been preceded by one of private preparation, the first revelation being received when the Prophet was in religious retirement—a ceremony called *Taḥannuth,* of which the meaning is uncertain, on Mt. Ḥira, near Mecca.

If the traditional dates assigned to the *suras* (chapters) of the Koran (*q.v.*) are correct, the earliest revelations to the Prophet took the form of pages or rolls which were to be read by the "grace of God." The Prophet was directed to communicate his mission at first only to his nearest relatives. The utterances were from the first a sort of rhyme, such as is said to have been employed for solemn matter in general, *e.g.,* oracles or prayers. At an early period the production of a written communication was abandoned for oral communications, delivered by the Prophet in trance; their delivery was preceded by copious perspiration, for which the Prophet prepared (in accordance with instructions found in the Koran) by wrapping himself in a blanket. Trusty followers wrote down these utterances, but the phenomena which

accompanied their delivery at least in one case suggested imposture to the scribe who apostatized in consequence. It is extraordinary that there is no reason to suppose that any official record was ever kept of these revelations; the Prophet treated them somewhat as the Sibyl did her leaves.

Certain doctrines and practices (*e.g.*, washing of the person and the garments) must have been enjoined from the first, but the doctrines to which the Prophet himself assigned most value seem to have been the unity of God and the future life.

Growth of the Early Community.—Mohammed's first converts were his wife Khadīja, his cousin Ali, and Abū Bekr, a son of Abū Quḥāfah, his most loyal disciple, and afterwards, his first successor. The early years of his work were marked by secrecy, so that when he made his first appearance as a public preacher some time about 616, he was already the head of a band of united followers.

First Period of Publicity.—Rejecting accounts of Mohammed's first appearance as a public preacher which are evidently comments on a text of the Koran, we have reason for supposing that his hand was forced by ardent followers. The astute rulers of the community perceived that the claim made by Mohammed was to be dictator or autocrat; and while this was naturally ridiculed by them, some appear to have been devoted adherents of the gods or goddesses whom he attacked. Apparently there was a war of words, followed by a resort to diplomacy and then to force; and then a period in which Mohammed's attention was directed to foreign conversions, resulting in his being offered and accepting the dictatorship of Yathrib. His increasing success led to serious persecution of his less influential followers, for whom he found a refuge in Axum. But since such an alliance was a menace to the existence of the Meccan community, a deputation was sent by the Meccan leaders to demand extradition of the exiles. To frustrate their efforts, Mohammed sent his cousin Ja'far armed with an exposition of the Prophet's doctrines afterwards embodied in the Koran as the Sura of Mary (No. XIX.; though with the addition of some anti-Christian matter). The Abyssinian king and his ecclesiastical advisers took the side of Mohammed and his followers, whom they appear to have regarded as persecuted Christians. The want of an Abyssinian chronicle for this period is a serious disadvantage for the study of Islamic origins. The sequel shows that regular correspondence went on between the exiles and those who remained in Mecca, whence the former were retained within the fold.

The Meccan leaders, roused to fury by this diplomatic victory, blockaded the Prophet and his followers in the quarter which they occupied; as in other sanctuaries, though blood might not be shed, a culprit might be starved to death. After a time the besieged found the situation intolerable and Mohammed retracted those of his utterances which had most offended the Meccans. A revelation came acknowledging the effectiveness of the Meccan goddesses as well as Allah, and the Meccans raised the siege. News of the reconciliation reached the Abyssinian exiles and before they could return the dispute had recommenced, because the Prophet had declared the revelation to be a fabrication of the Devil, who, it appears, regularly interpolates in prophetic revelations; such at least is the apology preserved in the Koran, whence the fabricated verses have been expunged. Since our knowledge of this episode (regarded as the most disgraceful in the Prophet's career) is fragmentary, we can only guess that the Prophet's hand had once more been forced by the more earnest of his followers, for whom any compromise with paganism was impossible. The exiles went back to Abyssinia; and about this time both Abū Ṭalib and Khadīja died, leaving the Prophet unprotected.

He fled to the neighbouring oasis of Ṭāif, where wealthy Meccans had possessions, and opened negotiations with various Meccan magnates for a promise of protection in case of his return. This was at last obtained from one Mot'im b. 'Adi.

The Flight to Yathrib.—Avoided by the Meccans, he was glad to accept an invitation from the inhabitants of Yathrib, afterwards known as *al-Medina*, Medina, "the City" (*i.e.*, of the Prophet), to come thither as dictator, to heal the feud and restore order. Accordingly he exiled himself and his flight *hijra* (anglicized incorrectly *hejira*, *q.v.*), initiated the Mohammedan era, July 16, A.D. 622. The new converts were told to carry on secret propaganda in Yathrib with this end in view. A trusty follower of Mohammed, Mus'ab b. 'Umair, who resembled him in appearance, was sent to Yathrib to assist in the work.

Although the transactions with the people of Yathrib had been carried on with profound secrecy, the nature of Mohammed's contract with his new adherents was somehow divulged to the Meccan magnates, and the danger of allowing an implacable enemy to establish himself on the high-road of their north-bound caravans flashed upon them. The rule which forbade bloodshed in the sacred city had at last to be suspended; but elaborate precautions were to be taken whereby every tribe (except Mohammed's own clan) should have their share in the guilt, which would thus be spread over the whole community fairly. When the committee appointed to perpetrate the crime reached Mohammed's house, they found that it was too late; Mohammed had already departed, leaving Ali in his bed.

Accompanied by Abū Bekr only, Mohammed took refuge in a cave of Mt. Thaur. The date at which he reached Kuba, on the outskirts of Yathrib, is given as 8 Rabia I., of the year A.H. 1; the fact that he arrived there on the Jewish Day of Atonement gives us the date Sept. 20, 622.

Mohammed as Despot of Yathrib.—The safe arrival of Mohammed at his destination marks the turning-point in his career, which now became one of almost unbroken success; by defeat little less than by victory. His policy appears to have been to bind his followers to himself and then to each other by every possible tie; he instituted brotherhoods between the Refugees and Helpers, which were to count as relationships for legal purposes, and having himself no sons, he contracted numerous marriages partly with the same end in view; *e.g.*, with the infant daughter of Abū Bekr, Ayesha ('A'ishah), whose ability he appears to have discerned; and the unamiable Ḥafṣa, daughter of Omar. Of his own daughters three were given to faithful allies, the one by whom his line is supposed to have been continued to our time, Fāṭima, was reserved for his cousin. Coming in the capacity of the prophet of the Israelitish God, Mohammed at first seems to have courted alliance with the Jews, but finding no possibility of compromising with them on religious questions or of obtaining their loyal support, he seems to have reacted towards paganism, and after about a year's residence at Medina the direction of prayer, which till then had been towards Jerusalem, was turned southward to the pagan temple at Mecca. With this change we may perhaps couple the adoption of the name *Allah* for the Deity. In general any practice taken over from some other sect was modified so as to render the Muslim method absolutely distinct; but on the subject of food Mohammed was satisfied with the regulations of the Council of Jerusalem, recorded in Acts xv., which were observed by few, if any, Christian sects. The prohibition of wine, which was enacted in A.H. 3, is said to have been occasioned by the riotous conduct of one of his followers when under the influence of liquor. As the system spread outside of Medina both conversion to Islam and persistence therein were reduced to simple tests; the pronunciation of the double formula of belief in Allah and Mohammed was sufficient to indicate conversion, whilst payment of an income-tax was evidence of loyalty.

The Campaigns of Mohammed.—The industries in which the Meccan refugees had been engaged were not of a sort which they could exercise at Medina, and hence a fresh source of revenue was sought in the attacking of Meccan caravans. After a year of futile attempts, Mohammed resolved to send an expedition to attack a caravan at the beginning of the sacred month of Rajab, a season when raiding was unknown among the Arabs. The violation of the sacred month seems to have caused considerable scandal in Arabia, but led to no serious consequence; on the other hand the shedding of blood created a feud between the Meccans and the refugees, whom they declined to identify with the people of Medina. Some months later another attack for which the Prophet had organized a party of some 300 men

led to the battle of Badr (Ramaḍān 19, A.H. 2, usually made to synchronize with March 17, 624) in which the Meccans numbering about a thousand were badly defeated. The day is called in the Koran by a Syriac expression the "Day of Deliverance," and both for internal and external politics was of incalculable advantage to Islam, whilst Mohammed in the popularity acquired by his victory was able to strike forcibly at his enemies in Medina.

The defeat at Badr naturally led to efforts on the part of the Meccans to avenge their dead and besides to secure the commerce by which they lived, from an enemy who was gradually getting all the seaboard that lay between Jeddah and Yanbo within his sphere of influence; and the year after Badr (A.H. 3), when Abū Sofiān led a force of some 3,000 men against Medina itself, part of it was under Khālid b. al-Walid, one of the greatest of Arab captains, afterwards conqueror of Syria. A battle was fought under Mt. Uḥud (or Ohod), north-west of Medina, wherein Mohammed's forces were defeated. The Meccans considering their task finished when they had killed as many as those who had fallen at Badr on their own side, instead of pursuing their victory went home. Two years later, they, with their allies, the tribes Fazarah, Asad, Murrah, etc., to the number, it is said, of 10,000, attempted to stamp out Islam, but Mohammed resorted to the expedient of defending his city by a trench and employed agents to sow dissension among the confederates. After a brief stay and scarcely striking a blow, the confederacy dispersed.

The next year (A.H. 6), Mohammed made a truce with the Meccans (the truce of Ḥodaibiyah), whereby he secured for his followers the right of performing the pilgrimage in the following year. The performance of the pilgrimage (A.H. 7), not only won important converts in the persons of Khālid and the no less able 'Amr b. al-'As, but in general impressed the population with the idea that Mohammed was winning. An excuse was easily found for invading Mecca itself in the following year and the city surrendered with little resistance. The Medinese, however, prevailed upon the Prophet to maintain their city as his political capital, while making Mecca the religious centre of his system. In the following year all Arabs who were not yet converted were given four months' grace before force was to be brought to bear upon them. In the succeeding year Mohammed himself conducted the pilgrimage, and delivered the important proclamation wherein he declared that God had completed their religion. The principle insisted upon was the brotherhood of Islam; but there is difficulty in enucleating the original sermon from later additions.

It would seem that at first Mohammed thought of himself as sent to his fellow-citizens only, but at the battle of Badr he appears to have formulated the rule that no one might fight on his side who had not embraced Islam; and when once he had won fame as a successful campaigner, those who wished to share his adventures had to pass the Islamic test. After the taking of Mecca, paganism in general was conscious of being attacked; and the city had scarcely been brought under the new régime before the Prophet had to face a confederation of tribes called Hawāzin and Thaqīf. The battle which ensued, known as the Day of Honain, was a narrow victory for Islam. Emissaries were now sent out to destroy idols, and only Ṭāif appears to have made any considerable resistance; against this place the Prophet first made use of siege artillery, and afterwards took it by capitulation.

Although the central portions of the peninsula were practically independent, large portions of the north-west and south-east were provinces of the Byzantine and Persian empires respectively, whence any scheme for the conquest of Arabia would necessarily involve war with these great powers. In the year A.H. 7, on the eve of the taking of Mecca, the Prophet sent missives to all known sovereigns and potentates, promising them safety if they embraced Islam. The text of these letters, which only varied in the name of the person addressed, is preserved (doubtless faithfully) by the Muslim Oral Tradition. At the time of his death he was organizing an expedition against Syria.

The Jewish and Christian Communities.—The Prophet claimed throughout that his revelation confirmed the Jewish and Christian Scriptures, and on neither the truth of the Biblical history and miracles nor the validity of the Mosaic legislation does he appear to have cast any doubt. He even allows that Israel was the chosen people. The Gospel was known to him chiefly through apocryphal and heretical sources, which cannot certainly be identified; but he accepted the doctrine of the Virgin-birth, the miracles of healing the sick and raising the dead, and the ascension; the crucifixion and resurrection were clearly denied by the sect from whom he had received his information, and rejected by him, though certainly not because of any miracle which the latter involved. His quarrel with the Jews at Medina appears to have been by no means of his own seeking, but to have arisen unavoidably, owing to his particular view of his office being such as they could not accept. When he discovered their military incompetence he appears to have been unable to resist the temptation to appropriate their goods; and his attack on the flourishing Jewish settlement of Khaibar appears to have been designed to satisfy his discontented adherents by an accession of plunder. Yet the consciousness that his process was economically wasteful suggested to him an idea which Islamic States are only now abandoning, viz., that of a tolerated caste who should till the soil and provide sustenance for the Believers who were to be the fighting caste. Whereas then his former plan in dealing with Israelites had been to banish or massacre, he now left the former owners of Khaibar (who had survived the capture of the place) in full possession of the soil, of whose produce they were to pay a fixed proportion to the Islamic State.

Disputes with Christians occur somewhat later in the Prophet's career than those with the Jews. Mohammed's manifesto to the world, about the time of the taking of Khaibar, appears to represent his definite breach with Christianity; and when in the "year of the embassies" the Christians of Najran sent a deputation to him, they found that the breach between the two systems was not to be healed. Of the three alternatives open to them—conversion, internecine war, and tribute—they chose the last, and the Prophet's attitude towards them became less hostile than towards the Jews.

Mohammed's Administrations and Reforms.—The financial requirements of Mohammed's state were of the simplest kind, for there is no trace of any governmental department having been instituted by him. As despot of Medina he combined the functions of legislator, administrator, general and judge; his duties in the last three capacities were occasionally delegated to others, as when he appointed a governor of Medina during his absence, or leaders for expeditions. The newly converted communities he left to manage their internal affairs as before, only sending occasional envoys to discharge special duties, especially instruction in the Koran and the principles of Islam and to collect the *Alms:* quite towards the end of his life he appears to have sent persons to the provinces to act as judges.

What afterwards proved the main source of revenue in Islamic States dates from the taking of Khaibar; for the rent paid to the State by tolerated communities for the right to work their land developed long after Mohammed's time into a poll-tax for Unbelievers (*see* CALIPHATE, and MOHAMMEDAN INSTITUTIONS), and a land-tax for all owners of land. Of the Prophet's reforms the three most important were his attempt to break down the blood-feud or system of tribal responsibility for homicide, whereby one death regularly led to protracted wars; his abolition of infanticide, which is condemned even in early Suras of the Koran; and, if tradition be right, the granting to women of the right to inherit property. The "Condition of Islam" whereby adultery was forbidden is said to have been ridiculed at the time, on the ground that this practice had never been approved. Against these services we must set the abrogation of some valuable practices. His unfortunate essay in astronomy, whereby a calendar of twelve lunar months, bearing no relation to the seasons, was introduced, was in any case a retrograde step. He also permitted himself a slight amount of bloodshed in Mecca itself, and that city perhaps never quite recovered its sacrosanct character. Of more serious consequences for the development of the community was his encouragement of the shedding of kindred blood in the cause

of Islam; his assassinations of enemies were afterwards quoted as precedents. No less unfortunate was the recognition of the principle whereby atonement could be made for oaths.

Mohammed's Domestic Life.—The Prophet's domestic troubles, to which an unreasonable amount of space seems to be devoted, even in the Koran, began after the Migration, when, probably for political reasons, he instituted a royal harem. One of these political motives was the principle which long survived, that the conquest of a state was consummated by possession of the former monarch's wife or daughter; another, as had been seen, the desire to obtain the securest possible hold on his ministers. Of the members of this harem the only prominent one is 'A'isha, married to the Prophet shortly after the Flight, when she had scarcely passed the period of infancy, but who appears to have been gifted with astuteness and ambition that were quite beyond her years, and who maintained her ascendancy over the Prophet in spite of the fact that many carping criticisms of his revelations are attributed to her. In her arms apparently he died, and on her statements we have to rely for what we know of his last hours.

The traditional description of Mohammed is "of middle height, greyish, with hair that was neither straight nor curly; with a large head, large eyes, heavy eyelashes, reddish tint in the eyes, thick-bearded, broad-shouldered, with thick hands and feet." He was in the habit of giving violent expression to the emotions of anger and mirth, and during his last years exhibited great physical and intellectual activity.

Chronological Table of Chief Events in the Life of Mohammed[1].

570. Birth.
595. Marriage with Khadīja.
610. Commencement of Call.
613. Public Appearance.
616. Persian conquest of the nearer East.
? 617. Flight of his followers to Abyssinia.
? 618–619. Siege in Mecca. Retractation and subsequent repudiation. Death of Abū Ṭalīb and Khadīja.
? 620. Flight to Ṭāif.
622. July 16. Beginning of the Muslim era.
622. Sept. 20. Arrival at Kuba after the Flight.
632. Jan. 27. Death of his son Ibrāhīm.
June 7. Death of Mohammed.

Family of Mohammed[1].—*Wives:*—**Khadīja* (Children:—Qāsim; ? 'Abd Manāf [Ṭāhir, Tayyib]); **Zainab* m. Abu'l-'As b. Rabī', d. A.H. 7; **Ruqayyah,* m. 'Othmān b. 'Affān, d. A.H. 2; **Umm Kulthūm* m. 'Othmān b. 'Affan, d. A.H. 9; **Fāṭimah,* m. 'Alī, d. A.H. 11; *Saudah bint Zam'ah.* ? d. A.H. 54, **'A'ishah (Ayesha) bint Abī Bekr* (d. A.H. 56), **Ḥafṣa bint 'Omar* (d. A.H. 45 or 47), *Zainab bint Khuzaimah* d. before A.H. 11, **Zainab bint Jaḥsh,* d. A.H. 20, **Umm Salimah,* d. A.H. 59, **Maimūnah,* d. A.H. 38, **Juwairiyah,* d. A.H. 56, **Umm Ḥabībah Ramlah bint Abī Sofiān,* d. A.H. 44.

Concubines:—**Ṣafiyyah bint Ḥuyyay,* d. A.H. 36, **Raiḥānah bint Zaid,* **Māriyah the Copt.* d. A.H. 15 or 16, mother of Ibrāhīm. (Other names given by Ibn Sa'd, vol. viii.)

Sources.—The literary matter ascribed to the Prophet consists of (1) the Koran (*q.v.*); (2) certain contracts, letters and rescripts preserved by his biographers; (3) a number of sayings on a vast variety of topics, collected by traditionalists. The references in the Koran to a form of literature called "Wisdom" (*ḥikmah*) suggest that even in the Prophet's time attempts had been made to preserve some of the last; the general uncertainty of oral tradition and the length of time which elapsed before any critical treatment of it was attempted, and the variety of causes which led to the wilful fabrication of prophetic utterances, render the use to which No. 3 can be put very limited. It is very much to be regretted that the number of *pièces justificatives* (No. 2) quoted by the biographers is so small, and that for these oral tradition was preferred to a search for the actual documents, some of which may well have been in existence when the earliest biographies were written. Besides these contemporary documents many events were celebrated by poets, whose verses were ostensibly incorporated in the standard biography of Ibn Isḥāq; but in the abridgment of that biography which we possess many of these are obelized as spurious; the *diwan* (or collection of poems) attributed to Ḥassan b. Thābit, however, is ordinarily regarded as authentic. Though they rarely give detailed descriptions of events, their attestation is at times of value, *e.g.,* for the story that the bodies of the slain at Badr were cast by the Prophet into a pit. Besides this, the narratives of eye-witnesses of important events, or of those who had actually taken part in them, were eagerly sought by the second generation, and some of these were committed to writing well before the end of the 1st century. The procedure whereby the original dates of the events (so far as they were remembered) were translated into the Muslim calendar—for something of this sort must have been done—is unknown, and is unlikely to have been scientific.

[1]Dates are given A.H.

* is prefixed to names which figure on occasions that seem to be historical. Female names are in italics.

BIBLIOGRAPHY.—The biography of Ibn Isḥāq had circulated long before the two chief causes for the falsification of tradition had begun to have serious effects; these were the need for legal precedents, and the concept of saintliness, which gave rise to the classical works on the *Evidences of Mohammed's Mission* by Abū Nu'aim (d. A.D. 1012–13) and Baihaqī (d. A.D. 1066).

Lives of the Prophet († indicates that the work is lost): †'Urwah b. Zubair (d. 712–713); Musa b. 'Ukbah (d. 758–759); †Mohammed b. Isḥāq (d. 768); Mohammed b. Hishām (d. 828–829), ed. Wüstenfeld (Göttingen, 1860); reprinted in Egypt by Zubair Pasha, a series of excerpts from the last; Mohammed b. Omar al-Wāqidī (d. 823), portion published by Kremer (Calcutta, 1855), abridged trans. of a fuller copy by Wellhausen, *Muhammad in Medina* (Berlin, 1882); Mohammed b. Sa'd (d. 844–845), an encyclopaedic work on the history of Mohammed and his followers, called *Ṭabaqat,* ed. Sachau and others (Berlin, 1904–12, incomplete); Mohammed b. Jarīr al-Ṭabarī (*see* TABARĪ). Other writers are enumerated in the *Fihrist, cf.* Sprenger's *Leben Muhammads,* iii.

Modern Authorities: The critical study of Mohammed begins in Europe with the publication by Th. Gagnier in 1723 of the *Life* by Abulfeda (*q.v.*). Presently there appeared an apologetic biography by Henri Cmte. de Boulainvilliers (2nd ed., Amsterdam, 1731), to which Gagnier replied in 1732 (*La Vie de Mahomet, traduite,* etc., *ibid.*). Then came the biography of G. Weil (*Muhammed der Prophet,* Stuttgart, 1843), without religious bias; the popular life by Washington Irving (London, 1849) is based on this. That by J. L. Merrick (*The Life and Religion of Mohammed,* Boston, 1850) rests on Shi'ite sources. The search for mss. in India conducted by A. Sprenger led to the discovery of fresh material, which was utilized by Sprenger himself in his unfinished *Life of Mohammed* (Pt. 1, Allahabad, 1851), and his more elaborate *Das Leben und die Lehre des Mohammed* (1861–65), and by Sir William Muir in his *Life of Mahomet* (London 1858–61), 4 vols.: afterwards abridged in one volume and reprinted. The biography by S. W. Koelle, *Mohammed and Mohammedanism* (1889), is pro-Christian, the popular work of Syed Ameer Ali, *The Spirit of Islam* (1896), an apology for Mohammedanism. The more notable later works include H. Grimme's *Mohammed* (Münster, 1892, and Munich, 1904); F. Buhl's *Mohammeds Liv* (Copenhagen, 1903—Danish; since translated into German); A. N. Wollaston's *Muhammad, His Life and Doctrines* (1904); D. S. Margoliouth, *Mohammed and the Rise of Islam* (N.Y., 1905, etc.); Prince Caetani, *Annali dell' Islam,* i., ii. (Milan, 1905–07); and J. T. Andrae, *Die Person Muhammeds in Lehre und Glauben seiner Gemeinde* (Stockholm, 1917).

See further CALIPHATE, *ab. init.*; KORAN; MOHAMMEDAN INSTITUTIONS; MOHAMMEDAN LAW; MOHAMMEDAN RELIGION; MECCA.

(D. S. MA.; X.)

MOHAMMED V. (1844–1918), Sultan of Turkey, was born at Topqapu on Nov. 3, 1844, a younger son of the Sultan Abdul Majid (1823–1861). He led a quiet and retiring life, and suffered at times considerably from the jealousy and suspicion of his elder brother, the Sultan Abdul Hamid II. On the deposition of Abdul Hamid he was invested as caliph (May 10, 1909). He was, for the most part, merely a tool in the hands of the Committee of Union and Progress and, though he was supposed to dislike the pro-German policy of Enver Pasha, he was unable to take any effective steps to oppose him. He died at Yildiz on July 3, 1918, and was succeeded by his brother Vahid-ed-Din (1861–1926) as MOHAMMED VI. Mohammed VI., the last sultan of Turkey, left Constantinople Nov. 17, 1922, on a British battleship, was declared deposed Nov. 23, and died in exile.

MOHAMMED AHMED IBN SEYYID ABDULLAH (1848–1885), Sudanese tyrant, known as "the Mahdi," was born in Dongola. His family, known as excellent boat-builders, claimed to be *Ashraf* (or *Sherifs*), descendants of the Prophet. His father was a *fiki* or religious teacher, and Mohammed Ahmed devoted

himself to religious studies. He went to live on Abba Island on the White Nile about 150 m. above Khartum; many dervishes gathered round the young sheik, whose reputation for sanctity speedily grew. He travelled secretly through Kordofan, where (with ample justification) he denounced to the villagers the extortion of the tax-gatherer and told of the coming of the mahdi who should deliver them from the oppressor. In May 1881 a certain Abu Saud, a notorious scoundrel, was sent to Abba Island to bring the sheik to Khartum. Abu Saud's mission failed, and Mohammed Ahmed no longer hesitated to call himself Al-Mahdi al Montasir. "The Expected Guide." In August he defeated another force sent to Abba Island to arrest him, but thereafter deemed it prudent to retire to Jebel Gedir, in the Nuba country south of Kordofan, where he was soon at the head of a powerful force; and 6,000 Egyptian troops under Yusef Pasha, advancing from Fashoda, were nearly annihilated by him in June 1882.

By the end of 1882 the whole of the Sudan south of Khartum was in rebellion, with the exception of the Bahr-el-Ghazal and the Equatorial Provinces. In January 1883 El Obeid, the capital of Kordofan, was captured. In the November following Hicks Pasha's force of 10,000 men was destroyed at Kashgil, and in the same year the mahdi's lieutenant, Osman Digna, raised the tribes in the eastern Sudan, and besieged Sinkat and Tokar, near Suakin, routing General Valentine Baker's force of 2,500 men at El Teb in February 1884. The operations undertaken by Great Britain in face of this state of affairs are narrated under EGYPT: *Military Operations*. It need only be added that General Gordon (*q.v.*) was besieged at Khartum by the mahdi and was killed there when the town was captured by the mahdists on the 25th–26th of January 1885. The mahdi himself died at Omdurman on June 22, 1885, and was succeeded by his khalifa Abdullah.

See *Mahdiism and the Egyptian Sudan* by F. R. Wingate (1891); *Ten Years' Captivity in the Mahdi's Camp* (1882–92) from the MS. of Father Joseph Ohrwalder by F. R. Wingate (1892) and *Fire and Sword in the Sudan* (1879–95) by Slatin Pasha.

MOHAMMED ALI (1769–1849), founder of the present royal house of Egypt, born at Kavala, a small seaport on the frontier of Thrace and Macedonia. His father, an Albanian, was an *aga*, a small yeoman farmer, and he himself began life as a petty official and trader in tobacco. In 1798 he became second in command of a regiment of bashi-bazouks, or volunteers, recruited to serve against Napoleon in Egypt. He took part in the battle of Aboukir (July 25, 1799), was driven into the sea with the Turks, and was saved from drowning by the gig of the British admiral. In 1801 he returned to Egypt, in command of his regiment, and on May 9 distinguished himself at the battle of Rahmanieh. In the years that followed, Mohammed Ali, leader of a compact body of Albanian clansmen, was in the best position to profit by the struggle for power between the Mamelukes and the representatives of the Porte. In 1803 he cast in his lot with the former; in 1804 he turned against them and proclaimed his loyalty to the sultan; in 1805, the sheiks of Cairo, in the hope of putting a stop to the intolerable anarchy, elected him pasha, and a year later an imperial *firman* confirmed their choice. The disastrous British expedition of 1807 followed; and while at Constantinople the prestige of the sultan was being undermined by the series of revolutions which in 1808 brought Mahmud II. to the throne, that of Mohammed Ali was enhanced by the exhibition at Cairo of British prisoners and an avenue of stakes decorated with the heads of British slain.

In spite of his chance victories, however, he was too shrewd not to see the superiority of European methods of warfare; and as the first step towards the empire of which he dreamed he determined to create an army and a fleet on the European model. In 1808 the creation of the navy was begun with the aid of French officers and engineers. In 1811 the massacre of the Mamelukes left Mohammed Ali without a rival in Egypt, while the foundations of his empire beyond were laid by the war against the Wahhābīs and the conquest of the holy cities of Mecca and Medina. The Wahhābī War indeed dragged on till 1818, when Ibrahim (*q.v.*), the pasha's son, who in 1816 had driven the remnant of the Mamelukes into Nubia, brought it to an end. This done, the pasha turned his attention southward to the vast country watered by the Upper Nile. In 1820 the oasis of Siwa was subdued by his arms; in 1823 he laid the foundations of Khartum.

By this time Mohammed Ali was the possessor of a powerful fleet and of an army of veterans disciplined by European officers. To obtain these money had been necessary; and in order to raise money the pasha instituted internal "reforms"—a bizarre system of state monopolies and showy experiments in new native industries (*see* EGYPT: *History*). The viciousness of these expedients was, however, only gradually revealed, and Mohammed Ali seemed at once the most enlightened and the most powerful of the sultan's valis. To Mahmud II., whose whole policy was directed to strengthening the central power, this fact would have sufficed to make him distrust the pasha and desire his overthrow; and it was sorely against his will that in 1822, the ill-success of his arms against the insurgent Greeks forced him to summon Mohammed Ali to his aid. The immediate price was the pashalik of Crete; in the event of the victory of the Egyptian arms the pashaliks of Syria and Damascus were to fall to Mohammed Ali, that of the Morea to his son Ibrahim. The part played by Mohammed Ali in the Greek War is described elsewhere (*see* EASTERN QUESTION, TURKEY: *History*; GREECE: *History*; GREEK INDEPENDENCE, WAR OF; IBRAHIM). The intervention of the Powers, culminating in the shattering of the Egyptian fleet at Navarino (*q.v.*), robbed him of his reward so far as Greece was concerned; the failure of his arms in spite of this intervention gave Sultan Mahmud the excuse he desired for withholding the rest of the stipulated price of his assistance.

This disappointment would not perhaps in itself have sufficed to stir Mohammed Ali to revolt; but it was ominous of perils to come, which he thought it wise to forestall. In the spring of 1831 two pashas, Hussein of Bosnia and Mustafa of Scutari, had succumbed to the sultan's arms; and, since he was surrounded and counselled by the personal enemies of the pasha of Egypt, it was likely that, so soon as he should feel himself strong enough, he would deal in like manner with Mohammed Ali. It was to anticipate this peril that Mohammed Ali determined himself to open the struggle. On Nov. 1, 1831, his troops crossed into Syria.

Wild rumours went abroad as to his intentions. He was master of the holy cities, and the official *Moniteur Ottoman* denounced his supposed plan of aiming at the caliphate in collusion with the sherīf of Mecca. As for the pasha himself, he loudly disclaimed any such disloyal pretensions; his aim was to chastise Abdulla, pasha of Acre, who had harboured refugees from his "reforms"; to overthrow Khusrev, who had encouraged him in his refusal to surrender them; to secure the fulfilment of the sultan's promise with regard to Syria and Damascus. Mahmud, on the other hand, was torn between hatred of the pasha and hatred of the Christian Powers which had forced him to make concessions to the Greeks. Voices urged him to come to terms with Mohammed Ali, secure peace in Islam, and turn a united face of defiance against Europe; and for a while he harboured the idea. In the end, however, his pride prevailed; in April 1832 the Turkish commander-in-chief Hussein Pasha left Constantinople for the front; and in May the ban of outlawry was launched against Mohammed Ali.

The events which followed during the next ten years, and their effect on the international situation belong to the history of the Eastern Question (*q.v.*). So far as Mohammed Ali's own fortunes were concerned, the Convention of Kutayah (April 8, 1833), which closed his first successful war with the Porte, gave him the objects of his immediate ambition; and, though still nominally only the sultan's representative, he ruled an empire stretching from Khartum to the borders of Anatolia. Had he been as wise as a ruler as he was astute as a diplomatist, he might have consolidated his power. But the peoples who had welcomed him as a deliverer soon found his yoke more intolerable than that of the Turk; the Syrians broke into revolt in 1834, and four years later it was an insurrection of the Arabs of the Hauran which served as the pretext for the war which Sultan Mahmud opened against him. Again the Egyptian arms were victorious, but the intervention of the Powers robbed Mohammed Ali not only of the spoils of his most recent victories, but also of those secured in

1833, and in the end he had to be content with the hereditary pashalik of Egypt and the government of Nubia, Darfur, Kordofan, and Sennaar, conferred upon him by *firmans* of the sultan in 1841. With this Mohammed Ali passes from the stage of history. He was an old man; his mind was soon to give way; and for some time before his death on Aug. 2, 1849, the reins of power were held by his son and successor Ibrahim. See *Cambridge Modern History*, vol. x., ch. xvii.

MOHAMMEDAN ARCHITECTURE. When in a victorious advance the Arab followers of Mohammed subdued the old civilized nations of Asia and Africa, Persians, Turks, Byzantines, Syrians and Copts, their own civilization was not yet much developed and in many respects dependent on those of the neighbouring countries; but the greater was their faith in the one God, inimical to every kind of idolatry. The architecture of the Mohammedan world, therefore, was created by members of those overthrown peoples who were clients of the Arabs or had themselves turned Muslim, and the characteristic Mohammedan style of architecture originated in the fact that in the unitary civilization of Islam the earlier styles, till then kept separate by national antipathies, were fused into a new oneness.

In the Mohammedan world ecclesiastical and aristocratic buildings, such as mosques, monasteries, mausoleums, palaces and castles, greatly predominate. Middle-class architecture is known only from a few excavations. The mosque (*masjid*) is the most original creation of the Mohammedan genius, and the most commonly encountered; consequently it offers the best means of studying the development of architectural style. Both the non-Christian places of worship and the Christian churches, with their concentration on a holy-of-holies, altar or the like, were too reminiscent of image-worship or idolatry. Mohammed therefore took a simple assembly-room (*musalla*), with a flat roof supported on pillars, as the place for the public Friday prayer; a niche resembling a door (*mihrāb*) showed the direction (towards Mecca) in which the congregation had to prostrate themselves when praying, while a pulpit (*minbar*) was used by the preacher and leader in prayer, and a superstructure on the roof (minaret) by the summoner to prayer. The first mosques in the great camps in Mesopotamia, Syria and Egypt, such as Kufa and Old Cairo, were also on this plan, but on an immense scale, and in many cases the nave was drawn parallel to the *mihrāb*-wall, so that the faithful could come to prayer in the same ranked formation in which they went forth to battle against the unbelievers.

'Omayyad Style.—When the Beduin victors embraced a sedentary life in the conquered lands of civilization, the Spartan communism that had prevailed gave way to private economy and luxury, and the wooden mosques of the earlier period were replaced by magnificent structures of stone. It is true that in Damascus, the capital, the church of St. John erected by the Byzantine emperor Justinian was simply taken over and used as the chief mosque, while in Jerusalem the church of St. Mary became the Aqsa mosque, and so in other instances; but over the rock at Jerusalem from which the angel Gabriel was said to have carried the prophet through the heavens in a dream, an octagonal domed building mostly in the Byzantine style (*see* Byzantine and Romanesque Architecture), the Dome of the Rock, was erected, with the smaller Qubbat-as-Silsila beside it. Except in such instances, however, existing clay walls were replaced by stone, and wooden pillars by stone columns; examples may still be seen in the 'Amr mosque (erected in 642, rebuilt in 827 and 1329) and the al-Azhar in Old Cairo. The columns were taken from the ruins of Roman temples and Christian churches, but later the Mohammedans themselves imitated their acanthus capitals and joined them with round arches; the walls were ornamented with marble tablets, and with inscriptions and foliate work in Byzantine glass-mosaic.

Moorish Style in Spain and North Africa.—After the fall of the 'Omayyads (A.D. 750), this style disappeared from the East, but in the West, where in 756 the 'Omayyad 'Abd-ar-Rahmān founded a kingdom of his own, it soon began to develop on separate lines, and is still a living force. The earliest examples are the Sidī Oqba mosque at Qairuān, begun in 670 and rebuilt in the 9th century, and the az-Zitūna mosque at Tunis. In this period the hall of the mosque is prefaced, as also in the East, by a courtyard surrounded by a colonnade; it contains water-basins in which the faithful could perform their ablutions in preparation for prayer, and a lofty quadrangular tower, receding in the last third of its height, serves as minaret. Farther on the first nave rises above the others, and that part of it which lies opposite the *mihrāb*, with the chieftain's lodge (*maqsūra*), is crowned with a cupola; from that point another longitudinal nave, also higher than the rest, runs to the front of the courtyard, where a second domed space forms a kind of portal. The immense mosque of Córdoba (8th to 10th century) illustrates this type in its perfection. Horseshoe arches of alternate brick-red and white keystones rested on slender pillars, and above them rose a second storey of round arches of the same composition, supporting the original cedarwood ceiling. In the *maqsūra*, richly-decorated lobar arches, intercalated between the horseshoe arches, ran above the *mihrāb* so as to form a blind arcade, and ultimately continued the wall-square of the *maqsūra* up into the octagon, where the dome sprang from two intersecting quadrangles of arches. The *mihrāb* itself was still adorned with Byzantine glass-mosaic, but elsewhere this form of decoration was superseded by the stucco arabesque—borrowed, like the rich carvings on the *minbar* and the faïence tiling on the *mihrāb* at Qairuān, from the 'Abbāsid art of the East. This plan, with its slender stone pillars, horseshoe and lobar arches, tiling and stucco arabesques, in later centuries was carried on into a graceful style, a kind of Maghrebine rococo and remains the distinctive characteristic of all Moorish and Mudejar art in Spain till the 16th century, in Morocco and—with an admixture of Ottoman elements—in Algiers and Tunis down to the present day.

'Abbāsid Style.—The new dynasty of the 'Abbāsid caliphs, which founded Baghdad (762) and also Sāmarrā (836), drew its chief support from the Arabs of Mesopotamia and the Persians of Khorasan, and later from Persianized Turkish mercenaries. In those countries, however, since the days of the Babylonian and Persian civilizations, building had been done mainly with bricks that were merely air-dried; these were often covered with coloured glazed bricks of the same nature (Assur, Babylon, Susa). Moreover, on account of the shortage of building-timber and large ashlar, the vaulted style throve exceedingly, taking the form of the pointed arch, the ogee arch, and the dome on a circular tambour, led up to at the angles of the walls by small conical vaults (trompe-vaults). As, however, the disposition of the available spaces was strictly limited by the necessity of equilibrating the thrust of the vault, the shape of the building tended to be very irregular, and this had to be corrected by sham façades. In the mosques of the 'Abbāsid period; *e.g.*, the great Mosque and the Abū Dilif at Sāmarrā, the Ibn Tūlūn mosque at Cairo, the mosque of Raqqā, etc., the plan previously customary was followed, but the pillars were replaced by thick columns with small false pillars at the angles, joined together by pointed arches, but the first named mosque did not yet possess arches. The panels of wall between them, framed by moulded stucco friezes, were discharged by similar, but smaller, arched windows, as were the intervals between the windows in the crenellated outer walls. Owing to the small supporting power of the bricks, the minarets were massive, and were ascended by a spiral staircase.

Perso-Turkish Style.—On the downfall of the 'Abbāsid caliphate and its supersession, first by Turkish "mayors of the palace," then by independent Turkish dynasties in Egypt and Syria, Mesopotamia, Asia Minor and Persia, India and Turkestan, the older architectural styles were entirely supplanted by the Persian vaulted style, except in north Africa. Rapidly increasing in number through pious foundations, the mosques had no longer to shelter such large congregations, and a new, purely Persian type,—nearly always established in connection with a theological college (*Madrasa*)—gained chief favour. In this style the courtyard, used for ablutions but also for prayer, is surrounded not by pillared halls, but by two-storied arcades, behind which lie the monastic cells of the teachers and students; from the middle of each side, however, runs an immense hall, open to the front and

roofed with a vault of ogee arches. Each of these halls serves as a lecture-room for one of the four faculties in theology and law, and one of them contains the *mihrāb* and the *minbar*. These *īwāns*, which are often twice as high as the adjacent parts of the building, are further emphasized by rectangular façades, splendidly ornamented and flanked by small minarets. A similar but slightly shorter *īwān* serves as gateway, and indeed the main *īwān* itself is generally also the entrance to the space behind it. This latter is crowned with a dome, narrowed in at the bottom, and contains the founder's tomb or the *mihrāb*. With their slender minarets, their magnificent *īwāns* and gateways, and their lofty domes (often gilded), these mosques are among the most astonishing buildings of the East, the more so because their walls are almost always overlaid with a mosaic of dull or glazed bricks and faïence plaques in glowing colours, arranged in lines of monumental and cursive script, and with flower-arabesques recalling tapestry and anglepillars going up into rope-like tori, while golden "stalactites," *i.e.*, rows of consoles projecting corbelwise one beyond the next, stand out from niches and under cornices and balconies. Unfortunately these fairy-tales from the *Arabian Nights* are now almost all in a sad state of dilapidation. The most celebrated are the Blue Mosque at Tabriz, the Masjid-i-Shāh at Mashad, the gigantic *madrasas* of Tamerlane at Samarcand, all of the 15th century; others, incorporated in older pillar-mosques or adapted to their plan and purpose, are the Great Mosque of Veramin (1322), that of Isfahan (11th–14th centuries), the sepulchral mosque of the Imām Rizā at Mashad (1418), and the Masjid-i-Shāh at Isfahan (*c.* 1600).

The dome of the *īwān* mosque was originally developed in another architectural type, the mausoleum. Reaching back to old Persian traditions, a favourite form of princely tomb in Persia from the 10th to the 14th century was the sepulchral tower with a circular or polygonal ground plan, the classical examples of which resemble petrified nomad huts. A conical roof rested on a stalactite cornice, beneath which a band of inscriptions gave the name and titles of the deceased, and below a second row of stalactites or an overhanging penthouse the wall of the tower descended straight, or in vertical ripples like folds of stuff, or in architectonic gate-like arrangements like tent-openings. The finest mausoleum of this kind is that of Mumine Khātūn at Nakhichevān (Armenia), erected in 1186. In various sepulchral buildings, such as that of Harun-al-Rashid's wife Zobeide at Baghdad, we may remark the transition to the second type. Here the space set apart for the sarcophagus is surrounded by galleries with ogee arches on a quadrangular or octangular ground-plan, the bulbous and often pointed domes being raised on a tambour above the rest of the building, and flanked by minarets. Examples may be seen in the mausoleum of Sultan Sanjar at Merv (1157), that of the Mongol Uljaitū Khodābanda at Sultānīya (1316), those of Tamerlane and his family at Samarcand (15th century), etc.

Mameluke Style.—In Egypt and Syria the anti-caliphs of the Fatīmid house, who came immediately from Africa, but ultimately from Persia, had already transformed the 'Abbāsid pillar-mosque in stone (Hākim Mosque, Cairo, 996). The Ayyūbids (1169–1250) and Mamelukes (1250–1517) subsequently brought the *īwān*-and-dome mosque to preëminence, though with considerable alterations. The inner courtyard became appreciably smaller; the great façades of the gateway and the *īwān* vanished, being incorporated in a closed block with simple façades of which the features were on a large scale, and this block contained the *madrasa* and other subsidiary spaces. The coloured brickwork was replaced by alternate courses of white and red freestone; the ogee arches by pointed and lobar arches, frequently narrowed at the base, and often composed of artfully indented red and white keystones; and the foliate-patterned faïence tiles by geometrical twined ornament in stucco and stone. Most of the monuments of this style are to be seen in Cairo (*e.g.*, the "Tombs of the Caliphs," the mosques of Sultan Hassan [1362], Quait Bey, etc.), others at Aleppo, Damascus and elsewhere.

Ottoman Style.—In Asia Minor, under the Seljuq and early Ottoman rulers, the inner courtyard was transformed into a central domed hall, and the *īwāns* into lateral aisles, as in most of the mosques of Konia, Isnik and Brussa. After the capture of Constantinople (1453), this development, originally due entirely to the severity of the climate, was combined with Byzantine traditions, and gave birth, mainly through the agency of the architectural genius Sinān, to those immense domed mosques—such as the Mahmadīya (1463–71), the Sulaimānīya (1550–56), and others at Stamboul, the Salīmīya (1512–20) at Adrianople, etc., which continued the plan of St. Sophia's (*see* ARCHITECTURE; *Byzantine and Romanesque Architecture*). A hollow dome resting on four gigantic binding-vaults was enlarged by half-domes round its circumference, and these again by smaller half-domes intersecting them, thus reaching the greatest height and volume obtainable by a single hollow vault, and surpassing in loftiness even the dome of St. Peter's at Rome. However vast their proportions, these buildings presented an appearance of squatness, which had to be counterbalanced by slender, pencil-like minarets. The architectural forms are related to the Mameluke style in their detail, but faïence tiles also were used for the decoration of the smaller surfaces; and in the 18th century the influence of the European rococo style made itself felt.

Indian Mohammedan Style.—In India (*see* INDIAN ARCHITECTURE) also the Persian *īwān*-and-dome mosque was the predominant type. But since the conquerors, being but few, were obliged to employ Indian masons, the Persian true vault was driven out by the Indian corbelled vault. In the earlier period the Persian ogee arches formed a mere façade in front of a mosque of the Arabian type, with Hindu pillars, purged of their heathenish figural plastic decoration, and *maqsūra* domes; the best are the mosques at Gujarat. In Delhi, apart from a few sultans' tombs like those of Īltutmysh and Mohammed Tūghlaq, only parts of the Great Mosque, such as the Alāī Darwāza (13th century) and the great minaret, the Qutb Minār, have been preserved; the walls, often inclined, are noteworthy. After the buildings in the Hindu manner erected by the Emperor Akbar (1556–1605) at Fathpur-Sikrī, Agra and Sikandra, the Persian influence becomes stronger under the later Mogul emperors Jahāngīr and Shāhjahān in the 17th century. The Friday mosques with pillar-halls and very squat *īwāns* as gatehouses, the mausoleums like the tomb of Humāyūn at Delhi and the marvelous Tāj Mahal at Agra, are perfectly proportioned creations of the same type as the Persian vaulted sepulchres. The most usual material is white marble with coloured tarsia work, but red sandstone is also found. The principal architectural forms are the ogee arch, the lobar arch, and the Indian lotus dome; *chattrīs*—small domes with projecting roofs, carried on pillars—are widely used as ornament.

Secular Architecture.—The tendencies in the development of the mosque appear in every detail in secular architecture. Of the palaces of the caliphs at Damascus, Baghdad and Cairo, as of many others built in later times, we know only from descriptions. We are, however, acquainted with several of the country houses (*bādiya*) of the 'Omayyads in the desert to the east of the Dead sea, including Qusair 'Amra with its vaulted baths adorned with frescoes in the later antique style. Another old Persian type (*hīra*) is to be found at Mshattā, in the same region, and in Ukhaidir and the 'Abbāsid residence at Sāmarrā in Mesopotamia. They are rectangular castles, from whose entrance one proceeds through a number of anterooms to the hall of audience. Next come the prince's apartments and the harem; behind is a garden, and perhaps soldiers' quarters on both sides. With the downfall of the 'Abbāsids, cities gradually assumed a type which, with its castles and its narrow, irregular streets, resembled mediaeval European towns. Fine examples of such fortresses in a style closely akin to the European are to be seen in the castles of Aleppo and Baalbek. The Alhambra, in Spain, is another such; the rooms of the castle are grouped in an irregular but very intimate style around courts and gardens, but—as in the Alcázar at Seville and in Moroccan palaces—are clearly divided into reception-rooms, harem and *mashuar* (offices); the decoration is extraordinarily rich and luxurious. Subsequently the plan of dividing the palace up into a system of courts and pavilions surrounded by gardens, as in the Safawid castles at Isfaham and the Old Sarai at Stam-

PHOTOGRAPHS, (1) ASSOCIATED SCREEN NEWS, (2, 3) EWING GALLOWAY

EXAMPLES OF MOHAMMEDAN ARCHITECTURE

1. Dome of Rock (Mosque of Omar), Jerusalem, erected over the rock at Jerusalem from which the angel Gabriel was said to have carried the prophet through the heavens in a dream. It is an octagonal domed building in the Byzantine style; built by Abdalmalik, A.D. 691, with later additions
2. Hall of Justice in the Alhambra, Granada, Spain. This hall is at the eastern end of the royal palace built chiefly between 1248–1354 in the reign of Al Ahmar and his successors. Richly modelled geometric plaster decorations, brilliantly painted and gilded, are carried out in the series of courts, halls and apartments
3. Cairo. In the upper right (with dome and two slender minarets of the mosque of Muhammed Ali), is the Citadel, built by Saladin in 1166. The domed buildings in the foreground are the tomb mosques known as the Tombs of the Mamelukes (*c.* 15th century)

bul, was introduced from Persia; the living-rooms, small and adorned with frescoes (often erotic) and tiling, were grouped around one or more central *īwāns*. In India, at Delhi, Agra, Lahore and Gwalior, separate pavilions were built on the castle walls, with a view over the valley and the cool river on one side, and over arcaded gardens on the other. From these private apartments access was gained through a small door to an open hall with a gallery, on which the ruler gave public audience; this hall (*dīwān-i ʻamm*), which was set apart for the grandees, was surrounded by a courtyard where minor reviews were held, and to which the common folk were admitted. It was reached from the gate on the town side by a passage flanked by offices and shops, leading to an outer court with soldiers' quarters and a gateway with a bandstand (*naggara khāna*).

Caravanserais—fortified hostelries for travellers—are generally built on the plan of the *īwān* mosque, the cells serving as stables and guest-rooms; bazaars are covered streets with shops, having pillars with round-arched vaulting in the West, and long rows of ogee-arched vaults in the East. Most of the bridges disappeared long since, but Isfahan and Julfa are joined by two very beautiful examples dating from the 17th century, with a two-storied superstructure and pavilions.

Few hospitals have survived, though at one time there must have been a great number. The magnificent Mūristān of Sultan Qalawūn at Cairo (1285) is essentially a monument of the Mameluke *madrasa*-style. Pump-rooms (*sabīl*) were often philanthropic foundations; in Egypt they usually included an elementary school on the upper floor, beneath which was the latticed pump-room proper, and in front of it a basin. The Ottomans, however, particularly in the 18th century, transformed them into delightful pavilions with immense overhanging roofs and a basin on each of the four sides.

Private houses are of extraordinarily varied types, but in all cases the living-rooms and reception-rooms are separate from the women's apartments. In the Mediterranean region the latter are generally on the upper storey, with windows closed with *musharrabiya,* but in the East they are in a second court. Here also, ever since the best period of Sāmarrā, the walls are broken by stucco niches to hold lamps, glasses, bottles, books, etc., while the West prefers painted wooden wainscoting with built-in cupboards. Furniture is almost wholly lacking. The methods of securing protection from the heat are interesting: in the West, where water is more plentiful, there are half-darkened inner halls containing springs; in dry Mesopotamia and Persia there are subterranean summer apartments with air-shafts like conning-towers; in India, quarters are transferred to lofty terraces exposed to the wind and surrounded by small ponds. For architectural ornament *see* Mohammedan Art. *See* also, Periods of Art.

Bibliography.—Saladin-Migeon, *Manuel d'Art Musulman* (2nd ed., 1926); E. Diez, *Die Kunst der islāmischen Völker* (1915) and *Churasanische Baudenkmäler* (1918); G. Marçais, *Manuel d'Art Musulman* (1927); P. Coste, *Monuments modernes de la Perse* (1867); F. Sarre, *Reise in Kleinasien* (1896) and *Denkmäler Persischer Baukunst* (1910); Schubert-Soldern, *Baudenkmäler von Samarkand* (1898); A. Musil, *Qusejr ʻAmra* (1907); F. Sarre and E. Herzfeld, *Archäologische Reise im Euphrat- und Tigrisgebiet* (1911) and *Ausgrabungen von Samarra* (1924 etc.); V. A. Smith, *History of Fine Art in India and Ceylon* (1911); C. Gurlitt, *Konstantinopel* (1912); G. L. Bell, *Palace and Mosque at Ukhaidir* (1914); R. L. Devonshire, *L'Egypte Musulmane et les Fondateurs de ses Monuments* (1926); R. E. Brunnow and A. von Domaszewski, *Provinzia Arabia* (Strasbourg, 1904–09). (H. Goe.)

MOHAMMEDAN ART. At the death of the prophet Mohammed in 632, his conquering Bedouin hosts already stood on the frontiers of the highly civilized empires of Byzantium and Persia. During the previous four centuries these empires had passed through great vicissitudes, and of the tradition of ancient Hellas but feeble remnants survived. In Byzantium Christianity, an importation from the East, prevailed; court, civil service and army, however, were intermixed with descendants of the barbarian tribes which had come during the migration of the Nations, and in the Semitic provinces the Monophysite spirit rose up against the "idolatry" of the Greeks. In Persia, on the other hand, there ruled the Sassanids, whose power rested upon their hosts of cavalry from the interior of Persia, and who cultivated, side by side with the Zoroastrian religion of their fathers, ancient oriental traditions only faintly touched by Hellenistic influences. When, on the death of the fourth elected caliph ʻOsman in 661, the early communism of Islām came to an end, the whole of Tripoli, Egypt, Syria, Mesopotamia, Armenia, Georgia and Persia were already under the sway of Islām, which was soon extended to the rest of North Africa and Spain, Turkestan and the lower Indus valley. Until the middle of the 10th century all these lands were ruled by the Arabs; but even under the first dynasty of the Umayyads (661–750) the Christian Syrians and Copts began to gain a considerable influence in intellectual life, followed by the Persians under the ʻAbbāsid dynasty (750–945), and the Ostrogoths under the Umayyad caliphs of Spain (independent after 755); for the Arabs themselves owned few traditions of culture equal to the needs of a universal empire. With the decay of their empire, the ʻAbbāsid caliphs were forced to maintain their power with the help of mercenaries from the nomadic Turkish tribes of the north, but from the middle of the 9th century onwards these Turkish mercenaries began to create "lieutenancies" enjoying an even greater degree of independence, with the result that after 945 the caliphs found themselves reduced to a position resembling that of the popes. In the middle of the 11th century western Asia was overrun by new hordes of Turkish nomads, who founded the Seljuk empire, which, however, soon disintegrated into a number of small states. In the first quarter of the 13th century the Mongols and their kindred peoples of horsemen from Central Asia pushed as far as Syria, Asia Minor and Hungary. Other Turkish tribes followed, notably the hosts of the great conqueror Tīmūr (Tamerlane, *c.* 1400) in Turkistan. In 1300 the Ottomans founded the Ottoman Empire, and in 1502 the Kizilbash, of the Persian Shiʻa sect, founded the Persian empire under rulers of the Safawid house; these two empires remained unaltered till a few decades ago. In 1526, in India, which had previously lain under the domination of a series of Afghan and Turkish dynasties, descendants of Tamerlane founded the Mogul empire, which was ultimately destroyed by England in 1803. In Africa, on the other hand, the leadership soon fell to the nomadic Berber tribes, which formed, in addition to a number of small states, the orthodox kingdom of the Almorawids (1087–1147) and that of the Almohads (1147–1230) in the far West, and, after the loss of Spain in 1492, the kingdoms of the Marīnids, Saʻdites and Sherīfs of Sijilmāsa. Egypt was ruled from 969 to 1171 by the Shiʻite anticaliphs of the Fatīmid dynasty—Berbers likewise—and before and after that period by mercenaries (mostly of Turkish race), including the Ayyubids (1169–1250), who were Kurds, and the Mamelukes (1250–1517), who were overthrown by the Ottoman Sultan Selim I.

Origins and Nature of Mohammedan Art.—In a world enclosed between desert and steppe and ruled by nomadic races, Mohammedan art inevitably followed an entirely different path from that of the West. Western classical art developed among settled tillers of the soil and in towns, and consequently it is intellectual; it loves the clear structural consistency of architecture, and carries it on into architectural ornament; it prefers the more or less naturalistic sculpture and relief, the portrayed figure, and reproduces them in industrial art. The art of the nomads, on the other hand, proceeds from the tent and the loom, and for that reason the tectonics of Mohammedan architecture are also limited to the primary forms, though it frequently resolves them into delightful shapes, and adorns all the wall-surfaces with purely geometrical decoration resembling rugs over the framework of a Kirghiz tent. Their decorative art is based on pure ornament, script, arabesque and intertwined bands. As in early Irish, Scandinavian and also Romanesque art, representations of human beings and animals are combined with fillet and arabesque ornament, and in plastic art they appear only in low relief. Only in painting do they acquire an independent life under antique Sassanian and eastern Asiatic influences, but even so they are partly in the nature of calligraphy, against the background of an equally conventional, tapestry-like landscape. Except in the most recent

period, naturalism never existed. Added to this, the Arabian world had a dislike of figural art—already perceptible in eastern Christianity—which absolutely prohibited figural representations in the early period of Islām and under the Berber dynasties of Africa and the Mamelukes of Egypt and Syria, though under the 'Omayyads and 'Abbāsids and most of the Shi'ite and Turkish dynasties it was only excluded from public buildings.

Plastic Art.—Plastic art on the larger scale therefore seldom fell under outside influences. Thus the Seljuks brought with them from eastern Turkestan a plastic tradition akin to the Buddhist art of central Asia; this tradition is represented by the few extant statues and reliefs of lions, double eagles, dragons, angels, etc., from the city walls of Konia and Baghdad, and by a few stucco plaques depicting scenes of court life. Apart from these, we find human and animal figures in low relief scattered here and there through the decorative carving on rafters and beams of the entire period from the 11th to the 14th century. Under the Mogul emperors in the 16th and 17th centuries Indian influence appears in the elephant-statues of Fatehpur-Sikrī and Delhi, and Sassanian influence in the 19th century in the rock reliefs of Fath 'Alī Shâh of Persia. Other plastic art, however, is entirely restricted to small-scale works, chiefly figures of lions, elephants and birds in glazed stoneware or bronze, strongly conventionalized as the nature of the material required, and used as water-vessels or smoking appliances; a madonna with Mongolian dress and appearance, made of faïence, is an exception.

Painting.—Figure-painting is much more important. It is true that it was excluded from public, political and religious edifices. In the private apartments, however—bathroom and harems especially—painting was tolerated by the clergy, and found its expression in frescoes, illustrated erotic and edifying books, and household vessels, goblets, bottles, etc., adorned with figures. Even the caliphs decorated the private apartments in their palaces in this way. Thus between 712 and 715 the Umayyad al-Walīd had the bathrooms in his desert castle of Qusair 'Amra painted throughout with frescoes in the later antique style, depicting birth and death, the three ages of life, hunters and hunting animals, musicians and dancing-girls, women bathing, the caliph on the throne, the emperors overthrown by Islām, and so on. This latter group betrays the influence of Sassanian art, which dominates the harem frescoes reconstructed out of scanty remnants in the 'Abbāsid residence at Sāmarrā (836–876). Here we find dancing-girls in every possible pose, naked and in flowing robes, with diadems and long braided hair, with floating veils, bowls and wine-jars; huntresses and horse-women, priests and warriors, and animals of every kind, in a heraldic style on medallions composed of intertwining tendrils and bands in endless repetition, symmetrical and hieratic. In the Alhambra at Granada (13th–14th cent.) we meet with the last Moors of Spain represented as noble knights and troubadours in roof-paintings of an almost Gothic style; and in the frescoes and faïence tiling of the castles of Isfahan and Ashraf, displaying exquisite calligraphy, and betraying strong Eastern Asiatic influence, we see the amorous and oenophilous sentiment of the courtly youth of the Safawid era. In India, the Mogul rulers of the 16th and 17th centuries had their harem apartments painted throughout with frescoes, though these were discarded about 1700 by the orthodox emperor Aurangzēb; but wall-paintings, some with Buddhist subjects, have been preserved in the bedroom of Akbar's soon-abandoned residence at Fatehpur-Sikrī, and we know from a few contemporary miniatures the semi-European paintings that Jahāngīr caused to be executed at Agra. (*See* also PAINTING.)

Ornament.—Ornament is the centre of Mohammedan art. It has supplanted all the other possibilities offered by different individual technics. Utilizing them all, dependent on none, it is a self-contained world of form, which embraces indifferently the walls of mosques and castles, the backgrounds of figure-paintings, the details of sculpture, glasses, pots and vases, furniture and bronze implements, arms and jewellery, bookbindings and calligraphy, a vast storehouse of forms, turning every technique, every material to its own uses in the most perfect taste. The motifs from which this ornament grew came from the later antique, the ancient East, and the barbarian migrations. In the earliest monuments, particularly the great frieze in relief at Mshattā, the prevailing feature, as in Byzantine and Romanesque art, is the spiral tendril springing from the vine, its spaces filled in with vine-leaves and branches of grapes, and diversified with all kinds of animals and large rosettes. In the frescoes and in the "third style" of the stucco wall-facings in the 'Abbāsid residence at Sāmarra we find the same motif, though already again greatly conventionalized. Beside it, however, we encounter a new type of ornament undoubtedly traceable to the wood-carving of the nomad tribes of the north, consisting of very denatured palm-leaves, whose contours soon became an independent style, a complex of free curves. Under the Turks and the Arab dynasties that took their artistic notions from them (10th to 16th century), this developed into a purely abstract art of decoration, carried to the furthest possible extent; its leading motifs are the fillet, the arabesque and the palm-leaf. The first is the most important and is derived from the northern nomadic art. Plain or twisted, with herring-bone or circular patterns, it divides every area into border and central field, angle and centre medallions, friezes, etc. It curves into circles and wavy lines, imitates the shapes of architectural vaults, piles up tendril-wise in vaulted arcades and forms complicated trellis patterns. This developed into the twined pattern of stars and rosettes favoured during the Mameluke period, which presents designs which, immensely numerous though they are, are always mathematically accurate. The intervening spaces are filled with polygons of every shape, stars, garlands, rosettes, often plain or in simple patterns that secure their whole effect through colour-contrast, and frequently decorated with rich arabesques diversified with palm-leaf motifs. The early twining vine-leaf, the palm-leaf, the "tree of life" of the ancient east, are combined in an inextricable dramatic unity, enriched since the Mongol period with completed palm-leaves and even with distortions of these into diabolical masks, houses, etc., and Chinese cloud-strata and shreds. Thus western Asia, especially Persia, was dominated by the arabesque, in delicate spirals, often of the shape of snail-shells, with little rolled-up and not uncommonly pinnate leaves, and rosettes, and palm-leaves radiating outwards. It served also as a background for decorative figures of phoenixes and Chinese dragons, hunting animals and birds, musicians and dancing-girls, but most of all for ornamental inscriptions. The clumsy early Arabic script, the "Kufic," with its numerous vertical and oblique strokes, produced an extraordinarily monumental effect, and for that reason, it continued to be employed as a decorative writing, and developed into a new form, used with special frequency in Persia—the "floral" Kufic, in which the top of the characters blossom into floral tendrils. This was also combined with the trellis ornament, a notable example being the stucco-work in the Alhambra at Granada. The later cursive *naskhī*, with its wealth of curves and twists, also proved a highly decorative script, the final letters of words being generally crossed with the long strokes of the initial letters like an ornament. They were also frequently used to provide a delicate background to the heavier characters of the Kufic. The *shikasta*, and the animal figures which were artfully formed from the characters of some sentences (generally from the first *sūra* of the Koran) were confined, however, to the Persian book-designer's art. After the 16th century Mohammedan ornament began to decay. As early as the 13th century niches framed by arches and pillars, vases with bouquets of flowers, hanging lamps, cypresses, etc., had appeared sporadically; these now came into favour as decorative motifs, and their semi-naturalism drove out the wealth of abstract ornament.

Architectural Ornament.—Since tectonic arrangement in architecture was confined to the broad lines, a wide field was presented for ornament. In the 'Omayyad period preference was given to the glittering glass mosaic and deep-shadowed pierced stone filigree-work, both common in Byzantium. With the victory of the sun-dried brick under the 'Abbāsids, these were superseded by stucco facing sometimes moulded in the flat, sometimes likewise cut in high relief, as in the third style of Sāmarrā and in wonderful inscriptions in floral Cufic from Persia, all originally richly painted. Later, in the Turkish and Mongolian periods, stucco gave

BY COURTESY OF (1, 3, 5, 6, 7, 10) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM. (4) THE TRUSTEES OF THE BRITISH MUSEUM; PHOTOGRAPHS, (2, 8, 9, 11) F. BRUCKMANN

1. Top of a carved stone sarcophagus, from the tomb of Bairam Quli Khan at Faizabad, near Bukhara, Turkistan. Dated 942 (A.D. 1534). 2. Persian or Syrian inlaid candlestick with handles, 14th cent. Hamburg Museum für Völkerkunde. 3. Horn or "oliphant" (ivory), carved with interlaced ornament; probably Mesopotamian, 10th–12th cent. The metal mounts are of later date. 4. Bowl with *graffito* designs, "Amol" pottery, 10th–12th cent. 5. Pottery dish, Persian, 17th cent. 6. Bottle, siliceous glazed earthenware, Turkish, 16th cent. 7. Stone and glass window, in black and white. 8. Albarello, Syria, 14th cent.; thick faience. Ht. 25.5 cm. 9. Bronze duck, perhaps an incense burner, Persia or Turkistan, 7th–8th cent. Bobrinsky collection, St. Petersburg (1912). 10. Enamel glass mosque lamp. 11. Helmet, iron, Mongolian, middle of 16th cent. (Moscow)

way to the cheaper substitute for the more costly mosaic, in freestone or brick, but most often in faïence tiling. The less important parts of the rough core of the wall, often quite carelessly put together, were overlaid with a particoloured mosaic of glazed bricks of varied shapes, making all kinds of twined patterns and formalised Cufic words endlessly repeated; while the major portions were covered with mosaics of tiles cut skilfully to the exact shapes of the prevalent patterns, in harmonious colour-schemes, particularly blue, or in combinations of faïence ornament on a stucco ground (in relief) or friezes of inscriptions in incised stucco in the intervals of faïence mosaic. Admirable also are the script friezes of glazed tiles with dark blue characters on a ground of golden-brown arabesques. With the decay of ornament after the 16th century, this type of mosaic was generally supplanted by square faïence tiles with the decoration simply painted on them. Apart from one or two magnificent portions of buildings, Syria, Egypt and the West were content with coloured stucco-work and mosaics of particoloured stone plaques, generally white and red or white and black. (For plan and tectonics *see* MOHAMMEDAN ARCHITECTURE.)

Furniture.—Another reason for this rich wall-decoration lies in the almost complete absence of furniture, in our sense of the term, in Mohammedan places of worship and dwelling-houses. This, like the custom of sitting on the floor, was due to the nomadic habit. Household crockery was kept in stuccoed recesses in the walls, or on wooden shelves and in cupboards built into the walls; of the latter there is at Berlin a fine example from Aleppo, with biblical paintings in the Persian style. Furniture, in our sense, was represented in private houses by small, low, round or oblong tables, and in India also by beds (*chārpoy*). Persons of consequence used the *takht,* but sat on it in the same posture as on the floor; chairs came into use in the 17th century only in the highest circles. In the mosques the Koran was placed on a desk (*kursī*) like a campstool, and was often kept in a small circular cabinet; the pulpit (*minbar*) was a domed box at the top of a staircase, reached through a doorway that could be closed. A feature of most of these objects is the manner in which they are decorated with tasteful tarsia-work of small boards, richly carved and inlaid with mother-of-pearl, ivory, etc. This was necessary owing to the wood available and the danger of warping. The harem doors were worked in like fashion, often with rich bronze ornamentation, and the balcony-railings (*musharabīya*), made of small curved wooden pales. (*See* also INTERIOR DECORATION.)

The remaining objects in the house comprised rugs and cushions, jewel-cases and boxes, together with table utensils, lamps, smoking equipment, open charcoal-pans (as stoves) and warming-pans, candle-sticks, etc., in bronze, faïence, glass, ivory and other materials. (For rugs and woven fabrics, *see* TEXTILES.)

Ceramics.—The Mohammedan ceramic art built upon ancient oriental traditions, enriched them for its own religious purposes with a new and highly effective technique, and pursued its development under growing influences from eastern Asia. The use of the coloured glazed brick was inherited from Babylon, as was the unglazed earthenware in the barbotin style (in which the pattern is made by applying bands of clay) with the "tree of life" and "naked goddess" (Astarte) motifs, enriched with Hellenistic and Sassanian elements, laurel and acanthus leaves, stubs of palm-leaves, and later wreathed medallions centred with animal figures, griffins, eagles and the like. Examples are to be seen in the pottery of Sāmarrā, though this is almost entirely in tiny shards. Echoes of this barbotin technique appear in the ware of Mosul down to the 14th century, and in the Ghabrī ware of Persia, in the sgraffito manner, often with lively painting, until *c.* 1200. Contemporaneously, in Sāmarrā, we find the first lustre-ware. Islām in its early days was puritanical enough to proscribe gold—like silk—as a worldly luxury, and for that reason, in later times, faïence painted with a gold lustre changing to green, brown and violet was used as a substitute; in the earliest examples the forms of the magnificent golden and silver vessels of the Sassanian epoch can still be plainly traced. This style rose high in favour, particularly in the Seljuk and Mongol periods, but disappeared at the beginning of the 17th century. The 'Abbāsid caliphs also imported porcelain, from China (Sung dynasty), and caused its white, yellow and green overflow-glazing and its stippled, fish and other designs to be imitated in earthenware. With the Seljuks came a new wave of far eastern influence, the chief centre of the industry under their rule being Rhagae, the forerunner of Teheran. The "*mināi*" ware shows chiefly bowls, beakers, tankards and bottles in spirited painting and gilding on a white ground, often with rich figure-compositions arranged in bands. There are also vessels of similar types as well as such akin to the bronzes, in animal and human form; their design is left white, generally on a ground of violet lustre, and shows the classical arabesque and palm-leaf motifs, sphinxes and birds with crowned women's heads, peacocks, elephants, scenes of court life and war, and, above all, horsemen with their characteristic pigtails and their garments adorned with arabesques. After the destruction of Rhagae by the Mongols, Sultānābād and Veramin became the centres of the ceramic industry in the 13th and 14th centuries. Favourite types were not only *mināi* and lustre ware, but also faïence in green and dark blue tones, in many cases with moulded ornamentation, and tiles richly decorated in lustre. From the 16th century onwards, Chinese white porcelain with blue and grey designs was imported in large quantities and became a regular type; its decoration was copied and freely developed, but porcelain itself could not be successfully manufactured, and a kind of semi-faïence, closely resembling it, was made instead. Persian pottery forms the basis of that of Syria, Egypt, Spain and Asia Minor. In the area of the Arab civilisation, figure-motifs disappeared at an early period, and bands of script or arabesque, arranged radially or in rings, became the prevalent form. In Spain, under Christian rule, this art developed still further, and absorbed Gothic motifs; the 14th and 15th century wares of Malaga (whence the name "majolica") and of Paterna and Manises, two suburbs of Valencia, exercised a very strong influence on the majolica ware of the early Italian renaissance. On the other hand, in the Ottoman pottery of Kutahia and Isnik ("Damascus" and "Rhodos" ware), which flourished from the 15th century onwards, relatively naturalistic tulips, carnations, roses, lilies, cypresses, etc., and also figure subjects, were preferred for purposes of decoration, cobalt blue, turquoise, green and manganese violet being used as colours, generally on a white ground. (*See* also POTTERIES AND PORCELAINS.)

Glass and Crystal Ware.—Unlike pottery, glass-making was inherited from Hellenic antiquity, and was centred in Syria and Egypt. The Fatīmid period produced narrow-necked bottles, tankards and beakers, and scent-bottles ornamented with externally applied bosses, threads and bands, or with spiral tendrils and animal figures moulded into the glass. In addition, imitations were made ("Hedwig glasses") of rock-crystal vessels with ornament consisting of figures and circular tendrils, of Sassanian origin; many of these came early into the possession of religious or noble houses in Europe, and have thus been preserved. The most marvellous work, however, was produced at Aleppo in Syria, under the Ayyubid and Mameluke dominations. Bottles, beakers, goblets and above all hanging lamps for mosques, were covered with bands of arabesque and script and with medallions in enamel colours (white, red, blue and yellow) and gold; the subjects included figures of horsemen and others, and the coats of arms of the court offices. The celebrated "Luck of Edenhall" was a goblet of this type. Modern Persian glass originated in the industry promoted by Shāh 'Abbās the Great (*c.* 1600). (*See* GLASS.)

Metal-work.—Here again oriental traditions, particularly those of the Sassanian empire and the Far East, predominate. Most of the work is in bronze, iron being still used almost only for weapons. The use of gold and silver also was limited, because it was forbidden by the Koran; and although the prohibition was often ignored, the great value of such objects led to their early destruction and melting down. Mohammedan jewellery of the early period is therefore of extreme rarity, being represented only by a few buckles, bracelets, etc., of the Fatīmid and Mongol periods, and such pieces as the Gerona silver chest (akin to the similar ivory coffers) in Spain and the Berlin silver tankard of the 13th century, with its embossed reliefs of Sassanian animal friezes.

Bronzes.—Such animals in the Sassanian style, lions, dragons, sphinxes, peacocks, doves, cocks and the like, were also cast in bronze in three dimensions, and served, like their ceramic counterparts, as basins, braziers, etc. They were particularly sought after in the later 'Abbāsid, Fatīmid and Seljuk periods, and from Egypt they became the prototypes of similar European forms. It was the Seljuks, apparently, who introduced the round bronze mirror, the reverse of which shows in low relief either two sphinxes face to face—in the manner of the *mināi* pottery—surrounded by a twined pattern, or two friezes with the astrological symbols of the seven chief heavenly bodies (sun, moon and the five nearest planets) and the twelve signs of the zodiac, surrounded by a band of script; this goes back ultimately to Chinese origins. In the earlier period, mugs, etc., were ornamented with animals in low relief, but this was quickly supplanted by engraving. Under the later Seljuks (particularly the Ortoqid Atabegs of Mosul) and the Mamelukes, engraving became almost the only form of decoration, but only to serve as a basis for the yet richer technique of inlaying: small silver plates and wires, themselves delicately engraved, were hammered into the ribs and surfaces, which were hollowed out and undercut at the edges. In place of this an Ortoqid bowl in the provincial museum at Innsbruck has the spaces filled in with cellular enamel. This was a method of evading the prohibition of precious metals, just as gold lustre was in pottery. The ornament consisted of friezes and medallions in lattice and arabesque work, the interstices being filled with figures of warriors, hunters, musicians, animals and astrological symbols. These were superseded later by Mameluke coats of arms and inscriptions. In the 15th century the technique was imported from Syria to Venice, where productions of the same kind, *alla damaschina* or *all' azzimina* were made right into the 16th century by Mohammedan masters, and were in great demand. In the East the process is still common, but both technically and artistically it has decayed. In the 15th century, however, there was a renascence of pure metal-engraving, but the design—inscriptions and arabesques in the Tīmūrid and Safawid styles—was not cut into the material, but left free in the manner of a relief, the background being etched in black. Decoration was applied to bowls and basins, mugs and vases, mortars, braziers and warming-pans, candlesticks and smoking-utensils, inkstands and jewel-cases, Koran-holders, mosque-lamps, and *kursīs*. These are generally in the simplest possible forms—spherical, cylindrical, prismatic—and are developed by cutting off corners, adding projections, narrowing and channelling the walls, and by reduplication; the subjects include motifs of vegetation and animal life—the former mainly in the necks and feet of vessels, the latter for handles and ears, feet and sometimes small spouts. (*See* Bronze.)

Weapons.—Ancient Mohammedan weapons of any artistic value are comparatively rare: most of the extant pieces date from the 17th or 18th or even early 19th century, while the period from the 14th to the 16th is represented by a fair number of fine examples. Mohammedan swords were famous even in antiquity for their wonderful blades of "Damascene" and "Toledo" steel. This high standard was attained by a laborious process of repeatedly welding together pieces of iron of different qualities, but its ultimate explanation lies in the peculiar process used for smelting the Indian raw material—a method whose results have been surpassed only by those of the modern Bessemer process. The earlier blades are all straight; curved sabres and daggers do not become common until after 1500. The blades were ornamented with inlaid work of gold and silver threads, arabesques, blessings and—on the celebrated "Mongol blades"—also phoenixes and dragons in the Chinese manner; at a later period the inlay was confined to the part near the hilt, the remainder being adorned with engraved reliefs. For the handle and guards, gold and cellular enamel were used, as on the magnificent "Boabdil" swords named after the last Moorish king in Spain (15th century), with their hooked guards, and many Ottoman and Persian daggers and sabres of the 17th and 18th centuries; nephrite, ivory and silver plating with jewelled ornament were also used, especially for daggers. The scabbards had ornaments to match the hilts, and were covered with nielloed silver plating, leather, snake-skin or ray-skin. Battleaxes and maces are also found, though these were often mere symbols of command and high position. The former display not only inlay, but also in many cases engraved relief and even filigree work. The heads of the maces were often made of rock crystal, but more frequently were cast solid, in a smooth pear-shape, with grooves or bosses, richly inlaid. Shields were round with a boss in the centre: in Egypt under the Mamelukes they were of inlaid iron, elsewhere generally of leather, with painted lacquer surface.

The armour, of Sassanian origin, consisted of a mail shirt, arm-pieces and greaves, a round breastplate, and a pointed helmet consisting of several spangles riveted together. Not until a late period did a coat of four plates (*chār-āina*), and even a cuirass in the Spanish manner, become common. From the 15th century onwards the helmet was made in one piece, though there were in addition a number of movable parts such as nosepieces, cheek-pieces, neckpieces, etc. The decoration, however—grooves or medallions between radiating ribs on a broad frontlet—betrays the original construction. The earlier pieces (15th century) were broad and protuberant, and came so low down over the forehead that eye-notches were necessary, the reason for this shape being that the turban was worn under the helmet; the later examples fitted closely, and were pointed or hemispherical with spikes attached, nosepieces and crests. The usual ornamentation in the early helmets, most of which are ascribed to western Turkistan, consists of silver-wire inlay; later, in Persia, it is generally iron engraving, sometimes combined with inlaid work; and in the grooved Ottoman storm helmets, black etching. An offshoot of the last-named is the "Zischägge," often richly worked, which was used in the 17th century in Hungary, Poland, and even Germany.

Bookbinding and Lacquering.—Koran manuscripts, and also rich miniature books were all bound in leather, the edges being protected by a flap. A very old binding from Egypt shows inlaid work, but apart from this the usual decoration up to the 15th century consists of stamping with beaded edges, medallions in the centre, and in the corners triangular ornaments of unobtrusive script, plait and palm-leaf patterns. From the 16th century onwards, however, this decoration is transferred to the inner side of the cover, in finely-detailed filigree-work against a brightly-coloured background. On the outside it is replaced by opulent stamped gilding which has indeed a similar composition but is formed of arabesques and bands of clouds, and even of decorative figure-groups; sometimes also the outside is covered in the Chinese manner with lacquer-work, which in the early period shows occasional dragons and phoenixes, and later flowers and romantic and genre scenes. From the end of the 18th century this technique was in high favour, and was applied not only to bookbindings, but also to writing-cases, jewel-cases, toilet accessories, and even shields and bows. (*See* also Bookbinding; Lacquering.)

Development and Influence Elsewhere.—When the great civilizations of Egypt and Babylon ceased to exist, the culture of Hellas had conquered the Orient with Alexander's victorious progress. Islām was only one factor in the recovery of the East brought about by the Aramaic, Coptic, Persian and Arab stocks, parallel to which proceeded the migration of the nomads of central Asia and eastern Europe and the Germanic nations whom they pushed before them. This migration took its rise from the frontiers of China, and in the later thrusts of the Turks and Mongols it also overran the area of the Arabian civilisation; and beside and behind it came the peaceful influence of the Far East. Thus in its early period Mohammedan art continues the assimilation of Hellenistic and ancient Oriental motifs begun by the later Persians, and from the 'Abbāsid era it falls almost wholly under the tradition of the Sassanian empire. With the rise of the Turkish dynasties the nomad character becomes increasingly marked, and from the Seljuk period onwards the influence of Eastern Asia grows in strength, particularly from the Mongol to the Safawid period. Meanwhile Islām fused all these influences into a completely individual abstract style, which reached its zenith, artistically and technically, between the 10th and 16th centuries. Thereafter decadence begins, veiled in the 17th century by extravagance of external splendour, but betrayed by a tendency towards some degree of naturalism and an increase of European

influence, and leading to complete decay by the middle of the 19th century. During its greatest period, however, the influence of the Mohammedan culture extended through India as far as Java, to China, to the Sudan, and to the whole of Russia. The European culture of the middle ages and the Renaissance was very largely derived from it. Mohammedan brocades and carpets, ivories (coffers and "olifant" horns), glasses and aguamanils, etc., found their way from Spain, Sicily and Fatīmid Egypt into the ecclesiastical and princely treasure-houses of Europe; in the period from the Crusades to the conquest of Granada the borrowings consisted mainly of Mameluke weapons and glass, azziminia bronzes, Toledo blades and majolica-ware from Spain, albarellos, etc., and book-bindings. In the east the Tatars brought their culture and art, especially weapons and clothes, to the Russians. Further, through the Turkish wars various Mohammedan utensils and objets d'art—stuffs, costumes, rugs ("Polish rugs"), sabres, helmets, etc.—became naturalised in Hungary and Poland, and even in Austria, Saxony, Bavaria and Prussia.

BIBLIOGRAPHY.—Saladin-Migeon, *Manuel d'Art Musulman* (Paris 1907, 2nd. ed. 1927); F. Sarre, and F. R. Martin, *Meisterwerke muh. Kunst in München 1910* (Munich 1912); E. Diez, *Die Kunst der islamischen Völker* (1915); E. Kühnel, *Islamische Kleinkunst* (1925); S. Lane-Poole, *The Art of the Saracens in Egypt* (1888); G. Schmoranz, *Altorientalische Glasgefässe* (Vienna 1898); H. Wallis, *The Godman Collection* (1901); F. Sarre and E. Mittwoch, *Metall* in F. Sarre Collection (Leipzig 1906); *The Burlington Fine Arts Club Exhibition of the Fayence of Persia and the Near East* (London 1908); F. R. Martin, *Ältere Kupferarbeiten aus dem Orient* (Stockholm 1912); H. Rivière, *La céramique dans l'art musulman* (1913); R. Meyer-Riefstahl, *The Parish-Watson Collection of Muhammedan Potteries* (New York 1922); F. Sarre, *Islamische Bucheinbände* (Leipzig 1924); F. Sarre, *Die Keramik von Samarra* (1925); E. Herzfeld, *Die Malereien von Samarra* (1927). (H. GOE.)

MOHAMMEDAN CAMPAIGNS. Among the military cataclysms which have changed the course of world-history on the largest scale, none is so little known to us in detail as the outburst of the first Mohammedan invaders from their Arabian deserts. That they smashed in a few years the old Sassanian kingdom of Persia, tore Syria, Egypt and Africa from the East-Roman Empire, and even after their first wild rush was over, pushed their conquests as far as India on one flank and Spain on the other, is certain. But the details are wrapped in obscurity, and the very dates of important battles and sieges are doubtful. This comes from the fact that we have no solid contemporary history written by the witnesses of the cataclysm. From the side of the conquerors there is nothing earlier than the chronicle of Al-Wakidi, written a full century after the Arab conquest of Syria and Persia, when the early campaigns of the Muslim had become a heroic legend, and were decorated with exploits and marvels which make them not much more utilizable as solid history than the *Chanson de Roland* or the Romance of Fulk Fitzwarren. The Persian kingdom left memories of Sapor and Chosroes, mixed up with those of earlier and more fabulous kings, in much later epics—but no serious account of its own downfall. At Constantinople the later 7th century and the earlier 8th century show the biggest blanks in chronicle-writing in the whole history of the East Roman realm. We have to depend for our knowledge of the Saracen invasion, as seen by the Christian witnesses, on Theophanes and Nicephorus, both of whom wrote at the beginning of the 9th century, some 130 years or more after the loss of Syria and Egypt. They had no great desire to linger over the details of ancient disasters, nor had they any military interests. All that we get from them is curt mentions of battles and sieges, which are not always easy to identify with the military operations described by the romantic Al-Wakidi.

Matters become quite different as regards information when we have passed the year 800: the series of contemporary Arab Chronicles begins and military details of value can be extracted from them of the organization of the armies of the 9th century Caliphs. Still more useful are the elaborate descriptions of Arab warfare in the *Tactica* of the Emperor Leo the Wise (886–912), the notes on the Byzantine Empire of his son Constantine Porphyrogenitus (912–959) and the Manual on Military operation of Nicephorus Phocas (963–969), all of which deal at length with the ways of the chief enemies of the empire.

THE FIRST RUSH

Unfortunately the main military problem of the epoch is not how the armies of the Caliphs fought indecisively with those of the Emperors from A.D. 800 to 1000, but how the first rush of Mohammed's earliest followers, a century and a half earlier, broke down the Roman Eastern frontier, which had stood successfully for 600 years against enemies much more formidable, the Parthian and the Persian monarchies. On this neither the jejune annals of Theophanes and Nicephorus, nor the miraculous tales of Al-Wakidi and Al-Beladhuri give us any real assistance. We can only be certain that the destruction was not wrought either by heroic single combats, such as those which the Arab annalists describe, nor by the miracles of sand-storm and tempest with which they sometimes diversify their narratives. As far as we can reconstruct any outline of the campaigns of 632–641, the situation would seem to have been as follows. The old Roman military line of defence against the East had never been properly restored since the disasters of the reign of Phocas; and the garrison-armies of Syria and Mesopotamia had never been reconstituted on their old scale. When Heraclius imposed peace on the vanquished Persians in 629, he got back the Eastern provinces in a state of complete dilapidation—they had been in the hands of the enemy for more than ten years. The empire was bankrupt, and the army with which the last victories over the Persians had been won was an extemporized and heterogeneous levy, largely composed of barbarian auxiliaries. A great part of it must have been disbanded at the peace, for financial reasons. The recovered provinces had not settled down again to the habit of obedience; their population had been serving an alien master for many years, they had never been strong in "Roman" sentiment, and they were torn by virulent religious quarrels between the "orthodox" and the many sectarians. That active or passive dislike for the restored imperial government was rife is shown by the tame submission of many sections to the next invader, and by the not infrequent cases of actual treachery. The first Roman fortress which the Arabs attacked—Bostra—was surrendered by an apostate governor.

When the Muslim—bands of light horse with their modest *impedimenta* carried on camels—came up against Transjordania, they were attacking from the rear a province which had always in earlier days been attacked from the front in serious war. Previous Arab raids had been mere Bedouin *razzias*: Syria's earlier dangers had been from Parthian and Persian attacks from the north-east, on the front along the Euphrates.

Clearly then this new attack was delivered against a disorganized group of provinces, with an apathetic or even disloyal population, and under-garrisoned by an army which had recently been destroyed and reconstructed. The immense forces which the Arab romancers describe as arrayed against them never existed, and the Syrians and Egyptians made no more attempt to defend themselves against the Muslim than they had against the fire-worshipping Persian twenty years back. The resistance was entirely that of the Roman army, assisted by the strong walls of many towns which had been fortified in earlier and more prosperous ages. The army, such as it was, was weak in numbers; its main strength lay in the heavy cavalry which had replaced the ancient legions during the last two centuries; infantry had sunk into decay many generations back.

The Arabs had not been a formidable foe in earlier centuries, because of their inveterate tribal and family feuds, which made combination impossible. It required the genius of Mohammed to unite old enemies, and bind them together by a fanatical fighting creed. Even after his death, when early victories ought to have bound them together, there was grave danger of disruption, which was only prevented by the tact and moderation of his successors the caliphs Abu-Bekr and Omar. With a little less self-denial on the part of their leaders, the Arabs might have relapsed into their habitual petty quarrels, and the creed of the prophet might have made no figure in history. But spirited exaltation prevailed over ancient jealousies—invasions of Syria and Persia began, and suc-

cess was, from the first, so brilliant, that their feuds were for the moment silenced, and a strong conviction of their own invincibility came upon the Muslims.

CONQUEST OF SYRIA

Details are wanting—we only know that in all the earlier battles the Romans had the worst of the game. That the conquest of Syria nevertheless took seven years (632–638) was only due to the fact that the Arabs, formidable in the charge, had no skill in siegecraft. Hence the long sieges of Damascus and Antioch, and the possibility of isolated strongholds like the sea-girt Aradus holding out long after the bulk of the country had been overrun. In truth the invaders were not very numerous—if the regular Roman troops were also very limited in strength. And it was only gradually that the Arabs recruited their ranks with new hordes from the more recently converted corners of their own peninsula, and presently with renegades of all sorts, adventurers to whom plunder was all attractive, or disloyalists who thought Monotheism less repulsive than the theological formulae of their local enemies of the governmental faction.

It was the special luck of the Arab invaders that of the two realms which they invaded, Persia was ruled by a boy of 14 newly elected as a compromise at the end of the bitter civil war, while in the Roman empire was reigning a worn-out veteran. Heraclius had been a brilliant leader in the old Persian campaigns, but he was now over sixty, and already smitten with the dropsy which ultimately proved fatal to him. He was in Syria for one year of the War only, and then retired to Constantinople, taking with him the "True Cross," which he had brought back to Jerusalem in triumph only five summers before. In the last period of his illness he appears to have been suffering intermittently from mental affliction. His brother Theodore and his son Constantine failed to replace him in a satisfactory fashion, and in five years more all Syria fell into the hands of the Muslims (633–638). Egypt, where the population was still more hostile and discontented, and where many of the officials behaved with absolute treachery, was lost in two more years (639–41). Only the great harbour at Alexandria was defended with any resolution. After Heraclius' death an expedition from Constantinople recovered it for a moment, but lost it within the year (646), and no Christian army was to be seen again in Egypt till the age of the Crusades.

In the first years of the Arab conquest of Roman and Persian territory, the military system adopted appears to have been that of establishing great garrison-centres in a limited number of places selected for their strategical importance—Basrah and afterwards the more famous Kufa were the original bases on the Persian side, Damascus that on the Syrian; Fostat (Old Cairo) was the military centre of Egypt. Though detachments might be made to hold places of less importance, the armies were generally organised in and started from one of these base-camps. The organisation was at first tribal. North Arabian and South Arabian sections being formed in each great camp, and ere long many bodies of "clients," newly converted Syrian or Persian renegades, who were admitted to share the fortunes of the original invaders. In the second generation there was little difference between the original Muslims and their adopted comrades.

When the first rush of Conquest was over, and permanent dynasties, first the Ommayads and then the Abbasides, had replaced the elective Caliphs of the early years, the first signs of a change in military organisation were soon seen. The Caliph, like all oriental princes, took to keeping large bodies of royal guards, who both guaranteed the safety of his person, and formed the solid nucleus of any army with which he took the field. These mercenaries were at first Arabs, but before the end of the Ommayad dynasty strangers had already begun to replace them, and the Abbasides of the long-lived second caliphate line, regularly employed Soudanese Blacks, Persians, and above all Turks. The native Arabs had been found too factious and independent: the Turks, useful tools under a strong sovereign, ended by becoming their employers' masters, when the later Abbasides sank into debility, and like the Praetorian guards of Rome and the Mamelukes in Egypt, they became king-makers. But this disgrace was still far off in 750, when the first Caliph of the second dynasty mounted the throne.

THE CALIPHS' ARMIES

The Byzantine writers, who had two centuries of Arab warfare behind them when they wrote their accounts of the Caliphs' armies, have to distinguish between two sorts of collisions with the Saracen enemy. Comparatively rarely, and hardly ever after the year 800, the Caliph himself took the field with his household troops in addition to the *levée en masse* of the Muslims of Syria, Mesopotamia and Iraq. More usually the wars consisted of raids into the upland of Asia Minor by the Emirs of the frontier towns—Tarsus, Mejafarkin, Antioch, Mardin or Malatia, which it was the duty of the military governors of the East-Roman themes to ward off, or to avenge by similar raids into Cilicia or North Syria.

The emperors Leo and Constantine in their books describe the Saracens as composed almost entirely of mailed light horse armed with lance and javelin—only occasionally do we hear of black Soudanese archers—and unencumbered by wheel transport—all their baggage was carried by camels. They moved with extraordinary rapidity, and the governor who had to face a raid would do better by not attempting to follow their track, but rather by besetting the routes by which they must return to their own country. They had only the choice of a limited number of passes, and if provision was made for blocking each of these, the enemy must infallibly be intercepted. And he would be caught when loaded with plunder, and therefore unable to move with the same rapidity with which he had started. Of course if he should besiege a town, and not merely practise the normal circular raid, the circumstances would be altered, and an attempt should be made to fall upon him when he had settled down before the walls of the besieged place. But this would be exceptional.

The last great formal invasion of Asia Minor was that of the Caliph Al-Mutassim in 838, who penetrated as far as Amorium in Phrygia—but even this was only a raid on the very largest scale, in revenge for an irruption of the emperor Theophilus into Northern Syria in 836,—not a serious attempt to win new territory from the East-Romans. Al-Mutassim's father Haroun-al-Raschid had gone still further into Asia Minor in his campaign of 806, having taken Angora, and seen the waters of the Black Sea at Heraclea; but he too had made no attempt at annexation, and contented himself with imposing an ignominious peace on the Emperor Nicephorus. It may be said indeed that the famous defence of Constantinople by Leo the Isaurian in 717–718, when the formidable attack by sea and land of Muslemah and Soliman had suffered a decisive repulse, marks the end of the first period of Arab invasions, when the conquest of the whole eastern world was still inspiring the hopes of the Muslims. In later wars the *Jehad* might be preached, and the enthusiasm of "True Believers" might be called upon for a desperate effort: but their rulers were no longer fanatics, and preferred a favourable peace to the continuance of an effort which had failed.

In the ninth century the strength of the Caliphate began to decline, in the tenth it was so reduced that the East-Romans launched campaigns against it, and reconquered Cilicia, North Syria, and part of Mesopotamia. This falling off in offensive was caused by decay at the heart—a succession of weak caliphs, engaged in civil war with pretenders, lost control over the outlying provinces, whose governors became practically independent, and only assisted their sovereigns when it was convenient to them with men or money. At Baghdad itself the Turkish royal guards were continually indulging in mutiny, and not infrequently deposing a sovereign in order to finger the accession donative of his successor. The authority of the Abbasides was really confined to Iraq, and sometimes when a specially arrogant governor or vizier was asserting himself, it did not even extend to the walls of their palace. After the Seljuk Tribes had swept over western Asia in the later eleventh century; swamping the provincial dynasties which had preserved a nominal allegiance to the Caliphate, the phantom at Baghdad became a perfectly negligible quantity. The only wonder is that the line of the Abbasides continued to survive in lineal succession, till the Tatars of the 13th century starved the

last bearer of the title to death in his own treasure house (1258).
(C. W. C. O.)

MOHAMMEDAN INSTITUTIONS: *see* ISLAMIC INSTITUTIONS.

MOHAMMEDANISM: *see* ISLAM.

MOHAMMEDAN LAW: *see* ISLAMIC LAW.

MOHAMMERAH, a town and port of South-west Persia situated in Lat. 30° 25′ Long. 48° 10′ on the right bank of the Karun river (*q.v.*) at the point where it enters the Shatt al Arab (*q.v.*). Until the beginning of the 19th century the old village of the same name lay on the left bank of the Karun on the island of Abadan (*q.v.*) opposite the present town.

The place first came into prominence in 1837, when it was attacked and demolished by the Turks on the ground that it was becoming a thriving commercial port to the detriment of Basra. Persia claimed an indemnity of one million pounds sterling: the Turks on the other hand claimed that both Mohammerah and Abadan were Turkish territory. The British and Russian Governments intervened to prevent war and by the Treaty of Erzerum (1847), Mohammerah and its anchorage, and Abadan island were allocated to Persia. One of the principal difficulties in effecting this settlement was the fact that in 1765 the Karun, which had hitherto entered the Persian Gulf by a separate channel via Marid, Qubban and the Khor Musa, left that channel and followed a small canal which had been dug to connect Marid with Mohammerah by the Bahmishir, then a branch of the Shatt al Arab, thus depriving Persia of the advantages of independent access to the Persian gulf. On the inclusion of Mohammerah and district in Persian territory they were constituted, administratively, a deputy-governorship under the provincial Governor of Arabistan (Khuzistan) with headquarters at Shushter; but in practice they were farmed out, or delegated to the ruling Shaikh of the Muhaisin section of the Chaab, the Shia tribe of Arabs inhabiting the region. Sir Khazaal Khan G.C.I.E., K.C.S.I., the present titular Shaikh, has always maintained most cordial relations with British representatives in the Persian gulf and Mesopotamia. A British vice-consulate has been established at Mohammerah since 1891.

During the Anglo-Persian War of 1857 the town was assaulted and taken by the British force under Sir James Outram and occupied until the conclusion of peace.

Mohammerah is connected by river with Ahwaz (105 m.); good motor roads connect the town with Ahwaz (80 m.), Basra (25 m.), Abadan (9 m.). It is in telephonic communication via Ahwaz with the rest of Persia, but not with Basra owing (1928) to diplomatic difficulties.

The only local product of importance is dates, which are exported in considerable quantities from the date-groves which line the Shatt al Arab and Bahmishir rivers. It is, however, a port of considerable importance, its imports averaging for the past three years over one million pounds sterling; exports about £200,000: representing respectively about 45,000 and 22,000 tons. 146 ships entered the port in 1925–6 of which 141 were British. The average rainfall at Mohammerah is 8 in. per annum, as compared with about double that amount at Masjid, Sulaiman, 120 miles north. The climate is hot but not unhealthy.

MOHAVE. The Yuman tribe farthest upstream on the Colorado river, where Arizona, California, Nevada adjoin. Similar to the Yuma, they suffered somewhat less from Caucasian contacts, and in 1910 over 1,000 remained. (*See* Kroeber, *Bur. Am. Ethn. Bull.* 78, 1925.)

MOHAVE DESERT, a name applied to that arid section of the "Great basin" which lies just north of the Colorado desert (*q.v.*). It includes much the greater part of San Bernardino county and the eastern portions of Los Angeles and Kern counties, Calif., and embraces an area of some 15,000 sq. miles. The Mohave desert is about 2,000 ft. above the sea in average altitude, but the entire area consists of a series of more or less nearly parallel ranges and intervening minor desert valleys. The mean annual rainfall is between 3 and 4 in.; the midday temperature during the summer ranges between 70° and 125° F.

See W. C. Mendenhall, "Some Desert Watering Places in South-eastern California and South-western Nevada" in the U.S. Geological Survey, *Water Supply Paper* No. 224.

MOHAWK. This easternmost tribe of the Iroquois (*q.v.*) or League of Five Nations, formerly in and about Mohawk valley, New York, now live to the number of over a thousand on reservations in Ontario. They were one of the smallest tribes of the confederacy, but perhaps the most aggressive, and Hiawatha, one of the two founders of the league, was a Mohawk.

MOHEGAN and **MOHICAN.** These cognate tribes, of Algonkin affinities, occupied respectively eastern Connecticut and much of the Hudson valley in New York. They were similar to the other Algonkin of the middle Atlantic and New England coast. Fenimore Cooper's *Last of the Mohicans* notwithstanding, mixed blood remnants of both tribes survive, respectively near Norwich, Conn., and Stockbridge, Mass., whereas other elements have lost their identity among the Delaware, Iroquois or other tribes.

MOHI, BATTLE OF: *see* SAJO, BATTLE OF THE.

MOHL, HUGO VON (1805–1872), German botanist, was born at Stuttgart on April 8, 1805, and was educated at Tübingen and at Munich. In 1832 he became professor of botany in Tübingen, a post which he retained until his death on April 1, 1872. Von Mohl was concerned chiefly with the structure of the higher forms, including both rough anatomy and minute histology. The word "protoplasm" was his suggestion; he recognized under the name of "primordial utricle" the protoplasmic lining of the vacuolated cell, and first described the behaviour of the protoplasm in cell-division. He also held the view now generally adopted of growth of cell-wall by apposition. He first explained the true nature of pits, and showed the cellular origin of vessels and of fibrous cells; he was, in fact, the true founder of the cell theory. His early investigations on the structure of palms, of cycads, and of tree-ferns permanently laid the foundation of all later knowledge of this subject: so also his work on *Isoetes* (1840). His later anatomical work was chiefly on the stems of dicotyledons and gymnosperms.

The most notable of Von Mohl's numerous papers were republished in *Vermischte Schriften* (1845). His important *Die Vegetabilische Zelle* appeared in 1851 (Eng. trans. 1852). *See* J. Sachs, *History of Botany* (1890); De Bary, *Botanische Zeitung* (1872), p. 561; *Proc. Roy. Soc.*, xxiii. 1.

MOHL, JULIUS VON (1800–1876), German Orientalist, brother of Hugo von Mohl (*q.v.*), was born at Stuttgart on Oct. 25, 1800. Having studied theology at Tübingen (1818–23), he abandoned the idea of entering the Lutheran ministry, and in 1823 went to Paris, at that time, under Silvestre De Sacy, the great European centre of Oriental studies. From 1826 to 1833 he was nominally professor at Tübingen, but continued his studies in London and in Oxford. In 1826 he was charged by the French government with the preparation of an edition of the *Shah Nama* (*Livre des rois*), which became his life-work. The first volume appeared in 1838; the seventh and last was left unfinished at his death, being completed by Barbier de Meynard. He resigned his chair at Tübingen in 1834, and settled in Paris. In 1844 he was nominated to the academy of inscriptions, and in 1847 he became professor of Persian at the Collège de France. He served for many years as secretary, and then as president of the Société Asiatique. His annual reports on Oriental science from 1840 to 1867, collected after his death under the title *Vingt-sept ans d'histoire des études orientales* (Paris, 1879), are an admirable history of the progress of Eastern learning during these years. He died in Paris on Jan. 3, 1876.

His wife Mary (1793–1883), daughter of Charles Clarke, had passed a great part of her early life in Paris, where she was very intimate with Madame Récamier. For nearly 40 years her house was one of the most popular intellectual centres in Paris. She died in Paris on May 14, 1883. Madame Mohl wrote *Madame Récamier, with a Sketch of the History of Society in France* (London, 1862).

See Kathleen O'Meara, *Madame Mohl, her Salon and Friends* (1885); and M. C. M. Simpson, *Letters and Recollections of Julius and Mary Mohl* (1887).

MÖHLER, JOHANN ADAM (1796–1838), German Roman Catholic theologian, was born at Igersheim, Württemberg,

on May 6, 1796. He studied at Tübingen, where, after taking orders, he began to lecture in 1822, becoming full professor in 1828. His most famous work, *Symbolik* (1832), defending Catholic doctrine against Protestant theologians, was perhaps the most effective of the polemical writings of its time, and provoked replies from Baur, Marheineke and Nitzsch. The feeling aroused in Tübingen by the controversy induced Möhler to remove (1835) to the Catholic atmosphere of Munich. He was dean of Würzburg when he died (April 12, 1838).

Möhler wrote *Die Einheit in der Kirche oder das Prinzip des Katholicismus* (Tübingen, 1825); *Athanasius der Grosse u. d. Kirche seiner Zeit* (2 vols., Mainz, 1827), besides the *Symbolik* (Eng. trans. by J. B. Robertson, 1843; 8th. ed., 1871–72, and *Neue Untersuchungen der Lehrgegensätze zwischen den Katholiken u. Protestanten* (1834). His *Gesammelte Schriften u. Aufsätze* were edited by Döllinger and his *Patrologie* by Reithmayr, in 1839.

See J. Friedrich, *J. A. Möhler* (Munich, 1894); Vigener, *Drei Gestalten aus dem modernen Katholicismus* (1926).

MOHMANDS, a Pathān (Afghān) tribe holding about 1,200sq.m. of hilly country N.W. of Peshāwar, in the North-west Frontier Province of India. This tract is hot, infertile and almost treeless, the hills being sparsely covered with low scrub, stunted palms and coarse grass. Water is scarce in summer, yet the lowlands are malarious. The harvests depend entirely on the rainfall. The whole of this region was claimed by the amīr of Afghanistan, but in 1893 he handed over most of it under the Durand Agreement to the Indian Government, which, however, gave a guarantee to the Mohmand clans, whose lands fell within the Durand line, that they should not lose by their severance from Kābul. These are known as the Assured Clans. Owing to their poverty, even more than to their pugnacity, the Mohmands have always been persistent raiders into British territory, and their forays necessitated punitive expeditions in 1851–52, 1854, 1864, 1879 and 1880, culminating in the campaign of 1897, when they joined in the general upheaval along the north-west frontier. Descending in force the Mohmands burnt Shabkadar, a village in British territory. Immediate counter-measures being imperative, British forces advanced from the Malakand and Peshāwar to effect a junction in Bajaur, a brigade being detached northward to attack the Mamund valley. This brigade was strongly opposed and retired with loss. It resumed the offensive, however, and defeated the Mamunds. Meanwhile the main force, heavily attacked, had repulsed the Mohmands. Those in the hilly hinterland submitted. But the Mamunds were not yet subdued and their valley had to be re-occupied, though they soon came to terms. British losses in their valley amounted to 282 men out of 1,200.

The Mohmands played some part in Afghān history after they had driven off the older inhabitants of their present seats in Kafiristan early in the 16th century. They joined in the great revolt of the Roshanīa sect in 1586 against the Mughals, and after its suppression retained their lands. Under the Abdāli rulers of Kābul a Mohmand chief became *sūbahdār*, "governor," of Sirhind province. More aristocratic by instinct than the Afghāns to the south, the power of their chiefs of clans is well-developed, but they have never recognized any supreme head of the whole tribe, and even within the clan faction is strong, succession to its headship being often divided and disputed. The Mohmands rule over a considerable mixed population of Hindus and Mohammedan traders and tenants, largely no doubt converts from the tribes they dispossessed. Their shrines are useful as sanctuaries for murderers, etc., but they are not especially fanatical. A through trade in females kidnapped from Swat, etc., assists some clans to live, in spite of priestly censure, and there is a similar trade in hides, rice, etc., but it is mostly in the hands of non-Mohmands.

MOHN, HENRIK (1835–1916), Norwegian meteorologist, was born at Bergen on May 15, 1835, and was educated at the Cathedral School in that town and at the university of Oslo. In 1861 he became observer at Oslo university, where in 1866 he was elected professor of meteorology and from 1866–1913 was director of the Norwegian meteorological institute which he had been largely instrumental in founding. He carried out much valuable meteorological work, collaborating in 1876–8 with the mathematician Guldberg in a study of the dynamics of the atmosphere and subsequently extending his investigations to the subject of storms, the meteorology and oceanography of the northern Atlantic, the climate of Norway, and use of the hypsometer. He died at Oslo on Sept. 12, 1916.

MOHR, KARL FRIEDRICH (1806–1879), German pharmacist, was born at Coblenz on Nov. 4, 1806, the son of a chemist. He studied under L. Gmelin, and, after five years at Heidelberg, Berlin and Bonn, returned to Coblenz to assist his father. He gave up business in 1857, and devoted himself to research work until 1863 when he returned to the university at Bonn, where he died, on Sept. 28, 1879. Mohr was the leading scientific pharmacist of his time in Germany; he was the author of many improvements in analytical processes. He invented the pinch-cock, the cork-borer, Mohr's balance for the determination of specific gravities and other pieces of apparatus. His methods of volumetric analysis were expounded in his *Lehrbuch der chemisch-analytischen Titrirmethode* (1855). His *Geschichte der Erde, eine Geologie auf neuer Grundlage* (1866), also obtained a wide circulation. In a paper "Über die Natur der Wärme," in the *Zeitschrift für Physik* (1837), he gave one of the earliest general statements of the doctrine of the conservation of energy.

See Kahlbaum's *Monographien aus der Geschichte der Chemie,* No. 8.

MOHS, FRIEDRICH (1773–1839), German mineralogist, born at Gernrode in the Harz mountains, was professor at Graz and at Freiburg, and, lastly, professor of mineralogy and superintendent of the imperial cabinet at Vienna from 1826 onwards. His great work was the *Grundriss der Mineralogie* (Eng. trans., *Treatise on Mineralogy,* by Wilhelm Haidinger, 1825). He died at Agardo, near Belluno, Italy, on Sept. 29, 1839.

MOHUN, CHARLES MOHUN, 4th BARON (*c.* 1675–1712), duellist, was the son of the 3rd Baron Mohun, who died in 1677 as the result of a wound received in a duel. The boy had no regular guardian, and before he was seventeen had become notorious for rowdyism, had fought a duel and had been tried on a charge of murdering William Mountfort, the rival of his friend, Richard Hill, who was in love with the actress Mrs. Bracegirdle. By an overwhelming majority he was found not guilty by his peers. This verdict has been severely criticized, notably by Macaulay, who saw in it merely a gross instance of class favouritism. But a careful examination of the evidence (in the *State Trials*) justifies the decision, and establishes the presumption that the fight was fair. In 1699 Mohun was tried for another alleged murder, but was acquitted unanimously. His boon companion, Edward Rich, earl of Warwick (1673–1701), who was tried on a separate indictment for the same crime, was found guilty of manslaughter. On Nov. 15, 1712, Mohun forced the 4th duke of Hamilton, with whom he had been at law for some years, into a desperate duel in Hyde Park in which both combatants were killed. Thackeray has utilized this incident in *Esmond.* On Lord Mohun's death the barony, created in 1628 in favour of his great-grandfather John Mohun (*c.* 1592–1640), became extinct.

See *The Whole Life and History of My Lord Mohun and the Earl of Warwick* (1711); J. Evelyn, *Diary and Correspondence;* Historical Mss. Commission, 11th Report, appendix v. (Dartmouth mss.); G. C. Boase and W. P. Courtney, *Bibliotheca cornubiensis* (1874–82); Howell, *State Trials;* and Colley Cibber, *Apology,* ed. R. W. Lowe (1889).

MOHUN, MICHAEL (*c.* 1625–1684), English actor, played at the Cockpit in Drury Lane before the Civil War. He served in the king's army, and emigrated. At the Restoration he returned with Charles II. and played a great variety of parts, usually as second to Charles Hart.

MOHUR, a Persian gold coin, used in India from the 16th century. Between 1835 and 1891 a gold coin, also called a "mohur," was struck by the Government of British India and was of the nominal value of 15 rupees. On the establishment of a gold standard in India in 1899 the British sovereign was declared legal tender and the mohur was superseded.

MOI, a name used collectively for the hill tribes of Tongking in Indo-China who are probably of mixed race with Mongolian, Indonesian and Caucasian blood (*see* MĀN). Generally speaking

their polity is one of pure democracy, the chief, if any, being elected. In marriage patrilineal endogamy is reported to be the rule, though exogamy is permitted in some groups. There are traces of polyandry, and of a matrilineal system of genealogy and inheritance. A man works for his bride in her father's house, and the heir of a dead man marries his widow. They seem to be Buddhist by religion, but venerate stones. The dead are in some places buried, in others exposed on platforms. Trial by ordeal takes the form of a diving test to see which can stay under the longer. Like the Karens they have a quasi-Biblical legend of the Creation, and they have a legend about Amazons who smelt copper. They shave the heads of their children habitually, and their own when in mourning, a trace, perhaps, of Hindu influence. Their medicine-men practise legerdemain, and cure sickness by "extracting" the cause in the form of "dirt." They have separate buildings for the unmarried, and the approaches to their villages are made under tunnels of thorn which can be cut down to block the way. They use a flexible sawing thong to make fire, piston-bellows, the gourd organ, and as weapons the crossbow and the gun-arrow, both of which may be used with poison.

MOIDORE, a corruption of the Portuguese *moida d'ouro*, literally, money of gold, the name of a gold Portuguese coin, coined from 1640 to 1732. This was of the sterling value of 13s. 5½d. It is the double *moida d'ouro*, of the value of 4,800 reis in 1688, that was current in western Europe and the West Indies for a long period after it ceased to be struck. It was the principal coin current in Ireland at the beginning of the 18th century, and spread to the west of England. At the same period it was current in the West Indies, particularly in Barbados. It was rated at 27s.

MOIR, DAVID MACBETH (1798–1851), Scottish physician and writer, was born at Musselburgh on Jan. 5, 1798. He studied medicine at Edinburgh university, and practised at Musselburgh until his death on July 6, 1851. He contributed prose and verse to the magazines, and particularly, with the signature of "Delta," to *Blackwood's*. A collection of his poetry was edited in 1852 by Thomas Aird. The famous *Life of Mansie Wauch, Tailor* (1828) shows his gifts as a humorist.

He also wrote *Outlines of the Ancient History of Medicine* (1831), and *Sketch of the Poetical Literature of the Past Half Century* (1851).

MOIRE. A textile fabric possessed of a distinctive "watered" or shaded ribbed effect produced by various methods of "finishing." A moiré or "watered" finish is generally applied to fine ribbed silk fabrics of the poplin type, though similar effects are also sometimes produced in cotton fabrics. Although a ribbed weave is more conducive to the development of a moiré or watered effect, similar effects can also be obtained with other weaves in fabrics of comparatively close and firm texture, and more especially in those produced from silk, artificial silk and mercerised cotton. The moiré effect results entirely from the varying angles at which the rays of light are reflected from the surface of the fabric.

Moiré effects are produced from two distinctly different methods of finishing. One of these produces the true moiré effect, known as "moire antique" and "moire Anglaise," which is a purely physical phenomenon. This "moire antique" effect is obtained by first damping the material and folding it with the face side inward, and with the two selvedges running together side by side. The cloth is then passed between heated cylinders and under considerable pressure. This is the more permanent of the two styles. The second is an imitation produced mechanically by means of engraved copper rollers. (H. N.)

MOISSAC, a town of south-western France in the department of Tarn-et-Garonne, 17 m. W.N.W. of Montauban on the Southern railway between Bordeaux and Toulouse. Pop. (1926) 3,807. The town owes its origin to an abbey probably founded in the 7th century by St. Amand, the friend of Dagobert. After being devastated by the Saracens, the abbey was restored by Louis of Aquitaine, son of Charlemagne. Subsequently it was made dependent on Cluny, but in 1618 it was secularized by Pope Paul V., and replaced by a house of Augustinian monks, suppressed at the Revolution. The town, which was erected into a commune in the 13th century, was taken by Richard Coeur de Lion and by Simon de Montfort. Moissac stands at the foot of vine-clad hills on the bank of the Tarn; it is divided into two parts by the lateral canal of the Garonne, which crosses the Tarn by an aqueduct a short distance above the town. The abbey-church of St. Pierre (15th cent.) has a porch of the 12th century, decorated with the finest Romanesque carving. St. Martin, the oldest of the other churches of Moissac, dates from before the year 1000. Moissac has paper mills, and trade in wines, fruit (grapes, peaches, etc.), vegetables and agricultural produce.

MOISSAN, HENRI (1852–1907), French chemist, was born at Paris on Sept. 28, 1852. He was educated in Frémy's laboratory and attended lectures by Sainte-Clair, Deville and Debray. In 1879 he was appointed to a junior post in the Agronomic institute, Paris, and was subsequently (1886) professor of toxicology and of inorganic chemistry (1889) at the School of Pharmacy, and of inorganic chemistry at the Sorbonne (1900). He was awarded the Lacase prize in 1887 and the Nobel prize for chemistry in 1906; he died in Paris on Feb. 20, 1907.

Moissan's first research was on a biological problem and dealt with the interchange of oxygen and carbon dioxide in leaves, but he soon went over to inorganic chemistry. His early work in this field was on the oxides of the iron group metals, and of chromium; he also made a careful study of the chromous salts. In 1884 he turned to the study of fluorene and prepared several new compounds, including phosphorus and organic derivatives. In 1885 he found that potassium fluoride could be dissolved in certain proportions in liquid hydrofluoric acid to give a solution which conducted electrolytically and which remained liquid at low temperatures. A year later by electrolysing this solution in a platinum tube using platinum-iridium electrodes he obtained for the first time the wonderfully active fluorine gas. He made a full study of the properties of the gas and of its combinations with other elements. In 1892 Moissan developed the electric arc furnace as a means of obtaining very high temperatures for experimental work; by its aid he prepared many new compounds, especially carbides, silicides and borides, and melted and volatilized substances which had previously been regarded as infusible. He prepared tiny artificial diamonds (*see* GEMS, ARTIFICIAL) by cooling very rapidly a solution of carbon in molten iron, and also discovered carborundum (silicon carbide). He studied the chemistry of the carbides and the action on them of water, and was led by the results to suggest that petroleum formation may be due to a similar process occurring in the earth. Moissan also prepared the hydrides of calcium, sodium and potassium, and found them to be non-conductors of electricity.

His published works include *Le four électrique* (1897) and *Le Fluor et ses composés* (1900), besides numerous papers, mainly in the *Comptes rendus* of the Société Chimique. A *Traité de Chimie minérale* (5 vols.) was published under his direction in 1904–06.

See A. Stock in *Berichte der Deutschen Chemischen Gesellschaft* (vol. xl., 1907); P. Lebeau, "Henri Moissan," in the *Bulletin de la Société chimique de France* (vol. iii., 1908); W. Ramsay, "Moissan Memorial Lecture," in the *Journal of the Chemical Society* (vol. ci., 1912).

MOJI, a town of Japan, on the Kyushu side of the Shimonoseki Strait. It is the starting-point of the Kyushu railway, and as there is abundance of coal in its neighbourhood, it has become a town of considerable importance. Pop. (1925) 95,087. It is the first Japanese port of call for many steamers from Europe.

MOJSISOVICS VON MOJSVAR, JOHANN AUGUST GEORG EDMUND (1839–1907), Austro-Hungarian geologist and palaeontologist, was born at Vienna on Oct. 18, 1839. He studied law in Vienna university and in 1867 entered the Geological institute, becoming chief geologist in 1870 and vice-director in 1892. He retired in 1900, and died at Mallnitz on Oct. 2, 1907. He paid special attention to the cephalopoda of the Austrian Trias. With Melchior Neumayr (1845–90) he conducted the *Beiträge sur Paläontologie und Geologie Oesterreich-Ungarns*. In 1862, with Paul Grohmann and Dr. Guido von Sommaruga, he founded the Austrian Alpine club.

His publications include *Das Gebirge um Hallstatt* (1873–76); *Die Dolomitrisse von Südtirol und Venetien* (1878–80); *Grundlinien der Geologie von Bosnien-Herzegowina* (1880) with E. Tietze and A. Bittner; *Die Cephalopoden der mediterranen Triasprovinz* (1882);

Die cephalopoden der Hallstätter Kalke (1873–1903); and *Beiträge zur Kenntniss der obertriadischen Cephalopodenfaunen des Himalaya* (1896).

MOKANNA (*al-Moqanna'*, the Veiled), the name given to Ḥakīm, or 'Aṭā, a man of unknown parentage, originally a fuller in Merv, who posed as an incarnation of Deity, and headed a revolt in Khorāsān against the caliph Mahdī. For about three years he sustained himself in the field against the troops of the caliph and for two years longer in his fortress of Sanam; then, reduced to straits in 779, he and his followers took poison and set fire to the fortress. He is a hero of Moore's *Lalla Rookh.*

MOKHA (Mocha, properly Makha), a town in Arabia on the Red Sea coast 13° 19′ N. and 43° 12′ E. Formerly the chief port for the Yemen coffee export, it has much diminished in importance. The coffee grown in the mountain districts of Haraz, Uden, and Ta'iz is now shipped at Hodeida or Aden, though the article retains the trade name of "Mocha." The town lies in a small bay 40 m. N. of Perim at the southern entrance to the Red Sea. The neighbouring country is an arid plain, the town being supplied with water by an aqueduct from the village of Muza, situated 16 m. E. This is probably the Muza of the Periplus, a great seat of the Red Sea trade in antiquity, which like other old Tehama towns, formerly seaports, has long since been left by the receding sea.

MOKSHANY, an agricultural town of Russia, in the province of Penza, in 53° 25′ N., 44° 35′ E. Pop. (1926) 9,786. Mokshany was built in 1535 as a fort to protect the country from the raids of the Tatars and the Kalmucks and is supposed to occupy the site of the Meshcheryak town of Murunza, mentioned as early as the 9th century.

MOLASSES, the syrup obtained from the drainings of raw sugar or from sugar during the process of refining. In American usage the word usually applies to both forms of the syrup, but in English usage the second form is more usually known as "treacle" (*see* SUGAR). The word, which in early forms appears as *melasses, molassos*, etc., is from the Port. *melaço*, or Fr. *mélasse, cf.* the late Lat. *mellaceum*, syrup made from honey (*mel*). The geological term "molasse" (Lat. *mollis*) is applied to the soft greenish sandstone of the district between the Jura and the Alps.

MOLAY, JACQUES DE (d. 1314), last grand master of the Knights Templars, was born at Molay (Haute-Saône), about the middle of the 13th century. He entered the order in 1265 at Beaune in the diocese of Autun, and set out for the East to take part in the defence of the Holy Land against the Saracens. About 1295 he was elected grand master of the order. After the Templars had been driven out of Palestine by the Saracens, De Molay took refuge with the remnant of his followers in the island of Cyprus. Here, he received a summons (in 1306) from Pope Clement V. to go to Paris. De Molay left Cyprus with a retinue of 60 followers, and made a triumphal entry into Paris. On Oct. 13, 1307 every Templar in France was arrested, and a prolonged examination of the members of the order was held. De Molay, probably under torture, confessed that some of the charges brought against the order were true. He was kept in prison for several years, and in 1314 he was brought up with three other dignitaries of the Temple before a commission of cardinals and others to hear the sentence (imprisonment for life) pronounced. De Molay then withdrew his confession. The king immediately gave orders that De Molay and another of the four, who had also recanted, should be burnt as lapsed heretics. The sentence was carried out on March 11 (or 19th), 1314.

For the charges brought against the Templars and the famous process in connexion with them, *see* TEMPLARS; J. Michelet, *Procès des Templiers* (1841–51) and Lavocat, *Procès des frères et de l'ordre du Temple d'après des pièces inédites publiées par M. Michelet* (1888); E. Besson, "Étude sur Jacques de Molay" in *Mémoires de la soc. d'émulation du Doubs* (Besançon, 1876); H. Prutz, *Entwickelung und Untergang des Tempelherrenordens* (Berlin, 1888).

MOLD (formerly *Mould*, Welsh *Y Wyddgrug*), market town of Flintshire, north Wales; on the L.M.S. railway (Chester and Denbigh branch), 11 m. from Chester. Pop. of urban district (1931) 5,133. At the north end of the town, Bailey Hill, partly natural and partly artificial, was an early fortification, and in old records is known as Moaldes, Monhault, or Monthault (*de monte alto*). Maes Garmon (the battlefield of Germanus) associated with early Christian legend, is about a mile west of Mold. Mold castle, probably built by Robert Monthault (*temp.* William Rufus), often changed hands in Welsh border-warfare.

MOLDAVIA, an autonomous republic of the Russian S.F.S.R., created in 1925. Area 8,288 sq.km. Pop. (1926) 567,306. It is situated on the left bank of the Dniester river, in the Ukrainian S.S.R. between 48° 12′ and 46° 32′ N. and 28° 30′ and 30° 06′ E. Autonomy was granted to the region because refugees from Bessarabia, after the occupation of that country by the Rumanians, expressed a desire for cultural independence. The population consists of Ukrainians 48·5%, and Moldavians 30·1%, the rest being Jews, Germans, Bulgarians, Poles, Czechs and Greeks. Its surface consists of a plateau sloping gently from north-west to south-east, deeply dissected by small streams with steep banks. The great number of ravines thus cut in the spongy loess are unfavourable to agriculture, especially as the heavy rainstorms of June and July often wash the surface soil away. The soil is chiefly black earth. The climate is extreme and most rain falls in very heavy storms during the growth of crops, so that the harvest is often damaged by these floods.

Agriculture thus labours under heavy disadvantages and has more than the usual element of chance: this has tended to prevent progress, and to lower social conditions. The chief crops are maize, wheat, rye and sunflower seed. Sugar beet, makhorka tobacco, fruits and vines are also cultivated. The number of cattle is poor compared with that in the rest of the Ukraine and diminished markedly after the bad harvest of 1924. Peasant industries to supplement the uncertain harvest are widespread and include the preparation of foodstuffs, flour-milling, oil-pressing and wine-making, the making of leather goods, especially boots and shoes, purses, etc., and the preparation of homespun garments. Clay and alabaster are also worked, and household utensils, wood, metal and pottery made. Manufactures are little developed.

Balta was at first declared to be the temporary administrative centre and a hope was expressed that ultimately Kishinev and the surrounding district would be detached from Bessarabia and joined to the republic, and that Kishinev would then become the administrative centre. In 1928, however, Birzulav (Birzula), a small town of 9,973 inhabitants, in 47° 45′ N., 29° 30′ E. was declared the administrative centre. The railway net is comparatively good, but roads are poor, and become impassable in flood time, those on the ravine slopes being sometimes completely washed away. The literacy rate is low and this militates against efforts to introduce scientific improvements to prevent the washing away of the surface of ravines. (*See* BLACK EARTH AREA.) The system of agriculture is mainly the traditional three-field system and agricultural implements are old fashioned and, in a population of fugitives, often lacking altogether. The migration of refugees into an area where the allotment of land to each peasant was already small, especially in view of the meteorological risks in this region, has created a very difficult problem.

The lack of diplomatic relations between Russia and Rumania and the consequent closing of the Dniester for trade between the two countries complicates the situation, and the region, which suffered severely during the war and civil war of 1914–20, and the famine conditions of 1921 and 1924, is in an unsettled social and economic condition. For the history *see* RUMANIA.

MOLDAVIA, a former principality of south-eastern Europe, constituting, after its union with Wallachia on the 9th of November 1859, a part of Rumania (*q.v.*).

MOLDAVITE: *see* TEKTITE.

MOLÉ, LOUIS MATHIEU, COMTE (1781–1855), French statesman, was born in Paris on Jan. 24, 1781. His father, a president of the parlement of Paris, was guillotined during the Terror, and Molé's early days were spent in Switzerland and in England with his mother, a relative of Lamoignon-Malesherbes. After his return to France Napoleon attached him to the staff of the council of state, and subsequently gave him many high offices. Except for a short term of office as minister of marine he was in opposition under the Restoration. He was foreign minister, without real power, for a few months in 1830, and

in 1836 he became prime minister and foreign minister. Personal and political differences rapidly arose between Molé and his chief colleague Guizot, and led to an open rupture in March 1837. Molé, supported by Louis Philippe, held his ground against the general hostility until the beginning of 1839, when the chamber was dissolved, but Molé resigned on March 31, 1839. After the revolution he sat in the Constituent Assembly, and in 1849 in the Legislative Assembly, where he was one of the leaders of the Right until the *coup d'état* on Dec. 2, 1851, drove him from public life. He died at Champlâtreux (Seine-et-Oise) on Nov. 23, 1855.

See P. Thureau-Dangin, *Histoire de la monarchie de juillet* (1884–92); and Robert Cougny, *Dict. des parlementaires français* (1891).

MOLÉ, MATHIEU (1584–1656), French statesman, son of Edouard Molé (d. 1614), who was for a time *procureur-général,* was educated at the University of Orleans. Admitted *conseiller* in 1606, he was *président aux requêtes* in 1610, *procureur-général* in succession to Nicolas de Bellièvre in 1614, and he took part in the assembly of the notables summoned at Rouen in 1617. He fought in vain against the setting up of special tribunals, or commissions, to try prisoners charged with political offences, and for his persistence in the case of the brothers Louis and Michel de Marillac he was suspended in 1631. In 1641 he was appointed first president of the parlement.

In the long conflict between Anne of Austria and the parlement, Molé played a conciliatory part. In the popular tumult known as the day of the barricades (Aug. 26, 1648) he sought out Mazarin and the queen to demand the release of Pierre Broussel and his colleagues, whose seizure had been the original cause of the outbreak. Next day the parlement marched in procession to repeat Molé's demand. On their way back they were stopped by the crowd. "Turn, traitor," said one of the rebels to Molé, seizing him by the beard, "and unless you wish to be massacred, either bring back Broussel or bring Mazarin as a hostage." Many magistrates fled; the remnant, headed by the intrepid Molé, returned to the Palais Royal, where Anne of Austria was induced to release the prisoners.

Molé failed to prevent the outbreak of the first Fronde, but he negotiated the peace of Rueil in 1651. He refused honours and rewards for himself or his family, but became keeper of the seals, and therefore retired from the presidency of the parlement. He died on Jan. 3, 1656.

The *Mémoires* of Molé were edited for the Société de l'histoire de France (4 vols., 1855) by Aimé Champollion-Figeac, and his life was written by Baron A. G. P. de Barante in *Le Parlement et la Fronde* (1859). *See* also the memoirs of Omer Talon and of De Retz.

MOLE, (1) a small animal of the family *Talpidae* (*see* below), (2) a mark, or stain, and particularly a dark-coloured raised spot on the human skin. This word, O.E. *mál,* is probably cognate with Lat. *maculus,* spot. Its meaning of stain is seen in the corrupted form "iron-mould," properly "iron-mole," a stain produced on linen or cloth by rust or ink, (3) a large structure of rubble, stone, or other material, used as a breakwater or pier (*see* Breakwater). This word comes from Lat. *moles,* a mass, large structure. The "Mole of Hadrian" is the mausoleum of that emperor, now the castle of St. Angelo, at Rome.

In zoology the name of *mole* is applicable to the common mole (*Talpa europaea*), a small, soft-furred, burrowing mammal, with minute eyes, and broad, strong fore-limbs, adapted for digging, belonging to the order Insectivora and the family *Talpidae.* In a wider sense may be included under the same term the other Old World moles, the North American star-nosed and other moles, the African golden moles of the family *Chrysochloridae;* and, in a still looser sense, to the Asiatic zokors, the African strand-moles, belonging to the order Rodentia, and the Australian marsupial mole.

The common mole is about six inches long, with a tail of one inch. The body is long and cylindrical, and, owing to the forward position of the front limbs, the head appears to rest between the shoulders; the muzzle is long and obtusely pointed, terminated by the nostrils; the minute eyes are almost hidden by the fur; the ears are without conches, opening on a level with the surrounding skin; the fore-limbs are short and muscular, terminating in broad, naked, shovel-shaped feet, the palms directed outwards; the hind-feet are long and narrow, and the toes have slender claws. The body is densely covered with soft, erect, velvety fur, generally black, with a greyish tinge. Albino and other colour varieties are known.

The food of the mole consists of earthworms, in pursuit of which it forms underground excavations. The mole is most voracious and, if deprived of food, succumbs in from ten to twelve hours. Moles take readily to the water. The sexes come together about the second week in March, and the young—generally from four to six in number—are brought forth in about six weeks.

Much misconception has prevailed with regard to the structure of the mole's "fortress," *i.e.,* the large breeding hillock, which is generally placed in bushes, or amid the roots of a tree; a good account, however, is given by Adams (*Mem. Manchester Lit. and Phil. Soc.* 1903, vol. 47). Moles are disliked on account of the way in which they spoil lawns and pastures, and they destroy large numbers of the useful earthworm; but they are useful in aerating and turning the soil. The mole is the most important wild fur-bearing animal of the British Isles (*see* Fur). The geographical distribution of the mole is very wide.

MOLECULE, CHEMICAL. The chemical molecule is usually defined as the smallest part that exists free in the gaseous form of a chemical substance. A very large number of chemical substances, however, have never been obtained in the gaseous form, and, in fact, many substances are incapable of existence except in the solid form. The compound chemical substance, alum, for example, decomposes on melting and exhibits no trace of volatility; it can be subdivided mechanically almost an infinite number of times without any change in chemical properties appearing, though it can be ultimately resolved by chemical processes into the five elementary substances, potassium, aluminium, sulphur, oxygen and hydrogen. Obviously there must be some stage in the subdivision of alum at which further subdivision will destroy the individual substance and reveal the presence of the elementary constituents: this ultimate stage is the stage of the molecule. A molecule thus represents the limit of subdivision of a substance at which the chemical properties are wholly retained.

Chemical science is not directly concerned with the absolute sizes of either molecules or atoms, all molecular and atomic weights being multiples of an arbitrary unit. The element selected as the standard was originally hydrogen, as the lightest known gas. For purposes of convenience (accessibility of measurement, etc.), the modern standard is the gas, oxygen, which is approximately 16 times as heavy as hydrogen. Taking oxygen as 16, the atomic weight of hydrogen is 1·008, which for most practical purposes is taken as unity. Though chemistry is concerned only with these relative weights, it is possible on chemical considerations to obtain some very approximate idea of the absolute weights of molecules and atoms. If one grain by weight of the colouring matter, fluorescein, is dissolved in 354 gallons of water, the yellow colour is just perceptible in a single drop of the solution. This drop contains 1/500,000,000th part of the original fluorescein. Though this dilution is at the visual limit of fluorescein detection, it is still very far from the molecular stage. If the single drop, however, is diluted with water a further four million million times, a drop of the resulting solution would contain a molecule of fluorescein, and it is known by chemical analysis that the fluorescein molecule is 332 times as heavy as a hydrogen atom.

In the early days of chemical science the distinction between atoms and molecules was not appreciated. John Dalton, the founder of the atomic theory, in 1808 regarded the atom as the smallest ultimate weight of both elements and compounds. He thus referred, for example, to the ultimate particle of the compound of nitrogen and hydrogen as an atom of ammonia. The term atom is no longer used in connection with compound particles, and is reserved solely for the ultimate particles of elements. Dalton assumed that the elementary gases were composed of individual atoms, and that chemical combination occurred simply atom to atom. In the same year J. L. Gay Lussac discovered the "law of simple multiple proportions by volume," which, in modern

terms, states that the gaseous volumes of substances taking part in a chemical change and the total change of volume, if any, are small integral multiples of a common factor of these volumes. In a very great number of cases it was known that the volumes of gases taking part in chemical changes were equal, and in 1811 Amadeo Avogadro put forward the hypothesis that equal volumes of gases under the same conditions contain the same numbers of particles. Avogadro used the term molecule in the sense in which Dalton had used the term atom, and distinguished the gas particle by the term integral molecule. The simple term molecule is now reserved solely for gas particles and ultimate particles of compounds. By means of this hypothesis as to gas particles, Avogadro was enabled to discern that the gas particles of nearly all the elements were made up of more than one ultimate particle or atom, the majority of the elements possessing diatomic particles or molecules. The molecules of hydrogen and chlorine, for example, were deduced to be double, on the ground that the gaseous hydrogen chloride they formed had double the volume of the hydrogen or chlorine used in the combination. Similarly, oxygen had a diatomic molecule, because the volume of water vapour was double the volume of oxygen used or obtainable from it, and nitrogen likewise, because ammonia gas was double the volume of nitrogen obtainable from it. Avogadro's hypothesis and his deductions therefrom were disregarded, and confusion about atomic and molecular weights prevailed in chemistry for nearly half a century. But the hypothesis was revived in 1858 by another Italian, Stanislao Cannizzaro, who showed that all known physical and chemical facts confirmed its validity, and that the inferential distinction made possible between atoms and molecules reconciled all the contradictory experimental results accumulated since the beginning of chemistry as a science.

Avogadro's hypothesis, that equal volumes of gases under the same conditions of temperature and pressure contain the same number of molecules, necessarily involves that the weights of equal volumes of gases are the relative weights of their molecules or that the ratio of densities of gases is the ratio of their molecular weights. The method of density is the fundamental method of determining molecular and atomic weights in chemistry, the atomic weight of an element being the smallest weight of it ever found in its molecular weight or in the molecular weight of any of its compounds. The method of gas or vapour density for determination of molecular weight is, however, inapplicable to the cases of elements and compounds that are not vaporizable under experimental conditions, and other methods have to be resorted to. Minimum values for molecular weight can be obtained for the majority of non-volatile compounds by the method of equivalents. For example, fluorescein combines by replacement of hydrogen with alkalis to form salts in the proportion of 332 parts of fluorescein to one equivalent of an alkali metal. As a molecule cannot contain less than one atom of hydrogen, the least molecular weight of fluorescein is 332. This method is in common use to determine the molecular weights of organic acids by the formation of silver salts. If the basicity of the acid is known, *i.e.,* the number of hydrogen atoms that are replaceable, the true molecular weight is equal to the apparent molecular weight multiplied by the basicity. This method of equivalents may be used for all compounds, whether they contain hydrogen or not. All that is required is the percentage composition of any one constituent of a compound, the minimum molecular weight being a hundred times the atomic weight of the constituent divided by the percentage of it in the compound.

Investigation of the properties of solutions has disclosed that an internal pressure called the osmotic pressure is set up in liquids by the presence of dissolved substances, such that this pressure is approximately equal to that exertable by the same weight of the substance if it existed as a gas and occupied the same volume as the solution. Comparison of osmotic pressures thus furnishes a method of determining relative molecular weights, by reference to such properties as are dependent on osmotic pressures. These properties are lowering of the vapour pressure of the solvent, elevation of its boiling point, depression of its freezing point, and lowering of its solubility for other substances. Comparisons of molecular weights by these methods are seldom more than approximately correct, but they are invaluable in deciding which multiple of the equivalent weight is the molecular weight. A limitation to this method is the fact that many substances are decomposed or dissociate into smaller parts on solution. Substances that dissociate on solution form electrolytes, solutions that conduct electricity and give rise to abnormally high osmotic pressures. S. A. Arrhenius in 1884 showed that the abnormality was due to ionization, each ion contributing to the osmotic pressure an amount equal to that of the non-ionized molecule, and the electrical conductivity being proportional to the number of ions. Measurements of conductivity thus supplement the osmotic pressure method and enable determinations of molecular weight to be made even for substances which dissociate on solution.

Where only the equivalent weight of a compound is known, valuable indications as to the true molecular weight may often be obtained by analogy with other similar compounds. These analogies are usually based on resemblances in composition, in valency of the constituent atoms, in constitution and the spatial distribution of the atoms or groups of atoms, and in crystalline form (isomorphism). (J. D. M. S.)

MOLE-RAT, the name of a group of blind burrowing rodents, typified by the large grey *Spalax typhlus* of eastern Europe, Western Asia and Egypt, which represents the Old World family *Spalacidae.* The mole-rats are characterized by the want of distinct necks, small or rudimentary ears and eyes, short limbs provided with powerful digging claws, and a rudimentary tail; they make burrows in sandy soil, and feed on bulbs and roots. Bamboo-rats (*Rhizomys*) from India and Burma, and *Tachyoryctes* from East Africa, differ by the absence of skin over the eyes, the presence of short ears, and a short, sparsely-haired tail. They burrow among tall grass, or at the roots of trees. Another group is the African family *Bathyergidae,* which contains the Naked Mole-rats of East Africa (*Heterocephalus*). (*See* RODENTIA.)

MOLESKIN, a term employed not only for the skin of a mole but also, from a real or fancied resemblance, for a stout, heavy cotton fabric of leathery consistence, woven as a satin twill on a strong warp. It is much worn by working-men, and is used for gun-cases, carriage-covers, and other purposes in which a fabric capable of resisting rough usage is desirable.

MOLESWORTH, MARY LOUISA (1839–1921), Scottish writer, daughter of Major-General Stewart, of Strath, N.B., was born in Rotterdam on May 29, 1839, and was educated in Great Britain and abroad. In 1861 she married Major R. Molesworth. Her first novels, *Lover and Husband* (1869) to *Cicely* (1874), appeared under the pseudonym of "Ennis Graham." Mrs. Molesworth is best known as a writer of books for the young, such as *Tell Me a Story* (1875), *Carrots* (1876), and *The Cuckoo Clock* (1877). She died in London on July 20, 1921.

MOLESWORTH, ROBERT MOLESWORTH, 1ST VISCOUNT (1656–1725), was the son of Robert Molesworth, a Cromwellian who made a fortune in Dublin. He supported William of Orange and in 1695 became a prominent member of the Irish privy council. In 1716 he was created a viscount. He was succeeded by his two sons, John, 2nd viscount (1679–1726), and Richard, 3rd viscount (1680–1758), the latter of whom saved Marlborough's life at the battle of Ramillies and rose to be a field-marshal. The 3rd viscount's son Richard Nassau (1748–93) succeeded to the title, which has descended accordingly.

A great-grandson of the 1st viscount, JOHN EDWARD NASSAU MOLESWORTH (1790–1877), vicar of Rochdale, was a well-known High Churchman and controversialist; and two of his sons became prominent men—WILLIAM NASSAU MOLESWORTH (1816–90), author of *History of England 1830–1871* (1871–73), *History of the Reform Bill* (1865), and *History of the Church of England* (1882); and SIR GUILFORD MOLESWORTH (b. 1828), an eminent engineer and economist.

MOLESWORTH, SIR WILLIAM, BART. (1810–1855), English politician, son of the 7th baronet, was born on May 23, 1810 in London. After succeeding to baronetcy in 1823, he studied at Edinburgh, Cambridge, Offenbach, Rome and Naples. On the passing of the Reform Act of 1832 he was returned to parliament

for the eastern division of Cornwall. He made the acquaintance of Grote and James Mill, and in April 1835 founded, in conjunction with Roebuck, the *London Review*, as an organ of the "Philosophic Radicals." After the publication of two volumes he purchased the *Westminster Review*, and for some time the united magazines were edited by him and J. S. Mill. From 1837 to 1841 he sat for Leeds, and acquired considerable influence in the House of Commons by his speeches and by his tact in presiding over the select committee on transportation. But his Radicalism made little impression either on the house or on his constituency. From 1841 to 1845 he had no seat in parliament, occupying his leisure time in editing the works in Latin and English of Thomas Hobbes of Malmesbury, a recreation which cost him no less than £6,000. In 1845 he was returned for Southwark, and retained that seat until his death. On his return to parliament he devoted special attention to the condition of the colonies, and was the ardent champion of their self-government. In January 1853 Lord Aberdeen included him in the cabinet as first commissioner of works, the chief work by which his name was brought into prominence at this time being the construction of the new Westminster bridge; he also was the first to open Kew Gardens on Sundays. In July 1855 he was made colonial secretary but he died on October 22. He married in 1844, but had no children, and the baronetcy passed to a cousin.

The titles of his speeches and works are given in the *Bibl. Cornubiensis*, vol. i. and iii. *See* also Mrs. Grote's *The Philosophical Radicals* (1866) and Mrs. Fawcett's *Life* (1903).

MOLFETTA, a seaport and episcopal see of Apulia, Italy, in the province of Bari, 16 m. N.N.W. of Bari by rail. Pop. (1921), 46,242. The old cathedral of S. Conrad is Romanesque. The old town is surrounded by walls; the new town is more spacious, and is an active seaport. The town was given by Charles V. to the duke of Termoli in 1522, and was sacked by the French under Lautrec in 1529. In 1640 the fief passed to the Doria, then to the Spinola family. Two miles south-west is the Pulo di Molfetta, a large circular depression in the plain, on the edge of which was an important neolithic settlement.

MOLIÈRE (1622–1673), the name taken by the great French actor and dramatist, Jean Baptiste Poquelin. He was born in Paris, probably in Jan. 1622. His certificate of baptism is dated Jan. 15 of that year, in the parish of St. Eustache. The place of his birth is disputed. Part of his boyhood and early youth was passed in a house known as the *maison des singes* at the corner of the Rue St. Honoré and the Rue des Vieilles Etuves, but in 1622 his father may have occupied another house in the same street. The *maison des singes* no longer exists, but there is extant the drawing of a pillar of the house which stood at the angle of the street, decorated with sculptures representing a group of monkeys playing about an orange tree. The monkey was traditionally the emblem of the comic actor. If Molière was not born in the *maison des singes*, his destiny was at least symbolically determined for him when his father moved to it a few years later.

Jean Poquelin, Molière's father, came of an old family of Beauvais which for generations had been engaged in the same trade. Jean Poquelin, upholsterer, and the son of an upholsterer, married Marie Cressé, the daughter of an upholsterer, and in 1631, when Molière was only nine years old, succeeded his uncle as *valet tapissier de chambre du roi*. Six years later he arranged that his son should have the reversion of this office. The young Molière was to go the way of his ancestors. There was nothing which pointed to unusual genius in the family, though Marie Cressé was clearly a woman of taste and method. She had a Bible, a copy of Plutarch's *Lives*, excellent furniture and a plentiful supply of linen. Jean Poquelin was of a shrewd and amiable disposition, with a faith in education which reminds us of M. Jourdain. But the books in his house belonged to his wife, and his supreme ambition was, undoubtedly, that his son should succeed him in the family business.

The biographers of Molière look for early signs and influences that might have turned him towards the theatre, but the evidence is extremely suspect. Grimarest (1705) tells us that Louis Cressé, the maternal grandfather of Molière had a passion for the stage and that he perfidiously advised Jean Poquelin to release his grandson from the shop and send him to the celebrated college of the Jesuits at Clermont. This story is extremely improbable. *Noblesse oblige.* Louis Cressé was himself an upholsterer. The college of Clermont, moreover, was hardly a preparation for the stage. It is more reasonable to believe that Jean Poquelin, of his own initiative and from a wise belief in the value of learning, decided that his son should have as good an education as possible in preparation for his duties at the court. There is no sign in Molière of any vocation for the stage till he left college as a young man of 20. The utmost we can say of him in early boyhood is that he had special opportunities of frequenting the theatre. One of the friends of Jean Poquelin, also an upholsterer, was one of the masters of the *Confrérie de la Passion,* and in the theatre of the Hotel de Bourgogne, which was owned by the *Confrérie,* the masters had a private box reserved for them and for their friends. This box was known as *le paradis,* and paradise it may well have been for the young Molière. There he would see, as a child, the tragedies of the period and the famous buffoons, Turlupin, Gaultier-Gargouille and Gros-Guillame, then at the height of their popularity. The father of Molière himself, moreover, inherited two boxes within the enclosure of the famous fair of St. Germain, the home of the *théâtre de la foire,* where in the first half of the 17th century Bary and Orvietan delighted the crowd with their burlesques.

Marie Cressé died in 1632, when Molière was only ten years old, and a year later Jean Poquelin married Catherine Fleurette. There is no evidence in support of the allegation that Catherine in any way disliked or neglected the children of Marie Cressé, and critics who have assumed that she served as a model for the odious step-mother in *Le Malade Imaginaire* betray more ingenuity than common sense. Catherine died within three years of her marriage, so that Molière knew her only between the ages of 10 and 13. It is difficult to establish when exactly he went to Clermont. The evidence is conflicting. Clearly, however, his education was at no time neglected. There can be no doubt of the pride and affection with which Jean Poquelin regarded the eldest child of his first marriage. The college at Clermont was attended by the sons of the best families in France, and Jean Poquelin must have had considerable influence, or the young Molière must have shown considerable promise, to secure admission. Molière at Clermont acquired a thorough grounding in the humanities. Terence is said to have been his favourite dramatist, and Lucretius was his chosen philosopher. Special attention was paid to the French language, and the masters cultivated in their pupils a love of poetry and the theatre, encouraging them to compose and to produce ballets and plays. The attendance of Molière partly coincided with that of his future patron, the Prince de Conti, though the prince was nearly eight years younger. Tradition, questioned in this as in so many other points by modern research, obstinately affirms that, with Chapelle, his friend in later years, and with Cyrano de Bergerac and others, he studied philosophy under the celebrated Gassendi. Gassendi, to the scandal of his contemporaries, was a champion of Epicurus and the most formidable adversary of Descartes. Whether Molière was actually a member of the group of privileged youths who had private lessons from Gassendi may be doubted, but there is no doubt at all concerning his studies in philosophy. He is said to have translated Lucretius. The translation is unhappily lost, but its existence is attested by several independent witnesses and is hardly open to doubt. The plays are enough to show that Molière was thoroughly familiar with the philosophic learning of the time. There is, on the other hand, nothing to justify the legend that Molière was ever at the Sorbonne, or that he studied theology. On leaving Clermont, however, he almost certainly studied law and was probably called to the bar in 1641.

MADELEINE BÉJART

The formal and academic education of Molière was now complete, and he was presumably expected to devote himself henceforth to his father's business. The question when exactly Molière first met Madeleine Béjart, a meeting which was decisive for his

career, has been much disputed. The likeliest hypothesis is that he met her in Paris immediately on leaving college. The Béjarts were near neighbours of the Poquelins in the Rue St. Honoré. Madeleine was already perhaps an actress, and certainly a subject of lively interest to her neighbours. She was 24 years of age. Four years previously she had been the mistress of the brilliant and adventurous Comte de Modène, and she was the mother of a child formally acknowledged by the count. She was clearly in no respect a safe companion for the inheritor of a respectable middle-class tradition; and, if Molière were already acquainted with her in 1642, Jean Poquelin would be glad of the very suitable opportunity which soon occurred of sending him away from Paris for a time. In 1642 Louis XIII. went to Narbonne, and, according to Grimarest, Jean Poquelin arranged for his son to accompany the royal household as *valet tapissier* and thus fulfil the duties which had been so carefully reserved for him by the arrangement made in 1637. There is no good reason to doubt the statement of Grimarest, and we may, therefore, assume that Molière had on this occasion his first view of the provinces where he afterwards wandered as an actor for 13 years.

The precautions of Jean Poquelin were in vain. Molière returned to Paris probably in the late summer of 1642, where he almost immediately abandoned his father's business, and adopted a theatrical career. On Jan. 6, 1643, he signed a document surrendering his right to the reversion of the post of *valet tapissier* secured to him six years previously, and acknowledging the receipt from his father of 630 livres. The money was to be spent for a purpose which for the moment was unspecified, but which was revealed six months later in the celebrated contract signed in the house of the Béjarts on June 30, 1643, by the founders of the *Illustre Théâtre,* a document which the *Comédie Française* regards as the first of its charters.

The enterprise with which Molière thus became identified was due to the initiative of the family of which Molière may henceforth be regarded as an adopted member, and particularly of Madeleine who was the leading spirit in the new company. Her father, Joseph Béjart, an official in the Department of Forestry, had died earlier in the year, leaving a widow with five children and a number of debts. Three of his children, Joseph, Madeleine and Geneviève, joined the new company, and the other members of the troupe were of a similar standing, persons of small degree in the estimation of Jean Poquelin and of a Bohemian inclination. Madeleine, who was to be the friend and adviser of Molière for 30 years, and always the business man of the company, was of an amiable and free disposition—generous, affectionate, loyal in her friendships, able and prudent in the management of her affairs. There is no proof that she was at any time his mistress, and it is clear, despite everything that has been written to the contrary, that she never attached any importance to that aspect of their relationship—if, indeed, it ever existed. Her affection for Molière was from the first maternal rather than passionate.

This brings us to the most obscure of the many problems which confront the biographer of Molière, and it may be well to dispose of it as briefly as possible before following him into his theatrical career. On Feb. 20, 1662, nearly 20 years after Molière first made the acquaintance of Madeleine Béjart, he married a young girl of 19, who subsequently became one of the most celebrated members of his company. The girl, known to her contemporaries as Armande Béjart, was generally said to be the daughter of Madeleine. His enemies went further than that. The anonymous biographer who in 1688 published a life of Armande under the title of *La Fameuse Comédienne,* insinuates that Madeleine, at the time when Armande was born, was too promiscuous in her loves to be sure of the paternity of the child, and Boulanger de Chalussay, author of *Elomire Hypocondre,* a libellous comedy on Molière published in 1669, is still more explicit. He definitely suggests that Molière was the father of Armande. A third witness is Montfleury, a rival actor of the Hotel de Bourgogne, who wrote to Louis XIV. in 1663 and accused Molière of marrying the daughter of his mistress, leaving the king to draw his own conclusions. The king's answer was clear and immediate. The libellous *Elomire Hypocondre* was suppressed, and Louis stood godfather to the first child of Molière and his young wife. No one of credit believed in 1662 that Armande was the daughter of Molière, but it is equally true that no one, so far as we know, disputed the allegation that she was the daughter of Madeleine. His enemies wished to believe it and his friends did not trouble to deny it. The sequel is all the more surprising. A hundred and fifty-nine years later, in 1821, Beffara, an ex-commissioner of police, searching among the registers of Paris, discovered the marriage certificate of Molière in the parish of St. Germain l'Auxerrois. In this certificate Armande is given not as the daughter, but as the sister, of Madeleine, by Joseph Béjart and Marie Hervé. This discovery seemed to dispose once for all of any doubt as to the parentage of Armande, and it was reinforced in 1863 by the discovery of a legal document dated March 10, 1643, in which Marie Hervé, the widow of Joseph Béjart, renounced for herself and her children an inheritance which, as we have seen, consisted mostly of liabilities. In this document reference is made to four children of Joseph and to an "infant not yet baptised," the infant, of course, being Armande, who was thus, in a legal document signed and witnessed 19 years before her marriage, stated to be the sister and not the daughter of Madeleine.

These documents, which seemed for a moment to settle the question, have, in the opinion of many respectable critics, only made it more mysterious. Marie Hervé, in the act of renunciation dated 1643, describes all her children as minors. Joseph and Madeleine, however, had already attained their full legal majority. Marie Hervé, moreover, when Armande was born, was at least 53 years old and she had not had a child during the eight previous years. More remarkable is the fact that Molière, who might have produced these documents and thus silenced his enemies once and for all, never apparently made the least allusion to them, but acquiesced in the tradition, unquestioned for 160 years after his marriage, that Armande was the daughter of Madeleine. The inference has been drawn that the documents were not such as would have borne too close an inspection. The hypothesis which has won most support, though it is contemptuously dismissed by some scholars, is that Madeleine, for reasons variously given, which cannot be discussed within the limits of this article, was at the time of the birth of Armande anxious to avoid confessing her maternity and that she therefore induced her mother to acknowledge the child as her own. It is unlikely that the real facts of the case will ever be ascertained. Neither the gossips of the time nor the critics of a later generation help us very much to determine the attitude of Madeleine herself to the marriage, but it is clear that throughout her life she takes a very special interest in Armande. Armande received at her marriage a dowry of 10,000 livres, which purported to come from Marie Hervé. But Marie Hervé was at that time penniless. It was almost certainly Madeleine, the only rich member of the family, who supplied the money, and ten years later she left to Armande the whole of her fortune. No satisfactory explanation has been given why Madeleine should thus favour the youngest of her sisters at the expense of all the other members of the family. On the other hand no convincing reason has been given why Madeleine, if Armande was her daughter, should have wished to conceal the fact.

In the face of all this conflicting evidence, the just critic must apply the principles of English equity. The documents must be accepted until they are definitely proved to be falsifications of the truth, and according to the documents Armande is the sister of Madeleine.

THE FIRST THEATRICAL VENTURE

The Illustre Théâtre.—The contract between the members of the *Illustre Théâtre* was of a kind that had been familiar to the theatrical fraternity since Charles VI. had accorded his royal protection to the *Confrères de la Passion* in 1502. Each of the associates contributed to the funds of the company, and enjoyed in return a share in the profits and properties. No member might withdraw or be dismissed except at four months' notice. The plays were cast and the affairs of the theatre managed by a majority vote of the company. Madeleine Béjart was, by a special

provision, entitled to choose her own part in every play, and it was stipulated that the heroes should be impersonated alternately by Molière and two other members of the company. The company leased for three years a tennis court near the Porte de Nesle, at a rental of 1,900 livres. While, however, the necessary structural alterations were being made, the company visited Rouen, and it was probably in that city in Nov. 1643 that Molière made his first appearance as a professional actor. In December the company returned to Paris and urged on the work at the tennis court. In particular, Léonard Aubry, of the king's Office of Works, was urgently pressed to complete in good time the paving of the road in front of the theatre.

The history of the *Illustre Théâtre* is obscure. Its repertory consisted mainly of tragedies long since forgotten, and the only authentic evidence we have of its fortunes is a record of financial embarrassment. In Dec. 1644 we find the company indebted to François Pommier for 2,000 livres, and Marie Hervé, who made herself responsible for this debt, had pledged her house to another creditor of the company for 1,100 livres. In Dec. 1644 the receipts and assets of the company were all earmarked for its creditors, and the lease of the theatre was cancelled on the 14th of the month. Undaunted by these crushing reverses, the company moved to the tennis court of the *Croix Noire* on the *Quai des Ormes,* without, however, changing its fortunes. In March of the following year Molière, who had previously pawned two handsome ribbons with a milliner for 291 livres, undertook to make good any deficit that might be incurred on their sale. He was unable to discharge this debt until 15 years later, on May 13, 1659, two days after the first performance in Paris of *L'Etourdi.* The financial troubles of the company culminated in March 1645 in the imprisonment of Molière for debt at the suit of the master-chandler who supplied the theatre with candles. François Pommier likewise obtained a warrant against him, and he seems also to have been detained at the suit of a certain linen draper for the sum of 240 livres.

Too little is known of the work of the *Illustre Théâtre* to justify a discussion of its dramatic achievements. The biographical interest of the venture lies rather in the attitude of the two families who were principally concerned. That of the Béjarts is clear enough. Marie Hervé, signatory of the act of association, with three of her children in the company, supported the enterprise to the limit of her resources. She regarded Molière as in a sense one of the family, and treated his liabilities as being on the same footing as those of her own children. What was the attitude of Jean Poquelin? He had finally acquiesced in his son's adventure, and had even supplied him with the money to buy a share in the company. But he made no effort to help his son while the company still persisted in an enterprise which to him must have seemed hazardous and even fantastic. When, however, it was clear that the adventure could go no further, he lost no time in coming to the rescue. Léonard Aubry, whom we have seen paving the way for the *Illustre Théâtre* in Dec. 1643, went bail for Molière on his imprisonment in 1645, and guaranteed that François Pommier should be paid for account of the debtor the sum of 320 livres in weekly installments of 40 livres until the debt was discharged. On Dec. 24, 1646, Jean Poquelin himself assumed this liability and further payments by Jean Poquelin are recorded, amounting in all to 1,965 livres. Molière discharged these debts as soon as he could, and 23 years later he was able, in turn, to lend his father 10,000 livres under cover of a third party, for the reconstruction of the *Maison sous les piliers des Halles.* There is certainly nothing in the financial or personal dealings of father and son which can be quoted to the discredit of either party, and there is no real ground for any of the legends in which Jean Poquelin figures either as a mortally injured father or a monster of avarice.

PROVINCIAL TOURS

The enterprise of the *Illustre Théâtre* had ended in disaster, and Jean Poquelin might reasonably have hoped that his son would now return to the business of his fathers. What followed might be regarded as a proof of genius or infatuation. Molière, having failed in Paris, decided to go into the provinces. We do not know exactly how he, or more probably the Béjarts, contrived to arrange the matter, but in Jan. 1645, within six months of its bankruptcy in Paris, we find all that remained of the company in the service of the Duc d'Epernon, governor of Guienne, at or near Narbonne. The second stage in the theatrical progress of Molière had begun, and for the next 13 years he was to wander from place to place in the southern provinces of France. This is the most legendary period of a legendary life. Every town within reach of his activities has since been anxious to claim a piece of him or contribute to his Odyssey, and the real facts are difficult to establish. His itinerary has been painfully reconstructed from the marriage and baptismal certificates of friends or members of the company, from applications for licences to perform, from receipts given on account of taxes levied for the poor, from evidence of his association with noble protectors or local authorities. The evidence is always intricate and sometimes contradictory, and it is impossible to do more than indicate the general results. The following is a list of the towns which were certainly visited by Molière in the years indicated: Narbonne, 1645; Toulouse, Albi and Carcassonne, 1647; Nantes, 1648; Toulouse and Narbonne, 1649; Narbonne and Agen, 1650; Grenoble and Lyon, 1652; Lyon and Montpellier, 1653; Montpellier and Lyon, 1654; Montpellier, Lyon, Avignon and Pézenas, 1655; Pézenas, Narbonne, Bordeaux and Béziers, 1656; Béziers, Lyon, Dijon and Avignon, 1657; Lyon, Grenoble and Rouen, 1658. The above list includes only the towns for which documentary proof can be quoted, and no doubtful or merely probable cases are included.

The Duc d'Epernon, with whom we find Molière at the beginning of his provincial career, was the first person of distinction effectively to recognize and encourage the genius of Molière. The actor, Dufresne, was titular head of the new company, and Madeleine was its tragic star. In 1653 Molière found a more celebrated protector in his old schoolfellow, the Prince de Conti. By that time Molière was undoubtedly the leader of the company. He acts as its representative, and with Madeleine is, in effect, its responsible manager. It had recently been strengthened by the acquisition of two new members, Mademoiselle de Brie and Mademoiselle du Parc, and it would seem that the patronage of the Prince de Conti, and the pension granted as a result of it, was at the outset due less to the genius of Molière than to the charms of Mademoiselle du Parc, of whom the prince's secretary became opportunely enamoured. The prince was at this time at the height of his brilliant career. Molière spent a good deal of time in his society, and they read and discussed plays together. The sequel to the friendship was unfortunate. The Prince de Conti became suddenly regenerate, and, from being the gayest of his peers, was shortly to come before the world as the ascetic author of a satire upon the stage in which Molière, as in the later libels of his clerical enemies, was to figure as a corrupter of morals and the enemy of grace.

The traditional picture of the life of Molière during his provincial wanderings requires substantial correction in many respects. The vivid picture given of the life of a strolling player in the *Roman comique* of Scarron has seriously misled the biographers. Molière was certainly not the vagabond of popular legend. His status was more that of a civil servant than a gipsy. His engagements to perform while the Estates were in session were in the nature of public contracts, and on these occasions he received substantial grants which more than covered his expenses. Thus in Feb. 1656 he received at Pézenas from the treasury of the Estates the sum of 6,000 livres, roughly equivalent in value to 50,000 gold francs to-day, and representing for most articles a purchasing power considerably greater at that time than at any period since the War. When the company was not subsidized by the local authorities, or fulfilling its duties as a pensioner of the Duc d'Epernay or the Prince de Conti, it was free to go on tour in the ordinary way. The box office receipts on such occasions might be considerable. It is true that by a law of 1609 no place in the theatre might, without a special authorization, be sold for more than ten sous. But the law of 1609 was practically a dead letter. Thus, in 1652 at the Hôtel de Bourgogne a place in the

pit cost 15 sous, and a place in the galleries cost 110 sous—equivalent in value to the price of a stall at Covent Garden today. These receipts, of course, were supplementary to the pension paid by the protector of the company, and to the special indemnities given for extraordinary performances during a festival. The company of Molière is estimated to have received such indemnities to the tune of 11,000 livres (over 80,000 gold francs) within two years while in the service of the Prince de Conti. The only authentic glimpse we have of the standard of living of the company during its provincial wanderings is the account given by d'Assoucy who, in 1655, was its guest for several months. D'Assoucy is loud in his praises of the good fare of the actors and their generous habit of life.

The attitude to Molière and his friends of the public authorities and of private persons is well-defined by La Bruyère: "The actor was disreputable in the opinion of the Romans and honourable in the opinion of the Greeks; we ourselves esteem them as the Romans, but we live with them as the Greeks." In other words, the actor, though in 1650 he was still in theory infamous and must normally renounce his profession in order to be admitted to the sacraments or to Christian burial, was in fact almost universally welcome and respected. The worthiest representatives of the Estates might be kept waiting while a prince conferred with his actor friends, and Molière is one of the few men of whom it has been recorded that he dined with Louis XIV. The status and prosperity of the theatrical profession was at that time steadily rising. In 1641 Louis XIII. had issued a decree affirming that the theatre should henceforth be regarded as a source of innocent amusement to his subjects, and likely to distract them from evil pursuits; that actors should not be blamed for the exercise of their profession, and that it should not in any way prejudice their public intercourse.

For Molière the dramatist these were mainly years of observation and preparation. The repertory of the company would seem to have consisted mainly of contemporary French tragedies, of farces from the Italian and tragi-comedies from the Spanish. As an author Molière was as yet an apprentice. In 1655, before the Prince and Princess de Conti, he appeared in the *Ballet des Incompatibles,* to which he may have contributed some verses, and shortly afterwards, at Lyon, he produced *L'Etourdi,* the first of his authentic plays. Two years later came the first performance of *Le Dépit Amoureux,* given at Béziers in 1657. It was at this moment, when Molière was beginning his career as an author, that the Prince de Conti, in the throes of his pious conversion, intimated that he could no longer reconcile it with his conscience to be a patron of the drama.

RETURN TO PARIS

Molière returned to Paris in 1658 after his long absence. Thirteen years in the provinces had given him a thorough command of the arts and crafts of the theatre, secured for him the leadership of a devoted company, and provided him with a repertory which included two full-length plays of his own, and, probably, a number of small farces and sketches on which he was afterwards to draw during the next 14 years of production and authorship. He approached Paris by way of Rouen, from which he made a number of secret visits to the capital to prepare the way for his return. Who it was who gave Molière his introduction to the court is unknown. Possibly it was Mazarin, who might have heard of Molière through the Prince de Conti or through the painter, Mignard, who had met Molière at Avignon in 1657, and had there started with him a life-long friendship. All that we know for certain is that in the spring of 1658 Molière was in Rouen, and that, on Oct. 24 of the same year, under the protection of the Duc d'Orleans, he appeared before the king and his court in the guardroom of the Vieux Louvre. Loyal to his passion for tragedy, he played on this decisive occasion the *Nicomède* of Corneille. Among the spectators were the royal tragedians of the Hôtel de Bourgogne, who had often played this tragedy themselves, and with whom Molière was so shortly to be engaged in a bitter rivalry. The most devoted friends of Molière are lukewarm in their references to his tragic powers. The most they could say of his performance in *Nicomède* was that it did not displease the audience, and that the women of the company were excellent. At the end of the play Molière came forward, thanked the king for his graciousness, excused the shortcomings of himself and his company, with a judicious reference to the royal players whom they could not hope to excel, and asked permission to present one of the small entertainments with which he had regaled the provinces. We have only a brief summary of this little speech, but it was apparently made in the most felicitous terms, and the farce of *Le Docteur Amoureux* which followed it, but which unfortunately is not extant, still further pleased the king and his court. Louis XIV., as a result of the performance, arranged for Molière and his company to share the Salle du Petit Bourbon with the famous Italian comedians under Scaramouche, and it was there that in Nov. 1658 Molière began a series of productions which included a revival of his own provincial successes, *L'Etourdi* and *Le Dépit Amoureux.*

Molière was now 37. He had overcome the material obstacles to the career he had chosen. He was admittedly a comic actor of merit and an author who, on the lines of the old classic farces and of the more recent Italian models, could write a play of intrigue with a blend of exuberance and discretion peculiarly his own. In 1658, however, we cannot fail to admire with respectful astonishment the discernment of Louis XIV., who decided so quickly and on such slender grounds that this was a man to be watched and encouraged. *L'Etourdi* and *Le Dépit Amoureux* were popular successes and resulted in substantial profits for each member of the company, and they were equally successful when played before the king and his court in the spring of 1659. The dexterity of the plots, the easiness of the dialogue, and the excellence of the acting put these productions in a class apart from any comic plays yet produced on the French stage, with the single exception of the *Menteur* of Corneille, produced over 16 years previously. But these plays were in substance a clever exploiting of the conventional situations and characters of an ancient theatre. It was not till Nov. 1659 that the comic genius of Molière found its first individual expression in *Les Précieuses Ridicules,* and posterity has confirmed the verdict of the anonymous old gentleman who rose from his seat in the pit and cried out in his excitement: "Courage, Molière! Voilà la véritable comédie."

Les Précieuses Ridicules.—This is the first, and perhaps the most perfect, comedy of manners. It has been maintained that Molière wrote it or an early version of it during his provincial wanderings, but the evidence for so unlikely an hypothesis is inadequate. It was aimed directly at the capital. The brilliant salon of the Marquise de Rambouillet had begun under Louis XIII. as a legitimate protest against the brutal and illiterate society of the *Frondeurs.* It included a company of wits, poets and writers of memoirs who were to make the period illustrious. By the time Molière arrived in Paris, however, it had elaborated a code of gallantry, a standard of literary values, and a system of social etiquette in comparison with which the most eccentric affectations of the aesthetes of the last decade of the 19th century in England would seem the sports of an Arcadian simplicity. Critics like Boileau secretly appreciated its absurdity, but no one dared to attack so distinguished a coterie at the height of its vogue. It was left for Molière, newly arrived in Paris, with one foot precariously on the ladder of success, to invite this peculiar world to laugh at its own discomfiture. The sensation was immediate. The more discerning of the coterie admitted its justice, and applauded its genius. Madame de Rambouillet herself was present at the first performance, and Ménage, hitherto devoutly precious, declared on leaving the theatre that "we must now burn what we have adored, and adore what we have burned." Other members of the precious sect, however, were less amenable. The first performance was given on Nov. 18. The king and his brother were absent from Paris, and among those hit by the satire was a cabal sufficiently powerful to intrigue successfully against its repetition. The ms. was sent to the king, who thus became arbiter of the dispute, and he decided at once in its favour. The play was repeated on Dec. 2, before a crowded house at double prices. Molière returned often to his imitations of the classic farce; he wrote

many ballets to please the public and the court. But henceforth the principal events in his life are his comedies of observation and satire. His career henceforth is mainly a record of the bitter controversies excited by these plays, and his own persistent struggle for the freedom of the comic art. For the moment the omens were good. It is true that Thomas Corneille, writing to the Abbé de Pure, author of a tenth rate tragedy, regarded the success of *Les Précieuses Ridicules* as "sufficient proof that Molière and his friends are only capable of presenting trifles of this kind," and that the tragedians of the Hôtel de Bourgogne, already taking alarm, were openly contemptuous of their rivals. But there were 32 performances of *Les Précieuses Ridicules* between Dec. 2, 1659, and Easter 1660. People came to Paris from 20 leagues' distance to see the play, and the king on his return from the Pyrenees witnessed it on three separate occasions in the summer and autumn of 1660. On the third occasion he accorded the company a grant of 3,000 livres.

At the Palais Royal.—*Les Précieuses Ridicules* was followed in May 1660 by *Le Cocu Imaginaire*. Posterity feels that this was a retrogression. The public of his own day, however, was all applause, and the king was pleased to witness it on no less than nine occasions. Molière was, meanwhile, in danger of losing his theatre. M. Ratabon, in charge of building operations at the Louvre, began to demolish the Salle du Petit Bourbon in which the company of Molière was housed. He gave no warning to the actors, either from malice or more probably from negligence. The king at once intervened, and assigned to Molière the Salle du Palais Royal, in which he remained until his death in 1673. The rival companies of the Marais and the Hôtel de Bourgogne seized this opportunity to approach the members of the company of Molière with advantageous offers; but according to Lagrange: "all the actors loved M. Molière, their chief, who, in addition to his extraordinary merit and capacity, was of so honourable a nature and so charming a disposition, that they swore to follow his fortunes and never to abandon him whatever proposal might be made to them or whatever advantage might be offered them elsewhere." Even Mademoiselle du Parc, who, less loyal than her companions, had been enticed to the Hôtel de Bourgogne a short time before, had since returned to Molière.

The first production of Molière in the new theatre of the Palais Royal was *Don Garcie*, his only tragedy. We have noted before the obstinate devotion of Molière to the tragic muse. The *Illustre Théâtre* had been founded with a special view to the tragic gifts of Madeleine, and Molière on his return to Paris, had chosen to make his first appearance before the king in a tragedy. In 1659, during his first season at the Salle du Petit Bourbon, Molière presented no less than five tragedies of Corneille. All of them were failures and had to be abandoned in favour of *L'Etourdi* and *Le Dépit Amoureux*. Thomas Corneille describes the tragic acting of Molière and his friends as "detestable." *Don Garcie* was a final experiment, and, after endeavouring for nearly three years to obtain for it the favour of the king and the public, Molière at last accepted the verdict of his contemporaries. He never published the play and the fact that he afterwards incorporated some of its best verses in *Le Misanthrope* may be taken as a proof that he came to regard it as a lost cause. He did not, however, abandon tragedy without a struggle and some bitterness of spirit. He had ideas on the subject of tragic declamation which were wholly opposed to the feeling of the time and to the essential character of the French classical school. He pleaded for a greater simplicity of phrase and diction, and for a more natural and less organized emotion. His own views are expressed in *L'Impromptu de Versailles*, a direct attack upon the tragedians of the Hôtel de Bourgogne with which in Oct. 1663 he supported the last production of his own tragedy, and which reminds us in places of Hamlet's advice to the players at Elsinore. *Don Garcie* leaves us convinced that heroic tragedy in the manner of Corneille and Racine was incompatible with his genius, but it leaves us also wondering whether Molière might not have been a successful author of tragedy in the Elizabethan manner, with its mingling of tragic and comic scenes.

L'Ecole des Maris.—The failure of *Don Garcie* was more than balanced by the brilliant success of *L'Ecole des Maris*, produced on June 24, 1661. This play is a more considerable achievement than *Les Précieuses Ridicules*, being a comedy not of manners, but of character. Two rival conceptions of the education of women are opposed, and judgment given in favour of freedom and a reasonable indulgence. Each of two brothers is entrusted with the protection of two young girls, and each of them desires to marry his ward. The one mistrustfully prohibits all amusements, and endeavours to coerce youth into conformity with the tastes and inclinations of middle age. The other allows all innocent liberties and uses no constraint. The first loses and the second wins his wife. The friends of the author might see in the play a biographical significance not yet clear to the public; Molière, 40 years of age, was about to marry Armande at 19. Already he had asked for and obtained the right to two shares in the company which were to be accorded "to him and to his wife if he should marry."

From June 24 to Sept. 11 *L'Ecole des Maris* was played daily. The author was meanwhile, at the special request of the king, writing the *comédie-ballet* of *Les Fâcheux*, which was performed on Aug. 17, 1661, at a reception given to the king and his court by Fouquet in the gardens of Vaux. Le Brun painted the decorations; Torelli was engineer; La Fontaine contributed verses; Le Notre designed the gardens; while Molière exhibited for the delight of the court his famous gallery of bores, each of whom might be matched with an original in the brilliant audience. The thread on which Molière strung the episodes of the ballet was of an admirable simplicity. A pair of lovers desiring a quiet rendezvous are interrupted by a succession of intruders, each of them more tediously disconcerting than the last. Louis XIV. after the performance drew the author's attention to a famous bore whom he had omitted to present, by name Soyecourt, his own Master of the Chase, and Molière, in a subsequent revival of the play, made good this omission with the assistance, it is said, of the victim himself.

MARRIAGE

The unfortunate marriage of Molière with Armande Béjart took place on Feb. 20, 1662. We have already alluded to the circumstances of the marriage and the problems it presents. The character of Armande and her relations with Molière have been the subject of even more discussion than her parentage. It is again impossible to go into the details of the controversy. There can be little doubt that Armande is the "petite Menou" who six years previously as a child had taken the part of Ephyre in the *Andromède* of Corneille while the company was in the provinces. The promiscuous infidelities with which she is charged by the author of *La Fameuse Comédienne* can be safely dismissed, but there can be no doubt whatever that she gave Molière frequent and just cause of complaint. She was greedy of pleasure and spoiled with flattery. She had small regard for her husband's position. Molière was surrounded by enemies who did not scruple to use his private troubles to discredit him, and the least we can say of Armande is that she did not show him the loyalty he had a right to expect. There was a fundamental incompatibility between them, which Molière subsequently idealized in the encounters between Alceste and Celimène. The uneasiness of their relations was such as might have been expected to arise between a sensitive man of genius in middle life and a capricious girl whom everyone, including her own husband, had helped to spoil from the time she was a child of ten. It is difficult to date the various estrangements and reconciliations between them. There was certainly a long period (1666–71) during which they were in effect separated, and in Aug. 1667 Molière took a house in Auteuil where he lived with his friend Chapelle, and apparently saw his wife only at the theatre. Even then, of course, they must have been in constant touch with one another professionally. In 1671 there was a last effort to resume life together, and when Molière died in 1673 they were inhabiting the same house in the Rue de Richelieu. The first part given by Molière to his wife was that of Elise in *La Critique de l'Ecole des Femmes*. Her talent as an actress was much admired, and contemporary writers all bear witness to her vivacity and charm. Molière himself has painted

her portrait delightfully in Lucile of *Le Bourgeois Gentilhomme.* After his death she married a second-rate actor, Guerin d'Estriché, who ruled her firmly and with whom she appears to have been entirely happy. There were three children born to Molière, a son on Jan. 19, 1664, who died nine months later, a daughter on Aug. 4, 1665, who survived, and a second son on Sept. 15, 1672, who died within a month.

L'Ecole des Femmes.—On Dec. 26, 1662, ten months after his marriage, Molière produced *L'Ecole des Femmes,* a companion comedy to *L'Ecole des Maris.* With the production of this play he enters upon a more militant period of his career. Hitherto he had excited only the jealousy of professional rivals and the resentment of a coterie. Henceforth he had to reckon with serious charges of license and impiety. Socially the play was more startling than the modern critic can easily realize. It anticipated the modern feminist attitude to male jealousy by over two centuries. Molière was to suffer all the tortures of a man infatuated with a young wife of whom he could never be sure, and in *L'Ecole des Femmes* he stages his own misfortunes. No one has written of jealousy with a finer detachment or a more delicate sense of the moral and social issues involved than Molière. The author of *L'Ecole des Femmes,* regarding himself with comic detachment, takes his own weakness for a subject. In the same way we shall see him later on, in the hands of the doctors, using his own illness as a theme for one of his gayest comedies.

L'Ecole des Femmes ran continuously from Dec. 1662 to Aug. 1663, except for a short break at Easter, and Molière, taking the offensive against his critics, wrote a brilliant postscript to the comedy in one act, dedicated to the queen mother, in which he ridiculed his detractors. The new play, entitled *La Critique de l'Ecole des Femmes,* provoked a whole series of rejoinders. The two most important of them were *Zélinde, ou la Critique de la Critique* by de Visé, and the *Portrait du Peintre* by Boursault. The latter play was performed at the Hôtel de Bourgogne and witnessed by Molière himself, who replied with *L'Impromptu de Versailles,* to which allusion has already been made. Modern readers may look in vain for the irregularities of form and impieties of substance alleged by the critics of Molière. The main attack was delivered upon the scenes in which Arnolphe threatens Agnes with the cauldrons of hell if she should ever deceive him, and catechizes her upon her deportment with the enterprising Horace. "There is nothing more scandalous than the sixth scene of the second act," says the reformed Prince de Conti in his *Traité de la Comédie et des Spectacles.* There is no doubt that the implicit mockery by Molière of a falsely puritan conception of conduct and his broad views on the freedom of women and the reasonable confidence which should be placed in their discretion profoundly disconcerted his contemporaries.

RISING OPPOSITION

Tartuffe.—The next two plays were occasional: *Le Mariage Forcé* (Feb. 15, 1664), an impromptu farce with a ballet, for which Lulli wrote the music, and in which the king himself danced as an Egyptian, and the *Princesse d'Elide* (May 8, 1664), hastily produced to form part of the festival of *Les Plaisirs de l'Ile Enchantée* at Versailles. More important was the inclusion by Molière among *Les Plaisirs de l'Ile Enchantée* of a first performance of the first three acts of *Tartuffe.* The production of these three acts was the beginning of a violent and obstinate struggle in comparison with which the controversy over *L'Ecole des Femmes* was no more than a preliminary skirmish. The king was driven into a position which as clearly indicates his own admiration of the play as the strength of the opposition it aroused. Molière pleaded in vain that *Tartuffe* was a satire upon a false and not a genuine devotion, as he had on a previous occasion pleaded that *Les Précieuses Ridicules* was a satire upon the false and not the genuine exquisites. The satire went too nearly home, and not even Louis XIV. dared publicly to license an indictment of religious hypocrisy with which he secretly concurred. He found it necessary to forbid the public performance of *Tartuffe.* Lest, however, his private opinion of the play should be misunderstood, he invited Molière to Fontainebleau on July 21, and *Tartuffe* was read to an audience which included Cardinal Chigi, legate *a latere* of Pope Alexander VII. The royal approval, even though supported by the toleration of a cardinal legate, did not, however, suffice to silence the opposition. Pierre Roullé, vicar of St. Barthélemy of Paris, in a pamphlet addressed to the most glorious king in the world, after describing Molière as a demon in human flesh and trusting that he would ultimately pass through earthly to eternal fires, congratulated his majesty on his decision to "suppress, destroy, suffocate and burn" the offending work. Molière protested against this violent attack in the first of the "placets" to the king, which afterwards appeared as prefaces to the play. The author in this "placet" expresses his entire confidence in the royal support. Meanwhile, the reading parties at court continued, and in July 1664 the first three acts of the play were performed at the house of the Duc d'Orléans in the presence of the king, the queen and the queen-mother, while in Nov. 1664 the whole five acts were played before the Prince de Condé, and repeated in Nov. 1665. For another two years Molière persistently continued to plead for a public performance, and he at last obtained the royal consent subject to certain emendations designed to make it clear that no general attack upon the clergy was intended. But the battle was not yet won. Molière amended the play, which was publicly produced at the Palais Royal on Aug. 5, 1667. The king, however, was unfortunately absent in Flanders, and on the day following the production of the play, the president of the *parlement* closed the theatre and tore down the posters from its walls. Molière thereupon wrote his second "placet" in which he went so far as to declare that he would retire from the stage "si les Tartuffes ont l'avantage." The "placet" was taken to the king in Flanders by two members of the company. The messengers of Molière were well received. The king promised to examine the new version of the play on his return and, if possible, to authorize its performance. But that was easier said than done, even by the king of France. The archbishop of Paris had on Aug. 11 prohibited anyone in his diocese from presenting, reading, or hearing the comedy, either in public or private, under pain of excommunication, and the king on his return to Paris did not venture to license its production. Molière was persuaded not to carry out his threat of retirement, but he had to wait for another 18 months before the public performance of the play was finally authorized on Feb. 5, 1669. Its success was immediate and prolonged.

Le Festin de Pierre.—Meanwhile, *Le Festin de Pierre,* produced on Feb. 15, 1665, had been denounced as the work of an atheist, without respect for God or the nobility, and, like *L'Ecole des Femmes* and *Tartuffe,* had become the occasion of several contemporary pamphlets. The king cannot fail to have been embarrassed by this further outcry. He did not, however, prohibit the public performance of the play, though it is more than probable that he advised the suppression of certain passages and dissuaded Molière from continuing the run of it after the Easter vacation. The play, though successful, was not revived, nor was it printed during the life of Molière. The scene which most infuriated the critics of *Tartuffe* was that in which Don Juan brings his infamies to a climax by assuming the mask of virtue. The scene between Don Juan and the beggar was considered to be so shocking that it was omitted from the early versions of the play, and great exception was also taken to the philosophic discussions between Don Juan and his valet. It is, again, not very easy for a modern reader to understand the critics of Molière. Much of the fury inspired by *Don Juan* seems to have been due to a false association of the author with the sentiments of his hero. The play was also construed by some of its critics as a deliberate attack upon the *noblesse.* Hitherto, as in *La Critique de l'Ecole des Femmes* Molière had portrayed only a foolish marquis. In *Le Festin de Pierre* he portrayed a wicked one. The king, once again, allowed no doubt to subsist concerning his own attitude to the play. *Le Festin de Pierre* was produced in Feb. 1665. In August of that year Louis XIV. summoned Molière to St. Germain, granted him a pension of 6,000 livres, and took over the company from his brother. Molière and his players were henceforth known as the "Troupe du Roi."

The first play produced by Molière as head of the king's com-

pany was to bring him further enemies. *L'Amour Médecin,* an impromptu *comédie-ballet* written and produced in five days, pleased the court and the town, but the medical profession now had definite warning that Molière, like his own Don Juan, was incorrigibly *impie en médecine.* The first performance took place at St. Germain on Sept. 15, 1665. From 1665 onwards, as the health of Molière declined, his satires against the doctors became more frequent and more effective. There is no need to seek for any private reason for these attacks. Nine-tenths of the science of medicine in the 17th century was pure grimace, and Molière, with his keen eye for the charlatan in art, science or religion, could not fail, as he came to know them better, to add the doctors to his gallery of impostors.

For the last two years Molière had been encouraging the young Racine. The two men had little in common, being antipathetic in personal disposition as in their genius. Molière had, nevertheless, been the first to recognize the talents of the young author, and had not only helped him with criticism and advice in the preparation of *La Thebaide,* but accepted the play when the tragedians of the Hôtel de Bourgogne hesitated to produce it. *La Thebaide* was produced at the Palais Royal on June 20, 1664. Shortly afterwards Molière accepted a second play of Racine, and *Alexandre le Grand* was produced at his theatre on Dec. 4, 1665. Racine, however, was not satisfied with the acting. He does not seem to have made any complaint or suggestion to Molière on the subject, but on the day after its fourth performance, on Dec. 14, to the surprise and indignation of the company of the Palais Royal, the tragedians of the Hôtel de Bourgogne, with the author's connivance, performed the play privately before the king and his brother, and on Dec. 18 staged it publicly as part of their repertory. Molière could hardly fail to regard the incident as an affront to his actors and a betrayal of his friendship. The fortunes of Racine were henceforth identified with those of the Hôtel de Bourgogne, whither, 15 months later, he enticed Mademoiselle du Parc, who thus for the second time abandoned the company of Molière.

THE ZENITH

Le Misanthrope.—*L'Amour Médecin* was followed on June 4, 1666, by *Le Misanthrope,* the greatest of the comedies of Molière. His theme is no longer the special vice of a particular class or profession, but the whole attitude of the just man to a society necessarily founded on compromise. The antithesis from which the dramatic conflict arises is between virtue and convenience. Alceste, who can make no concessions, inflexible on the point of honour, over-sensitive in all his dealings, is contrasted with Celimène, who loves the frivolous world, and with Philinte, who represents a wise conformity with average conduct and opinion. The play was too subtle for the audiences of the Palais Royal, and after nine performances the receipts began to fall. The reception of the play by the court, of which inferentially it is a bold indictment, is not very clear. *Le Misanthrope* is undoubtedly a play which posterity has learned to appreciate more justly than any of its contemporary critics or admirers. The part of Alceste was played by Molière and that of Celimène by his wife, and the comedy may justifiably be read as a reflection of their domestic relations. The whole play is at once intimate and detached. It is a personal confession, but the comic genius of the author, serenely regarding his private woes, transforms this confession into a sane, contemplative record that remains true for all mankind.

On Aug. 6, 1666, Molière, presumably losing money on *Le Misanthrope,* produced *Le Médecin Malgré Lui,* revising for the occasion an old farce previously described as *Le Fagotier* or *Le Médecin par Force.* It is another play in which the medical profession is maltreated, perhaps the best of the farces, boisterous in its energy and invention, but running with a lightness of fancy and a fitness of expression peculiar to its author. The remainder of the year was spent in preparing for the festival of the *Ballet des Muses* at St. Germain, which lasted from Dec. 1, 1666, to Feb. 20, 1667. Molière contributed three items to the festival: *Melicerte, La Pastorale Comique* and *Le Sicilien.*

The year which followed was one of difficulty and discouragement. In the early summer Molière was ill, and after the festival at St. Germain he did not return to the theatre until June. He was then on a milk diet. *Tartuffe,* as we have seen, was suspended in August, and Molière, who had threatened to retire if the Tartuffes were allowed to have it their own way, abandoned his rooms in Paris for the villa at Auteuil. His relations with his wife were now at their worst, and for the next four years they were to remain unreconciled. The friends of his leisure at Auteuil, in addition to the faithful Chapelle, were Boileau and La Fontaine.

The fit of discouragement passed and in Jan. 1668 he returned to the Palais Royal with the comedy of *Amphitryon,* a masterpiece in the Latin tradition which pleased equally the town and the court. Molière seems to have spent his leisure moments at Auteuil re-reading the classic authors, for *L'Avare,* produced on Sept. 9, was frankly derived from Plautus. Between these two productions in the classic mode, there intervened a summer festival at Versailles, for which Molière wrote *Georges Dandin,* a farce in which husbands of low degree who marry into the county may find their woes embalmed for ever. Of the three masterpieces of 1668, *L'Avare* was the least successful. Avarice of the classic kind was not a vice of the period, and the subject was too sternly handled for the audiences who were still applauding *Amphitryon.*

Royal Festivals.—In the autumn of 1669 Molière was on duty with the king at Chambord from Sept. 17 to Oct. 20, where, on Oct. 6, in collaboration with Lulli, who wrote the music, he produced *Monsieur de Pourceaugnac.* It was this play that gave rise to the observation of Voltaire that in all the farces of Molière there were also scenes of high comedy. The high comedy is disputable, but the high spirits are undoubted. The best of the scenes is one in which the doctors are again satirized. Molière, on a milk diet, is clearly indisposed to be reconciled to the medical profession. Four months later Molière was again called to St. Germain, where he remained at the king's disposal from Jan. 30 to Feb. 18. During this time he wrote and produced *Les Amants Magnifiques,* an allegorical ballet upon a theme suggested by the king. To cover the expenses of the festivals of Chambord and St. Germain the king granted the company an indemnity of 12,000 livres. In the autumn of 1670 Molière is again at Chambord, where on Oct. 14 the most justly famous of all the comedy-ballets, *Le Bourgeois Gentilhomme* was produced. So greatly did it please the court that four performances were requested in eight days. The *turqueries* of the play, which a sensitive orientalist may deplore, were introduced at the special request of the king. The comedy itself was pure Molière and subject to no inspiration but his own. Lulli contributed the music, and special attention was given to the costumes and staging. Molière paid dearly for the royal favour. Since the production in 1666 of *Le Misanthrope* most of his time and energy had been given to the royal festivals in which his genius was necessarily subordinated to the requirements of the court; and in 1671 he was set a further task in the performance of which it was difficult for him to enrich his immortality. The new spectacle, commanded for the Tuileries in January, was a *tragédie-ballet* on the theme of *Psyche.* Time was short and Molière looking for a collaborator secured the great Corneille. The collaboration was surprisingly successful. Molière sketched the plan of the ballet, but wrote only a small part of it. The spectacle itself was scenically so complicated that it was six months before it could be transferred from the Tuileries to the *Palais Royal.* In the meantime Molière entertained the town with *Les Fourberies de Scapin,* the revised version of a play which seems to have been originally produced in 1661 under the title of *Gorgibus dans le Sac.* This was a return to his earliest manner of farce, probably based on one of his provincial sketches, and it drew from Boileau a vehement protest against such a wasting of the genius of his friend. Boileau was urging Molière at this time to abandon the stage and devote himself to authorship, but Molière made it a point of honour to remain faithful to his vocation. To the end he was resolved "a dévouer son dos à toutes les bastonnades de la comédie." Boileau pleaded in vain.

In Dec. 1671 Molière was summoned to St. Germain to organize

yet another entertainment for the king. *La Comtesse d'Escarbargnas,* a hasty sketch which served the occasion, was a play which Molière did not himself desire to publish. For this festival he also improvised a ballet from previous entertainments of the kind and wrote a *Pastorale.* The *Comtesse d'Escarbargnas* was transferred to the Palais Royal in July 1672, where it was played along with a revival of *Le Mariage Forcé.* This was the last of the royal festivals to which Molière was to contribute. He was at St. Germain from Dec. 1671 to Feb. 1672.

On Feb. 17 occurred the death of Madeleine Béjart. In accordance with custom she solemnly renounced her profession and was accorded Christian burial with the permission of the archbishop of Paris. Exactly a year later Molière died, as he had lived, an actor. For him the archbishop would be less accommodating.

Last Plays and Death.—In the year that remained to him, Molière, free for the moment from his royal taskmaster, wrote the last two of his comedies. *Les Femmes Savantes* was produced at the Palais Royal on March 11, 1672, and *Le Malade Imaginaire* on Feb. 10, 1673. *Les Femmes Savantes* inevitably provokes comparison with *Les Précieuses Ridicules.* The earlier play for all its brilliance and verity is thin and superficial beside this product of an observation more penetrating and mature. The first was aimed at a polite affectation which socially was absurd and artistically mischievous. The second deals more seriously with the dangers of a little learning, and is of a more general application. The history of *Le Malade Imaginaire* is more than a theatrical event. It is the history of the death of Molière. For some time his health had caused his friends the greatest anxiety, and on Aug. 11 and 12 the theatre of the Palais Royal was closed owing to his indisposition. He had, as we have noted, left the house at Auteuil, and was now living again with Armande in the house in the Rue de Richelieu. Madeleine had died in February, and his second son, born on Sept. 15, 1672, died on Oct. 11. Meanwhile, sick unto death, he was writing his comedy of the man sick only in imagination, an act of courage and detachment rarely equalled in the history of genius. The play was produced at the Palais Royal on Feb. 10, and repeated on Feb. 12 and 14. On Friday, Feb. 17, Molière was feeling worse, and was urged by his wife and the young actor Baron not to go to the theatre. The reply attributed to him by Grimarest, who had it from Baron himself, is celebrated: "Comment voulez-vous que je fasse. Il y a cinquante pauvres ouvriers qui n'ont que leur journée pour vivre; que feront-ils si l'on ne joue pas. Je me reprocherais d'avoir négligé de leur donner du pain un seul jour, le pouvant faire absolument." Molière went to the theatre and acted with difficulty. In the course of the performance he was seized with a convulsion which he covered with a forced laugh. When the play was finished he complained of being cold, and Baron had him carried home. He ate a little bread and cheese and went to bed, where he was taken with a violent fit of coughing. He asked for his wife, but before she could arrive he died in the arms of two lay-sisters who had come to Paris during Lent to collect for charity and were at the time staying at his house.

Armande, in the appeal which she subsequently addressed to the king, says that, while dying, he sent urgently to the parish priests of St. Eustache, who refused to come to his assistance. He accordingly died without the sacraments or any formal renunciation of his profession, and the archbishop of Paris was thus canonically justified in refusing him Christian burial. His wife appealed to the king against this decision, and for the last time Louis XIV. intervened on behalf of his faithful servant. The royal intervention, however, as in the case of *Tartuffe,* resulted only in a compromise. The archbishop signed an order permitting ecclesiastical burial in the cemetery of St. Eustache, but the funeral was to be without ceremony, with two priests only and after sunset. The obscurity that covers the birthplace of Molière rests also upon his grave. It is even doubted whether, as the king wished, he was actually interred in consecrated ground or, by secret instructions of the archbishop, in a portion of the cemetery reserved for those who were denied this privilege. In spite of the most careful researches it has since proved impossible to identify the tomb or the bones of Molière.

ESTIMATE OF MOLIÈRE

The Man and His Work.—Of Molière it may be said with confidence that he was not only a great author but a great man. His life has a dramatic quality which makes it possible to think of it as perhaps the greatest of his plays. Apart from the many legends, to which only a passing reference and very little credit has been allowed in this article, the events and productions of his career speak for themselves. He not only represents the most vital and enduring qualities of his race, but his works are a protest against and a correction of the defects to which the French genius is peculiarly liable. His mind is without prejudice; he rejects nothing till it threatens to limit the free exercise of a sane intelligence, or to distort a reasonable conduct. He is thus the natural scourge of academies and sects, the enemy of all excess. The logic of his race pushed to extremes results in a rationalism and a formality which it was his peculiar mission to expose and to deride. His plays represent a survival of the old Gallic spirit, near to earth and the realities, into the classic period of French literature which was in danger of becoming too limited and remote from ordinary social experience. His comedies are a constant plea for sanity and the golden mean, and his life was spent in challenging bigotry, imposture, and exaggeration in every class and profession of society. The perfect balance of the mind and disposition of Molière is most clearly shown by the fact that he could take his own misfortunes and sorrows for a comic theme as sweetly and evenly as the vices or foibles of other men. There is never a trace of malignancy in his satire. It is always generous in inspiration and inexhaustibly vivacious. He found only one constant and effective supporter, without whom, for all his courage and pertinacity, he could never have ridden the storms which he raised. Louis XIV. considered himself sufficiently above the society of his time to view with equanimity its just correction. To Louis XIV. we must accord the merit of recognizing in Molière the greatest of his subjects, though we must at the same time deplore the unconscious insolence with which he imposed upon his favourite tasks which were so obviously beneath him.

The plays, as we have seen, fall roughly into three groups; first, the farces of intrigue, based on the conventional figures of the comic theatre which he inherited from the old classic or the contemporary Italian stage; secondly, the episodic and spectacular entertainments which he was called upon to organize for the court; thirdly, the social comedies in which he fully expressed his individual attitude to life and which he filled with the deathless characters of his own creation. There is no fixed boundary between the three types. In the most conventional of the farces there are passages to which the genius of Molière gives an individual turn, and in some of the *comédie-ballets,* notably *Le Bourgeois Gentilhomme,* we find some of his best characters and scenes. Towards the close of his career Molière contrived to meet the demands of the king for spectacle and at the same time to write the comedies he desired. *Le Malade Imaginaire,* for example, was a *comédie-ballet,* but it was also a supreme gesture of the comic spirit—the play in which the great comedian passed from a counterfeiting of death to death itself.

The Epicurean sanity of Molière, with its persistent correction of all extremes, has often exposed him to criticism more formidable than that of the sectaries. Men of a generous habit have felt its limitations, complaining that Molière seems often to be no more than a champion of prudence and the middle way and that there are whole tracts of human experience which lie beyond the scope of his art. But this is only to say that Molière is a comedian. He is not a mystical philosopher, or even a poet of passion. His subject is man in society. The answer to those who accuse him of an excessive worldliness and moderation is to be found in the fact that the critics of his own age charged him with anarchism, atheism and impiety. To the people of his own time he was a splendid or an infamous revolutionary according as they championed him with La Fontaine or censured him with Bossuet. The critics of the 19th century complained that he cared for no truth or principle sufficiently to be either a moral or a religious revolutionary, and it cannot be disputed that the morality of Molière is that of a man who wisely avoids adventurous extremes.

But on behalf of the moderation which for him was the secret of social wisdom, he fought a lifelong battle with a courage and persistence that have rarely been equalled. His lack of doctrine was due not to any moral indifference, but to his sense of the unlimited energy and possibilities of life. The human spirit was for him too various to be limited by any formula.

The style of Molière, in verse and prose, was a reflection of his free spirit and his candid intelligence. He wrote with extreme facility, but he was never a sloven. He is both voluble and precise. His prose dialogue is unequalled outside the plays of Shakespeare, and his verse has an ease and variety that make it immediately tolerable even to the foreign reader for whom the French alexandrine is a taste to be painfully acquired. The most exacting authors of the classical tradition, like Boileau, no less than their romantic successors, like Victor Hugo, unite in praising the style of Molière from opposite angles. Foreign readers, though their appreciation of French may be limited, rarely fail to appreciate the lucidity and vivacity of his writing.

For Molière's personal appearance we have the portraits of Mignard and the description of Mademoiselle Poisson, who saw him in the flesh: he was "neither too stout nor too thin, tall rather than short; he had a noble carriage, a good leg, walked slowly and had a very serious expression. His nose was thick, his mouth large with thick lips, his complexion brown, his eyebrows black and strongly marked, and it was his way of moving these that gave him his comic expression on the stage." He was of a grave and melancholy disposition—a contemplative genius, given to fits of abstraction. But he could speak well on occasion, and all his friends bear witness to the wit and charm of his conversation. In his private dealings he was generous, sympathetic and candid, tolerant for the faults he understood so well, delicate in his appreciation of the views and sentiments of others. He was free, gentle and fearless. Exposed to a criticism and calumny such as few men have had to sustain, we can find in him no trace of envy or malice and nothing mean was ever charged to his account.

Bibliography.—The standard edition of the works of Molière is that contained in the collection of the *Grands Ecrivains de la France*, edit. by Eugène Despois et Paul Mesnard (1873–1900). It contains the best biography of Molière (vol. ix.) and a bibliography which is complete up to 1893 (vol. xi.). The earliest life of Molière is the preface to the first edition of his works published in 1682 by La Grange and Vinot. This is included in the edition of Despois et Mesnard. Grimarest, who obtained most of his information from Baron, a young actor who was for many years in the company of Molière, published a life of the dramatist in 1705; he is, however, untrustworthy. The life of Molière by Voltaire throws more light upon its author than upon his subject, and the excellent biography of Taschereau (1863) requires careful correction in the light of recent research. The life prefixed by Ste. Beuve to the edition of 1825 is of more value as criticism than biography. Among later biographies are those of Jules Claretie (1873); J. J. Weiss (1900); Georges Lafenestre (1909); Maurice Donnay (1911). The contemporary sources may be studied in the documents collected by Edouard Soulié, *Récherches sur Molière et sa famille* (1863), and the *Collection Molièresque* of Paul Lacroix (1867–75). This last work contains the more important contemporary libels including *La Fameuse Comédienne, Elomire Hypocondre* and *Zélinde*. It was supplemented by a *Nouvelle Collection Molièresque*, begun by Paul Lacroix (1863–84) and continued by Georges Monval (1884–90), who also edited a monthly review, *Le Molièriste*, an important source of information (1879–89).

Among the authors who have dealt with the problems of the marriage and family relations of Molière are Jules Loiseleur in *Les Points obscurs de la vie de Molière* (1877) and Edouard Fournier in *Etudes sur la vie de Molière* and *Le Roman de Molière* (1885). The most searching and authoritative modern studies in the biography of Molière are Gustave Michaut's; he critically reviews all the previous evidence and gives the results in *La Jeunesse de Molière* (1922), *Les Débuts de Molière à Paris* (1923), and *Les Luttes de Molière* (1925).

Critical studies of Molière will be found in the works of Jules Lemaître, *Impressions de théâtre* (1888–90); P. Bourget, *Etudes et Portraits* (1889); Brunetière, *Epoques du Théâtre Français* (1892), and *Etudes Critiques sur l'histoire de la litérature Française* (1895–1908). (J. Pa.)

MOLINARI, BERNARDINO (1880–), Italian conductor, was born in Rome in 1880. He studied at the Liceo S. Cecilia and, in 1912, was appointed permanent conductor at the Augusteo, Rome. His work as a supporter of the new Italian composers is of great importance, and he ranks as one of the leading European conductors.

MOLINE, a city of Rock Island county, Illinois, U.S.A., on the Mississippi river, adjoining Rock Island and opposite Davenport, Ia., 167 m. W. by S. of Chicago. It is on Federal highways 32 and 61; is a station on the Chicago-Dallas air-mail route; and is served by the Burlington Route, the Chicago, Milwaukee, St. Paul and Pacific, the Davenport, Rock Island and North-western and the Rock Island railways, and by river barges and steamers and motor-bus and truck lines. Pop. 30,734 in 1920 (24% foreign-born white, largely from Sweden and Belgium); and was 32,236 Federal census 1930. It has large, diversified manufacturing industries. It is frequently called "the plough city," from its most distinctive product, and farm implements are still the leading group of manufactures. The 85 plants of Moline and East Moline (*q.v.*) have 15,500,000 sq.ft. of floor space, employ over 11,000 workers, and have an annual output of $77,000,000. The city's assessed valuation of property for 1928 was $24,773,885. Moline was settled in 1832, laid out in 1842, and chartered as a city in 1855. In 1847 John Deere, inventor of the steel plough, moved here to take advantage of the water transportation facilities, and established a small shop from which has developed the largest plough-manufacturing business in the world.

MOLINET, JEAN (1433–1507), French poet and chronicler, was born at Desvres (Pas de Calais). In 1475 he succeeded Georges Chastellain as historiographer of the house of Burgundy, and Margaret of Austria, governor of the Low Countries, made him her librarian. His continuation of Chastellain's chronicle, which covers the years from 1474 to 1504, remained unpublished until 1828 when it was edited (Paris, 5 vols.) by J. A. Buchon. It is far from possessing the historical value of his predecessor's work. A selection from his voluminous poetical works was published at Paris in 1531, *Les Faictz et Dictz de feu . . . Jehan Molinet. . . .* He also translated the *Roman de la rose* into prose (pr. Lyons, 1503). He became, in 1501, canon of the church of Notre-Dame at Valenciennes, where he died on Aug. 23, 1507. He was head of the *rhétoriqueurs*, a Burgundian school of poetry.

See A. Wauters in *Biographie nationale de Belgique* (vol. xv., 1899).

MOLINO DEL REY, or King's Mill, a group of thick stone buildings about two miles southwest of the city of Mexico. There on September 8, 1847 was fought probably the bloodiest battle of the War between Mexico and the United States (1846–1848). Major General Winfield Scott, in command of some 8,000 United States troops, was opposed to some 19,000 troops under General Santa Anna. The battle lasted all day; both Molino del Rey and Casa Mata fell into American hands in the evening. The losses on the part of the Mexicans were over 3,000, whereas the United States troops had over 700 killed and wounded.

MOLINOS, MIGUEL DE (*c.* 1640–1697), Spanish divine, the chief apostle of the religious revival known as Quietism, was born on Dec. 25, 1640 at Patacina, near Saragossa. He entered the priesthood and settled in Rome about 1670. In 1675 Molinos had published a volume, *Guida spirituale, che disinvolge l'anima e la conduce per l'interior camino all' acquisito della perfetta contemplazione e del ricco tesoro della pace interiore.* This was shortly followed by a brief *Trattato della cotidiana communione.* No breath of suspicion arose against Molinos until 1681, when the Jesuit preacher, Segneri, attacked his views, though without mentioning his name, in his *Concordia tra la fatica e la quiete nell' orazione.* The matter was referred to the Inquisition. It pronounced that the *Guida spirituale* was perfectly orthodox, and censured the intemperate zeal of Segneri. But the Jesuits set Father La Chaise to work on his royal penitent, Louis XIV., who was on very bad terms with Innocent XI.

Following on official representations by the French ambassador in Rome, who happened to be a cardinal, Molinos was arrested in May 1685. At first his friends were confident of an acquittal, but in the beginning of 1687 a number of his penitents of both sexes were examined by the Inquisition, and several were arrested. A report got abroad that Molinos had been convicted of moral enormities, as well as of heretical doctrines; and it was seen that he was doomed. On Sept. 3, 1687 he made public profession of his errors, and was sentenced to imprisonment for life. In the following November, Innocent signed a bull condemning sixty-

eight propositions from his *Guida spirituale* and unpublished writings. Molinos died in prison at Rome on Dec. 28, 1697.

In fact the doctrine of Molinos went farther than the Reformers had done. The Reformation maintained that the Church, so far from being a help, was a hindrance, to union with Jesus; whereas Molinos welcomed both Church and Jesus as helps to union with God, always provided that the believer treated both as means to an end beyond themselves. In other words, he held that there was a triple stage in piety. Beginners gave themselves wholly to the Church. At the second step came devotion to Jesus. At the highest stage both Church and Jesus were left behind as *deiformes, sed non Deus,* and God remained alone.

But how could a finite being bring himself into direct relation with Infinity? The less sense of proprietorship we have in a thought or action—the less it is the fruit of our deliberate will—the more certain may we be that it is divinely inspired. But what state of mind is most likely to be visited by these spontaneous illuminations? Plainly the state that Molinos calls the "soft and savoury sleep of nothingness," where the soul is content to fold its hands, and wait in dreamy musing till the message comes. For this reason disinterested love became the great hallmark of Quietist sanctity. Although Molinos's system did not long survive him, few writers have struggled so long and so hard to disengage the essence of religion from its transitionary embodiment in an historical creed.

The *Guida spirituale* was published in Italian in 1675, and has been reprinted. An English translation appeared in 1688; it has been re-edited by Mrs. Arthur Lyttelton. French, Spanish and Latin translations have also appeared. For the history of its author *see* C. E. Scharling, *Michael de Molinos* (Ger. trans. from Danish; Gotha, 1855); H. Heppe, *Geschichte der quietistischen Mystik* (Berlin, 1875); and Dudon, *Le Quiétiste espagnol Miguel de Molinos* (1921). On the whole subject of Quietism *see* H. Delacroix, *Études d'histoire et de psychologie du mysticisme* (Paris, 1908). There is a brilliant, but very fanciful, account of Molinos and his doctrines in J. H. Shorthouse's romance, *John Inglesant.*

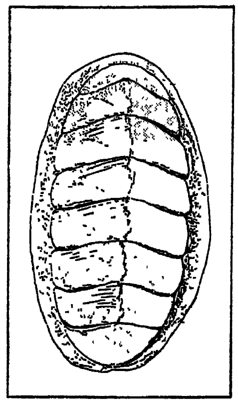
MOLKO (1500–1532), a Marano kabbalist, who proclaimed the advent of the Messiah. He was associated with David Reubeni, who also made Messianic claims. Molko, after a chequered career, was condemned to death by the ecclesiastical court at Mantua. He was offered his life by the emperor Charles V. if he would return to Christianity, but refused, and died at the stake.

MÖLLENDORF, WICHARD JOACHIM HEINRICH VON (1724–1816), Prussian field marshal, was born at Lindenberg on Jan. 7, 1724, and began his career as a page of Frederick the Great in 1740. In the Seven Years' War his brilliant conduct at the churchyard of Leuthen (1757) and at Hochkirch won him his majority. In 1760 his exertions retrieved the almost lost battle of Torgau, and the last success of the great king was won by the brigades of Prince Wied and Möllendorf (now major-general) at the Burkersdorf heights. Seventeen years later, as lieutenant-general, he won at Brix one of the few successes of the Bavarian Succession (or "Potato") War. Promoted general of infantry in 1787, and general field marshal in 1793, he commanded the Prussian army on the Rhine in 1794. He died in retirement at Havelberg on Jan. 28, 1816. Möllendorf was one of the first to protest against the maltreatment of soldiers by their officers.

MOLLIEN, NICOLAS FRANÇOIS, COUNT (1758–1850), French financier, was born in Paris on Feb. 28, 1758. He entered the ministry of finance as a young man, and put his great financial ability at the service of successive Governments. Under Colbert he improved the returns from the farmers-general of the taxes; he helped the conclusion of the Anglo-French treaty of 1786; after the coup d'état of Brumaire (Nov. 1799) he held successive financial appointments, and was constantly consulted by Napoleon, who, however, refused to accept the advice of his finance minister against his "continental system." He was again finance minister during the Hundred Days, and, though he declined office after the Restoration, was consulted in connection with the annual budgets.

See Mollien's *Mémoires d'un ministre du trésor public 1780–1815,* 4 vols. (1845; new ed., 3 vols., 1898); A. G. P. Barante, *Études historiques et biographiques* (1858); N. A. de Salvandy, *Mollien* (1851); also M. M. C. Gaudin (duc de Gaëte), *Notice historique sur les finances de la France 1800–1814* (1818).

MOLLUSCA. A large group of invertebrate animals constituting a large subdivision or phylum of the animal kingdom and comprising such forms as land and aquatic snails and slugs, oysters, mussels, cuttlefish and squids. The group is very large, containing over 60,000 living species, and, judged by its distribution, it has been highly successful, as its members have populated the sea, fresh water and the land. They manifest great diversity of habit and structure, and range in size from the giant squids of the Atlantic, which span over 50ft. in length, to snails less than a millimetre in length in the adult state.



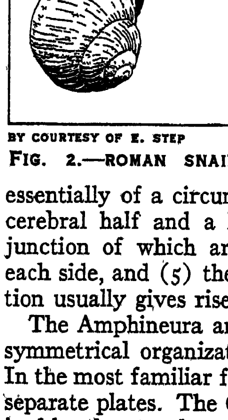
BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FIG. 1.—CHITON NOBILIS

The phylum is divisible into five classes: the Amphineura (chitons or coat of mail shells), the Gastropoda (limpets, whelks, snails and slugs), the Scaphopoda (or tusk shells), the Lamellibranchia (oysters, mussels and scallops), and the Cephalopoda (squids, cuttlefish and octopods). Certain problematical fossil forms, the Conularida, are sometimes treated as a class of the Mollusca. Their exact zoological position is, however, debatable, and they cannot be adequately discussed here (*see* GASTROPODA).

The Gastropoda are the largest class of molluscs, and easily outnumber the rest. The Scaphopoda are a small group of but two families. In the past such animals as Tunicates, Brachiopods and Cirrhipedes were included in this phylum, and a well defined concept of the latter was only formulated towards the end of last century. Thiele and Odhner at the present time hold the view that the Solenogastres or Aplacophora, a subdivision of the Amphineura, are more closely related in certain respects to certain groups of worms than to the Mollusca. This view is not accepted here and the Solenogastres are treated as molluscs (*see* AMPHINEURA).

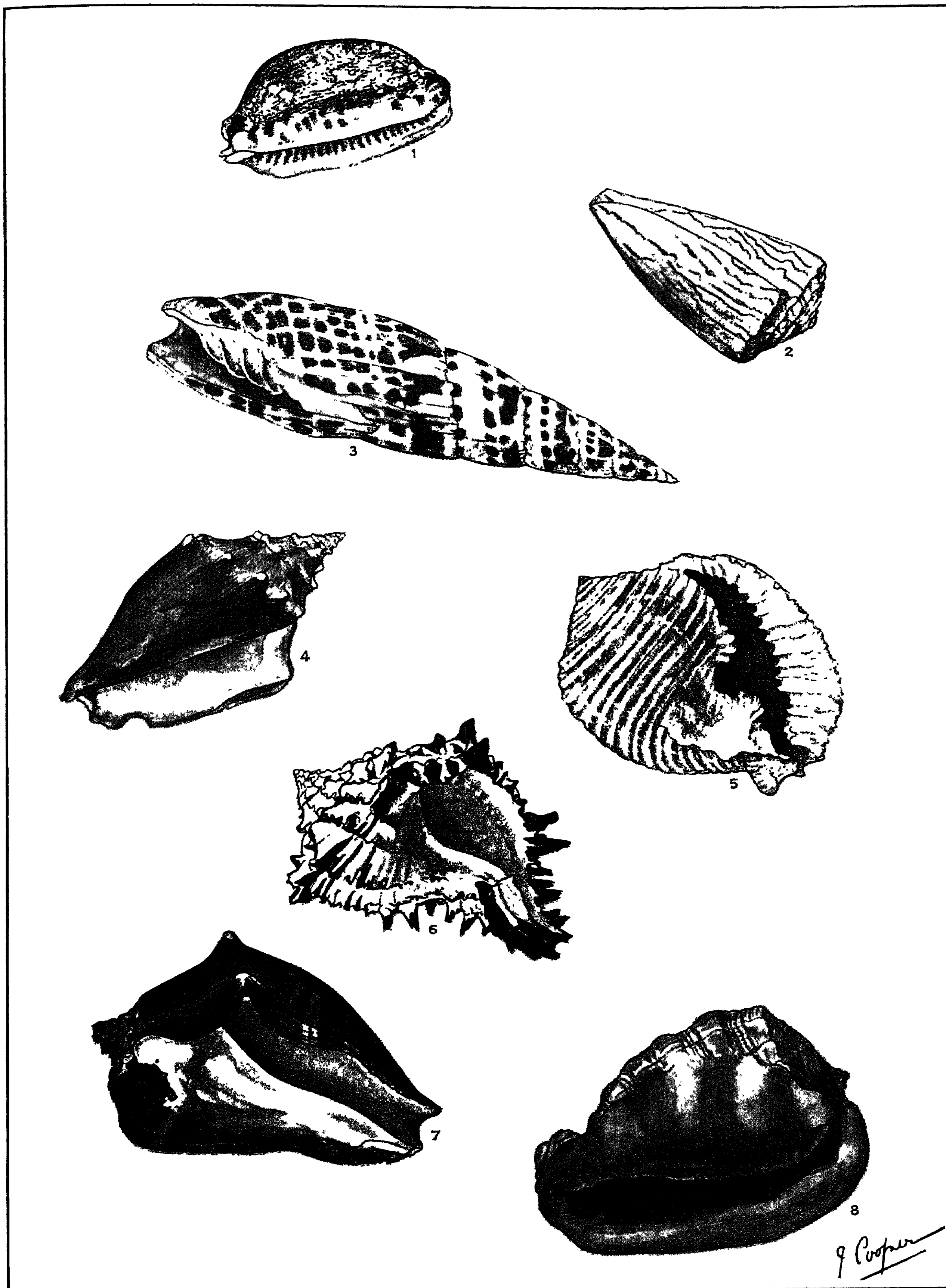
Definition and Classification.—The Mollusca are invertebrate animals, typically elongate in form and having an originally symmetrical organization. The viscera are sheathed in an outer integument, of which the lower part is modified as a muscular organ of locomotion, the foot, and the upper part (the mantle) is extended on each side and hangs down as a free fold around the body, enclosing a space, the mantle-cavity. The mantle secretes a calcareous shell and its under surface within the mantle-cavity gives rise to the organs of respiration (gills or "false" gills), or is modified in terrestrial, air-breathing molluscs to form a lung. In all Mollusca except the Lamellibranchia the anterior tegumentary region is modified as a more or less mobile head usually provided with sensory appendages and sense-organs. This threefold division of the body constitutes the essential plan of molluscan organization. In addition, it should be noted as especially characteristic of the phylum that (1) there are very scanty traces of segmentation; (2) the coelom is represented by the pericardium and gonad but is much reduced by the extensive vascular system; (3) the alimentary system (except in the Lamellibranchia) is characterized by the peculiar tongue beset with chitinous teeth (radula); (4) the nervous system consists essentially of a circumoesophageal ring composed of an upper or cerebral half and a lower or labial portion, from the point of junction of which arise longitudinal pallial and pedal cords on each side, and (5) the cleavage of the egg is spiral and segmentation usually gives rise to trochophore and veliger larval stages.



BY COURTESY OF E. STEP

FIG. 2.—ROMAN SNAIL

The Amphineura are exclusively marine, of elongate shape and symmetrical organization, having the mantle beset with spicules. In the most familiar forms (*Chiton*) the shell is divided into eight separate plates. The Gastropoda are asymmetrical and characterized by the atrophy or disappearance of the organs of the original



PAINTED FOR THE ENCYCLOPÆDIA BRITANNICA BY ISABEL COOPER AFTER SPECIMENS IN THE AMERICAN MUSEUM OF NATURAL HISTORY

SEA-SHELLS FROM TROPICAL WATERS

1. *Cypraea arabica.* Named from hieroglyphic-like markings on back. Found in Eastern seas. 2. *Conus princeps,* var. *regius;* length 1.5 to 2.25 inches. W. coast C. America. 3. The episcopal mitre (*Mitra episcopalis*). Ceylon and Philippines. 4. *Strombus gracilior;* carrion feeders. They are very active and progress by a sort of leaping movement. Their eyes are better than those of many [illegible] *ringens*); with outer edge of lip turned back, giving the effect of a grin. Peru and Panama. 6. *Phyllonatus nigritus;* length 3 inches; carnivorous. Pacific Coast. 7. *Melongena patula.* West coast of Mexico and Central America. 8. Red helmet or bull's mouth (*Cassis rufa*); length 5 to 7 inches; red, orange and chocolate markings. Found on shores of Japan

left-hand side, and by the spiral winding of the shell and visceral mass. The Scaphopoda are marine; the mantle is fused in the mid-ventral line, so as to enclose the visceral mass in a sheath which secretes a tubular shell. The Lamellibranchia are aquatic: the mantle is divided into right and left lobes which secrete a bivalve shell: the head is undeveloped and the gills become highly complex, subserving nutrition as well as respiration. The Cephalopoda are marine molluscs in which the head and foot are fused. The edges of this mass are produced into appendages; the ventral surface is much abbreviated and locomotion is mainly accomplished by the ejection of jets of water through an organ (the funnel) developed from the foot.

MORPHOLOGY

The structure and modification of the various organ systems are described in detail under each class but there are certain anatomical and physiological features which may be considered here.

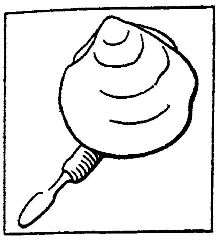


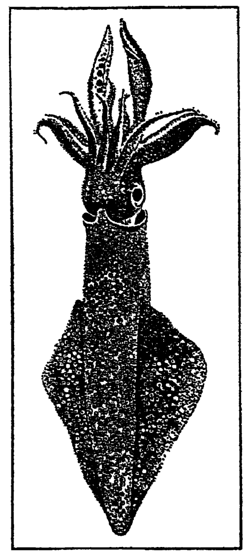
FIG. 3.—CRYPTODON

External Features.—The main divisions of the body (head, visceral mass, mantle and foot) are usually quite manifest. In the Scaphopoda and Amphineura, however, the head is moderately developed, and in the Lamellibranchia it is absent. In the Gastropoda it is usually very mobile and well-equipped with sense-organs. In the Cephalopoda it is fused with the foot; the appendages formed from the edge of the latter are arranged in a circlet round the mouth, and the transference of prey to the latter and a firm grasp on it, while it is being masticated by the jaws, are thus facilitated. The central nervous system (*see* below) tends to become concentrated in the head in Gastropoda and Cephalopoda. The occurrence in certain Gastropoda of a sheath of hard connective tissue around the ganglia and of cephalic cartilages enclosing the latter in the Cephalopoda produces an amount of "cephalization" uncommon in invertebrate animals. In the Lamellibranchia the mantle attains considerable importance. From it are developed the siphons by which the animal maintains connection with the water when burrowing in sand or mud. Its derivatives, the gills, are important not only in respiration but also in nutrition and in the incubation of the young. In the Cephalopoda it is of great functional importance in locomotion and (as a mechanical factor) in respiration and excretion.

The shell is secreted by the mantle in all molluscs. It consists in most cases of an organic matrix of conchyolin (a substance allied to chitin), impregnated with mineral salts. The latter consist mainly of calcium carbonate, but small quantities of calcium phosphate and magnesium carbonate are also found. The shell is formed in two layers—an external one of prisms of calcite and an inner of arragonite. The latter forms the nacre or mother-of-pearl seen in many shells. The shell grows in area by the addition of organic and inorganic matter secreted by the edge of the mantle and in thickness by addition of new matter to the inner layer secreted by the whole surface of the mantle. In addition to these two layers there is usually an external horny shell-epidermis or periostracum and a fourth more localized layer, the hypostracum, on the areas in which are inserted the muscles by which the shell is attached to the animal.

Internal Anatomy.—The alimentary system is divisible into three main regions—an anterior section comprising the mouth, pharyngeal mass and oesophagus, the mid-gut composed of the stomach and liver, and the intestine. In the Lamellibranchia the first of these is imperfectly developed. These animals feed on small particles and minute planktonic organisms and the mandibles, radula, pharyngeal musculature found in molluscs, which live on coarser food, are absent. In all molluscs the liver is the most important digestive organ and it may have absorptive and excretory functions. In the Gastropoda, Lamellibranchia and Scaphopoda there is an additional organ of digestion, the crystalline style. This is a rod of gelatinous substance containing digestive enzymes. It either lies free in the initial part of the intestine or is lodged in a special coecum developed therefrom. The Gastropoda and Lamellibranchia exhibit remarkable parallel modifications of this coecum. In the Cephalopoda there is a spiral coecum opening into the stomach which may be homologous with the style-sac; but, as in certain Gastropoda this and a spiral coecum coexist, the coecum of the Cephalopoda possibly represents the gastropod spiral coecum.

Circulation and Respiration.—The blood of most molluscs is colourless but haemoglobin and haemocyanin occur in certain forms. The blood is largely contained in a vascular system, but the latter rarely ends in capillaries and usually opens into capacious spaces (lacunae). These ramify among the various organs and their extensive development (*phleboedesis*) restricts the area of the primary body-cavity (coelom). The heart usually consists of a ventricle and two auricles. The blood is oxygenated in the surface-tissues of the mantle either in the respiratory organs (gills) or in the inner surface of the mantle-cavity ("lung" of air-breathing Gastropoda) or in the exposed surface of the mantle (certain Gastropoda, Scaphopoda). The gills are either true *ctenidia* (feather-like structures consisting of a hollow vascular axis supporting lateral filaments) or accessory branchial structures of various kinds. The surface of the ctenidia is covered with cilia in all molluscs but the Cephalopoda. By these cilia the water in the mantle cavity is kept in circulation. In the Lamellibranchia the food particles are sorted out by currents produced by the cilia and conveyed to the mouth. In the Cephalopoda the water in the mouth cavity is kept in circulation by the contraction and expansion of the mantle.



FROM MEYER, "TINTENFISCHE"

FIG. 4.—LOLIGO (CUTTLEFISH)

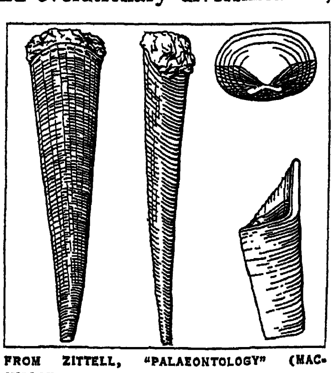
Coelom, Renal and Reproductive Organs.—The coelom is represented in most Mollusca by the pericardium and (when persistent) the cavity of the gonad. In the Cephalopoda there is a capacious gonadial portion of the coelom from the wall of which the ovary and testis are developed. In this class and certain Amphineura (the Aplacophora) the pericardium and gonadial coelom communicate with each other, but in all other molluscs the two portions of the coelom are separate. It is however to be inferred that the primitive connection between pericardium and gonad occurred in the ancestors of such molluscs, as in the more primitive members of the Gastropoda and Lamellibranchia the gonad opens into the duct connecting the kidney and the pericardium. It is not certain if the renal and generative ducts in all the groups of Mollusca are always true coelomoducts (*i.e.*, evaginations of the coelomic cavity). The kidneys open internally into the pericardium in all the classes except in *Nautilus* and the Scaphopoda. Whether this connection actually indicates that the kidneys are in all cases coelomic outgrowths is not certain. True nephridia only occur in larval Gastropoda and Lamellibranchia. In certain members of these two classes which have been carefully studied the adult kidneys are certainly mesodermal in origin and may be regarded as coelomoducts. In the Aplacophora, the archaic Gastropoda and the Scaphopoda there are no separate genital ducts, the ova and spermatozoa being discharged through the kidneys. This is likewise found in certain Lamellibranchia, but the genital conduit is gradually shifted towards the external end of the kidney and eventually acquires a separate opening. In the Neritacea among the Aspidobranchiate Gastropoda and the rest of that class in such forms as have been specially studied there is a separate genital duct formed from the originally left-hand kidney. In the Cephalopoda and Polyplacophora the gonaducts and kidneys are entirely separate.

The Nervous System.—The nervous system consists of ganglionic centres, nerve cords and sense-organs. The term "central nervous system" is not usually employed in connection with the nervous organization of the Mollusca; but there is in fact a

central group of ganglia connected by commissures and a peripheral system of nerves, localized ganglia and end-organs. The general plan of the system has been already indicated. The chief areas of the body and organs are innervated as follows. The head and its sense-organs are supplied with nerves from cerebral ganglia situated on the dorsal side of the circumoesophageal ring. The mantle and foot are innervated from pallial and pedal ganglia respectively from which the main pallial and pedal cords originate. The viscera receive their nerve supply from the labial commissure (the ventral part of the circumoesophageal ring) through a stomato-gastric system and also from a visceral commissure beset with ganglia which arises from the pallial ganglia. In primitive Mollusca the various ganglia are diffuse and the commissures joining them are long. In Gastropoda and Cephalopoda there is a marked tendency for the ganglia to be concentrated around the oesophagus and fused in a solid ring. The term "central nervous system" then becomes highly suitable. Whether this concentration has any functional significance is uncertain. It may be responsible for the highly co-ordinated movements performed by the Cephalopoda, but as far as nervous efficiency is concerned there does not seem much difference between those Gastropoda in which the ganglia are concentrated and those in which they are diffuse.

Reproduction.—The sexes are separate in most Mollusca and hermaphroditism is usually found in specialized forms. Sexual dimorphism is not marked. Copulation only occurs in the Cephalopoda and in certain Gastropoda in which a penis is found, but in some Lamellibranchia in which there is no copulatory organ fertilization is nevertheless internal. The eggs are laid separately in the Amphineura, Lamellibranchia, Scaphopoda and more archaic Gastropoda; in most aquatic Gastropoda and in the Cephalopoda they are deposited in masses which through the development of special capsules and supporting structures may become very complex. In a few Gastropoda, Lamellibranchia and Amphineura the eggs are incubated in the maternal body; but truly viviparous forms are rare. Parthenogenesis has been recorded in a single species of Gastropoda, *Paludestrina jenkinsi*. The development of the fertilized egg is described in detail under the separate classes (Gastropoda, etc., *qq.v.*).

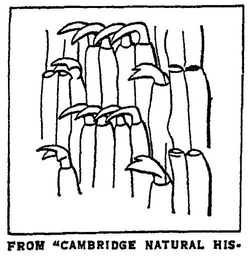
Bionomics.—The most primitive living molluscs are aquatic and the earliest fossil representatives (Lower Cambrian Gastropoda and Lamellibranchia) seem to have lived in the sea. The greater part of the modern Mollusca have retained this character. During the Devonian period they began to populate fresh water and in the Carboniferous they invaded the land. From that time onwards the population of freshwater and land has continued, that of land with increasing rapidity and evolutionary diversification, that of fresh water more slowly and with less variety of form and habit. The relative numbers of marine, fresh water and terrestrial forms may be gauged by the following list which gives the number of species in the British molluscan fauna as far as they can be thus classified. Marine 714, Fresh water 69, Land 91.



FROM ZITTELL, "PALAEONTOLOGY" (MACMILLAN)

FIG. 5.—HYLOTHES MAXIMUS

The Amphineura, Scaphopoda and Cephalopoda are exclusively marine in distribution and do not tolerate any reduction of the normal salinity of sea water. The freshwater fauna is made up principally of two groups—certain Tenioglossa (*Vivipara, Hydrobia, Melania, Ampullaria*) and Basommatophora (*Limnea* and *Planorbis*) among the Gastropoda and the Unionidae, Cyrenidae, etc., among the Lamellibranchia. The large terrestrial fauna is mainly drawn from a single suborder (the Stylommatophora) and a few families (*e.g.*, Helicinidae, Cyclophoridae, Auriculidae, etc.) of other Gastropoda. In other words, the population of fresh water is the achievement of a restricted group of Gastropoda and Lamellibranchia and the highly successful invasion of land has been carried out by the Gastropoda alone. As far as the Lamellibranchia are concerned the failure to populate land is readily explained, as their mode of nutrition has become highly specialized and entirely depends on water-borne particles and organisms. The absence of Cephalopoda from land and fresh water is not so easily explained. The Dibranchia are specialized for rapid swimming, so that the reason for their restriction to water is obvious. The littoral Octopoda, which live mainly on or just off the sea-bottom, can move over the latter with considerable agility so that locomotor specialization cannot be invoked to account for their absence from the land. In all likelihood the marked participation of the mantle in the locomotor function and its development as a muscular pumping organ in relation to respiration has deprived it of that capacity for being converted into an organ for breathing air characteristic of terrestrial Gastropoda. As for their failure to colonize fresh water there is no satisfactory explanation beyond the obvious suggestion that they may be physiologically intolerant of fresh and brackish water.

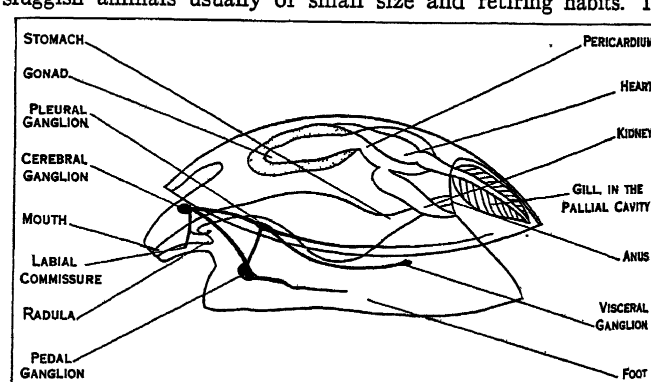


FROM "CAMBRIDGE NATURAL HISTORY" (MACMILLAN)

FIG. 6.—RADULA OF LIMPET

The marine Mollusca have a world-wide distribution as sedentary, swimming and floating animals and they are found at considerable depths in the sea, a few being found at a depth of over 2,900 fathoms. Certain groups are specialized for living permanently at great depths, *e.g.*, the Cirroteuthidae among the Dibranchiate Cephalopoda and the Septibranchia among the Lamellibranchia. The Pteropods, Heteropods and a few other Gastropoda, and the smaller branchiiform Cephalopoda are adapted in adult life as plankton organisms. By far the greater part of marine molluscs are sedentary and live on the bottom in relatively shallow water. Land and fresh water molluscs are likewise of almost universal distribution. The terrestrial forms are usually limited in their range by the requirement of a measure of humidity, shelter from excessive heat and light and of a certain amount of lime in the soil.

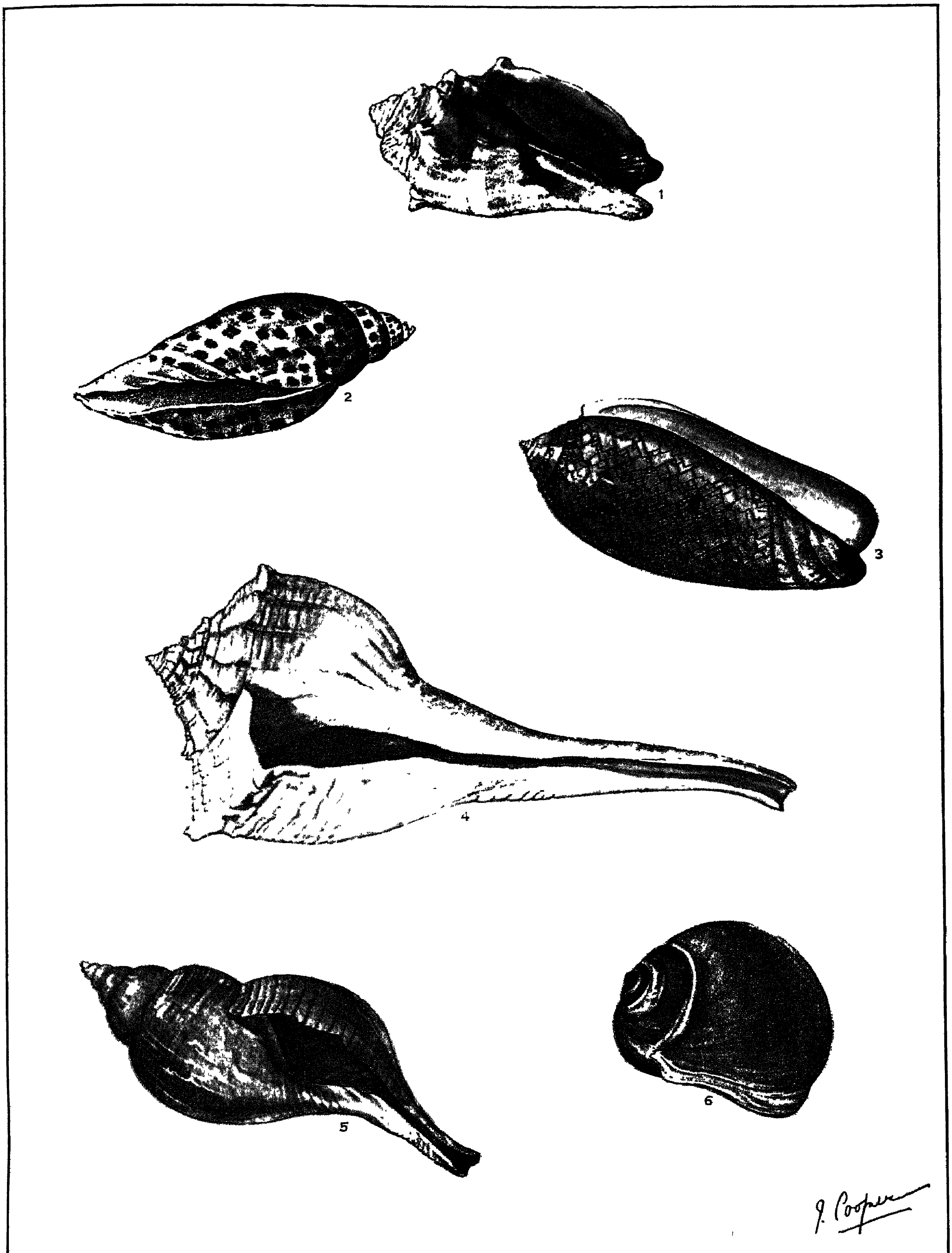
From the bionomic point of view the Cephalopoda stand apart from the rest of the Mollusca. Nearly all the living forms are highly mobile and vigorous animals, sometimes of large size and predatory habits. In these respects they are unique among invertebrate animals and afford the closest parallel to the vertebrates in organization and activity. The rest of the phylum are principally sluggish animals usually of small size and retiring habits. The greater number are vegetarian in diet. Certain Gastropoda are, however, carnivorous and, though their prey consists of either sessile animals such as Hydroids and sponges or slow-moving animals such as other molluscs, they are more vigorous and aggressive. The majority are, however, encumbered by their shell, and rely on passive defence rather than attack or flight in dealing with their enemies.



FROM LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK)

FIG. 7.—SCHEME OF A PRIMITIVE MOLLUSC

The Scaphopoda and Lamellibranchia live a specialized life buried in sand or mud. To this sort of life the lamellibranchs are particularly well adapted. They can live for a long time buried

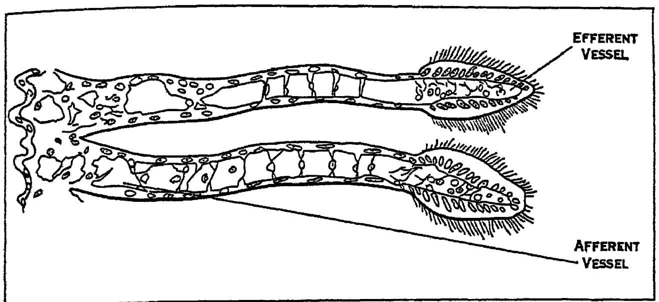


PAINTED FOR THE ENCYCLOPÆDIA BRITANNICA BY ISABEL COOPER AFTER SPECIMENS IN THE AMERICAN MUSEUM OF NATURAL HISTORY

SEA-SHELLS OF THE ATLANTIC SEABOARD

1. Fighting conch shell (*Strombus pugilis*); length 3.7 inches. About 65 species. Found from Cape Hatteras to Panama. 2. Peacock tail volute (*Voluta junonia*). Once sold for $200 each—now worth from $1 to $30 apiece. Island of Sanibel, a reef of Florida. 3. The porphyry olive (*Oliva porphyria*); length 4 inches. Markings have appearance of vast encampment of tents. Gulf of Mexico. 4. Left handed whelk (*Fulgur perversa*). Its original brown streaks fade and whiten with age. Gulf of Mexico. 5. Tulip band shell (*Fasciolaria tulipa*). Colour and design may vary greatly. Length 4 to 8 inches. South Atlantic. 6. Moon shell (*Natica duplicata*); round and smooth. Noted for the long foot it unfolds. New England to Gulf of Mexico

below the surface; but, as is pointed out in the article on this group (*q.v.*), this mode of life is not necessarily a sluggish and inactive one. Not only is a considerable amount of energy required to burrow in a semi-solid medium, but also those Lamellibranchia which live on open beaches must be always under the necessity of regulating their position during rough weather when the surface layers of sand are in continual motion. The Amphineura are



FROM ROBSON, "ANNALS AND MAGAZINE OF NATURAL HISTORY" (TAYLOR & FRANCIS)

FIG. 8.—GILL FILAMENTS OF HYPSOBIA NOSOPHORA

mostly sluggish, semi-adherent forms. The Gastropoda are more varied in their habits and include active carnivorous families, adherent and floating forms. Others are climbers, burrowers and swimmers. Both the Gastropoda and Lamellibranchia include commensal and parasitic forms as well as genera which bore into solid substances (rock, coral, etc.).

The Mollusca are on the whole short-lived. Most pulmonate Gastropoda are biannual, though some large Helicidae live as long as seven years. The marine Streptoneura live for several years but the Nudibranchs and Tectibranchs seem to be "annuals." The Cephalopoda, as far as is known at present, seem to have an average life of four to five years. Certain Lamellibranchia are known to live as long as 20 years.

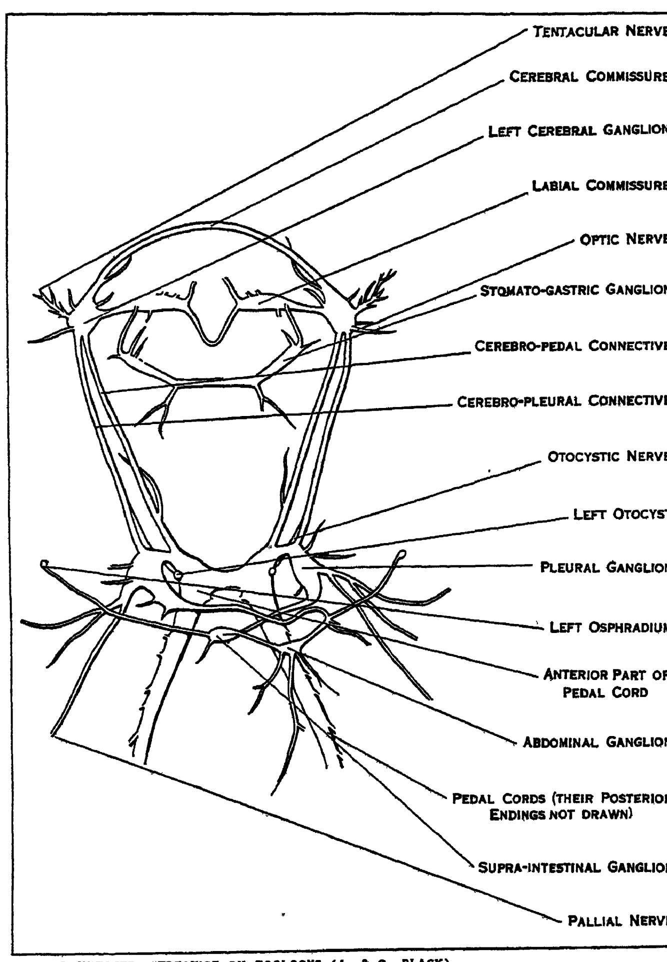
Interrelationships of the Various Classes.—Although it has been urged that the Solenogastres are not molluscs and should be placed in a different phylum and although Von Ihering has tried to prove that the Mollusca as at present constituted are not a homogeneous group, there seem to be no adequate grounds for doubting Pelseneer's dictum (1906) that the internal organization of the members of the phylum is remarkably uniform. In spite of very marked plasticity in external parts, the fundamental structural plan as sketched above remains singularly constant and unaltered. It is also significant that the larger classes all tend to show similar types of modification. To cite a single instance, the shell in all Mollusca save the Scaphopoda exhibits a constantly recurring tendency to become covered by the mantle and atrophied.

Nevertheless the relationship between the various classes is by no means clear. They each represent distinct evolutionary tendencies and it is by no means certain how far we can state that certain classes are more closely related than others. Grobben, for example, united the Gastropoda, Scaphopoda and Lamellibranchia into a grade, the Prorhipidoglossomorpha, distinct from the Amphineura and Cephalopoda. This association is up to a certain point justifiable. But it fails to express (a) the peculiar position of the Lamellibranchia which must have diverged along their distinctive evolutionary path at an early date in the history of the phylum and (b) the considerable resemblances between the Gastropoda and Cephalopoda. It is a useful working hypothesis to assume that there are three distinct elements in the phylum: (1) the Amphineura representing the most primitive age of development, (2) the Cephalopoda and (3) the Gastropoda, Lamellibranchia and Scaphopoda. It is true that the Amphineura (particularly the Chitons) have a simpler organization than the other Mollusca and may be considered to be the most primitive members of the phylum, though it is peculiar that they are not found as fossils until the Silurian (Ordovician?), whereas the other chief classes are recognizable in the Cambrian. Nevertheless it is not easy to employ the total complex of characters which each class represents, as an index of relationship or to decide with confidence which of those characters are actually primitive or how far resemblances have been brought about by convergence. For that reason it seems desirable to stress the individual and peculiar destiny of each class rather than insist on any grouping of the classes.

Relationships with Other Phyla.—A great deal of discussion has been devoted to the origin of the Mollusca. There are, however, two main and radically opposed views on this subject. The one emphasizes the resemblance between the trochophore larva of the Mollusca and the similar larva of the Annelida, and holds that the Mollusca are descended from the same ancestral form as the Annelida. The other theory (propounded by Lang and Thiele) stresses certain structural features of the adult as well as embryological data, and its authors would derive the Mollusca from the free-living Platyhelmia (Turbellaria). It is sufficient to say here that at present this question is unsettled, though the majority of zoologists would probably incline to the view that the Mollusca are more closely related to the Annelida than to any other phylum.

Historical.—The first systematic study of the Mollusca is due to Aristotle, who described various kinds of Cephalopoda, Gastropoda, etc., in his *Historia Animalium* and *de Partibus Animalium* and noted their habits with considerable accuracy. He made, however, a radical distinction between the naked forms and shelled forms which is no longer recognized.

The foundation of the modern study of the group may be attributed to Martin Lister, who in his *Historiae conchyliorum*



FROM LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK)

FIG. 9.—NERVOUS SYSTEM OF PATELLA VULGATA

(1685) gave anatomical and conchological descriptions of many Gastropoda and Lamellibranchia; but the group was for a long time imperfectly understood and the "testaceous" Mollusca were still kept separate by Linnaeus from the "naked" form and associated with different groups of invertebrates. Linnaeus's "Mollusca" (1758) were a heterogeneous assemblage and did not include the shell-bearing forms. The work of Cuvier (1799), however, who assigned to the Mollusca a position as one of the chief primary groups of the animal kingdom, did much to clarify con-

temporary knowledge of this group. Among the naturalists of that period Poli and delle Chiaje made important investigations into the anatomy of various molluscs. It should be pointed out that the study of the Mollusca has always been characterized by an inevitable duality of method. On the one hand, conchological studies upon the form and the sculpture of the shell have contributed to our knowledge of the specific and generic variety of the group as well as of the geographical distribution of its members. Of such studies may be mentioned the earlier treatises of Martini and Chemnitz, Reeve and Sowerby and the later studies of Adams, Gwynn Jeffreys, Alder and Hancock, Von Martens, E. A. Smith and H. Fischer. On the other hand, the recognition of the limits and character of the group and the elimination from it of members of other phyla are due to anatomical and embryological research of which the most distinguished exponents have been Vaughan Thompson, Kowalevski, Milne Edwards, Lacaze Duthiers, Kölliker, Spengel, Owen, Huxley, Lankester and Pelseneer. (G. C. R.)

Bibliography.—P. Pelseneer, "Mollusca" in Lankester's *Treatise on Zoology,* vol. v. (1906).
General Treatises, etc.: H. Simroth and H. Hoffmann, "Mollusca" in Bronn's *Klassen und Ordnungen des Tierreichs* (*Gastropoda*) (1908 and foll.); B. Woodward, *The Life of the Mollusca* (1913); E. Macbride, *A Textbook of Embryology* (1914); P. Pelseneer, *Les Variations and leur hérédité chez les Mollusques* (1920); J. Thiele, "Mollusca" and "Solenogastres" in Kükenthal and Krumbach's *"Handbuch der Zoologie,"* bd. v. (1925); Broili, *Zittel's Grundzüge der Paläontologie,* 7th ed., pt. 1; H. Pilsbry, *A Manual of Conchology.*
Special works: W. H. Dall, "Mollusca," etc., *Sci. Res. U.S. Fish. Comm. "Albatross," Bull. Mus. Comp. Zool.* xliii. (1908); H. Nierstrasz, "Die Amphineuren," *Ergebn.,* and *Fortschr. der Zoologie* (1908–10); A. Naef, "Studien zur generellen Morphologie der Mollusken" 1, 2 und 3, *Fortschr. Ergebn. Zool.,* 13 and 24 (1912); N. Odhner, "Norwegian Solenogastres," *Bergens Mus. Aarbok 1918–19* (1921); H. V. Ihering, "Phylogenie und System der Mollusken," *Abh. Archiv. Molluskenkunde* (1922); G. C. Robson, "On the Style Sac and Intestine of Gastropoda and Lamellibranchia," *Proc. Malac. Soc. London* (1922); A. Soderstrom, *Die Verwandtschaftsbeziehungen der Mollusken* (Uppsala, 1925); C. M. Yonge, "Feeding Mechanisms in the Invertebrates," *Biological Reviews* (1928); J. Thiele, *Zur Systematik der Mollusken;* K. Kunke, *Zur Biologie der Lungenschnecken* (Heidelberg).

MOLLUSCOIDA: *see* Brachiopoda.

MOLLWITZ. In 1741 Frederick the Great was besieging the Silesian towns of Brieg and Neisse when an Austrian army under Neipperg advanced to their relief. (*See* Austrian Succession, War of the.) In snowy weather each army was for some time in ignorance of the other's whereabouts, but Frederick eventually located the Austrians in the village of Mollwitz. He got to within 2 m. of them before they were alarmed; then solemnly formed his army in the usual two lines, with cavalry on the flanks, and advanced in parade order with bands playing. Neipperg sent his cavalry under Römer to delay the Prussians while he drew up his own army, his right on the boggy Langwitz stream, his left on Grüningen. He had 20,000 men, including 8,600 excellent cavalry, but only 18 guns. Frederick's army was similarly formed and of equal strength, but he had only 4,000 indifferent cavalry; he had, however, 60 guns. His cavalry on the right, under Schülenburg, had crowded into the infantry, which had to throw back three battalions *en potence,* a formation which later proved valuable. At 2 p.m. on April 10, 1741, the Prussian guns opened fire on the Austrian army, which was still forming up. The fire was severe and Römer decided that the best way to avoid it was to attack. He launched 30 squadrons against Schülenburg's ten and swept them headlong from the field. Frederick was involved in their rout and was persuaded by his lieutenant, Schwerin, to save himself in flight. The Austrian cavalry now turned upon the Prussian foot but found themselves faced by a very different proposition. Twenty years of drill had given Frederick's infantry a steadiness and fire control that no cavalry could shake. Five times Römer hurled his gallant squadrons against their ranks, on one occasion attacking the second line from the rear; five times they were driven off with heavy loss, Römer himself being killed. Neipperg sent forward Göldlein's infantry, but they could not face the rapid fire of the Prussians, with their new iron ramrods. Seeing his enemy waver, and knowing his own ammunition to be failing, Schwerin, now in command, ordered the advance. In perfect formation, with colours flying and bands playing, the Prussian infantry bore down upon the demoralized Austrians, and Neipperg wisely anticipated a rout by ordering a retreat. Weak in cavalry, Schwerin made no effective pursuit. The Austrians lost 4,400 men and nine guns, the Prussians 4,613 and one gun. Frederick's own share in this, his first battle, scarcely foreshadowed his future glory.

MOLLY MAGUIRES, an Irish American secret society which maintained numerous branches in the anthracite coal regions of Pennsylvania, U.S.A., from 1854 to 1877, and perhaps later. The name was imported from Ireland, where it had been used to designate one of the Ribbon societies that devoted its energies to intimidating and maltreating process servers and agents of landlords. The Irish society of Molly Maguires seems to have been organized in 1843, and its membership to have been confined to the very lowest classes. The Molly Maguires of Pennsylvania consisted of similar classes of Irishmen, but there seems to have been no connection between the two societies. Every member of the American organization was also a member of the Ancient Order of Hibernians, an association organized for benevolent purposes, and having branches in the United States and Great Britain.

In the mining districts of Pennsylvania the organization fell under the control of a lawless element, which created the inner order of "Molly Maguires," with the object, it appears, of intimidating the Welsh, English and German miners, and of ridding the region of mine superintendents, bosses and police who should make themselves in any way objectionable to members of the order. Any member having a grievance might lay a formal complaint before his "body master," who thereupon conferred with the officers of the neighbouring divisions and secured members from a distance to make away with the offending person. Under this system the crimes in a given district were always committed by strangers. The society grew in strength during the Civil War. By 1875 it completely dominated the coal miners and forced a general strike. After repeated efforts to bring the criminals to justice had failed, Franklin B. Gowen (1836–1889), president of the Philadelphia and Reading Coal and Iron Company, sent James McParlan, an Irish Catholic and a Pinkerton detective to the mining region in 1873; he joined the order, and even became secretary of one of the most notoriously criminal lodges. The evidence he secured led to the arrest, conviction and execution or imprisonment of many members during the years 1876–77, and subsequently the outrages ceased and the society was disbanded.

See F. P. Dewees, *The Molly Maguires* (Philadelphia, 1877); Allan Pinkerton, *The Molly Maguires and the Detectives* (1877); E. W. Lucy, *The Molly Maguires of Pennsylvania; The Commonwealth versus John Kehoe et al.* (Pottsville, Pa. 1878); and an article by J. F. Rhodes in *Amer. Hist. Review* April, 1910.

MOLOCH or Molech (in Hebrew, with the doubtful exception of 1 Kings xi. 7, always "*the* Molech"), the name or title of the divinity which the men of Judah in the last ages of the kingdom were wont to propitiate by the sacrifice of their own children. The Hebrew consonants might simply be read "the king" (*mélek*), an appellation for the supreme deity of a Semitic state or tribe: the traditional pronunciation (Μολόχ), which goes back as far as the Septuagint version of Kings, probably means that the old form was perverted by giving it the vowels of *bōsheth* "shame," the contemptuous name for Baal (*q.v.*).

The phrase employed in speaking of these sacrifices is that of dedication—"to make one's son or daughter pass through (or by means of) fire to (the) Molech" (2 Kings xxiii. 10; but elsewhere without the words "through fire" Lev. xviii. 21). It appears from Jer. vii. 31, xix. 5; Ezek. xvi. 20 *seq.,* that this phrase denotes a human holocaust, and not a mere consecration to Molech by passing through or between fires. We learn from 2 Kings iii. 27 that the piacular sacrifice of his son and heir was the last offering which the king of Moab made to deliver his country. Even the Hebrew historian ascribes to this act the effect of rousing divine indignation against the invading host of Israel. Ahaz's sacrifice of his son (2 Kings xvi. 3) may have been an isolated act of despair; but in the 7th century, however, when religion was transformed into servile fear (Mic. vi. 1 *sqq.*), the example of

Manasseh (2 Kings xxi. 6) did not stand alone, and Jeremiah and Ezekiel frequently refer to the "high places" for the sacrifice of children by their parents which rose beneath the very walls of the temple from the gloomy ravine of Hinnom or Tophet (Jer. xxxii. 35; Ezek. xvi. 18 *sqq.*, xxiii. 37). The children apparently were not burned alive; they were slain and burned like any other holocaust (Ezek. *loc. cit.;* Isa. lvii. 5), their blood was shed at the sanctuary (Jer. xix. 4; Ps. cvi. 38).

The horrid ritual was so closely associated with Yahweh worship (Ezek. xxiii. 39) that Jeremiah protests that it is not of Yahweh's institution (vii. 31, xix. 5). So too the idea of sacrificing the firstborn to Yahweh is rejected in Micah vi. After all, such a sacrifice could only be paid to the supreme deity; and Manasseh and his people never ceased to acknowledge Yahweh as the God of Israel. Thus the way in which Jeremiah (Jer. xix. 5), Leviticus (xviii. 21, xx. 2–5) and the author of Kings, seem to mark out the Molech or Baal as a false god, distinct from Yahweh, is precisely parallel to the way in which Hosea speaks of the golden calves or Baalim. In each case the people were worshipping Yahweh under the title of Molech or Baal; and the prophet refuses to admit that this is so, because the worship itself is an apostasy to heathenism. Note, also, the explanation attempted in Ezekiel xx. 25 *seq.*, 31. The seat of the cult appears to have been at Jerusalem, and the period during which it flourished does not favour any strong Phoenician influence. Nor does it seem to be of Babylonian origin. On the whole, the biblical tradition that the Molech-cult was Canaanite and indigenous (Deut. xii. 29 *sqq.*, xviii. 9 *seq.*) holds the ground. *See* HEBREW RELIGION. (W. R. S.; S. A. C.)

MOLSHEIM, a town of France, capital of an arrondissement in the department of Bas-Rhin, at the foot of the Vosges, on the Breusch. Pop. (1926) 3,040. It is the seat of a sub-prefect. Its industries embrace the manufacture of iron and steel goods and organ-building. There is also some trade in wine and grain. Molsheim was known in the 9th century as Molleshem, and formerly was the seat of a famous Jesuit college, later removed to Strasbourg and united with its university.

MOLTKE, ADAM GOTTLOB, COUNT (1710–1792), Danish courtier, was born on Nov. 10, 1710, at Riesenhof in Mecklenburg. Frederick V. made him hofmarskal (court marshal), and overwhelmed him with marks of favour, making him a privy councillor and a count and bestowing upon him Bregentved and other estates. As the inseparable companion of the king, Moltke's influence soon became so boundless that the foreign diplomatists declared he could make and unmake ministers at will. Moltke looked askance at liberal projects for the emancipation of the serfs, but, as one of the largest landowners of Denmark, he did much service to agriculture by lightening the burdens of the countrymen and introducing technical and scientific improvements. On the decease of Frederick V., who died in his arms (Jan. 14, 1766), Moltke's dominion was at an end. The new king, Christian VII., could not endure him, and exclaimed, with reference to his lanky figure: "He's stork below and fox above." In July 1766 he was dismissed from all his offices and retired to his estate at Bregentved. He lived in retirement till his death on Sept. 25, 1792.

His memoirs, written in German and published in 1870, have considerable historical importance. *See* H. H. Langhorn, *Historische Nachricht über die dänischen Moltkes* (Kiel, 1871).

MOLTKE, ADAM WILHELM, COUNT (1785–1864), Danish statesman, son of the minister Joachim Godske Moltke (1746–1818), and grandson of Adam Gottlob Moltke, was born at Einsiedelsborg in Funen, on Aug. 25, 1785. In 1831 he succeeded Johan Sigismund Mösting (1789–1843), as minister of finance. On the death of Christian VIII. he was one of the most prominent members of the Council of State, and when the constitutional crisis came in 1848 he seemed marked out as the man who could bridge over the gap between the old era and the new. The services which Count Moltke rendered to Denmark cannot be too highly appreciated. The mere fact that a distinguished statesman who had served the last two absolute kings of Denmark now voluntarily placed himself at the head of a ministry which included the most advanced of the popular agitators, gave the new government prestige. It was this, his first administration, which introduced the constitution of June 5, 1849, and he also presided over the third constitutional ministry which was formed in July 1851; but he resigned on Jan. 27, 1852, because he could not approve of the decree which aimed at transforming Denmark into a composite, indivisible monarchy. Moltke continued to sit in the Landsting, or Upper House, but henceforth kept in the background. He was a member of the consultative Rigsraad from 1855 to 1863. He died on Feb. 15, 1864.

See Swalin, *Det danske Staatsraad* (Stockholm, 1881); Madvig, *Livserindringer* (Copenhagen, 1887).

MOLTKE, HELMUTH CARL BERNHARD, COUNT VON (1800–1891), Prussian field marshal, for thirty years chief of the staff of the Prussian army, the greatest strategist of the latter half of the 19th century, and the creator of the modern method of directing armies in the field, was born on Oct. 26, 1800, at Parchim, Mecklenburg, of a German family of ancient nobility. His father in 1805 settled in Holstein and became a Danish subject, but about the same time was impoverished by the burning of his country house and the plunder by the French of his town house in Lübeck, where his wife and children were. Young Moltke therefore grew up in straitened circumstances. At the age of eleven he was sent to the cadet school at Copenhagen, and entered the Danish army in 1818. But at twenty-one he resolved to enter the Prussian service, in spite of the loss of seniority, and he became second lieutenant in the 8th Infantry Regiment stationed at Frankfort-on-Oder. At twenty-three he entered the war academy, doing brilliantly in the final examination in 1826. He then for a year had charge of a cadet school at Frankfort-on-Oder, after which he was for three years employed on the military survey in Silesia and Posen. In 1833 he was transferred to the general staff in Berlin. His tastes inclined him to literature, to historical study and to travel. He published a short romance, *The Two Friends* (1827); an essay, *Holland and Belgium in their Mutual Relations . . .* (1831); and *An Account of the Internal Circumstances and Social Conditions of Poland* (1832). In 1832 he contracted to translate Gibbon's *Decline and Fall* into German, for which he was to receive £75, his object being to earn the money to buy a horse. In eighteen months he had finished nine volumes out of twelve, but the publisher failed to produce the book and Moltke never received more than £25.

Turkish Experience.—He had already travelled in south Germany and northern Italy, and in 1835 on his promotion as captain he obtained six months' leave to travel in south-eastern Europe. After a short stay in Constantinople he entered the Turkish service, being duly authorized to do so from Berlin. He spent two years at Constantinople, learned Turkish, and surveyed for the sultan the city of Constantinople, the Bosporus and the Dardanelles. He travelled in the sultan's retinue through Bulgaria and Rumelia, and made many other journeys on both sides of the Strait. In 1838 he was sent as adviser to the Turkish general commanding in Armenia, who was to carry on a campaign against Mehemet Ali of Egypt. He rode several thousand miles in the course of his journeys, navigating the dangerous rapids of the Euphrates, and visiting and mapping many districts where no European traveller had been since Xenophon. In 1839 the army moved south to meet the Egyptians, but upon the approach of the enemy the general became more attentive to the prophecies of the mullahs than to the advice of the Prussian captain. Moltke resigned his post of staff officer, and took charge of the artillery, which, in the ensuing battle of Nisib, was the last portion of the Turkish army to run away.

Moltke with infinite hardship made his way back to the Black Sea, and thence to Constantinople. His patron Sultan Mahmud was dead; so he returned to Berlin where he arrived, broken in health, in December 1839. When he left Berlin in 1834 he had already "the courtier's, soldier's, scholar's eye, tongue, sword." When he returned it was with a mind expanded by a rare experience, and with a character doubly tempered and annealed. While away, he had been a constant letter-writer to his mother and sisters, and he now revised and published his letters as

Letters on Conditions and Events in Turkey in the Years 1835 to 1839. No other book gives so deep an insight into the character of the Turkish Empire, and no other book of travels better deserves to be regarded as a German classic.

One of his sisters had married an English widower named Burt, who had settled in Holstein. Her stepdaughter, Mary Burt, had read the traveller's letters, and when he came home as a wooer was quickly won. The marriage took place in 1841, though there were no children, and Moltke's love-letters and letters to his wife are among the most valuable materials for his biography. On his return in 1840 Moltke had been appointed to the staff of the 4th army corps, stationed at Berlin; he was promoted major on his wedding day. He published his maps of Constantinople, of the Bosporus and of the Dardanelles, and, jointly with other German travellers, a new map of Asia Minor and a memoir on the geography of that country, as well as a number of periodical essays on various factors in the Eastern Question. His *Russo-Turkish Campaign in Europe, 1828–29, described in 1845 by Baron von Moltke, Major in the Prussian Staff* (1845), was recognized by competent judges as a masterpiece. Moltke at this period became one of the first directors of the Hamburg-Berlin railway, and in 1843 published a review article entitled *What Considerations should determine the Choice of the Course of Railways?* which reveals a mastery of the technical questions involved in railway construction.

In 1845 Moltke was appointed personal adjutant to Prince Henry of Prussia, a Roman Catholic who lived at Rome. He spent much of his leisure there in a survey, of which the result was a splendid map of Rome (Berlin, 1852). In 1846 Prince Henry died, and Moltke was then appointed to the staff of the 8th army corps at Coblenz. In 1848, after a brief return to the great general staff at Berlin, he became chief of the staff of the 4th army corps, of which the headquarters were then at Magdeburg, where he remained seven years, during which he rose to lieutenant-colonel (1850), and colonel (1851). In 1855 he was appointed first adjutant to Prince Frederick William (afterwards crown prince and emperor), whom he accompanied to England on his betrothal and marriage, as well as to Paris and to St. Petersburg to the coronation of Alexander II. of Russia. Prince Frederick William was in command of a regiment stationed at Breslau, and there as his adjutant Moltke remained for a year, becoming major-general in 1856. On Oct. 23, 1857, owing to the serious illness of King Frederick William IV., Prince William became prince regent. Six days later he selected Moltke to be chief of the general staff of the army.

Moltke devoted himself to the adaptation of strategical and tactical methods to changes in armament and in means of communication, to the training of staff officers in accordance with the methods thus worked out, to the perfection of the arrangements for the mobilization of the army, and to the study of European politics. In 1859 came the war in Italy, which occasioned the mobilization of the Prussian army, and a consequent reorganization, by which its numerical strength was nearly doubled. The reorganization was the work not of Moltke but of the king, and of Roon, minister of war; but Moltke watched the Italian campaign closely, and wrote the history of it ascribed on the title-page (1862) to the historical division of the Prussian staff.

The Danish Campaign.—In December 1862 Moltke was asked for an opinion upon the military aspect of the quarrel with Denmark then becoming acute. He sketched a plan for turning the flank of the Danish army before the attack upon its position in front of Schleswig, and hoped that by this means its retreat to the islands might be intercepted. When the war began in February 1864, Moltke was kept at Berlin. The execution of the plan was mismanaged, and the Danish army escaped to the fortresses of Düppel and Fredericia, each of which commanded a retreat across a strait on to an island. The allies were now checked; but Düppel and Fredericia were besieged by them, Düppel taken by storm, and Fredericia abandoned by the Danes without assault; but the war showed no signs of ending, as the Danish army was safe in the islands of Alsen and Fünen. On April 30 Moltke was sent to be chief of the staff to the commander-in-chief of the allied forces, and, so soon as the armistice of May and June was over, persuaded Prince Frederick Charles to attempt to force the passage of the Sundewitt and attack the Danes in the island of Alsen. The landing was effected on June 29, and the Danes then evacuated Alsen. Moltke next proposed a landing in Fünen, but the Danes no longer felt safe in their islands, and agreed to the German terms. Moltke's appearance had quickly transformed the aspect of the war, and his influence with the king thus acquired a firm basis.

Campaign of 1866.—(*See* SEVEN WEEKS' WAR.) Accordingly, in the Austrian campaign of 1866, Moltke's plans were adopted, and he was almost invariably supported in their execution. The campaign in Denmark had revealed the amazing superiority of the breech-loader, with which only the Prussian troops were armed, over the muzzle-loader still used by all other armies. Moltke had mastered, as none of his contemporaries had done, the methods of Napoleon. In 1866 each of his decisions was Napoleonic. The first was to employ almost his whole force (280,000) against the preponderant enemy, Austria, with her Saxon satellite (270,000) and to paralyse the other German states with a mere fraction (48,000). With this small force he first captured the whole Hanoverian army (17,000) and then dispersed the south German armies (about 100,000). The second decision was to deploy 280,000 men upon the very long frontier separating Prussia from Austria and Saxony, there to form three armies, the Elbe army at Torgau, the first army (Prince Frederick Charles) in Lusatia, and the second army (the Crown Prince) at Landshut and Waldenburg in Silesia. His plan, resembling that of Napoleon in 1805, was to bring these three armies together by a concentric advance into the enemy's territory, Bohemia, where he believed the Austrian army to be assembling. The three armies had no sooner reached these positions than the king was persuaded to order the second army to march eastwards towards Neisse to meet an expected Austrian invasion from Moravia. Moltke's plan seemed to be upset, but on June 15 the political crisis came to a head and Prussia declared war. On the same day Moltke learned that the Austrian army had assembled not in Bohemia, but in Moravia. He immediately instructed the Crown Prince to turn back and march westwards to his original positions, and the Elbe army to advance through Dresden to join Prince Frederick Charles, who was to advance southwards through Löbau. The Saxon army retreated from Dresden and joined the first Austrian army corp on the Isar. On the 17th Benedek, commanding the Austrian army, gave orders for its march from Moravia to the neighbourhood of Josefstadt. Moltke had expected this and calculated that the Austrian movement could not be completed in time to enable Benedek with his whole army to attack either of the Prussian armies. On June 22 Moltke ordered both Prussian armies to advance into Bohemia and to seek to unite in the direction of Gitschin. The Austrians marched faster than Moltke expected, and might have opposed the Crown Prince with four or five corps; but Benedek's attention was centred on Prince Frederick Charles, and he interposed against the Crown Prince's advance four corps not under a common command, so that they were beaten in detail, as were also the Saxons and the Austrian corps with them, by Prince Frederick Charles. On July 1 Benedek collected his already shaken forces in a defensive position in front of Königgrätz. Moltke's two armies were now within a march of one another and of the enemy. On July 2 Frederick Charles, who had passed Gitschin, ordered his army to attack this position, whereupon Moltke, who had that day reached Gitschin from Berlin, instructed the Crown Prince, who was at Königinhof, to advance with his whole force against the Austrian right flank. Next day the Austrian army was defeated in the greatest battle of the century.

Moltke now marched with the first army on Vienna. The Austrian Emperor then sued peace.

After the peace, the Prussian Diet voted Moltke the sum of £30,000, with which he bought the estate of Creisau, near Schweidnitz, in Silesia. *The Campaign of 1866 in Germany* (1867), produced under Moltke's personal supervision, was remarkable for its accuracy and reticence. On Dec. 24, 1868, Moltke's wife died at Berlin.

Franco-German War.—In 1870 suddenly came the war with France. The probability of such a war had occupied Moltke's attention almost continuously since 1857, and a series of memoirs is preserved in which from time to time he worked out and recorded his ideas as to the transport and arrangement of the Prussian or German forces for the opening of the campaign. The great successes of 1866 had strengthened Moltke's position, so that when the mobilization order of the Prussian and south German forces was issued (July 15, 1870) his plans were adopted without dispute, and five days later he was appointed "Chief of the general staff of the army at the headquarters of H.M. the King" for the duration of the war. This gave Moltke the right to issue in the king's name, though of course not without his approval, orders which were equivalent to royal commands. Moltke's plan was to assemble the whole army to the south of Mainz. If the French should disregard the neutrality of Belgium and Luxemburg, and advance on the line from Paris to Cologne or any other point on the Lower Rhine, the German army would be able to strike at their flank, while the Rhine itself, with the fortresses of Coblenz, Cologne and Wesel, would be a serious obstacle in their front. If the French should attempt to invade south Germany, an advance of the Germans up either bank of the Rhine would threaten their communications.

Moltke expected that the French would be compelled by the direction of their railways to collect the greater part of their army near Metz, and a smaller portion near Strasbourg. The German forces were grouped into three armies: the first of 60,000 men, under Steinmetz, on the Moselle below Trèves; the second of 131,000 men, under Prince Frederick Charles, round Homburg, with a reserve of 60,000 men behind it; the third under the Crown Prince of 130,000 men, at Landau. Three army corps amounting to 100,000 men were not reckoned upon in the first instance, as it was desirable to keep a considerable force in north-eastern Germany, in case Austria should make common cause with France. If, as seemed probable, the French should take the initiative before the German armies were ready, and for that purpose should advance from Metz in the direction of Mainz, Moltke would merely put back a few miles nearer to Mainz the points of debarcation from the railway of the troops of the second army. This measure was actually adopted, though the anticipated French invasion did not take place.

Moltke's plan of operations was that the three armies while advancing should make a right wheel, so that the first army on the right would reach the bank of the Moselle opposite Metz, while the second and third armies should push forward, the third army to defeat the French force near Strasbourg, and the second to strike the Moselle near Pont-à-Mousson. If the French army should be found during this advance in front of the second army, it would be attacked in front by the second army and in flank by the first or the third or both. If it should be found on or north of the line from Sarrebourg to Lunéville, it could still be attacked from two sides by the second and third armies in co-operation. The intention of the great right wheel was to attack the principal French army in such a direction as to drive it north and cut its communications with Paris. The fortress of Metz was to be observed, and the main German forces to march upon Paris.

This plan was carried out in its broad outlines. The battle of Wörth was brought on prematurely, and therefore led, not to the capture of MacMahon's army, which was intended, but only to its total defeat and hasty retreat as far as Châlons. The battle of Spicheren was not intended by Moltke, who wished to keep Bazaine's army on the Saar till he could attack it with the second army in front and the first army on its left flank, while the third army was closing towards its rear. But these unintended or unexpected victories did not disconcert Moltke, who carried out his intended advance to Pont-à-Mousson, there crossed the Moselle with the first and second armies, which he then ordered to face north and wheel round in order to cut off Bazaine from Paris. But Frederick Charles, contrary to these instructions, directed the second army towards the Meuse and consequently found himself with only two corps facing the whole French army at Mars-la-Tour. The two corps, however, defeated Bazaine (August 16), who retreated to the position St. Privat-Gravelotte. Next day Moltke brought up the rest of the second army and on the 18th attacked Bazaine and drove him into the fortress of Metz. Moltke has been blamed for the last local attack at Gravelotte, in which there was a fruitless heavy loss, but it is now known that this attack was ordered by the king, and Moltke blamed himself for not having used his influence to prevent it.

During the night following the battle Moltke made his next decision. He left one army to invest Bazaine and Metz, and set out with the two others to march towards Paris, the more southerly one leading, so that when MacMahon's army should be found the main blow might be delivered from the south and MacMahon driven to the north. On Aug. 25 it was found that MacMahon was moving north-east for the relief of Bazaine. The moment Moltke was satisfied of the accuracy of his information, he ordered the German columns to turn their faces north instead of west. MacMahon's right wing was attacked at Beaumont while attempting to cross the Meuse, his advance necessarily abandoned, and his army with difficulty collected at Sedan. Here the two German armies were so brought up as completely to surround the French army, which on Sept. 1 was attacked and compelled to raise the white flag. After the capitulation of Sedan, Moltke resumed the advance on Paris, which was surrounded and invested. From this time his strategy is remarkable for its judicious economy of force, for he was wise enough never to attempt more than was practicable with the means at his disposal. The surrender of Metz and of Paris was a question of time. In this Moltke was completely successful. Metz surrendered on Oct. 27, and on Jan. 28, 1871, an armistice was concluded at Paris and the war ended.

On Oct. 29, 1870, Moltke was created graf (count or earl) and on June 16, 1871, field marshal. After the war he superintended the preparation of its history, which was published between 1874 and 1881 by the great general staff. In 1888 he resigned his post as chief of the staff. In 1867 Moltke was elected to the North German Diet, and in 1871 to the Reichstag. His speeches, dealing mostly with military questions, were regarded as models of conciseness and relevancy. He died suddenly on April 24, 1891, and after a magnificent funeral ceremony at Berlin his remains were laid beside those of his wife in the chapel at Creisau.

As a strategist Moltke cannot be estimated by comparison with Frederick or Napoleon, because he had not the authority either of a king or of a commander-in-chief. While it is doubtful whether he can be convicted of any strategical errors, it seems beyond doubt that he never had to face a situation which placed any strain on his powers, for in the campaigns of 1866 and 1870 his decisions seemed to be made without the slightest effort.

Authorities.—*Gesammelte Schriften und Denkwürdigkeiten des General Feldmarschalls Grafen Helmuth von Moltke* (8 vols., Berlin, 1892–93); *Moltke's militärische Werke* (Berlin, 9 vols., 1892–1900); *Feldmarschall Moltke*, by Max Jähns (3 vols., Berlin, 1894–1900); F. E. Whitton, *Moltke* (1921); Spenser Wilkinson, *The Brain of an Army*, new edition *with letters from Count Moltke and Lord Roberts* (1913); v. Schmerfeld, *Graf Moltke, Die deutschen Aufmarschpläne 1871–1890* (1929); in this volume are published for the first time Moltke's plans of campaign against France and Russia.

MOLTKE, HELMUTH JOHANNES LUDWIG VON (1848–1916), German soldier, born in Gersdorf, Mecklenburg, May 23, 1848, was nephew of the famous Count von Moltke. Becoming an officer in 1870, in 1902 he commanded the 1st Division of the Guards Corps, in 1904 became quartermaster-general, and two years later was appointed chief of the general staff of the army. At the outbreak of the World War, although already old and in failing health, he became principal director of the German operations. His strategy, based partly on the plans bequeathed to him by Gen. von Schlieffen (*q.v.*), whose pupil he had been, was devised to meet the problem of a war on two fronts. It involved a concentration of forces on the right flank, which, pivoting on Metz, and driving forward against the line Dunkirk-Verdun, was to force the French army to give battle on a reversed front. In the West, the left flank was to be held back, the troops in Alsace were to withdraw behind the Rhine, while a minimum defence was to face Russia. Bold and simple as was this plan, it neither allowed for the swift mobilization of the Russians, nor

for the problem of a shifting front. Forced by circumstances to introduce modification into the original plan, Moltke appears to have been unwise in his alterations. He withdrew six divisions from the main army to send to the Russian front, failed to concentrate on the north-east, and planned an offensive in place of a defensive in Lorraine. Thus the plans of von Schlieffen were prevented from bearing full fruit. For failing to co-ordinate the position of the German forces on the eve of battle, and for issuing confusing orders, Moltke has been charged with causing the German defeat at the battle of the Marne. He has also been blamed for placing Bülow, who was already in command of Kluck's second army, at the head of the first.

On Nov. 3, 1914, his health being seriously impaired, he was relieved of his post to make way for Falkenhayn, and was appointed chief of the home general staff in Berlin. He died on June 18, 1916. The following works by him were published after his death: *Erinnerungen, Briefe, Dokumente, 1877–1916* (1922), *Aufzeichnungen, Briefe, Schriften, Reden* (1923).

MOLUCCAS or **SPICE ISLANDS** (Dutch, *Molukken*), a name which in its wider sense includes all the islands of the Malay archipelago between Celebes on the west, New Guinea on the east, Timor on the south, and the open Pacific ocean on the north. They are thus distributed over an area between 2° 43′ N. and 8° 23′ S. and 124° 22′ and 135° E., and include: (1) the Moluccas proper or Ternate group, of which Halmahera is the largest and Ternate the capital; (2) the Bachian and Obi groups; (3) the Amboyna group, of which Ceram (Serang) and Buru are the largest; (4) the Banda islands (the spice or nutmeg islands *par excellence*); (5) the south-eastern islands, comprising Larat, Babar, etc.; and (6) the Kei islands and the Aru islands, of which the former are sometimes attached to the south-eastern group. The whole of Dutch New Guinea is included administratively with the Moluccas. Formerly the Moluccas were divided into two residencies, Ternate and Amboyna. In 1923 these residencies were united under one Government, *i.e.*, that of the Moluccas.

Most of the islands are mountainous, with still active volcanoes. As they lie near or under the Equator, the monsoons blowing over them are less regular, and the rainfall, of large volume throughout the year, is dependent on the height and direction of the chains. The vegetation of the small and narrow islands, all encompassed by the sea, is very luxuriant, and the products, principally nutmegs, mace, and other spices, include also copra, rice, sago, cajeput oil, damar, timber, trepang, pearls, pearl-shell, shells, tortoiseshell and bird-of-paradise plumes. In the main the flora of the Moluccas is of extreme fertility, and many Australian forms are intermingled with the predominating Asiatic. The flora of New Guinea is distinctly individual to the island. The fauna of the Moluccas is peculiar in its distribution. Land mammals are very few; *Viverra tangalunga* is the only carnivorous representative, the only ruminant a deer, and the only quadrumanous animal the baboon, *Cynopithecus nigrescens*. The strangely-formed babirusa of Celebes is found in the Sula isles and Buru. The little shrew, the wild pig, flying opossum and cuscus are common. Bird-life is profuse, parrots, king-fishers and doves predominating; most curious are the mound-builders, *Megapodidae*, and the large cassowary of Ceram; most beautiful the bird-of-paradise. New Guinea and the Aru isles are Australian in fauna. Insect life is even richer. In the gorgeous *Ornithoptera* butterflies have reached probably their highest state of development; the insects are remarkably beautiful even when compared with those of other parts of the archipelago. Fish and shell-fish abound in extraordinary variety. Poisonous snakes and man-eating crocodiles are found in New Guinea. The inhabitants are of mixed descent.

The geology of the Moluccas is imperfectly known. The great chain of volcanoes which runs through Sumatra and Java is continued eastwards into the Moluccas, and terminates in a hook-like curve which passes through the Damar islands to the Banda group. Outside this hook lies a concentric arc of non-volcanic islands, including Tenimber, the Lesser Kei islands, Ceram and Buru; and beyond is still a third concentric arc extending from Talaibu to the Greater Kei islands. The islands of these outer arcs consist chiefly of crystalline schists and limestones, overlaid by Jurassic, Cretaceous and Tertiary deposits.

The name Moluccas is said to be derived from the Arabic for "king." Argensola (1609) uses the forms *islas Malucas, Maluco*, and *el Maluco;* Coronel (1623), *islas del Moluco;* and Camoens, *Maluco*. After Magellan's passage round Cape Horn to the Far East, the Spanish had laid claim to the Moluccas under the Treaty of Tordesilas (1494), but in 1528 they were bought out by the Portuguese, whose influence in the Moluccas was predominant until the arrival of the Dutch early in the 17th century. Finding the power of the sultan of Ternate too strong in the north Moluccas, the Dutch concentrated on the southern islands, particularly Amboyna and Banda. The Bourgay Contract (1667), gave them an opening in the north, the friendship of the sultan of Ternate aided them immensely, and when in 1685 the Dutch declared all contracts with the sultan of Ternate void, they took the northern Moluccas under their rule, and with them went New Guinea, which, with the northern and southern isles, was gradually consolidated into the Moluccas of to-day. (*See* further MALAY ARCHIPELAGO, and separate articles on the principal islands and groups.)

MOLY, a mysterious plant with magical powers described in Homer, *Odyssey*, x. 302–306 (Gr. μωλυ). Hermes pulls it up and gives it to Odysseus as a protection against the arts of Circe. It is further described as "having a black root and a flower like milk, and hard for mortals to pull up." R. M. Henry in *Class. Rev.* (Dec. 1906), p. 434, who illustrates the Homeric account by passages in the Paris and Leyden magical papyri, argues that *moly* is probably a magical name, derived perhaps from Phoenician or Egyptian sources, for a plant which cannot be certainly identified. He shows that the "difficulty of pulling up" the plant is not a merely physical one, but rather connected with the peculiar powers claimed by magicians.

In modern times the name has been applied to a species of onion (*Allium Moly*), a native of southern Europe, grown in borders and rock gardens for its ornamental bright yellow flowers.

MOLYBDENITE, a mineral consisting of molybdenum disulphide, MoS_2. It closely resembles graphite in appearance, but may readily be distinguished from this by its greater density (4·7) and by its behaviour before the blowpipe. Crystals have the form of six-sided plates or scales, but they are never sharply defined, and their reference to the hexagonal system is doubtful. They have a perfect cleavage parallel to the large surface of the plates, and the flakes are readily bent, but are not elastic. The mineral is very soft (H=1 to 1·5) and unctuous, and makes a bluish-grey mark on paper; it is opaque and has a bright metallic lustre. The colour is lead-grey, differing slightly from that of graphite in having a bluish tinge. The name is from Gr. ὀλυβδος, lead or lead ore, with which graphite (black-lead) and molybdenite were confused; the latter was distinguished by P. J. Hjelm, who in 1782 discovered the element molybdenum in this mineral.

Molybdenite occurs as disseminated scales in crystalline rocks —such as granite, gneiss, schist and marble—and also in quartz-veins. It is fairly common in small quantities as one of the first minerals formed in high-temperature veins, along with tinstone, wolframite and bismuth compounds. The commercially workable deposits, however, belong to several different types, as follows: In pegmatites and quartz-veins associated with granite, *e.g.*, Canada, Saxony and Telemarken, Norway; as segregations in granite, *e.g.*, Moss mine, Quyon, Quebec; in metamorphic zones at the contact of granite and limestone (contact pyroxenite), Pontiac county, Quebec; in pipes of granite, with wolfram and bismuth, Queensland and the New England area of New South Wales.

Molybdenite has been used mainly for the preparation of molybdates for use as chemical reagents, and also in the manufacture of molybdenum steel (ferro-molybdenum), which by reason of its hardness and toughness is specially suitable for tools.

MOLYBDENUM (symbol Mo, atomic number 42, atomic weight 96). Pure compact molybdenum is a silvery white metal, softer than steel and quite malleable. Its melting point is very high, probably 2,500°C., whilst its tensile strength when drawn into wire, is about half that of tungsten or steel wire of the same diameter. Crude grey molybdenum, an electric-furnace product made direct from molybdenite, is impure owing to ab-

sorption of carbon. It is very brittle, with a hardness greater than that of quartz. Varying figures, *e.g.*, 9·01, 8·95, 10·28, are given for the density of the pure metal. The electrical resistance of ductile molybdenum is 5·6 microhms per c.c. for hard-drawn wire and 4·8 for annealed wire. Molybdenum is not appreciably affected by air at ordinary temperatures but at a dull-red heat the oxide is slowly formed. It is somewhat resistant to the action of acids but less so than tungsten. Concentrated hydrochloric and sulphuric acids attack it only very slowly, whilst moderately dilute nitric acid, like *aqua regia,* rapidly reacts with the metal. Concentrated nitric acid induces passivity. Molybdenum is attacked by fused but not by aqueous caustic alkalis. The most important alloy of molybdenum is ferro-molybdenum which is made in the electric furnace by fusing molybdenite concentrates with varying proportions of coke, lime, scrap iron, pyrites, etc. This is the usual form in which molybdenum is added to steels. There are also many types of non-ferrous molybdenum alloys. The non-ferrous stellite alloys, which are silver-white, insoluble in nitric acid and only slowly attacked by hydrochloric acid, are said to possess exceptional qualities when used for high-speed cutting tools. A typical molybdenum stellite gave the following analysis: Mo, 22·50; Co, 59·50; Cr, 10·71; Fe, 3·11; Mn, 2·04; C, 0·87; Si, S, and P, balance. Other alloys are chrome-molybdenum, nickel-molybdenum, ferro-molybdenum-tungsten and copper-nickel-molybdenum. Metallic molybdenum has come into use for a variety of electrical purposes, such as a support for lamp filaments, winding for electrical resistance furnaces, X-ray apparatus, plates used in wireless telegraphy, etc. High molybdenum steels, containing over 1% of the metal, are used for permanent magnets, rustless steels, and high-speed tools; whilst low molybdenum steels, containing less than 1% of the metal, find use for automobile parts, agricultural implements, railway forgings and track bolts.

The name molybdena which occurs in the writings of Pliny was employed by him to denote various substances containing lead. Later, this name was used to designate galena—the naturally occurring compound of lead and sulphur—or substances of similar appearance, whilst by the middle of the 18th century it was applied solely to graphite and the mineral sulphide of molybdenum which now bears the name of molybdenite. In view of their similar appearances it is not surprising that these two substances were classified together at this period. K. W. Scheele first pointed out, in his "Treatise on Molybdena" (1778), the essential difference between them. He showed, that unlike graphite, this other mineral, on treatment with nitric acid produced a "peculiar white earth" with acidic properties to which he assigned the name, molybdic acid. Further, since this same mineral, on heating gave rise to sulphurous fumes, he concluded correctly that molybdenite was a sulphide of molybdenum. Finally, in 1790, appeared an account, by P. J. Hjelm of the isolation of the new element molybdenum, as a metallic powder, by heating the oxide with carbon. Molybdenum is never found free in nature but always chemically combined with other elements. Although a large number of minerals containing molybdenum have been described, only two of them are so far of any practical importance, namely, molybdenite and wulfenite (*q.v.*).

Concentration of Molybdenum Ores.—As the percentage of pure molybdenite (MoS_2) present in the molybdenum ore is generally only ½%, the importance of a successful method for separating and concentrating the molybdenite can be readily appreciated and at one time represented a real difficulty to the industry. The application of oil flotation, however, has gone far to solve this difficulty, and molybdenite, when fairly clean, is now one of the easiest minerals to concentrate. The concentration of wulfenite ores is simplified by the fact that the mineral is heavy and easily wetted, so that any of the gravity methods may be applied. The presence of heavy minerals such as lead ores, including vanadinite, however, complicates the separation.

Preparation of the Metal.—There are several methods by which molybdenum may be obtained from its ores. Using the molybdenite concentrates, two methods are generally employed. In the alumino-thermic process—the one mainly in use—the metal is obtained by igniting a mixture of finely divided aluminium and the concentrate. The metal may contain as much as 2% of iron and small quantities of silicon. In the electric fusion process, the molybdenite concentrates are heated in a carbon tube by a current of 350 ampères at 60 volts. Sulphur dioxide is expelled, but to expel completely the sulphur the current is afterwards increased to 900 ampères at 50 volts. The metal so produced may contain considerable carbon but this can be removed by heating with molybdic oxide. The special treatment of wulfenite, from which about 10% of the world's supply of molybdenum is derived, has been studied by J. P. Bonardi, who has made a detailed report on this subject in *Chem. and Met. Eng.*, p. 364, 1919.

Chemical Properties.—Molybdenum compounds exhibit valencies of 6, 5, 4 and 3 while halogen derivatives exist corresponding with the empirical formula $MoCl_2$, but having the molecular formula Mo_3Cl_6. The most important and most stable compounds of molybdenum are those in which the metal is hexavalent. The trioxide, MoO_3, which may be made by roasting molybdenite in a current of air, is a white powder which can be completely volatilized at approximately 700°C., although appreciable volatilization occurs at 450–500°C. Heated to 150–200°C. in a current of hydrogen chloride the trioxide sublimes as $MoO_3 2HCl$. The oxide has both acidic and basic properties, for it dissolves in hot concentrated sulphuric or hydrochloric acid while with bases it forms molybdates containing varying ratios of MoO_3, to metallic oxide. Molybdenum forms many complex salts. In $Ag_2[MoO_4]$, the molybdenum has a co-ordination number of four, and X-ray analysis shows that the oxygen atoms are tetrahedrally distributed round the central molybdenum atom. The complex salts

$$K_3[MoCl_6],\ K_2[MoOCl_5]$$

and

$$MoO_2\bar{A}c_2\ (\bar{A}c = \text{an acetyl-acetone radical, } C_5H_7O_2)$$

exhibit molybdenum with a co-ordination number of six, and there is evidence that in such substances the associating units are arranged octahedrally round the molybdenum. In other derivatives, such as $K_4[Mo(CN)_8]$, a co-ordination number of eight is indicated.

Field tests for molybdenite: (*a*) Rubbed on porcelain or a white enamelled cup, molybdenite leaves a grey-green streak. (*b*) Heated on charcoal in the oxidizing flame, the powdered mineral emits a strong, sulphurous odour and deposits molybdic oxide, which is yellow when hot and white when cold. Nearer to the heated mineral, the coating is copper red. If the white coating is touched intermittently with the reducing flame, it becomes deep blue.

REFERENCE. *Molybdenum,* Publication No. 592, 1925, Department of Mines, Canada. (W. WA.)

Molybdenum Steels.—On account of its chemical similarity with tungsten, molybdenum was early substituted for the latter in Mushet's (*q.v.*) air-hardening steel, in modern high speed steels (*q.v.*) and various magnet steels. Research and experience since 1917 has shown that a fractional per cent of molybdenum (0·40% maximum) in heat-treated alloy steel is very useful to intensify the characteristic action of the other elements present, to induce air-hardening and to increase toughness. Such materials may be characterized as "molybdenized" alloy steels, rather than molybdenum steels. About 250,000 tons were made in 1928.

Most molybdenum-bearing steel used in 1929 was a medium carbon, low chromium analysis, ranging between the following limits: carbon 0·25 to 0·40%; manganese 0·40 to 0·70%; chromium 0·50 to 1·10%; molybdenum 0·15 to 0·30%. It is made into axles and other highly stressed parts. The lower alloys are water-hardened, the higher ranges hardened in oil. The steel is readily machineable even when heat-treated to a yield point of 150,000 lb. per square inch. Molybdenized 1% chromium steel (low in carbon) is the U.S. army standard material for aeroplane fuselage construction. It draws readily into thin-walled seamless tubing of great strength; it welds readily, and on account of its air-hardening propensities, the welded joints in the skeleton structure develop 90% efficiency. Molybdenized chromium-nickel steels (0·75 Cr, 1·5 Ni, 0·60 C) are used for large die blocks and such parts which must be uniformly hard to the very centre. A 6 in. piece can be air-hardened and tempered to Brinell hardness of 430

at corners, 418 at face and 402 at centre. The only molybdenized nickel steel in 1929 finding important use had 1½% nickel and 0·15% carbon. It is made into case-hardened parts like ball-bearing races. (E. E. T.)

MOLYNEUX. This historic English name came into the country from France at the time of the Norman Conquest through William de Molines (Moleyns, Molyneux), who obtained a grant of Sefton, in Lancashire, whence come the present earls of Sefton. His descendant Adam de Molyneux (Moleyns or Molins), who died in 1450, was bishop of Chichester and keeper of the privy seal; he was a son of Sir Richard Molyneux of Sefton, and uncle of the Sir Richard Molyneux (d. 1459), the Lancastrian favourite of Henry VI., whose descendant Richard Molyneux (1593–1636) was created in 1628 1st Viscount Molyneux of Maryborough, a title now merged in that of Sefton (created 1771). Another Molyneux family of some importance is the Irish one, descended from Sir Thomas Molyneux (1531–97), Irish chancellor of the exchequer, who, born at Calais, settled in Ireland in 1576. He was the great-grandfather of Sir Thomas Molyneux, Bart. (1661–1733), a well-known physician and zoologist, and of William Molyneux (1656–98), the philosopher, astronomer and politician, the friend of Locke, and author of *Dioptrica nova* (1692), whose famous work on the legislative independence of Ireland (*The Case of Ireland*, etc., 1698) created much stir at the time. The latter's son Samuel (1689–1728) was also a well-known astronomer.

MOM. A system of signs invented by Njoya about 1900, and written by a small group in the Cameroons. Over 300 separate signs were first used; the progress from purely pictographic representation to syllabaries and alphabetic forms is notable.

See Göhring, *Der Evangelische Heidenbote*, vol. lxxx. (1907) no. 6 and no. 11; also Van Gennep. *Religions, Moeurs et Légendes* (2nd series, p. 259 *sq.*).

MOMBASA, the chief port of Kenya Colony, East Africa, in 4° 4′ S.; 39° 43′ E. and 150 m. north of Zanzibar. It is built on a coralline island situated at the mouth of a deep arm of the sea. It had a population (1921) of 36,846, of whom 656 were Europeans and 7,574 British Indians. In 1924 the population had increased to 42,000 (821 Europeans). Mombasa harbour takes vessels up to 30 ft. draft, but is now used mainly by dhows; the principal harbour is Kilindini, at the southwest end of Mombasa island.

Spacious and land-locked Kilindini accommodates vessels of any size and takes all the traffic of the Kenya and Uganda railway which, starting from Mombasa, is carried to the mainland on a bridge half a mile long. A causeway is built by the side of the bridge, a navigable channel of 180 ft. being left. A deep-water wharf with two berths provided with all facilities for loading and unloading, built by the Government at a cost of over £1,000,000, was completed in 1926. A third berth was added in 1928. Much of the cargo had still, however, to be handled by lighters and the administration acquired large areas for development purposes. In 1898 the value of imports and exports combined was £370,000; in 1928 about £20,000,000. The increase indicates the growing trade of Kenya and Uganda.

Viewed from the sea Mombasa has a picturesque apearance, the most conspicuous object being the fort, built on a coral hill 40 ft. high. Except for the main street and Government Square, Mombasa is like any Oriental city—a maze of narrow, irregular streets and lanes. Some of the houses have finely carved doorways. To the south, overlooking the sea, is the European suburb. The public buildings include an Anglican cathedral, a Roman Catholic church, Hindu, Parsee, and Mohammedan temples, and schools, hospitals and law courts, the last named completed in 1902. Built into the façade of the law courts is a stone with an inscription recording the building of a fort, dedicated to St. Joseph, by the Portuguese at Kilindini in 1666. This stone was found in the ruins of Fort St. Joseph. Mombasa Fort, or citadel, quadrangular in form, reddish in colour, was built by the Portuguese in 1593–1595 and known as the Jesus Fort. It bears the symbol I.H.S. The fort was repaired by Seixas de Cabreira in 1635. The population of the town is cosmopolitan, with three well-marked racial distinctions: the Arab (Swahili), the Indian and the European. The climate is fairly healthy, and Europeans live there in tolerable comfort. The average annual rainfall is 47 inches.

Mombasa island (named after the town) is 3 m. long by 2½ m. broad, with an area of 9 sq.m. Except at the western end, the coast consists of cliffs from 40 ft. to 60 ft. high. The island contains many plantations, chiefly of coco-nut palms. Ruins of Arab, Portuguese and Turkish buildings are found in various parts of the island. At Ras Serani are the ruins of a chapel "Nossa Senhora das Merces," built by the Portuguese in the 17th century on the site of a Turkish fort, and turned into a fort again by the Arabs.

Mombasa takes its name from the Mombasa in Oman. A Perso-Arabic settlement was made here about the 11th century. It is mentioned by Ibn Batuta in 1331 as a large place, and at the time of Vasco da Gama's visit (1498) it was the seat of considerable commerce, its inhabitants including a number of Calicut Banyans and Oriental Christians. The ruler of the city tried to entrap da Gama (or so the Portuguese navigator imagined), and with this began a series of campaigns which gave full force to its Swahili name *Mvita* (war). The principal incidents are the capture and burning of the place by Almeida (1505), Nuno da Cunha (1529), and Duarte de Menezes (1587)—this last as a revenge for its submission to the sultan of Constantinople—the revolt and flight (1631) of Yusuf ibn Ahmed (who murdered all the Portuguese in the town—over 100), and the three-years' siege by the imam of Oman 1696–98 (the garrison being reduced to eleven men and two women), ending in the expulsion of the Portuguese. From March 12, 1728 to Nov. 29, 1729 a Portuguese force from Goa again held Mombasa, when they were finally driven out by the Muscat Arabs. In Dec. 1823 the Mazrui family, who had ruled in Mombasa from the early part of the 18th century, first as representatives of Oman, afterwards as practically independent princes, placed the city under British protection; and in Feb. 1824 Lieut. J. J. Reitz was appointed commandant or resident at the city by Captain (afterwards Vice-Admiral) W. F. W. Owen. Reitz, after whom Port Reitz (a deep ramification of the sea opposite Kilindini) is named, died at Mombasa either in 1824 or 1825. The protectorate was repudiated by the British government, which left the place to be bombarded and captured by Seyyid Said of Oman, who made repeated attacks between 1829 and 1833, and only got possession in 1837 by treachery. Said thereafter made Zanzibar his capital, Mombasa becoming of secondary importance. A revolt against Zanzibar in 1875 was put down with British assistance. The British government in the following year vetoed a proposal by the khedive Ismail to annex Mombasa and its hinterland up to the equatorial lakes to Egypt—a project which originated with General C. G. Gordon, when that officer administered the Upper Nile provinces. In 1887 the city was handed over by the sultan of Zanzibar to the British for administration. It became the capital of the East Africa protectorate (Kenya Colony). In 1907, however, the seat of the central government was removed to Nairobi. From 1921 till his death in 1927 Mombasa was the residence of Seyyid Khalid the two-days' sultan of Zanzibar. Mombasa still forms part of the sultanate of Zanzibar and is included in Kenya protectorate as distinct from Kenya colony. *See* ZANZIBAR and KENYA COLONY.

MOMEIN: *see* TENGYUEH.

MOMMSEN, THEODOR (1817–1903), German historian and archaeologist, was born on Nov. 30, 1817 at Garding, in Schleswig. After being educated at Kiel he devoted himself to the study of Roman law and antiquities. In 1843 a grant from the Danish government enabled him to go to Italy, where he began his important investigation of Roman inscriptions. He collected the inscriptions of Samnium, and in 1852 published those of the kingdom of Naples. He was appointed in 1848 professor of civil law at Leipzig. His work there was interrupted by his political opinions. During 1848, when the extreme party was in the ascendant, Mommsen supported the monarchy. When the Revolution had spent its force and Beust executed his *coup d'état,* he protested, with many of his colleagues, against this act. In consequence he was dismissed from his professorship.

Becoming professor at Zürich, Mommsen wrote exhaustive monographs on Roman Switzerland, and began to work on his *Roman*

History, the three volumes of which appeared between 1854 and 1856 (8th Germ. ed. 1888–94, Eng. trans. in Everyman series, 4 vols. 1911). In this he painted with astonishing vigour the great political struggle that accompanied the fall of the republic, but it was, above all, his new reading of old characters which demanded attention. Cicero, the favourite of men of letters, was for him "a journalist in the worst sense of the word"; Pompey, the hero of Plutarch and the Moralists, was brushed aside as a mere drill-sergeant; and the book culminated in the picture of Caesar, who established absolute rule in the name of democracy, "the complete and perfect man."

In 1854 the Berlin Academy made him chief editor of a *Corpus* of all extant Roman inscriptions and in order that he might carry on the work he was appointed in 1858 to a professorship at Berlin. The first volume appeared in 1861; five of the succeeding volumes he edited himself, and the whole was executed under his supervision and with the co-operation of scholars whom he had trained. Mommsen also found time to write two larger works, the *History of the Roman Coinage* and the *Römisches Staatsrecht,* a profound analysis of Roman constitutional law, and *Römisches Strafrecht,* on Roman criminal jurisdiction. His *Roman Provinces* previously published in 1884 (Eng. trs. 2 vols. 1909) gives an interesting picture of social life under the empire. He was one of the founders of the *Preussische Jahrbücher,* and for many years a member of the Prussian Parliament.

Equally great as antiquary, jurist, political and social historian, Mommsen lived to see the time when among students of Roman history he had pupils, followers, critics, but no rivals. He combined the power of minute investigation with a singular faculty for bold generalization and the capacity for tracing out the effect of thought on political and social life. Mommsen died at Charlottenburg on Nov. 1, 1903.

In addition to the above, Mommsen's chief publications are: the *Roman Chronology to the Time of Caesar* (1858); his editions of the *Monumentum Ancyranum* and of the *Digest* in the *Corpus juris civilis,* and of the *Chronica* of Cassiodorus in *Monumenta Germaniae historica,* the *Auctores antiquissimi* section of which was under his supervision. Many of his pamphlets and articles have been collected under the title *Römische Forschungen.* His *Reden und Aufsätze* appeared in 1905 and his *Schriften* in 1905 foll. A full list of his works is given by C. Zangemeister, *Mommsen als Schrifsteller* (1887; continued by Jacobs, 1905). *See* also monographs by C. Bardt (1903) and Gradenwitz (1904, in the *Zeitschrift der Savigny-Stiftung für Rechtsgeschichte*); O. Hirschfeld, *Gedächtnisrede auf Mommsen* (1904); L. M. Hartmann, *T. Mommsen* (1908) and M. Wilamowitz-Moellendorf, *T. Mommsen* (1918).

MOMORDICA, in botany, a genus of annual or perennial climbing herbs belonging to the family Cucurbitaceae, natives of the tropics, especially Africa, and known in cultivation chiefly as hothouse plants. They are grown for their ornamental fleshy fruits, which are oblong to cylindrical in shape, orange to red in colour, prickly or warted externally, and burst when ripe, generally with elastic force, into irregular valves. *M. Balsamina,* known as balsam apple, is a very pretty annual, well adapted for trellises, etc., in warm outside situations, as is also *M. Charantia,* the balsam pear, a somewhat larger species.

MOMOTIDAE: *see* Motmot.

MOMUS, in Greek mythology, the son of Night (Νύξ), the personification of censoriousness. He is frequently mentioned as a sort of licensed grumbler, finding fault with all that the gods do: hence the proverb "even Momus could not find fault" (Plat. *Rep.* 487A) to denote perfection. He appears very seldom in serious works (*Cypria,* frag. 1): a lost satyr-play of Sophocles bore his name. Lucian often introduces him, and he appears in a well known Aesopic fable.

See Hesiod, *Theog.* 214; Lucian, *Hermotimus,* 20, and especially *Deorum Concilium;* Philostratus, *Epistolae,* 37.

MONA, the name used by classical writers, and in particular by Tacitus, to denote Anglesey (*q.v.*). This island was raided by the Roman general Suetonius about A.D. 60 and conquered by Agricola about A.D. 79. The Romans probably mined copper there, but no trace has yet been found of any Roman military post, and the villages of the inhabitants which have been recently excavated show only mediocre traces of Roman civilization. The name Mona seems also to have been occasionally used, perhaps from ignorance, for the other large island lying between England and Ireland, Man. The ancient name of this latter was probably not unlike that of Mona, but is not accurately known to us (? Monapia, Manavia).

MONACO, a sovereign principality on the Mediterranean coast, 9 m. E. of Nice, bounded on all sides by the French department of Alpes-Maritimes. Pop. (1923) 22,153; area 6 sq. miles.

The Phoenicians, and after them the Greeks, had a temple on the Monaco headland, to Heracles, surnamed by the Greeks Μονοικος, whence the name Monaco. Monoeci Portus, or Portus Herculis, is often mentioned by later Latin writers. In 968 the Genoese Grimaldi family entered into possession and for the most part allied themselves with France until 1524, when Augustin Grimaldi sided with the emperor Charles V. Honoré I., Augustin's successor, was made marquis of Campagna and count of Canosa, and special privileges were granted, including the right to toll from vessels passing the port. Honoré II. (1641) re-allied his house with France, losing Canosa, etc., but becoming duke of the Valentinois. In 1731 Antoine, his great grandson, was succeeded by his daughter, Hippolyte, wife of Jacques Goyon, count of Matignon and Thorigny, who succeeded his wife and took the name of Grimaldi. In 1793 the National Convention dispossessed the reigning family and annexed Monaco to France; the Treaty of Paris (1814) restored the family; that of Vienna (1815) put Monaco under the protection of Sardinia. Mentone and Roccabruna revolted in 1848 and were annexed and occupied by Sardinia till 1859. In 1860 Nice was transferred to France, and in 1861 Monaco passed under French protection, Mentone and Roccabruna being sold to France separately.

In 1911 Prince Albert of Monaco granted the principality a constitution, providing for a national council of 21 members, elected for four years by universal suffrage and *scrutin de liste.* Government is in the hands of a Ministry assisted by a council of State, acting under the authority of the prince; and legislative power rests with the prince and the national council. On June 26, 1922, Prince Louis II. (b. 1870) succeeded his father, Albert, as prince of Monaco.

The territory of Monaco is divided into three communes: Monaco, pop. (1923) 2,020, the old settlement on the summit of a rocky headland defended by ramparts; La Condamine, pop. (1923) 10,705, on the west of the bay, a bathing resort with manufactures of perfume and liqueurs; Monte Carlo, pop. (1923) 9,428, with its casino and its pigeon-shooting ground and many hotels. Each commune is administered by a municipal authority. The judicial system, since 1819, has been based on the French code, there being a court of first instance and a *juge de paix,* and by arrangement, two Paris judges form a court of appeal. Monaco has formed the see of a bishop since 1887. There is a semi-military police force.

The town of Monaco possesses a Romanesque-Byzantine cathedral of St. Nicholas, a mediaeval Genoese and Renaissance palace and Prince Albert's oceanographical museum, opened in 1910. Another museum near the cathedral contains prehistoric exhibits from the Grimaldi grottoes near Mentone and Roman antiquities from La Turbie. La Turbie on the borders of Cisalpine Gaul was the site of the colossal tower of Augustus. The village is reached by a funicular railway from Monte Carlo.

There seem to have been gambling tables at Monte Carlo in 1856, but in 1861 François Blanc of Homburg obtained a concession for 50 years from the prince. This concession passed into the hands of a company, which in 1898 obtained an extension to 1947, paying £400,000 in 1899, £600,000 in 1913, as well as a rent of £50,000 per annum till 1906, £70,000 till 1916, £80,000 till 1926, £90,000 till 1936 and £100,000 till 1947. The inhabitants are forbidden access to the gambling tables, but are exempt from taxation and derive large profits from the visitors. The principality exports olive oil, oranges and perfumes, importing in exchange coal and wine.

See G. Saige, *Monaco, Ses Origines et Son Histoire* (1898); A. Smith, *Monaco and Monte Carlo* (1912).

MONADNOCK, a mass of rock or a hill which, as an erosion remnant, rises above the general peneplain level. Monadnocks

consist usually of some harder rock intrusion or fold which resists weathering and erosion processes. The term is derived from Mount Monadnock in New Hampshire, U.S.A., which represents such a geological structure. The famous Stone Mountain of Georgia is a granite monadnock. The Devil's Tower (*Mato Tepee*) of Wyoming is a volcanic "neck," the hard core of igneous rock having remained after the softer sides have worn away. Monadnocks of the latter type are frequent in the Peak Downs, Queensland, Australia.

MONAGHAN, a county of Ireland in the province of Ulster, bounded east by Armagh, south-east by Louth, south by Meath, south-west by Cavan, west by Fermanagh, and north by Tyrone. Area 319,741 ac., or about 496 sq. miles. Pop. (1926) 65,143. The north-western part is included in the great central plain of Ireland, but to the south and east the surface is irregular. The principal range is that of Slievebeagh, a barren tract extending into Fermanagh, its highest summit being 1,254 feet. The principal rivers are the Finn, rising near the centre of the county and passing into Fermanagh, and the Blackwater, which forms the boundary with Tyrone. The Ulster canal passes the towns of Monaghan and Clones, affording communication between Lough Neagh and Lough Erne. In geological structure the county drops from the Upper Carboniferous outlier of Slievebeagh in the north-west to a Carboniferous Limestone area towards Monaghan town; but south of this a Silurian area stretches across the Cavan and Armagh borders. At Carrickmacross, an outlier of Carboniferous Limestone, Coal Measures (with poor seams of coal) and Trias is encountered. Gypsum has been quarried in the Trias, and lead ore was formerly mined in many places in the Silurian area. The Triassic clay furnishes excellent bricks. Eskers or glacial ridges occur at several places. Limestone is abundant, and worked at small cost. Freestone and slates are quarried.

The district now called the co. Monaghan was included in the district of Uriel or Orgial, known as Macmahon's country. It was made shire ground under its present name by Sir John Perrot in the reign of Elizabeth. At Clones there is a round tower, another at Inishkeen is in ruins. Near Clones are two large raths. There are several Danish forts. The 6th century abbey of Clones, once the seat of a bishopric, was rebuilt in the 14th century.

The soil is generally fertile where it rests on limestone, and there is also a mixed soil of deep clay, capable of high cultivation; but in the hilly regions a strong retentive clay prevails, which could be made productive only by careful draining and culture. Spade husbandry generally prevails. Oats, potatoes and turnips are the principal crops. The number of cattle, sheep, pigs, goats and poultry, is well maintained. Linen is the only manufacture of consequence, but the cultivation of flax has almost died out. The Belfast and Clones line of the Great Northern railway crosses the county from north-east to west, and the Dundalk and Clones line runs from south-east to west, with branches to Carrickmacross and to Cootehill (co. Cavan). Monaghan returns three members to Dáil Eireann.

MONAGHAN, county town of Monaghan, Ireland, on the Ulster canal and the Belfast and Clones line of the Great Northern railway, by which it is 52 m. S.W. by W. of Dublin. Pop. (1921) 4,272. There is a modern Roman Catholic cathedral (1862–92) for the diocese of Clogher. The town takes its name (Muinechan, the town of monks) from an early monastery. It was incorporated by James I., but was little more than a hamlet until the close of the 18th century.

MONAL, MONAUL or IMPEYAN PHEASANT, a beautiful pheasant (*Lophophorus impeyanus*) inhabiting the Himalayan mountains. The cock has a blue and green back with metallic reflections and both sexes bear a crest (*see* PHEASANT). There is an excellent account of this species in C. W. Beebe's *Monograph of the Pheasants.* It is now protected by game-laws in British territory.

MONA MONKEY, a West African guenon (*q.v.*) of the genus *Cercopithecus.* The mona (*C. mona*) is characterized by the presence of a black band running from the eye to the ear. The general colour of the upper parts is black, with a pair of white spots near the tail, while a band across the forehead and the whole under surface are likewise white. (*See* PRIMATES.)

MONARCHIANISM, a theological term designating the view taken by those Christians who, within the Church, towards the end of the 2nd century and during the 3rd, opposed the doctrine of an independent personal subsistence of the Logos, and affirmed the sole deity of God the Father. The representatives of the extreme monotheistic view, which, while regarding Christ as Redeemer, clung tenaciously to the numerical unity of the Deity, were called Monarchians, a term brought into general use by Tertullian. It is usual to speak of two kinds of monarchianism—the dynamistic and the modalistic, though the distinction cannot be carried through without some straining of the texts. (*a*) By monarchians of the former class Christ was held to be a mere man, miraculously conceived indeed, but constituted the Son of God simply by the infinitely high degree in which he had been filled with Divine wisdom and power. This view was taught at Rome about the end of the 2nd century by Theodotus, who was excommunicated by Bishop Victor, and at a later date by Artemon, excommunicated by Zephyrinus. About the year 260 it was again propounded within the Church by Paul of Samosata (*q.v.*). (*b*) Modalistic monarchianism, conceiving that the whole fullness of the Godhead dwelt in Christ, took exception to the "subordinatianism" of some Church writers, and maintained that the names Father and Son were only different designations of the same subject, the one God, who "with reference to the relations in which He had previously stood to the world is called the Father, but in reference to His appearance in humanity is called the Son." It was first taught, in the interests of the "monarchia" of God, by Praxeas, a confessor from Asia Minor in Rome about 190, and was opposed by Tertullian in his well-known controversial tract. The same view—the "patripassian" as it was also called, because it implied that God the Father had suffered on the cross—obtained fresh support in Rome about 215 from certain disciples of Noetus of Smyrna, who received a modified support from Bishop Callistus. (For the subsequent history of modalistic monarchianism *see* SABELLIUS.)

See the Histories of Dogma by A. Harnack, F. Loofs, R. Seeberg; also articles ADOPTIANISM, ARIANISM.

MONARCHY, strictly, the undivided sovereignty or rule of a single person. (Fr. *monarchie,* from Lat. *monarchia,* from the Gr. μόνος alone, ἀρχή rule.) Hence the term is applied to states in which the supreme authority is vested in a single person, the monarch, who in his own right is the permanent head of the state. The word has, however, outlived this original meaning, and is now used, when used at all, somewhat loosely of states ruled over by hereditary sovereigns, as distinct from republics with elected presidents; or for the "monarchical principle," as opposed to the republican.

The old idea of monarchy, *viz.* that of the prince as representing within the limits of his dominions the monarchy of God over all things, culminated in the 17th century in the extreme version of the doctrine of the divine right of kings, and was defined in the famous dictum of Louis XIV.: *L'état c'est moi!* The conception of monarchy was derived through Christianity from the theocracies of the East; it was the underlying principle of the mediaeval empire and also of the mediaeval papacy, the rule of the popes during the period of its greatest development being sometimes called "the papal monarchy." The monarchical principle was shaken to its foundations by the English revolution of 1688; it was shattered by the French revolution of 1789; and though it survives as a political force, more or less strongly, in many European countries, "monarchists," in the strict sense of the word, are everywhere a small and dwindling minority. To express the change phrases were invented which have come into general use, though involving a certain contradiction in terms *viz.* "limited" or "constitutional monarchy," as opposed to "absolute" or "autocratic monarchy."

Finally, a distinction is drawn between "elective" and "hereditary" monarchies. Of the former class the most conspicuous was the Holy Roman Empire; but in Europe all monarchies were, within certain limits, originally elective; and, after the introduction of Christianity, the essential condition of the assumption

of sovereign power was not so much kinship with the reigning family as the "sacring" by the divine authority of the Church. The purely hereditary principle was of comparatively late growth, the outcome of obvious convenience, exalted under the influence of various forces into a religious or quasi-religious dogma. (*See* also GOVERNMENT and SOVEREIGNTY.)

MONASSIR (MONASIR), tribe of Semitic stock, living in the Nile valley between Birti and Dar Robatab. They are a prosperous, sedentary tribe, claim kinship with the Ababda, and speak Arabic, but are of mixed blood.

MONASTICISM, an ascetic system of living apart from the world (Gr. μοναστής, a monk, from μόνος, alone). Monasticism is the attempt to develop and regulate the exercise of asceticism and mysticism (*qq.v.*). It is by no means a creation of Christianity; long before the Christian era a highly organized monasticism existed in India and other parts of Asia.

BY COURTESY OF THE BRITISH MUSEUM

A FRANCISCAN NUN

(1). *Pre-Christian Monasticism.*—Greek asceticism and mysticism seem never to have produced a monastic system; but among the Jews, both in Judaea and in Alexandria, this development took place. In Judaea the Essenes before the time of Christ lived a fully organized monastic life (*see* Schürer, *Jewish People*, ii. §30); and the same is true in regard to the Therapeutae in the neighbourhood of Alexandria (the authenticity of Philo's *De Vita contemplativa*, describing their life, is again recognized by scholars).

A general sketch of pre-Christian asceticism and monasticism, with indication of the chief authorities, is given in O. Zöckler's *Askese und Mönchtum* (1897) pp. 32–135. This account is epitomized by J. O. Hannay, *Spirit and Origin of Christian Monasticism* (1903), app. i.: the view now common among scholars is there maintained that these pre-Christian realizations of the monastic idea had no influence on the rise and development of Christian monasticism.

(2). *Beginnings of Christian Monasticism.*—The practice of asceticism asserted itself at an early date in Christian life: men and women abstained from marriage, from flesh meat, from the use of intoxicating drink, and devoted themselves to prayer, religious exercises and works of charity (S. Schiwietz, *Das morgenländische Mönchtum*, 1904, pt. i.; J. O. Hannay, *op. cit.* chs. 2, 3). In Egypt, at the middle of the 3rd century, it was the custom for such ascetics to live in solitary retirement in the neighbourhood of the towns and villages. This was the manner of life which St. Anthony (*q.v.*) began to lead, *c.* 270; but after 15 years he withdrew to a deserted fort on the east bank of the Nile, opposite the Fayum. For 20 years he lived a solitary life until would-be disciples called on him to guide them. There are reasons for doubting whether Anthony was actually the first Christian hermit (*see* E. C. Butler, *Lausiac History of Palladius*, 1898, p. 230), but an isolated case does not invalidate the 4th century tradition that Anthony was the father of Christian monasticism.

(3). *St. Anthony's Monachism.*—The form of monastic life directly derived from St. Anthony was the type that prevailed in middle and northern Egypt up to the middle of the 5th century. The chief authorities for the study of this type of monastic life are the *Vita Antonii* (probably by Athanasius), the *Historia monachorum* (ed. E. Preuschen), the *Historica Lausiaca* of Palladius (ed. E. C. Butler)—these works are to be found in Latin in Rosweyd's *Vitae Patrum* (*Migne, Patrol. Lat.* LXXIII., LXXIV.)—and the writings of Cassian (English translation by Gibson in "Nicene and Post-Nicene Library.")

Antonian monachism grew out of the purely eremitical life, and it retained many of the characteristic features inherited from its origin. The party of travellers whose journey in 394 is narrated in the *Historia monachorum* found at the chief towns along the Nile, from Lycopolis (Assiut or Siut) to Alexandria, and in the deserts that fringed the river, monastic habitations, sometimes of hermits, sometimes of several monks living together.

(4). *St. Pachomius's Monachism.*—Very different was the type of monastic life that prevailed in the more southerly parts of Egypt. Here, at Tabennisi near Dendera, about 315–320, St. Pachomius (*q.v.*) established the first Christian cenobium, or monastery properly so called (*see* P. Ladeuze, *Cénobitisme Pakhomien* (1898); Schiwietz, *op. cit.* pt. ii. §§ 12–16; E. C. Butler, *op. cit.* pt. i. p. 234, pt. ii. notes 48, 49, 54, 59). Before his death in 346 Pachomius had established nine monasteries of men and one of women, and after his death other foundations continued to be made in all parts of Egypt, but especially in the south and in Abyssinia. Palladius tells us that (*c.* 410) the Pachomian or Tabennesiot monks numbered some 7,000. The life was fully cenobitical, regulated in all details by minute rules, and with prayers and meals in common. Work was done for its own sake, not merely for an occupation, thus marking a new departure in the monastic ideal. St. Pachomius not only inaugurated Christian cenobitical life, but he also was responsible for the creation of the first "religious order."

The Coptic abbot Shenout governed on similar lines the great "white monastery," and the ruins still survive near Akhmim. It remained purely Coptic, with no infiltration of Greek ideas or influence (*see* J. Leipoldt, *Schenulte von Atripe*, 1903). Egyptian monachism began to wane after 500, and since the Mohammedan occupation it has ever been declining.

(5). *Oriental Monachism.*—The monastic institute was imported early in the 4th century from Egypt into Syria. The most celebrated was the life of the Stylites or pillar hermits (*see* SIMEON STYLITES). Monastic life here tended to revert to the eremitical form, and to this day Syrian and Armenian monks are to be found dwelling in caverns and desert places, and given up wholly to the practice of austerity and contemplation (*see* E. C. Butler, *Lausiac History of Palladius*, pt. i. p. 239). Before the close of the 4th century monachism spread into Persia, Babylonia and Arabia.

(6). *Basilian and Greek Monachism.*—Though Eustathius of Sebaste was the first to introduce the monastic life within the confines of Greek Christianity in Asia Minor (*c.* 340), it was St. Basil who adapted it to Greek and European ideas and needs (*see* BASILIAN MONKS). St. Basil's standards have remained the standards of Greek and Slavonic monasticism.

(7). *Early Western Monachism.*—The knowledge of the monastic life was carried to western Europe by St. Athanasius, who in 340 went to Rome accompanied by two monks. Monasticism soon became common in Rome and throughout Italy, and before long spread to Gaul and to northern Africa (*see* E. C. Butler, *op. cit.* pt. i. p. 245; also Hannay, *op. cit.* ch. 7).

(8). *St. Benedict's Monachism.*—St. Benedict (*c.* 500) effected a permanently working adaptation of the monastic ideal and life to the conditions of Western races. The life was to be self-denying and hard, but not one of any great austerity (*see* BENEDICT OF NURSIA; and E. C. Butler, *Benedictine Monachism*). The individual monk was sunk in the community, whose corporate life he had to live. St. Benedict's rule was a new creation in monastic history (*see* F. A. Gasquet, *Sketch of Monastic Constitutional History*). St. Benedict defines his monastery as "a school of the service of the Lord" (*Reg., Prol.*). The great act of service is the public common celebration of the canonical office, the "work of God" he calls it, to which "nothing is to be preferred" (*Reg. c.* 43). The rest of the day is filled up with a round of work and reading. Work (and in St. Benedict's time it was predominantly field work) took a more important place in the life than was the case under St. Pachomius or St. Basil, occupying notably more time than the church services. St. Benedict introduced, too, the idea of law and order, of rule binding on the abbot no less than on the monks; thus he reduced almost to a vanishing point the element of arbitrariness found in the earlier rules. Lastly he introduced the idea of stability, whereby monk and community were bound to each other for life.

BY COURTESY OF THE BRITISH MUSEUM

A BENEDICTINE MONK

THE BENEDICTINE RULE

(9). *Western Monachism in the Early Middle Ages.*—Soon the Benedictine form of monastic life became the only one in Western Europe (*see* Benedictines). The only serious rival was the Irish rule of Columban. The beginnings of Celtic monachism are obscure. When, however, Irish monachism emerges into the full light of history, it was in its manifestations closely akin to the Egyptian, or even to the Syrian type: there was the same love of the eremitical life, the same craving after bodily austerities of an extraordinary kind, the same individualistic piety. The Irish monks were great missioners in the north of England and the northern and central parts of Europe, and in the course of the 7th century the Irish rule of St. Columban and the Roman rule of St. Benedict met in the monasteries in central Europe that had been founded by Columban and his Irish monks. The Benedictine rule supplanted the Irish so inevitably that the personnel ceased to be Irish, that even in St. Columban's own monastery of Luxeuil his rule was no longer observed, and by Charlemagne's time all remembrance of any other monastic rule than the Benedictine had died out. During the 7th and 8th centuries the Benedictine houses were the chief instrument in the christianizing and civilizing and educating of the Teutonic races.

(10). *Offshoots and Modifications of Benedictine Monachism.*—As previously stated, St. Pachomius's monasteries formed an order—a curious anticipation of what six centuries later was to become the vogue in Western monasticism. The Benedictine houses never coalesced in this manner; even when, later on, a system of national congregations was introduced, they were but loose federations of autonomous abbeys; although the convenient expression "Benedictine order" is frequently used, the Benedictines do not form an order in the proper sense of the word. But with the 10th century we reach the period of orders, and it is on this line that all subsequent developments in Western monasticism have run. The first order was that of Cluny, founded in 910 (*see* Cluny).

The chief offshoot from the Benedictine institute was the Cistercians (*c.* 1100); their ground idea was to return to the letter of St. Benedict's rule (*see* Cistercians).

Towards the end of the 10th century and during the 11th a strong tendency set in to revert to the eremitical life, probably owing to the example of the Greek monks, who at this time entered Sicily and south Italy in great numbers. This tendency produced the orders of the Camaldulians or Camaldolese (*c.* 975) in Italy, and in France the Grandmontines (1076) and Carthusians (1084), all leading practically eremitical lives, and assembling ordinarily only for the church services. The Vallombrosians (1038) near Florence maintained a cenobitical life, but eliminated every element of Benedictine life that was not devoted to pure contemplation. At Fontevrault (founded in 1095) the special feature was the system of "double monasteries" *i.e.,* neighbouring, but rigorously separated, monasteries of men and of women.

(11). *New Kinds of Religious Orders.*—A new form was that of the canons regular or Augustinian canons (*q.v.*) who about the year 1060 arose out of the older semi-monastic canonical institute, and lived according to the so-called "Rule of St. Augustine." The essential difference between monks and regular canons may be explained as follows: monks, whether hermits or cenobites, are men who live a certain kind of life for its own sake; external works, either temporal or spiritual, are accidental. But canons regular were in virtue of their origin essentially clerics, and their common life, monastery rule, and the rest, were something additional grafted on to their proper clerical state.

Two special kinds of orders arose out of the religious wars waged by Christendom against the Mohammedans in the Holy Land and in Spain: (1) the military orders: the Knights Hospitallers of St. John and the Knights Templars, both at the beginning of the 12th century, and the Teutonic Knights at its close; (2) the orders of Ransom, whose object was to free Christian prisoners and slaves from captivity under the Mohammedans, the members being bound by vow even to offer themselves in exchange; such orders were the Trinitarians (*q.v.*) founded in 1198, and the order of Our Lady of Ransom (de Mercede), founded by St. Peter Nolasco in 1223; both were under the Augustinian rule.

RISE OF MENDICANT ORDERS

At the beginning of the 13th century arose the series of great mendicant orders. Their nature and work and the needs that called them into being are explained in the article Mendicant Movement, and in the separate articles on St. Francis of Assisi and Franciscans (1210), St. Dominic and Dominicans (1215), Carmelites (1245) Augustinian Hermits (1256)—these were the four great orders of mendicant friars—to them were added, in 1487, the Servites (*q.v.*) founded in 1233. Among monks and canons regular each monastery has its fixed community. The friar, however, does not belong to any particular house, but to the province or order. In the monk attachment to his own monastery is a virtue; in the friar detachment is the ideal. The monk, or the canon, normally exercises his influence on the world in and through his community, not as an individual but as a member of a corporate body. The friar's sphere of work is normally outside his convent, and he works and influences directly and as an individual. Here too should be mentioned St. Francis's great creation, the Tertiaries (*q.v.*) or devout men and women living in the world, who while continuing their family life and their ordinary avocations, followed a certain rule of life, giving themselves up to more than ordinary prayer and the pursuit of good works, and abstaining from amusements of a worldly kind.

(12). *The Religious Orders in the Later Middle Ages.*—The 13th century was the heyday of monasticism in the West; the mendicant orders were in their first fervour and enthusiasm and the great abbeys of Benedictines, Cistercians and Augustinian canons reflected the results of the religious reform and revival associated with Hildebrand's name. Under the Benedictine rule were formed the new congregations or orders of Silvestrines (1231), Celestines (*c.* 1260) and Olivetans (1319; *qq.v.*). But towards the end of the century a period of decline set in, which ran its course in increasing volume throughout the 14th century. A great wave of secularity rolled over the Church, engulfing the religious orders with the rest. The great schism was reflected in the mendicant orders which were divided into two obediences, to the destruction of discipline. The great wealth of the old monastic orders exposed them, especially in France and Italy, to the vicious system of commendation, whereby a bishop, an ecclesiastic, or even a layman was appointed "commendatory abbot" of a monastery, merely for the purpose of drawing the revenues (*see* Abbot); the monasteries were often deprived even of necessary maintenance, the communities dwindled, and regular observance became impossible. In the German lands, the lowest level was touched, and the writings of the Augustinian canon Johann Busch and of the Benedictine abbot Trithemius reveal a state of things in the first half of the 15th century that urgently called for reform. The first move in this direction was made in the Netherlands and north Germany under the influence of Gerhard Groot (*q.v.*) and issued in the formation of the Windesheim congregation of Augustinian canons and the secular congregation of Brothers of Common Life (*q.v.*) founded *c.* 1384, both of which became centres of religious revival. During the first half of the 15th century numerous and effective efforts at reform were initiated in all the orders without exception, and in every part of Europe. These movements, promoted by the councils of Constance and Basle, partook of the spirit of the time and were characterized by an extreme austerity of life, a certain hardness of spirit, and a sort of police regulation easily understandable at a time of reaction from grave abuses. At this time arose the Hieronymites (*q.v.*) founded in 1375, under the Augustinian rule, the Observants (1415) among the Franciscans (*q.v.*), and the Minims (founded *c.* 1460 by St. Francis of Paola, *q.v.*), whose programme was to outdo the Minors or Franciscans. The Refor-

BY COURTESY OF THE BRITISH MUSEUM (PRINT ROOM)

A DOMINICAN NUN, THIRD ORDER OF ST. DOMINIC

mation destroyed the monasteries in northern Europe and crippled those in central Europe. But a tide of reaction soon began to flow.

MODERN TIMES

(13). *The Modern Orders.*—During the Reformation period there sprang up to meet the needs of the time, a new kind of religious order, called Regular Clerks. These are religious orders in the full sense of the word, as the members take the solemn religious vows. Regular clerks are by their institute clerics and priests, and they are devoted to some particular work or works as their own special object—as education, the preaching of missions and retreats, or the going on missions to the heathen. They carry still further the tendencies that differentiate the friars from the monks; and have commonly given up the choral celebrations of the canonical office, which had been maintained by the friars.

Of regular clerks by far the most important are the Jesuits (*q.v.*) founded in 1540; there are also the Theatines (founded 1524 by St. Cajetan and Caraffa, afterwards Paul IV.); the Barnabites (founded 1530, by St. Antonio Zaccaria) and others (*see* Max Heimbucher, *Orden u. Kongregationen* [1897] II., §§108–114). Strictly speaking the "religious congregations" should be distinguished from the orders of regular clerks, the difference being that in the former the vows, though taken for life, are only "simple vows" and more easily dispensable by authority; but the character and work of the two institutes is very similar. The chief of these congregations are the Passionists (founded by St. John of the Cross, 1725) and the Redemptorists (founded by St. Alfonsus Liguori, 1749), both dedicated to giving missions and retreats. The Christian Brothers, devoted to primary education, founded by St. Jean Baptiste de la Salle in 1679, are not in orders (Heimbucher, *op. cit.* §§115–118).

Besides the religious congregations there are a number of "secular congregations," composed of secular priests living together under temporary vows and free to leave at will; the following deserve mention: Oblates of St. Charles (founded by St. Charles Borromeo, 1578); Oratorians (founded by St. Philip Neri, *c.* 1570); the French Oratory (founded by Cardinal Berulle, 1613), a similar but distinct institution, which produced a number of scholars of the highest distinction—Thomassin, Morin, Malebranche, Richard Simon, Juénin, Lebrun, Masillon, and others; Lazarists (founded by St. Vincent de Paul, 1624); Sulpicians (founded by M. Olier, 1642), and a vast number of others, including several for the mission to the heathen (*see* Heimbucher *op. cit.* §§124–140).

During the period under review, from the Reformation to the French Revolution, the old orders went on alongside the new, and many notable revivals and congregations arose among them: the most noteworthy were the Capuchins (*q.v.*) among the Franciscans (1528); the Discalced Carmelites (*q.v.*) of St. Teresa and St. John of the Cross (1562); the Trappists (*q.v.*) among the Cistercians (1663); and most famous of all, the Maurists (*q.v.*) among the Benedictines of France (1621).

(14). *The Religious Orders in Recent Times.*—At the end of the 18th century and the opening of the 19th the religious orders received a succession of blows in those countries in which they had survived the Reformation. The Jesuits were suppressed by Pope Clement XIV. in 1773, and restored by Pius VII. in 1814. As the result of the ecclesiastical policy of the emperor Joseph II. nearly all religious houses of all kinds were suppressed throughout the Austrian dominions (1780). The French Revolution swept them out of France and caused the secularization of the great majority in Central Europe and Italy. In Portugal and Spain they were dissolved in 1834–35; in Italy in 1866; in the Prussian dominions in 1871. The last half of the 19th century, and more especially the last quarter, witnessed a remarkable revival of vitality and growth in most of the older orders in nearly every country of western Europe, and besides an extraordinary number of new congregations, devoted to works of every sort, were founded in the 19th century: Heimbucher (*op. cit.* §§118, 134–140) numbers no fewer than 70 of these new congregations of men. In the new countries especially in the United States and Australia, but also in South Africa, orders and congregations of all kinds are most thriving. The chief set-back has come again in France, where, by the Association Laws of 1903, the religious orders have nearly all been suppressed and expelled and their property confiscated. Many religious returned to France after the World War.

WOMEN'S PART

(15). *The Nuns.*—In all ages women, hardly less than men, have played their part in monasticism. In the earliest Christian times the veiled virgins formed a grade or order apart, more formally separated from the community than were the male ascetics. There is reason for believing that there were organized convents for women before there were any for men; for when St. Anthony left the world in 270 to embrace the ascetic life, the *Vita* says he placed his sister in a nunnery (παρθενών). We learn from Palladius that by the end of the 4th century nunneries were numerous all over Egypt, and they existed also in Palestine, in Italy and in Africa—in fact throughout the Christian world. It is a curious coincidence that the sister of each of the three great cenobitical founders, Pachomius, Basil and Benedict, was a nun and ruled a community of nuns according to an adaptation of her brother's rule for monks. In the West the Benedictine nuns played a great part in the Christian settlement of north-western Europe. As the various monastic and mendicant orders arose, a female branch was in most cases formed alongside of the order; and so we find the canonesses, and hermitesses and Dominicanesses, and Franciscan nuns, or Clares (*q.v.*). Then there were the "double orders" of Sempringham (*see* GILBERT OF,) and Fontevrault, in which the nuns were the predominant, or even the dominant, element. Of the modern orders of men only a few include nuns. The great majority of these modern congregations of women follow the Augustinian rule, supplemented by special constitutions or by-laws; such are the Brigittines, the Ursulines and the Visitation nuns: others follow the rule of the third order of the Franciscans or other mendicants (*see* TERTIARIES). In early times nuns could go out of their enclosure on occasion; but in the later middle ages, up to the Council of Trent, the tendency was to keep them more and more strictly confined within their convent precincts. In 1609 an English lady, Mary Ward, founded at Munich the "Institute of Mary," the nuns of which were not bound to enclosure. St. Vincent de Paul soon followed; in 1633 he established the Sisters of Charity, bound only by yearly vows, and wholly given up to works of charity—chiefly nursing in hospitals and in the homes of the poor, and primary education in poor schools. The nuns belonging to the older orders tend to the contemplative idea, and they still find recruits in sufficient numbers, in spite of the modern rush to the active congregations. These latter exist in wondrous number and variety, exercising every imaginable form of good work—education, both primary and secondary; the care of hospitals, orphanages, penitentiaries, prisons; of asylums for the blind, the deaf and dumb, the insane; of refuges for the aged poor and the destitute.

BY COURTESY OF THE BRITISH MUSEUM

A MONK OF THE CARTHUSIAN ORDER

For monasticism generally *see* Helyot, *Histoire des ordres réligieux* (1714, 2nd ed. 1792); Max Heimbucher, *Orden und Kongregationen*, 2nd ed. 1907, 3 vols. (good bibliography); Leclerc, art. "Cénobitisme" in *Dictionnaire d'Archéologie et de Liturgie;* and for first 10 sections, E. C. Butler, *Benedictine Monachism. See* also the works named at the end of the various articles referred to in the text.

MONASTIR, one of the largest cities in S. Serbia, Yugoslavia (Serbian *Bitolj*). Pop. (1921), 28,418, comprising Serbs, Mohammedan Slavs, Albanians, Turks, Bulgarians, Vlachs, Greeks and the largest Jewish colony in Serbia. Each of these has its own district and conducts its own national and religious propaganda. The town is situated on an upland plain 2,019 ft. above sea-level, at the mouth of a ravine, and with richly wooded mountains to the east. Monastir is unfortified, but is of military value both because the fertile plain affords a good base for supplies and because many roads converge upon it. A river traverses the town,

with quays and promenades, but the streets are badly made, and the houses, though solidly built, are mostly only of one story. There are several large public buildings and a school. The chief industries are rubber, tanning, the manufacture of ribbons, stockings and carpets, and before the World War (1914–18) silver filigree work, the output of which is now much lessened. The plain affords excellent pasturage for cattle, and wheat, maize, tobacco, madder and the poppy are cultivated. The town is famous for its fairs, and serves as a distributing centre for S.W. Serbia, carrying on an active trade in grain, flour, cloth, hides and bones. The military advantages of its position led the Turks, about 1820, to make it the headquarters of an Army corps, which greatly increased its general and commercial importance. In 1898 it was made the see of a Bulgarian bishop. The ancient diocese of its Greek archbishop is known as Pelagonia from the old name of the Kara-Su or Tzerna plain. Monastir itself has been identified with the ancient *Heraclea Lyncestis* on the Via Egnatia. In the Balkan Wars (1912–13) Monastir was taken from the Turks by the Serbs and assigned to Serbia by the Treaty of Bucharest (1913).

MONAZITE, a mineral consisting of phosphate of the cerium metals, the formula being $(Ce,La,Di)PO_4$; small and variable amounts of thorium (ThO_2, 1–10%) and yttrium are usually also present. It is of considerable commercial importance as a source of thoria for the manufacture of mantles for incandescent gas-lighting; the cerium is used to a limited extent in pharmacy, and alloyed with iron it forms the "flints" (sparking metal) of automatic lighters.

Crystals of monazite belong to the monoclinic system, and are usually flattened parallel to the ortho-pinacoid. The large (up to 5in. in length) reddish-brown, dull and opaque crystals from Norway and the Urals are simple in form, whilst the small, translucent, honey-yellow crystals from the Alps are bounded by numerous bright faces. The hardness is 5½, and the specific gravity 5·1–5·2. Light which has traversed a crystal or grain of monazite exhibits a characteristic absorption spectrum, and this affords a ready means of detecting the mineral.

As minute crystals monazite is of wide distribution in granites and gneisses, being present in very small amounts as an accessory constituent of these rocks. By powdering the rock and washing away the lighter minerals in a stream of water the heavy minerals (zircon, anatase, rutile, magnetite, garnet, monazite, xenotime, etc.) may be collected. This separation has been effected naturally by the weathering and disintegration of the rocks and the accumulation of the heavier minerals in the beds of streams. Under these conditions monazite has been found as rounded water-worn grains in the alluvial gold-washings of the Urals, Finland, Siberia, the United States, Brazil, Colombia, New South Wales, etc. Larger crystals of monazite are found embedded in pegmatite veins in the Ilmen mountains (southern Urals); at Arendal and other places in southern Norway, where it is collected in the felspar quarries to the extent of about one ton per annum; and in the mica mines at Villeneuve, Quebec, where masses of monazite weighing 20lb. have been found.

The deposits worked commercially are the monazite-bearing sands of North Carolina, Brazil, Ceylon and Travancore. In Brazil it occurs in river-gravels and also in the sand on the sea-beaches; an extensive accumulation of very rich monazite sand occurs on the seashore near Alcobaça in Bahia, and this has been shipped as ballast in the natural state. In Travancore the sands of the sea-shore and of the sand-dunes along the coast are concentrated by washing, and the grains of monazite are separated electro-magnetically from the associated zircon and ilmenite.

See "Monazite," Imp. Mineral Resources Bureau (London, 1920).

MONBODDO, JAMES BURNETT, Lord (1714–1799), Scottish judge and anthropologist, born at Monboddo, Kincardineshire, studied at Aberdeen and Edinburgh. He was made a lord of session in 1767 with the title of Lord Monboddo. In his *Antient Metaphysics* (1779–99), Monboddo conceived man as gradually elevating himself from an animal condition, in which his mind is immersed in matter, to a state in which mind acts independently of body. In his equally voluminous work, *The Origin and Progress of Language* (1773), he brought man under the same species as the orang-outang. He traced the gradual elevation of man to the social state, which he conceived as a natural process determined by "the necessities of human life." He looked on language (which is not "natural" to man in the sense of being necessary to his self-preservation) as a consequence of his social state. His views about the origin of society and language and the faculties by which man is distinguished from the brutes have many curious points of contact with Darwinism and neo-Kantianism. He died on May 26, 1799.

Boswell's *Life of Johnson* gives an account of Johnson's visit to Burnett at Monboddo, and is full of references to the natural contemporary view of a man who thought that the human race could be descended from monkeys.

MONCEY, BON ADRIEN JEANNOT DE, Duke of Conegliano (1754–1842), marshal of France, the son of a lawyer, was born at Besançon on July 31, 1754. He received a commission in the army in 1778. Moncey won great distinction in the campaigns of 1793 and 1794 on the Spanish frontier (*see* French Revolutionary Wars), rising in a few months to the command in chief of the Army of the Western Pyrénées. After this he was employed in the highest commands until 1799, when the government, suspecting him of Royalist views, dismissed him. But the *coup d'état* of the 18th Brumaire brought him back to the active list, and in Napoleon's Italian campaign of 1800 he led a corps from Switzerland into Italy. In 1801 Napoleon made him inspector-general of gendarmerie, created him a marshal of France in 1804, and in 1808 he received the title of duke of Conegliano. In 1808 Moncey was sent to Spain in command of an army corps. He took a leading part in the emperor's campaign on the Ebro and in the second siege of Saragossa in 1809. He refused to serve in the invasion of Russia. When, however, France was invaded (1814) Marshal Moncey reappeared in the field and fought the last battle for Paris. He remained neutral during the Hundred Days, but after Waterloo he was imprisoned, for refusing to take part in the court-martial on Ney, and lost his marshalate. He was reinstated in 1816. His last active service was as commander of an army corps in the short war with Spain, 1823. He died on April 20, 1842.

MONCTON, a city and port in Westmoreland county, New Brunswick, Canada, 89 m. by rail N.E. of St. John, at the head of navigation on the Petitcodiac river, the seat of the workshops and general offices of the Canadian National railway. Pop. (1931) 20,689. It has large stove factories, engine and boiler works, and an extensive lumber trade.

MOND, LUDWIG (1839–1909), British chemist, was born at Cassel in Germany on Mar. 7, 1839. After studying at Marburg under Hermann Kolbe and at Heidelberg under Robert Bunsen, he came to England in 1862 and entered into partnership with Mr. Hutchinson, a well-known alkali manufacturer at Widnes, where he elaborated the practical application of a method he had patented for recovering the sulphur lost as calcium sulphide in the black ash waste of the Leblanc alkali process, which he introduced into some 30 works in England and France. He became a naturalized British subject in 1867. In 1873 he entered into partnership with Sir John Tomlinson Brunner (1842–1919), who was employed in the office of Mr. Hutchinson, and thus founded the great chemical manufacturing firm of Brunner, Mond and Co. They began to make alkali by the ammonia-soda process, under license from the Belgian chemist Ernest Solvay. This process had previously been a failure in all the works it had been experimented on, but Mond gradually conquered the technical difficulties, largely as a result of his inventing and employing strictly scientific methods of controlling the reaction involving the recovery of the ammonia and the other products. About 1879 he began experiments in the economical utilization of fuel and his efforts led him to the system of making producer-gas known by his name (*see* Gas). In connection with this he worked out a gas battery. Whilst developing the production of chlorine products from the ammonium-chloride obtained in the ammonia-soda reactions, he noticed that the nickel valves used for the control of the gases were acted upon by carbon monoxides. A study of the formation of the nickel carbide led to the discovery of nickel

carbonyl. The conditions of its formation made possible a successful process for the extraction of nickel from its ores, which involved both the finding, acquisition and development of mines in Canada, the elaboration of new and suitable smelting operations there and the invention of highly specialized apparatus for the refining works in Wales. A liberal contributor to the purposes of research, Mond founded in 1896 the Davy-Faraday Research laboratory in connection with the Royal Institution, and contributed to the International Catalogue of Scientific Literature, to the erection of laboratories and to research at many universities in England (London, Liverpool, Manchester). He died in London on Dec. 11, 1909.

MONDAY, the second day of the week (*see* CALENDAR). The word is derived from O.E. *Monandaeg* (Lat. *Lunae dies*, French *lundi*). The day has been humorously canonized as St. Monday, the festival of cobblers, who seldom work on Mondays, and were supposed not to know on which day the feast of St. Crispin, their patron saint fell, save that it should be a Monday, and thus celebrated every Monday. Collop Monday, in the north of England, is the Monday before Shrove Tuesday, so called in allusion to the dish of collops, taken preparatory to the Lenten fast. Plough Monday in England is the first Monday after Epiphany, when in mediaeval times the ploughmen had their fête-day. The lord mayor of London holds a Grand Court of Wardmote at the Guildhall on Plough Monday when the election of common councilmen is announced.

MONDOÑEDO, a city of northern Spain, in the province of Lugo, 27 m. N.N.E. of the city of Lugo, on the river Masma. Pop. (1920) 9,462. Mondoñedo occupies a sheltered valley among the northern outliers of the Cantabrian mountains. According to local tradition, the bishopric of Dumium, near Braga, was transferred to San Martin de Mondoñedo (10 m. from Mondoñedo) in the 8th century; it was brought to Mondoñedo itself in the beginning of the 12th century. The principal buildings are the cathedral, a Corinthian structure of the 17th century and an ex-convent of Franciscan friars of Alcantara. The industries include lace-making, linen-weaving and leather manufacture.

MONDOVÌ, a town and episcopal see of the province of Cuneo, Piedmont, Italy, 17 m. E. of Cuneo by rail. Pop. (1921), 12,375 (town); 20,030 (commune). The lower town is 1,283 ft. above sea-level, the upper 1,834 feet. At the foot of the hill lie the industrial and commercial suburbs with potteries, etc. About 2 m. to the east is the sanctuary of Vico, a church designed by Ascanio Vittozzi in 1596 and crowned by a famous dome (1730–48).

See L. Melano Rossi, *The Santuario of the Madonna di Vico* (London, 1907).

MONEL METAL, the trade-marked name of a copper-nickel alloy developed in 1905. The alloy contains about 69% nickel, 28% copper, 2% iron, together with small amounts of carbon, manganese and silicon, and is made directly from the copper-nickel ores of Sudbury, Ont., Canada, by roasting the copper-nickel converter matte (*see* NICKEL) and reducing the resulting oxide to metal with charcoal.

The alloy is nickel white in colour and its distinguishing characteristics are its rust-proofness and corrosion-resistance, its ready manufacture by all usual methods and its satisfactory mechanical properties. Its corrosion rate is low in moist atmosphere, fresh and sea-water, solutions of most organic salts, alkalis, and of all except nitric and other strongly oxidizing acids. Very corrosive solutions, such as those of ferric salts, of sulphurous acid, of the free halogens, attack it appreciably. The alloy is quite malleable, both hot and cold, and machinable. It is readily melted and cast. It can be forged, rolled, machined, drawn and welded and in consequence is readily fabricated and is available in a wide variety of commercial forms. Some of the most important characteristics of monel metal are: density, 8·80; melting range (about), 1,345-1,375° C; modulus of elasticity, 25,000,000 lb. per sq.in.; tensile strength (hot-rolled), 90,000 lb. per sq.in.; tensile strength (cold-rolled), 100,000 to 150,000 lb. per sq.in.; elongation (hot-rolled), 50%; Brinell hardness (hot-rolled), 150; thermal expansion (25–100° C), ·000014 per 1° C; electrical resistivity, 42·5 microhms per c.c.; magnetic permeability (100 Gauss), 10–15; forging and rolling temperature range, 940–1,240° C.

MONESSEN, a city of Westmoreland county, Pennsylvania, U.S.A., on the Monongahela river, 30 m. S. of Pittsburgh; served by the Pittsburgh and Lake Erie and (through West Monessen and Charleroi, across the river) the Pennsylvania railroads. Pop. (1920) 18,179 (35% foreign-born white); and was 20,268 Federal census 1930. It is an important and rapidly growing unit of the Pittsburgh industrial district, with a factory output (chiefly steel, tin plate, and wire fence) valued in 1925 at $49,092,211. The borough was settled and incorporated in 1897 and was chartered as a city in 1921. The name was formed by prefixing the first syllable of Monongahela to the name of the German steel centre.

MONET, CLAUDE (1840–1926), French painter, was born in Paris on Nov. 14, 1840. He was one of the chief founders of the Impressionist school. At Hâvre he became acquainted with Boudin, under whose guidance he learned to love and to understand nature. At the age of twenty he became a soldier, and spent two years of his military service with the regiment of the Chasseurs d'Afrique in the desert. Falling ill with fever, he was sent home, and entered the studio of Gleyre, who tried in vain to keep him to academic art. Monet left his studio, where he had become acquainted with Sisley and Renoir. At that time he also knew Manet, and in 1869 he joined the group of Cézanne, Degas, Duranty, Sisley, and became a *plein air* painter. During the war of 1870 he withdrew to England, and on his return was introduced by Daubigny to a dealer, M. Durand-Ruel, in whose galleries almost all his works have been exhibited. In 1872 he exhibited views of Argenteuil, near Paris; in 1874 a series entitled "Cathedrals," showing the cathedral of Rouen under different lights. Some time later he painted views of Vétheuil (1875) Pourville and cliffs of Etretat (1881), of Bordighera (1886), of the Creuse (1889), Le Meules (1891) and some further views of cathedrals (1894). In December 1900 he exhibited some pictures called "Le Bassin aux Nymphéas," and was engaged at the beginning of 1901 in painting views of London.

In his later years he worked in the neighbourhood of Giverny, where he lived, and devoted himself to the study of motifications in the aspect of a limited number of subjects caused by changes of light and the seasons. On the motive of the "Bassin aux Nymphéas" he produced a series of twelve large compositions. Another series painted in 1913 is the "Arceaux Fleurs" representing a corner of his garden. In 1918 he produced similar studies under the title "Saule Pleureur." He died at Giverny on Dec. 5, 1926.

See Gustave Geffroy, *Claude Monet* (1922); and IMPRESSIONISM.

MONETARY UNION. An agreement between two or more countries, whereby the national currency of each contains an equal amount of gold and silver, so that the mint par of exchange between them is in the ratio of one to one, and the coins of each country adhering to the union can, by custom if not by law, circulate freely in all the countries, parties to the agreement.

The outstanding example of this is the Latin Monetary Union, founded in 1863 and embracing France, Belgium, Switzerland, Italy and later Greece. Each country kept its own nomenclature for its currency, France, Belgium and Switzerland terming their monetary unit the franc, Italy the lira, and Greece the drachma. The important point was that, by the laws of each country, 3,100 of these units must be coined from a kilogramme of gold, ·835 fine, and 200 from a kilogramme of silver. It may be added that all members of the union originally recognized the double standard of gold and silver, in the ratio of 3,100 : 200 or $15\frac{1}{2}$: 1. Based on the gold standard, the par of exchange with England is Frs. 25·2215 equal to one pound sterling. It was only in 1873 that, owing to the depreciation of silver, all the members of the union agreed to limit the coinage of new silver five-franc pieces, and by thus putting an end to the "free coinage" of silver, placed their common currency virtually upon the gold standard. Henceforward, the double standard was known as the "limping standard," in recognition of the fact that silver had been divorced from an equal position to gold.

Certain other countries, although not members of the Union,

employed as their unit of currency a coin equivalent to the franc or lira. Among these were Spain (the peseta), Serbia (the dinar), Bulgaria (the leva), and Rumania (the leu). All these were equal to a franc, lira or drachma at the mint par of exchange.

The other important monetary union was the Scandinavian Union, comprising Sweden, Norway and Denmark. Here the national monetary units even had a common name, the krone. The Scandinavian Union was formed between Sweden and Denmark in 1873, and Norway joined two years later. Kr. 18·159 equal one pound sterling.

The World War broke up both unions. Bank-notes and currency notes were never recognized as currency within the terms of the union, and were never legal tender beyond the frontiers of the issuing country. Currency inflation and restrictions on the import and export of coin and notes, gold and silver, put an end to monetary unions in fact, if not in name, and even when, in recent years, stabilization and revaluation of depreciated currencies has proved practicable, each country has fixed the stabilization point at the level most convenient to itself, regardless of its former associates in the union. Thus the old mint par of exchange of the franc, lira and drachma against sterling was Frs. 25·2215 to the pound. When Belgium stabilized in 1926, the new par was fixed at 35 belgas to the pound. The belga was a new unit, in its turn equivalent by law to five francs, so this means a new par of Frs. 175 to the pound. A year later, Italy was able to stabilize, and she selected the ratio of 366 new lire to 100 old gold lire, thus making the new mint parity 92·46 lire to the pound. The Swiss franc never depreciated, and parity has been kept at Frs. 25·22 to the pound. Finally, in 1926, France stabilized her franc "de facto" at 124 francs to the pound, while in early 1929 the drachma was quoted at 375 to the pound.

Although members of the Scandinavian Union also suffered from inflation, the attacks of the disease were not unduly severe, and recovery proved practicable. The Swedish crown returned to a gold basis in 1924, the first of all European currencies, and a few years later heroic efforts brought the Norwegian and Danish crowns nearly back to par, Norway actually returning to gold in April, 1928. The post-war period also introduced a fourth member, the Estonian kroon. (N. E. C.)

MONETT, a city of Barry county, Missouri, U.S.A., in the Ozark region of the south-western part of the State; a division point on the Frisco railway lines. Pop. (1920) 4,206 and 4,099 in 1930. It is an important shipping point for fruit, especially strawberries, of which 202 carloads were sent out in 1928. The city was founded in 1887 and incorporated in 1888.

MONEY. The word "Money" is believed to be derived from *Moneta,* an attribute of the Roman goddess Juno, because the ancient Roman Mint was established in the Temple of Juno Moneta. It is possible however that the goddess's attribute Moneta was itself derived from the use of the Temple as a Mint.

Money is often described as a *medium of exchange.* If a man exchanges his labour for money, and exchanges the money for food, he is in effect exchanging his labour for food. The money intervenes as a means or medium, received only to be parted with; the end is the food.

Price.—The exchanges in which money is or may be used as a medium are of a certain definite type; they are exchanges organized through markets. In order to arrive at a more precise conception of money, it is essential to make clear what this means. We can imagine casual and isolated exchanges being effected in a primitive state of society. A man exchanges a cow for an ornament. He prefers the ornament to the cow and his neighbour prefers the cow to the ornament, and these preferences are themselves sufficient to bring the exchange about. In a market, however, exchanges are not isolated. The market is so organized that any one contemplating an exchange can compare the things which different people are willing to give for what he has to dispose of, and can select the most favourable offer. He will not exchange an ornament for a cow if he knows that someone else will offer a cow and two sheep. But suppose someone else offers twelve sheep or a carpet, how is he to decide among them all? What is needed is some common basis of comparison of the offers. A solution is to be found in the selection of *one* of the products dealt in, to be used as a medium of exchange. If all the different things are exchanged in the market for specified quantities of this medium, the desired comparison becomes possible. For any particular product no one will offer more or accept less of the medium than his neighbours. The market equalises the terms on which, at any one time and place, all the exchanges are made. In a market so organized every product has its price, the quantity of the established medium for which it will exchange. The price is a definite quantity at a given time and place because, in virtue of the equalizing effect of the market, similar things do not exchange for different quantities of the medium. The comparison of exchanges is a comparison of prices. At the time the comparison is made, the prices are those involved in hypothetical exchanges. Once an exchange has been concluded, it ceases to play a part in the competition of the market; it is no longer available as an alternative.

To quote a price is to make an offer. Acceptance of the offer creates an obligation on the seller's part to deliver the goods to the buyer. On the other side it creates a debt from the buyer to the seller. The debt is discharged by the delivery of money. Thus the market is composed at any time of a number of competing offers of goods at a price, or alternatively of a number of competing bids for goods at a price. Money, the medium of exchange, supplies the unit in which price is reckoned, the measure of value. Money is the means appointed for the payment of debts.

Characteristics Required of Money.—What then are the qualities required of a commodity used as money, if it is to fulfil this function well and efficiently? (1) In the first place it must be the kind of thing that can be specified. If a price is to be quoted in the form of a stated number or quantity, the things used as money must be so uniform or so perfectly graded that they can be counted or measured without individual scrutiny. (2) If things of small value are to be dealt in, in the market, and if small differences of value are to be distinguished, money must be capable of a sufficient degree of subdivision. If cattle were the only money, nothing worth less than a whole cow or ox could be bought or sold, and bargains would have to raise or lower prices by a whole cow or ox at a time. (3) Money is brought to market by every one. It is not like other kinds of merchandise, which are dealt in by specialists who are expected to know all about the stuff they sell. Money should be something easily recognized by everyone and distinguishable from imitations. (4) People carry money to and from the places at which they buy and sell. It should therefore be portable. (5) Those who sell may want to keep the proceeds in the form of money for some time before they have occasion to buy. Money should therefore be something durable, not readily subject to destruction or decay.

All these different qualities were eventually found, after long and varied experience, to be best combined in the two precious metals, gold and silver.

Paper money consists of notes, each made legal tender for a specified amount (denomination) of the money of account, and printed on water-marked paper in such a manner as to make forgery as difficult and unlikely as possible. These notes are mere tokens or tickets, entitling the bearer to pay debts to the amount of their several denominations. They can be issued in high denominations for which coins would be inconveniently big, or in low denominations for which coins would be inconveniently small. (*See* MINT.)

Measurement of Value.—The monetary unit is the common denominator of all market values (prices). So long as it is equated to a prescribed weight of a commodity, such as gold or silver, the measurement of values is a clear enough process. Gold and silver themselves are dealt in on the market, and prices of other commodities simply represent the terms on which they exchange in the market for gold or silver. Paper money itself may be so regulated that the monetary unit is the equivalent of a fixed quantity of gold or silver. For example it may be made convertible, on demand, into coin. In general, countries using paper money have endeavoured to maintain convertibility into metal, and when they have lapsed from it have aimed at re-establishing it. A metallic standard is the universally accepted monetary

policy. Departures from it occur only at times of emergency and transition. Nevertheless such departures do occur, and some times years, and even generations pass before the theoretically normal standard is restored. In such conditions, when the monetary unit is represented by nothing more solid than paper money, what is the significance of a price? In terms of what does the price measure value? This question is fundamental in the theory of money. If all the exchanges in the markets could be settled from day to day, and no debts of any kind remained outstanding till the next morning, the absolute value of the unit would be a matter of no practical consequence. Prices would do all that is required of them by representing the proportions holding among exchangeable values. But in real life not only are debts left outstanding and balances of money kept in hand for indefinitely varying intervals, but pecuniary rights and interests extending over long periods are constantly being created and dealt in. Mortgages, the bonds, debentures and preference shares of companies, the debts of public authorities, national and local, are examples.

Every creditor and every holder of money is concerned in the value of the unit in which money and debts are reckoned. Essentially the unit represents purchasing power. What the creditor possesses is a power of access to markets, where everything is offered at a price. His power over any one product is measured by the inverse of its price. If he wants to buy bread, the greater the price of bread, the less is the purchasing power of a given sum of money in terms of bread. But a creditor does not limit his wants to any one product. He will need to buy a selection from among all the products on sale, and his purchasing power ought to be measured in relation to the prices of this selection. We need to estimate what may be called the "wealth-value" of the monetary unit, its purchasing power in terms of wealth in general. This is a problem admitting of no exact or theoretically perfect solution. The prices of different products are constantly varying in relation to one another, and no possible selection of products can be perfectly typical at all times and places.

What we can do, however, is to construct what is called an index number of prices. In order to compare the value of the monetary units at two different times, we compile a list of products dealt in in the markets at both times, and we express for each product the price at one time as a ratio of the price at the other time. We then take an average of these ratios. For example, if there were five products, and their prices had increased respectively by 2, 4, 6, 8 and 10 per cent, the average increase would be 6 per cent. That means that the purchasing power of the unit in terms of these five products has fallen in the proportion of 106 to 100. The process of averaging can be elaborated by allowing for the relative importance of the products. If one is five times as important as another, it can be reckoned as five products and the other as one. There are many refinements in the theory of index numbers (*see* INDEX NUMBER). What we are concerned with here is that there is a sufficiently definite conception of a price level, measured by an index number, and that the wealth value or purchasing power of the monetary unit varies inversely as the price level. The problem we have to solve is this: how is the price level related to the supply of money? Prices are determined in markets. Dealers who find sales of any product to consumers increasing, and their stocks diminishing, raise prices; if they find their sales falling off and their stocks accumulating, they lower prices. In the one case they give more orders to producers, and at higher prices; in the other they give fewer orders to producers, and at lower prices. They are always seeking an equilibrium price at which their stocks are just kept at a convenient level.

Consumers' Income and Consumers' Outlay.—The price level of all products is settled in the same way as the price of any one of them. Demand is composed of all the money that consumers spend. We must include not only what they spend on consumable goods, but what they spend on investment. In ordinary speech this is said not to be spent but to be saved. But in reality it is spent on the products of which fixed capital is composed. The demand for the services of builders arises from the money spent on the acquisition of houses in just the same way as the demand for the services of bootmakers arises from the money spent on the acquisition of boots. People may apply their savings not to acquiring houses but to buying stocks and shares; but shares represent money spent on the capital assets (plant, etc.) of companies. A man may employ his savings to buy shares from another, but the seller of the shares is then left with money to invest or spend. Without multiplying instances, it is clear enough that money invested is spent. A man devotes his income partly to buying consumable goods and partly, in the form of savings, to buying capital goods or pecuniary rights in capital goods. The total demand for all products is the total of what all people in the community spend from their incomes. The total of incomes may conveniently be called the "consumers' income," and the total spent the "consumers' outlay." These are totals of monetary units.

The price level is determined by the amount of the consumers' outlay; it tends to be such that the consumers' outlay just buys the community's output of wealth, commodities and services, consumable goods and capital goods. If the price level is too high, sales fall short of output, and stocks accumulate. If the price level is too low, sales overtake output, and stocks are reduced. In the one case dealers tend to put prices up, and in the other to put prices down, till equilibrium is reached. Thus, with a given output of wealth, prices are proportional to the consumers' outlay. Any departure from this principle implies an increase or decrease in the stocks of commodities.

The Unspent Margin.—Everyone who receives and pays money, whether it be his own income or the turnover of his business, will in general at any time have a balance in hand unspent, representing the margin of his receipts over his payments up to date. In a country where a banking system exists, this balance need not be money. It may be partly and even mainly composed of bank credit. A debt can be paid not only with money, but by being set off against another debt, and a bank provides facilities for this procedure. A debt due from a banker (bank credit or "credit money") can be assigned from one creditor to another by means of a bank note or cheque. Bank credit tends to be used for all the major payments. A man with a banking account on which he can draw will keep the greater part of his balance in the form of bank credit; the money he holds will be no more than pocket money. On the other hand those who are not rich enough to have banking accounts (numerically the great majority) must keep their balances in money. Anyone's balance, whether it be all money or partly bank credit, will be constantly varying. From time to time, when it grows beyond what the possessor thinks it reasonable to hold as idle money, he will invest a portion (spend it on capital). Through all these variations the balance will tend to a more or less definite norm or average, depending upon his income and circumstances.

If we add up all the balances held in the community, we get a total composed of (1) all the bank credit, and (2) all the money in the hands of the public outside the banks. This total we will call the "unspent margin." The unspent margin excludes the money in the hands of the banks, because this is merely a part of the assets held by the banks against their liabilities to depositors, and these liabilities have already been counted under the heading of bank credit. If money is paid into or drawn out of the banks, the unspent margin remains unchanged; all that happens is that money is transformed into bank credit, or bank credit into money. But if a change in the volume of bank credit is brought about by a change in the total amount of the banks' assets other than money (their "earning assets," such as loans, discounts, investments, etc.), then an equal change is effected in the unspent margin.

The unspent margin may be divided into two parts, consumers' balances and traders' balances. A trader is at the same time a consumer, and his private balance and business balance may not be kept separate, but the existence of such cases does not invalidate the broad division. The consumers' outlay must be equal to the consumers' income, *except* in so far as the consumers' balances change. If the balances increase or diminish over any interval of time, then the consumers' outlay over that interval is less or greater than the consumers' income by the precise amount by which the balances change.

Traders' Stocks.—The consumers' outlay is what is paid to the traders and others who take part in all the processes of production, transport and dealing, by which goods and services of every kind are placed at the consumers' disposal. But the consumers' income itself is simply composed of the remuneration derived, in the form of profits, wages, salaries, rent, interest, from these very processes. (Incomes which are not so derived are directly or indirectly charged upon incomes which are.) If the consumers' income is not exactly equal to the receipts in terms of money derived from the economic activities of the community, that is because there intervenes a class of traders who hold varying amounts of goods in stock, and whose profits are not identical with their net cash receipts, but can only be calculated from a balance sheet. Traders are those who either produce or buy goods with a view to sale. If a trader's sales of goods from stock outstrip his purchases or output, his net cash receipts are in excess of his income. If the sales by all the traders as a group outstrip their output, then their net cash receipts are in excess of their income, and the consumers' income falls short of the consumers' outlay by the difference.

It should be pointed out that traders are constantly buying from one another. Retailers buy from wholesale dealers, and wholesale dealers from producers. Producers buy their materials from wholesale dealers, and dealers buy from one another. But all these transactions are in anticipation of the ultimate sale to the consumer (or to the investor), and their effect is to distribute the price received from the consumer among all the different traders, and the other people engaged in economic activity. To these latter the money payments, in the form of wages, salaries, interest and rent, are pure income. When a trader sells, money is substituted for goods in his working capital; when he spends money on buying or producing, goods are substituted for money. If there were no such thing as credit, a trader's transactions would involve very large fluctuations in the amount of money held by him. In that case, when consumers spend more than they receive and their balances are diminished, the traders' balances would be increased by an equal amount.

Temporary Borrowing.—The use of banking, however, makes the course of events quite different. The holding of a balance of idle money is a source of loss. Instead of keeping a large balance of money in hand to meet any big expenditure that the course of business may make desirable, traders rely on borrowing temporarily from their bankers. They pay interest so long as they need the loan, and then when they receive money they pay it back. Thus goods may pass from trader to trader, and each will become indebted so long as he holds the goods, and will pay off the debt as soon as he sells them. The result is that when the traders' sales are accelerated, they do not hold the extra proceeds in money; they pay off bank advances. And when their sales fall off or their output outstrips sales, they do not meet the situation by reducing their balances of money; they borrow more from the banks. Traders' balances do of course vary. Apart from casual variations, they tend to rise and fall in proportion to turnover. They are also materially affected as we shall see presently, by the prospects of business and the state of credit. But the primary response of the traders to an increase or decrease in cash receipts in comparison with disbursements is to be found not in their balances but in their indebtedness to the banks.

If we imagine a community without banks (as in the middle ages) and suppose an addition made to the supply of money, the people who in the first instance receive the money will find their cash balances disproportionately increased. They will forthwith increase their expenditure. The money then passes into the hands of the traders who supply them, and they in turn will proceed to spend it (*e.g.*, on replenishing their stock in trade, or extending their fixed capital) and pass it on to others who will be placed in turn in the same position. Demand is increased, production stimulated, and the incomes of people engaged in trading and production swollen. Production cannot be stimulated beyond capacity, and as that limit is approached the increased demand takes effect in a rise of prices instead of additional output. Increased output and increased prices alike mean increased consumers' income and consumers' outlay. And as people's incomes increase, they hold increased cash balances. A new state of equilibrium is reached when the requirements of the community in regard to balances have so far increased as to absorb all the additional money.

Expansion of Credit.—In a community with a highly developed banking system what requires to be considered is, not so much an addition to the supply of money, as an addition to the supply of bank credit. In fact an addition to the supply of money, raising people's balances of money above requirements, would probably be immediately paid into the banks and so transformed into bank credit. The unspent margin is composed of bank credit, plus the money outside the banks. Apart from changes in the supply of money, it can be increased or decreased by an increase or decrease in the earning assets of the banks. Suppose, now, that the banks proceed to lend more, that there is what is called an expansion of credit. The borrowers are probably traders. They do not borrow money to hold it idle, but disburse it forthwith on the purchase of goods. The goods purchased have to be supplied or replaced by producers, whose incomes from profits and wages are thereby increased. The money lent by the banks quickly reappears in the form of an addition to the consumers' income. It is almost true to say that, if the banks begin to lend £10,000 a day more than before, the consumers' income is increased by £10,000 a day, though of course no such numerical statement could be exact.

Close on the increase in the consumers' income follows an increase in the consumers' outlay, but not in general an exactly equal increase, for the recipients of the increased incomes will probably retain a little in balances. The increased consumers' outlay is felt by the dealers in commodities as increased demand. They sell more and will apply superfluous receipts to repaying bank advances, but may retain a little in balances in virtue of their increased business. The dealers in commodities, finding themselves with increased sales, reduced stocks and less indebtedness, will be led to give further orders to the producers. The activity of the producers is intensified, they borrow more, the consumers' income is still further swollen, and demand is again increased. Whereas in the first instance the lending by the banks and the consumers' income are made greater by approximately equal amounts, the increase in lending is soon offset by an increase in repayments. The actual increase in the outstanding amount of bank loans (and therefore in the amount of the unspent margin) is limited to the excess of lending over repayments. This excess is equal to the increase in consumers' balances, plus the increase in traders' balances (in fact that is another way of saying that it is equal to the increase in the unspent margin).

As productive activity approaches capacity, prices rise. In fact, unless productive resources are seriously under-employed at the outset, the expansion of credit will very quickly cause a rise of prices. The rise of prices will tend to be such that the consumers' outlay will just buy total output; consumption and production will then keep pace. Equilibrium will be regained when consumers' balances are in due proportion to the consumers' income and consumers' outlay. Their balances cease to increase, and consumers' income and consumers' outlay are equal. The increased lending by the banks is then completely balanced by increased repayments.

A similar analysis applies to a contraction of credit, the case of diminished lending by the banks. Productive activity declines, and the consumers' income decreases. The consumers' outlay also diminishes but to a less extent, because balances are drawn on. Sales fall off, and traders repay bank advances more slowly. With diminished sales and producers under-employed, prices fall. Equilibrium is reached when consumers' balances have been reduced in due proportion to the consumers' income and the consumers' outlay. But in the case of a credit contraction a further period of adjustment may still be required, to bring productive power into full employment again.

Quantity Theory.—In all these cases, if, after the transition is completed, the economic activities of the community revert to what they were before it began, the mutual proportions among in-

comes, balances, prices and other quantities expressed in monetary units will be substantially unchanged. All will have risen or fallen, as the case may be, in proportion to the unspent margin. In practice this does not occur, for economic conditions are constantly changing, and the process of transition itself would probably modify them. Nevertheless the principle that the price level will be proportional to the unspent margin, hypothetical though it be, is one of profound significance. Money is not wealth. It is composed of symbols or tokens, which are valued not in themselves but for what they will buy. All sums of money, incomes, balances, debts, may be regarded as entitling their possessors to so much wealth. The amount of wealth represented by any sum of money is proportional to the number of monetary units it contains and inversely proportional to the price level. A man's balances of money and credit money are determined with a view to his probable receipts and payments. Balances, receipts and payments may be regarded each as the equivalent of a certain amount of wealth. Essentially the process by which the balances are adapted to the receipts and payments takes account of their mutual proportions, and not of the absolute number of monetary units in each. That is to say, had the number of monetary units in each been different, but the amount of wealth represented by each the same, no material difference would have been made in the economic structure of the community. The numbers of money units representing balances, receipts, payments, prices, debts are of the form only; their mutual proportions are of the substance. This is the principle underlying what is called the quantity theory of money, which states that, other things being the same, the price level is proportional to the unspent margin.

The unspent margin is composed of money and bank credit. If among all the things assumed to be the same we include the proportion of bank credit to money, the quantity theory may be enunciated in another form, that the price level is proportional to the quantity of money in the community. This is the older form of the theory, but it has the disadvantage of making one further assumption. The quantity theory is abstract and almost sterile so long as it makes the assumption that "other things are the same." Our earlier analysis enables us to see what the effect of other things varying will be. The price level is proportional to the consumers' outlay, and inversely proportional to the output of wealth (subject to temporary discrepancies due to changes in stocks of commodities). The authorities, whether governments or banks, responsible for monetary and credit policy, have no means of promptly regulating or certainly measuring the consumers' income, the consumers' outlay or the output of wealth; the factor which is ascertainable, and which they keep under observation is the unspent margin. This circumstance gives a special practical importance to the unspent margin and therefore to the quantity theory.

The consumers' outlay and the unspent margin are related together by what may be called the velocity of circulation. If people hold smaller balances in hand in proportion to their receipts and payments, they may be said to "spend money faster." Velocity of circulation is used in more than one sense in monetary theory. It is sometimes (indeed usually) taken to mean the number of times every unit of money or credit money is transferred from one owner to another in a unit of time. But for the purposes of the quantity theory it is more convenient to define velocity as the ratio of the consumers' outlay to the unspent margin. (This is called "circuit velocity" by Messrs. Foster and Catchings.) Velocity is no more ascertainable than consumers' outlay. Changes in velocity have to be inferred from changes in the unspent margin and in the price level. The price level itself has to be measured by index numbers which can never be anything but approximate.

Velocity however is affected by certain known causes, particularly by people's expectations in regard to markets. When demand is active and prices are rising, traders become more unwilling than usual to keep money idle, for the consequent loss of profit is greater; they pay away money for goods as fast as they can. When demand is sluggish and prices are falling, traders become unwilling to add to their stocks of goods. The loss on idle money is diminished, and in extreme cases vanishes altogether; for investment in goods may, owing to a fall of prices, bring an actual loss instead of a profit. With a given unspent margin the consumers' outlay is greater when credit is expanding and prices rising, smaller when credit is contracting and prices falling. Therefore when expanding credit increases the unspent margin, the price level rises more than in proportion, and when contracting credit decreases the unspent margin, the price level falls more than in proportion. On the other hand these exaggerated movements in the price level may be temporarily masked by changes in stocks of commodities. The quantity theory is often misinterpreted to mean merely that when the unspent margin increases prices rise, and whenever it decreases prices fall. But it is more precise than that, for it says that, other things being the same, whenever the unspent margin increases or decreases prices rise or fall exactly in proportion. In the nature of things such a principle can never be proved by practical examples, because the condition that other things remain the same can never be fulfilled. The quantity theory can never be anything but theory; along with the requisite analysis of the "other things," it supplies a clue to the interpretation of the facts.

Relation of the Monetary Unit to the Standard.—We have now shown how the price level or its reciprocal, the wealth value of the monetary unit, is determined. In the earlier sections we have shown how the value of the unit can be fixed in terms of gold or silver. Here are two processes for determining the value of the monetary unit; how are they to be reconciled? Payment by weight automatically equates the monetary unit to a specified amount of the standard metal. The quantity of metal in use as money is bound so to adjust itself that the market value in monetary units of the metal as an industrial material is equal to its value as money. For if its price as a material is too low, some will be diverted from money to industry; if too high, some will be diverted from industry to money. Where coin is used and payment by tale prevails, the adjustment is not so certain. To divert metal from industrial to monetary use, the market price must fall to the coinage price. To divert it from monetary to industrial use, the market price must rise to the melting point of the coin, that is to say, to the point at which the metal in a coin is worth more than the value for which the coin passes current. There may be a gap between coinage price and melting point, not only on account of seigniorage, but possibly on account of imperfection in the coin.

Suppose that for any reason the value of the monetary unit falls, or in other words the price level rises. The rise in prices would be general. Under the conditions of practical life it would not be in identically the same proportion for all products, but any product would, in the absence of any disturbing cause, be affected to approximately the same extent as the average of the others. The market price of the standard metal would rise. If the coins in circulation are imperfect, there is no one melting point applicable to all. The value as bullion of the least imperfect coins would be highest, and would overtake their nominal value first. Thus the best coins would be melted or sold as metal first, and only the more imperfect would be left. Before the modern improvements in the technique of coining, the deterioration of the coinage through the disappearance of all the best coins was a frequently recurrent experience in all countries. An issue of debased or light coin (containing less than the prescribed amount of the standard metal) if added to the existing stock of money, has the effect of depreciating the unit. The good coins of full weight then reach melting point, and their disappearance keeps down the stock of money, and, so long as any of them remain, the depreciation is kept within limits. The debased coin simply displaces the good coin.

This is the principle known as "Gresham's Law." Bad money drives out good. H. D. Macleod rather hastily attributed it to Sir Thomas Gresham on the strength of a letter written to Queen Elizabeth, but he afterwards found that the law had been known long before (*e.g.*, to Oresme and Copernicus). Gresham's law only operates where coins are paid by tale at their nominal value. If the better coins pass in payment at the value of the metal they actually contain, there is no profit in melting them. But it is so

inconvenient to have to allow a variable premium on coins that this does not usually occur.

If the coinage is perfect, all the coins reach melting point at the same time. It must not be inferred that the entire stock of money will be disposed of as metal in a day. As soon as coins begin to be melted, the stock of money is thereby diminished, and the tendency to depreciation is counteracted. Only so much coin is melted as will bring this result about. Paper money convertible into good coin behaves in the same way as good coin itself. If the issue is increased, and the unit tends to depreciate, notes are converted into metal, and so withdrawn from circulation. Without invoking the quantity theory, it is easy to see that an increase in the supply of money must, if it goes far enough, depress the value of the unit, and a decrease raise it. So long as money is composed of a marketable material or is convertible into such a material, the adjustment which raises or lowers the value of the unit so as to be constant in terms of the material is automatic.

The value of the monetary unit in terms of the standard metal is constant, but that does not mean that its value in terms of wealth in general is necessarily constant. Like any commodity the standard metal may be exposed to variations of price not in accordance with the general trend of the price level. But it is also exposed to special influences on account of the very fact that it is used as money. Every country that uses gold or silver as its monetary standard provides a market for the metal at the coinage price, and holds a stock in the form either of coin in circulation or of reserves against paper currency. There is an industrial demand for the precious metals for the production of plate, jewellery, etc., and for various purposes such as the use of gold in dentistry or in the manufacture of fountain pens. But this industrial demand is not easily expanded and is incapable of absorbing any considerable amount of surplus metal. When gold or silver is displaced from the monetary stock of any country, and has to be disposed of, the only adequate opening is in other countries which have the same metal for their monetary standard. If the metal is sold abroad, the proceeds will be held in the form of foreign money or credit money. The out-turn of the transaction will depend on the terms on which this foreign money can be disposed of.

The Foreign Exchange Market.—It is the business of the foreign exchange market to buy and sell foreign money. The things dealt in are pecuniary rights, embodied in bills of exchange, cheques, telegraphic transfers and similar instruments, entitling the possessors to specified sums in foreign countries. For each foreign monetary unit so offered, a price is quoted in terms of the money of the country where the market is being carried on. In order to make clear the working of the foreign exchange market, the best course will be first to consider the general case where currencies may be free to vary independently of one another, and then to pass to the particular case of countries linked by a common metallic standard. The things produced or consumed in any country may be divided broadly into two classes, those which are, and those which are not, suitable for exportation and importation. The former, comprising goods actually exported and imported and goods in competition with exports or imports, may be called foreign trade products. The latter, the goods and services unsuitable for export or import, may be called home trade products. The boundary between the two is not a precise one, but the characteristic of the foreign trade products is that their prices are regulated by international markets, whereas the prices of home trade products depend on local markets only. A foreign trade product has a different price in terms of the currency of every country in which it is dealt in. But these prices are in competition with one another. In virtue of the rates quoted in the foreign exchange market, every currency can be expressed in terms of every other, and the prices of a foreign trade product in any two countries, when so expressed, cannot differ by more than the cost of transporting the product from one to the other (so long as markets are functioning effectively).

If we suppose the consumers' outlay in any country to increase, without any corresponding increase in production, the result will be the increase of consumption. There will be increased demand both for home trade products and for foreign trade products. For the former the increased demand will soon be reflected in a rise of prices. But the prices of foreign trade products are tied down by international markets, and cannot rise appreciably, so long as foreign exchange rates remain unchanged. In the first instance therefore the increased demand will take the form of an increase in the quantity consumed. There will arise an excess of imports; the country will be consuming more than its production will pay for in international markets. The foreign exchange market has to provide for payment for this import excess; dealers will receive more than usual of the country's currency and will part with more than usual of foreign currencies. In order to preserve a balance between their holdings of different currencies, they will offer less of the currencies of which they are short for that of which they hold too much; the country's currency will become cheaper in terms of foreign currencies. When that happens, the foreign exchanges are said to become "unfavourable"; when the value of the country's currency in terms of foreign currencies rises, the exchanges are said to become "favourable." An expansion of the consumers' outlay without any increase in production tends to bring about an excess of imports and an unfavourable exchange; a contraction of the consumers' outlay without any decrease in production tends to bring about an excess of exports and a favourable exchange. The prices of foreign trade products, being approximately fixed in terms of foreign currencies, are raised by an unfavourable exchange, and lowered by a favourable exchange. If the movements in the foreign exchange market are perfectly free, the adjustment of the prices of foreign trade products will correct the excess of imports or exports as the case may be. An unfavourable exchange will check the consumption of foreign trade products, and a favourable exchange will stimulate it. Equilibrium will thus be re-established. An expansion of the consumers' outlay will in any case have raised the price level of home trade products, or a contraction will have lowered it. Thus, provided the foreign exchange rates are free to move, there is in the one case an all round rise of prices, in the other an all round fall.

But if the country shares with its neighbours a common metallic standard, this is not so. If the currency of any country is convertible into gold, and the gold is convertible into the currency of any other, all the currencies are convertible into one another at no greater cost than is involved in sending gold from country to country. Now gold is a foreign trade product, and one very easily transportable. In time of peace the cost of sending it (in considerable quantities at a time), even to the greatest distances, never much exceeds 1% of its value (including insurance and loss of interest). Between London and New York it is about $\frac{5}{8}$%. If the consumers' outlay expands, the prices of foreign currencies cannot rise beyond the point at which they can be acquired by sending gold (called the "export gold point" or "export specie point"). The price level of foreign trade products is prevented from rising beyond the corresponding level. The excess consumption of foreign trade products is therefore not checked, and equilibrium is not regained. The exchanges remain at the export gold point, and gold continues to be exported. The gold in fact pays for the excess of imports. The only way in which the outflow of gold can be stopped is by correcting the undue expansion of the consumers' outlay by which the excess imports are attracted. In a country with no more than a primitive credit system and no paper money, where the greater part of the unspent margin is in the form of coin, gold movements will themselves affect the unspent margin, and consequential changes in the consumers' outlay will follow. The path to equilibrium may be complicated by changes in the circuit velocity of money, but sooner or later the gold movements must be decisive.

A highly developed banking system modifies this process. In the first instance an inflow or outflow of gold takes effect in an increase or decrease in the gold holdings of the banks. If the banks are content to see their reserves modified without altering the total amount of bank money, the effect of the gold movements on the consumers' outlay is suspended. In general, however, banks aim at keeping a nearly constant proportion between their deposit liabilities and their reserves. With that object in view they

expand credit when they receive gold, and contract credit when they lose gold, and these credit movements bring about an increase or a decrease, as the case may be, in the consumers' outlay. The influx or efflux of gold then has much the same effects as if there were no banks, but this depends upon the banks taking the appropriate action.

Central Banks.—Under modern conditions a highly organized system of banking has been evolved. The tendency is to concentrate the responsibility for the regulation of credit and money in a central bank. The central bank is the channel through which paper money is issued, and is responsible for maintaining adequate gold reserves to ensure the convertibility of the paper money. It is also the basis of the bankers' clearing system; that is to say, the other banks (the "competitive banks") pay their liabilities to one another by cheques on the central bank. And when the competitive banks run short of money, the central bank supplies their requirements by lending (by way of rediscounts or advances). The paper money often takes the form of the central bank's own notes, with the privilege of being legal tender. In practice it is not even necessary that they should be legal tender. In the United States the Federal Reserve notes are not legal tender, but are regarded by the public as absolutely on the same footing as money. In some countries the central bank is given a monopoly of the issue of notes, and in some others, where it has no monopoly, the rights of issue of other banks are no more than a survival and are restricted. In these ways the whole responsibility for the paper currency has come into the hands of the central bank. And where gold coin circulates (as in England, Germany and France before 1914) it is on the central bank that the competitive banks and therefore the whole community rely for supplies of coin. People do not take gold to the Mint to be coined, they sell the gold to the central bank for credit, and if they need gold coin they draw upon the credit for it. The price of gold in the market is regulated not directly by the coinage price but by the central bank's buying price. The buying price is fixed close enough to the coinage price to ensure that this practice shall prevail. For example in England the Bank of England is required by the Bank Charter Act of 1844 to buy gold at £3.17s.9d. per standard ounce (11/12 fine), while the coinage price is £3.17s.10½d. The difference—(1·6 *per mille*) is no more (and usually less) than equivalent to the loss of interest incurred in the interval between delivery of gold to the Mint and the completion of the process of coinage.

If the central bank issues notes which are legal tender, and so can pay its liabilities with paper, some special provision is needed to make the notes convertible into gold. For example the notes may not be legal tender in payments by the central bank itself, so that the bank must pay in coin if so required. Or an express obligation may be imposed on the central bank to convert the notes into coin. Or, yet another alternative, the central bank may simply be required to sell gold bullion at a fixed price.

This last method was first suggested by Ricardo, and embodied in the Act of 1819 for the resumption of cash payments by the Bank of England. At that time it never became operative. But the plan was revived in the Gold Standard Act, 1925, and has now become recognised under the name of the Gold Bullion Standard.

Whatever the precise arrangement may be, the general effect is that the central bank is the source of supply of money for the community, and at the same time undertakes to convert gold into money and money into gold. The creation of credit by the competitive banks depends upon their supply of money, and the central bank is therefore in a position to dictate credit policy. Its note issue is backed partly by gold and partly by bills, advances and other securities. It can at any time increase or decrease the note issue by increasing or decreasing its holding of these securities. The competitive banks, when they run short of money, borrow from the central bank, thereby increasing its holding of securities and its note issue; and the terms on which the competitive banks lend to traders throughout the community tend to conform (or can be made to conform) to the terms on which the central bank lends to them. The extent to which an inflow or outflow of gold affects the credit position, and through it the consumers' outlay and the price level, depends upon the response of the central bank. If the central bank so reduces or increases its lending that the change in the amount of gold held is offset by an equal and opposite change in its securities, its total assets and its note issue remain unchanged, and the effect of the gold movement is counteracted. If the relation of the note issue to the gold reserve is prescribed by law, and the central bank treats the relation so prescribed as the guiding principle of its credit policy, then the inflow or outflow of gold will regularly take effect in an expansion or contraction of credit. Where a number of countries have a common metallic standard, the effect is that the currency of each is regulated by reference to the foreign exchanges. As soon as the rate of exchange between any two of them is allowed to vary so far as to reach one of the gold points, gold begins to flow. To observe a gold standard means in effect to keep the foreign exchange rates fixed.

Bimetallism.—Under modern conditions gold is the accepted standard; silver persists only in China, Persia and Abyssinia. In the middle ages silver was the principal standard, but gold was widely used as a merchants' medium. Sometimes two separate moneys of account co-existed, one tied to gold and the other to silver. Sometimes there were even more than two, their market values in terms of one another, of gold and silver, and of various coins being governed by very complex and obscure causes. This state of confusion even now appears in parts of the East. But in Europe economic development gradually brought monetary order. Gold and silver had their respective coinage prices and melting points in terms of one accepted money of account. But infinite trouble was caused because the prices so fixed in different countries were not consistent with one another or with the market values of gold and silver. Each metal flowed out of the countries where it was valued lowest and into those where it was valued highest. The process was really an application of Gresham's law. The mediaeval confusion was one of the consequences of imperfect coinage. By the end of the 18th century matters had improved, and the market value of gold in terms of silver had become a comparatively stable and ascertainable ratio. Now, in the market for the precious metals the demand for use as money has always overshadowed the industrial demand. If all countries, or even if several of the wealthiest countries established bimetallism, *i.e.* the free coinage of both gold and silver, and based their coinage systems on the same ratio of gold to silver, that ratio would govern the market prices of the precious metals all over the world. This actually occurred in the 19th century. *See* BIMETALLISM.

Nowadays a metallic standard has come practically to mean a gold standard. To any one country a gold standard means stable rates of exchange in the others. Three different methods of securing this end may be distinguished. That based on the free coinage of gold may be called a gold specie standard. That based on the convertibility of paper money into bullion is called a gold bullion standard. The third is what is known as a gold exchange standard.

Gold Exchange Standard.—The principle of the gold exchange standard is convertibility of the currency not into gold but into foreign currencies. The central bank or currency authority holds a reserve in the form of bills of exchange or other pecuniary rights in foreign centres, and instead of offering to buy and sell gold at fixed prices, offers to buy and sell foreign currencies. The currency of the country (which may be either paper money or token coins), instead of being convertible into gold, is convertible into foreign currencies which are equivalent to gold. The gold exchange standard presupposes the existence somewhere of a gold bullion standard or a gold specie standard. It can be combined with these other standards in the same country. A central bank may undertake to sell gold at the coinage price, and may yet in practice forestall demands for gold by selling foreign exchange. In general people demand gold for the purpose of acquiring foreign exchange by selling the gold abroad, and if they are offered the foreign money they need they do not ask for the gold. A country which adopts the gold exchange standard gains the advantage of holding interest-bearing assets in place of idle gold. And from the standpoint of the world in general the system has the advantage of

economising gold. It pushes one step further the advantage which the use of paper money brings in this respect, without the dangers of inconvertible paper money.

But the economy of gold itself has dangers. Since the demand for gold for monetary purposes dominates the bullion market, a general diminution of that demand would result in a fall in the wealth value of gold, in other words a rise in the price level in terms of all gold currencies. The probable extent of such a fall in wealth value is illustrated firstly by the fall in the value of silver relative to gold after the abandonment nearly everywhere of the free coinage of silver, and secondly by the rise in the price level which accompanied the extensive displacement of gold by paper money during and after the World War. In the former case the price of silver in London fell from 60d. a standard ounce in 1872 to 22d. in 1903 (*i.e.*, the ratio rose, from 15½ to 1, to 43 to 1). In the latter the price level in the United States (which retained the gold standard) rose from 100 in 1913 to 247 in May 1920.

The problem of future currency policy was considered at the Genoa conference in 1922, at which all Europe was represented, together with Japan and the British Empire. The price level had fallen far from its highest point, but was still substantially above the pre-war average. Recommendations were adopted in favour of a development of the gold exchange standard in order to guard against too great a competition for gold, but at the same time it was proposed that the central banks of the world should co-operate and regulate credit with a view to preventing undue fluctuations in the purchasing power of gold. That meant that the economy of gold arising from the use of the gold exchange standard, while being used to guard against an undesirable appreciation of gold or fall of prices, should not be pushed so far as to cause an undesirable depreciation of gold, or rise of prices.

Price Stabilization.—The general use of paper money has placed the entire monetary stock of gold in the hands of the central banks in the form of gold reserves. It is they who control the market for gold. They stand ready to buy and sell gold in unlimited quantities at fixed prices, that is to say, in each country, at prices fixed in its own monetary unit. In order to prevent fluctuations in the wealth value or purchasing power of gold, they must prevent fluctuations in the wealth value of the monetary units. By credit regulation a central bank can expand or contract the consumers' income and the consumers' outlay, and so can elevate or depress the price level. But in order to carry out an internationally concerted policy of price stabilization, the central banks as a group must be prepared to regulate credit independently of their gold reserves. The price level being held stable, they must be prepared to buy or sell gold, and to see their gold reserves increase or decrease, without modifying their credit policy. To expand or to contract credit would be to raise or lower the price level. This policy of price stabilization by international action, though it has gained very general recognition, is still in an experimental stage. The price level is exposed to many non-monetary influences affecting particular products or groups of products, such as variations in crops, discovery or exhaustion of mines, changes in manufacturing processes. The policy of stabilizing the wealth value of gold requires not that an index number of prices should be kept rigidly fixed, but that those variations which might arise from purely monetary causes should be prevented.

The course of foreign trade and the balance of payments introduce a further complication. A change in the balance of payments modifies the relations between the internal and external price levels. If a country suffers from a shortage of production of foreign trade products, or if it has to make an exceptional external payment, its imports must be curtailed relatively to its exports in order to adjust its visible trade to its new balance of payments. If it is to retain the gold standard, there must be a contraction of credit to bring about a shrinkage of the consumers' outlay. In the same way a country which experiences increased productivity or receives an exceptional payment from abroad maintains equilibrium by expanding credit and bringing about an increase in the consumers' outlay. In the one case the price level of home trade products rises in comparison with that of foreign trade products, in the other it falls. If world prices remain stable, internal prices must rise or fall, and to that extent the price level in the country affected will not be perfectly stabilized.

The preceding sections have been written on the assumption that paper money is convertible into gold. The Genoa plan is based on the continued general use of the gold standard. Proposals have been put forward (particularly by Mr. J. M. Keynes) for applying the policy of stabilization of purchasing power to a paper currency entirely dissociated from gold. The practicability of such a plan is a matter of controversy, and the general return to the gold standard throughout the greater part of the world has made the question an academic one. Apart from schemes of the type favoured by Mr. Keynes, paper money dissociated from gold is a monetary disease. The abuse of paper money became so prevalent during and after the World War, that it has been given an almost disproportionately important place in latter-day monetary theory.

War Finance and Inflation.—The overwhelming exigencies of war drive a country to supplement its tax revenues by borrowing money on a great scale. The amount that can be borrowed from investors is limited to what they can be induced to save. It may not be enough. The Government can neither relax its efforts nor leave its liabilities unpaid. It has recourse to temporary borrowing. Banks lend by creating credit; they create the means of payment out of nothing. Inflation occurs. The consumers' income and the consumers' outlay are swollen, consumption is stimulated, stocks of goods are drawn on, prices rise and the foreign exchanges become unfavourable. There results an outflow of gold. The accepted method of stopping an outflow of gold, a contraction of credit, is not available, and it becomes impossible to continue to provide gold for export. Either the convertibility of paper money into gold is suspended or the export of gold is prohibited; in either case the gold standard ceases to operate. Inflation increases the unspent margin. In a country where bank credit is the principal medium of payment, the money portion of the unspent margin increases after an interval; the requisite increase of the note issue is a condition of the credit expansion, for the banks cannot lend to the Government unless they are assured of whatever supplies of legal tender money may be demanded by their depositors. In a country where bank credit is little developed and paper money is the principal medium, the Government will probably be driven at an early stage to borrow direct from the central bank and to take out the proceeds in paper money. The Government may even shorten the process by printing paper money for itself and paying its creditors with it.

As soon as inflationary finance has led to the abandonment of the gold standard the monetary unit begins to depreciate. The depreciation is likely soon to be accelerated by speculation. People are unwilling to hold balances in a discredited unit. They pay away their money as fast as they can in exchange for "real values," for things, that is, of which the value does not depend upon the monetary unit. They buy commodities, or ordinary shares, or foreign currencies—anything which can rise in price as the value of money falls. When people pay away balances, they can only pay them to one another. The aggregate of balances cannot decrease. The unspent margin has been swollen by bank advances to the Government and cannot be decreased except by repayments. When people accelerate their payments the effect is to increase the consumers' outlay out of proportion to the unspent margin. And along with the consumers' outlay the consumers' income increases. The velocity of circulation is increased. The result is that the price level is raised *more* than in proportion to the unspent margin. A rapid rise of prices disorganizes markets. The prices of different products rise very unequally. People buy things for a temporary investment rather than for consumption. For such an object foreign currencies are a more convenient acquisition than any commodity, and it sometimes happens that there is a rush to the foreign exchange market which raises the rates of exchange, and therefore the prices of foreign trade products, out of all proportion to the prices of home trade products. The same discredit of the currency which leads people to pay away balances of cash, impels them to borrow from the banks. It is highly profitable to borrow for a short period and to use the proceeds to buy

commodities or foreign exchange, if in the interval before repayment the money value of the things bought has risen by an amount many times the charge for interest. The currency units in which the loan is repaid are worth much less than those in which it was originally received. If temporary borrowing is stimulated, that means that the banks create more credit and the unspent margin is further increased, and all the effects of inflation are accentuated. Moreover discredit of the currency makes long-term borrowing impossible. People will not put their savings in investments which depend for their value upon a depreciating unit. The Government, having started inflationary borrowing, finds that it cannot borrow in any other way. A vicious circle of inflation is set up, and it is only too likely to end in a complete breakdown of the currency system, the value of the unit in gold or in wealth dwindling to an infinitesimal fraction of its former parity.

Devaluation and Deflation.—When discredit has brought depreciation of the unit beyond a certain point, a restoration of the former gold value becomes impossible. The gold standard can only be restored by devaluation, the adoption of a new parity, not differing by much from the existing gold value of the currency in the market. Devaluation was common in the middle ages, when the imperfection or debasement of the coin had led to a depreciation of the unit, and a restoration was deemed impracticable or undesirable. Nowadays it is sometimes denounced as being something like a fraud, which robs creditors of their due. This is a misapprehension of the real nature of a monetary standard. The equivalence of the monetary unit to a specified weight of gold or silver is established by law and can be altered by law. Creditors have no vested right in the maintenance of the law unchanged. On the other hand when the depreciation is not so great as to make a return to the old parity with gold impracticable, there are real advantages in re-establishing it. The old parity commands confidence in a way that no new parity could do.

The process by which a currency is raised in value, either to its former gold parity, or to a new parity above its existing value, is called deflation. Deflation requires a diminution of the consumers' income and the consumers' outlay, and is usually effected by means of a contraction of credit and similar measures. The shrinkage of demand and the fall of prices have a paralyzing effect on enterprise, causing trade depression, unemployment and bankruptcies. It is on account of these injurious consequences that the value of a currency unit can only be raised to a very limited extent. One of the features of the "trade cycle" (the periodic fluctuations of productive activity familiar to economists between 1815 and 1914) was a general worldwide rise of prices, followed by an equally general contraction of credit and fall of prices. The unemployment and trade depression characteristic of the latter phase of the cycle were symptoms of deflation, though the preceding inflation, applying as it did to all gold standard countries, was not based on inconvertible paper money. (*See* also BANKING AND CREDIT; CURRENCY; QUANTITY THEORY OF MONEY; CHEQUE; BILL OF EXCHANGE; MONEY MARKET; BANK RATE; INFLATION AND DEFLATION; TRADE CYCLE; DOLLAR STABILIZATION, etc.)

BIBLIOGRAPHY.—F. A. Walker, *Money* (1878); W. S. Jevons, *Money and the Mechanism of Exchange* (17th ed., 1907); Irving Fisher, *The Purchasing Power of Money* (1918); G. Cassel, *The World's Monetary Problems* (1921), and *Money and Foreign Exchange after 1914* (1922); A. Marshall, *Money Credit and Commerce* (1923); J. M. Keynes, *A Tract on Monetary Reform* (1923); D. H. Robertson, *Money;* H. Withers, *The Meaning of Money* (1923); G. F. Knapp, *The State Theory of Money* (1924); W. T. Foster and W. Catchings, *Money* (1923); J. R. Bellerby, *Monetary Stability* (1925); R. G. Hawtrey, *Monetary Reconstruction* (1926); *The Gold Standard in Theory and Practice* (1927); *Currency and Credit* (1928); E. Cannan, *Money in Relation to Rising and Falling Prices* (1926); K. Hellferich, *Money* (1927); A. Burns, *Money and Monetary Policy in Early Times* (1927). (R. G. H.)

MONEY, QUANTITY THEORY OF: *see* QUANTITY THEORY OF MONEY.

MONEY BILL: *see* PARLIAMENT.

MONEY-LENDING. In primitive societies the taking of interest for the loan of goods or services rendered, in transactions between members of the same community, was unknown. All that was expected was the return of similar goods or services. With the substitution of money for corn and cattle, this idea that advantage must not be taken of the necessities of one's kindred still prevailed, and it was adopted in Europe by the Church. Thus in England it was unlawful at common law for a Christian to take interest on money lent, a prohibition enforced by various mediaeval enactments on usury (*q.v.*).

In 1897 a select committee of the House of Commons, after an exhaustive enquiry adopted the proposal originally made by the present writer that the equitable doctrine of unconscionable bargains with heirs and reversioners should be applied to all money-lending transactions. This proposal, with further provisions, was embodied in the Money-Lenders Act 1900. By this statute, although there is no restriction upon the rate of interest, where proceedings are taken by a money-lender for the recovery of money lent or the enforcement of any agreement or security, and there is evidence that the interest charged is excessive or that the amounts charged for expenses, enquiries, fines, bonus, premium, renewals or any other charges are excessive, and that in either case the transaction is harsh and unconscionable or is otherwise such that a court of equity would give relief, the court may re-open the transaction and take an account between the money-lender and the person sued, and may, notwithstanding any statement or settlement of account or any agreement purporting to close previous dealings and create a new obligation, re-open any account and relieve the borrower from payment of any sum in excess of the sum adjudged by the court to be fairly due, as the court, having regard to the risk and all the circumstances, may adjudge to be reasonable; and if any such excess has been paid or allowed in account by the debtor, may order the creditor to repay it, and may set aside or revise any security or agreement, and if the money-lender has parted with the security may order him to indemnify the borrower.

In proceedings under the Betting and Loans (Infants) Act 1892, where a money-lending circular is sent to an infant the sender shall be deemed to have known that the person to whom the document was sent was an infant, unless he can prove that he had reasonable grounds for believing such person to be of full age. A money-lender is defined as a person whose business is that of money-lending, or who advertises or announces himself or holds himself out in any way as carrying on that business, but does not include a pawnbroker, a friendly society, a body corporate empowered by special act of parliament to lend money, a banker or a body corporate exempted by order of the Board of Trade.

By the Money-Lenders Act 1927 ss. 2 and 3 of the Money-Lenders Act 1900 are repealed and the whole of the Money-Lenders Act 1911. Every money-lender must now take out annually, whether carrying on business alone or as a partner in a firm, an excise licence in respect of every address at which he carries on business. Such licence must show the money-lender's authorized name and authorized address or addresses. Such name and address means those under which a money-lender is authorized by a certificate to carry on the business of money-lending. The name must be his true name. The duty on an excise licence is £15. The certificate, which is only granted upon evidence of good character, capability and responsibility, may be granted by a petty sessional court. If refused there is an appeal to quarter sessions. The money-lender's name must be stated on all documents issued by him. Restrictions are also imposed on money-lending advertisements and the employment of touts is prohibited. No contract is enforceable unless a note or memorandum is signed by the borrower, and a copy thereof given to him. Such note must contain full particulars of the loan. Compound interest is prohibited, and the rate of interest may not be increased by reason of any default in payment. Upon request the money-lender must supply to the borrower information as to the state of the loan. Where the interest exceeds the rate of 48% the court, unless the contrary is proved, shall presume that the interest charged is excessive and the transaction harsh and unconscionable. A charge for expenses in negotiating a loan is made illegal. Proceedings for the recovery of money lent must be brought within 12 months from the date on which the cause of action accrued. The act applies to Scotland,

but not to Northern Ireland.

See H. H. L. Bellot, *Legal Principles and Practice of Bargains with Money-Lenders* (1906); G. Stone and D. Meston, *Law Relating to Money-Lenders* (1927). (H. H. L. B.)

United States.—In the United States each State may prescribe its own maximum rate of interest, although a few do not fix any. National banks conform to the legal interest rate of the State in which they are located, and if in a State where no legal rate is established they may not charge more than 7%. A charge of interest above the legal rate constitutes usury, for which offence various penalties are prescribed by the laws of different States. In Maryland, New York and New Jersey corporations, when borrowing money at rates in excess of the legal rate, are precluded from setting up the defence of usury, and hence are legally bound by any contract they may make to pay interest at any rate. The laws of the State of New York permit demand loans of $5,000 or more, for which stock or bonds or other negotiable instruments have been pledged as security, to be made at any interest rate. A time loan, however, with stock exchange collateral, at a rate higher than 6%, is usurious. In many States where a regular legal rate is fixed there is permitted a higher rate by special contract. Lenders often evade the legal rate of interest law by charging the borrower a "commission" in addition to the interest.

The legal rates of the various States and Alaska and some of the particular provisions are as follows:—

Alabama—8%; by contract 8%; lender forfeits interest as penalty for usury. *Alaska*—8%; by contract 12%. *Arizona*—6%; by contract 10%; penalty as in Alabama. *Arkansas*—6–10%; by contract 6–10%; lender forfeits principal and interest as penalty for usury. *California*—7%; by contract 12%. *Colorado*—8%; by contract 12%. *Connecticut*—6%; by contract 12%; penalty for usury of imprisonment or fine or both and no action may be brought for recovery of either principal or interest. *Delaware*—6%; by contract 6%; but parties may agree in writing on any rate where the loan exceeds $5,000 on accepted collateral security and is payable on demand. No penalty for usury, but action at law may be had for recovery of interest over 6%. *District of Columbia*—6%; by contract 8%; penalty as in Alabama. *Florida*—8%; by contract 10%; penalty as in Alabama. *Georgia*—7%; by contract 8%; penalty as in Alabama. *Idaho*—7%; by contract 10%; penalty as in Alabama. *Illinois*—5%; by contract 7%; penalty as in Alabama. *Indiana*—6%; by contract 8%; lender forfeits excess interest as penalty for usury. *Iowa*—6%; by contract 8%. *Kansas*—6%; by contract 10%. *Kentucky*—6%; by contract 6%. *Louisiana*—5%; by contract 8%. *Maine*—6%; by contract any rate. *Maryland*—6%; by contract 6%; but 3½% per month may be charged on petty loans of $300 or less made by specially licensed loan agencies. Corporations are precluded from setting up usury as a defence. *Massachusetts*—6%; by contract any rate. *Michigan*—5%; by contract 7%. *Minnesota*—6%; by contract 8%. *Mississippi*—6%; by contract 8%. *Missouri*—6%; by contract 8%. *Montana*—8%; by contract 10%. *Nebraska*—7%; by contract 10%. *Nevada*—7%; by contract 12%. *New Hampshire*—6%; by contract any rate; lender forfeits three times the excess interest as penalty for usury. *New Jersey*—6%; by contract 6%; lender forfeits all interest as penalty for usury. Corporations are precluded from setting up usury as a defence. *New Mexico*—6%; by contract 10% if there be collateral security for the loan, 12% if there be no collateral security. Lender forfeits double the interest as penalty for usury; usury is also a misdemeanour punishable by fine. *New York*—6%; by contract 6%; demand loans of $5,000 or more secured by negotiable collateral, any rate; corporations are precluded from setting up usury as a defence. Contract is void as to both principal and interest as penalty for usury; usury is also a misdemeanour. *North Carolina*—6%; by contract 9%; penalty as in Alabama. *North Dakota*—6%; by contract 10%; penalty as in Alabama. *Ohio*—6%; by contract 8%; penalty as in Indiana. *Oklahoma*—6%; by contract 10%; lender forfeits double the interest as penalty for usury. *Oregon*—6%; by contract 10%; lender forfeits both principal and interest as penalty for usury. *Pennsylvania*—6%; by contract 6%; special provisions for licensed money-lenders; penalty as in Indiana. *Rhode Island*—6%; by contract 30%. *South Carolina*—7%; by contract 8%. *South Dakota*—7%; by contract 12%. *Tennessee*—6%; by contract 10%. *Texas*—6%; by contract 10%. *Utah*—8%; by contract 12%. *Vermont*—6%. *Virginia*—6%; by contract 6%; bankers, brokers and moneyed corporations may loan money or discount at not exceeding ½ of 1% for 30 days, minimum fee 50 cents. Exceptions in favour of insurance companies loaning money on insurance policies. *Washington*—6%; by contract 12%. *West Virginia*—6%; by contract 6%. *Wisconsin*—6%; by contract 10%. *Wyoming*—7%; by contract 10%; lender forfeits interest as penalty for usury. (J. H. B.)

See F. W. Ryan, *Usury and Usury Law* (Boston, 1924).

MONEY MARKET. This term is sometimes used to include the whole machinery of a financial centre and so to include the Stock Exchange and the instruments of company promotion. More usually, it is confined to the organization which provides credit of short duration, consisting of the banks which make advances for short periods, the discount houses which buy and sell bills of exchange, the accepting houses or merchant bankers which, with the banks, provide trade with first-class bills by putting their name to them for a small commission. Dealers in exchange who buy and sell foreign currencies and foreign bills of exchange, are also sometimes included, but in London the parlance of the City usually confines the term to the banks, the accepting houses and the discount houses.

At the centre of the system stands in London the Bank of England, and in other centres the central bank, which derives most of its power and prestige from acting as banker to the Government and to the other banks, receiving deposits from them and making advances to them, though in London, as will be explained, the Bank of England's advances to banks are seldom made directly. In America, owing to its vast area, there are twelve central banks known as Federal Reserve banks, co-ordinated under the regulation of a Federal Reserve board which sits at Washington. The Bank of England is peculiar as a central bank by reason of its freedom from Governmental control, though this freedom is more apparent than real. While in other countries it is usual for the Government, by a power of appointing part of the board of directors and sometimes by owning part of the capital, to have a direct influence on, or interest in, the operations of the central bank, the Bank of England is by its constitution, a joint-stock bank owned by shareholders who are members of the general public, with its board elected nominally by the shareholders, though in fact any vacancies are filled by the board itself subject to confirmation by the shareholders. But while the Bank of England is thus, in appearance, an ordinary company working to earn dividends for its shareholders, the prestige that it gains from acting as banker to the Government gives the latter, as its most important customer, power to exercise strong influence on its policy. In actual practice, the bank and the Treasury work together to regulate England's monetary policy, especially since the World War, which, by creating a huge public debt, both long-dated and floating, has made the Government a much more important factor than it was before in the monetary position. On the other hand, in other centres, especially in Europe, although Government influence over the central bank is more direct, the experiences of the war and of the after-war period have demonstrated the necessity for freeing the bank from it as far as possible, especially in the matter of confining the power of the Government to demand unlimited advances from the bank.

The need for this restriction arises from the fact that advances made by a central bank increase the amount of money, or purchasing power, in the hands of the community, whether the advances are made in the form of bank-notes issued for this purpose or in the form of a credit in the bank's books (as is done in England) against which the Government can draw cheques; the cheques are paid in to their banks by the contractors and others who receive them; and the advance made to the Government increases the amount of "cash in hand and at the Bank of England" held by the other banks, and so widens the foundations on which

they build their credit operations. The same increase in purchasing power is effected whenever a central bank makes an advance to any kind of borrower, and its power to widen the basis of credit, when moderately exercised, gives great elasticity to the monetary systems of those countries in which it has been highly developed. Those who charge the English banking system with cast-iron rigidity because the Bank of England's note issue has to be covered (above a certain fixed line) pound for pound with gold, forget that the bank's power to create credits in its books, by making advances or by buying securities, is regulated solely by the bank's own prudence. The ease with which a central bank can create new purchasing power, either by the printing press or by entries in its books, afforded, during and after the war an easy way of financing themselves to impecunious Governments which had not enough courage to tax their citizens or reduce expenditure; when purchasing power is increased without a corresponding increase in goods to be purchased, prices go up and inflation begins with disastrous consequences if carried too far. Hence the need for restricting the demands of Governments on central banks, to which is entrusted the duty of regulating the supply of money so as to maintain the country's gold stock and the exchange value of the currency, which is liable to immediate deterioration if inflation sets in. This duty of maintaining the gold stock has been always an especially important part of the Bank of England's functions, owing to London's exceptional position (now shared by New York) as a free gold market, and by performing this duty and acting as the banker of the Government and the other banks it has long ceased to be a company working for its shareholders (though it incidentally earns them a dividend) and become a national institution, working to give the country sound money.

Expansion and Contraction of Credit.—This it does by expanding and contracting the volume of credit and by varying its price. It expands credit by making advances and buying securities, so giving the power to those who borrow from it or sell to it to draw cheques which they can pay into their banks, or to take notes from it which they can put into circulation or turn into gold for purposes of export; it contracts credit by selling securities or by borrowing in the market from the discount houses and other large dealers in money and it regulates the price by raising or lowering its rate of discount, at which it buys bills of exchange, and its rate for advances, which is usually $\frac{1}{2}\%$ higher. By making changes in its official rate it affects the general price of credit throughout the country, because the other banks base on Bank rate the rates that they allow to depositors (subject to the bargaining power of the depositor) and the rates at which they make advances to their borrowing customers. The effect of a rise in bank rate thus makes credit dearer to all who are engaged in business and so tends to induce them to reduce their commitments by selling commodities that they are carrying on borrowed money; a lower level of prices is thus produced which stimulates exports and reduces imports and tends to turn the foreign exchanges in favour of London and to check demands on its gold stock, to protect which a rise in bank rate is usually designed. By these methods the central banks of the countries which have currencies based on gold, work to maintain the value of the national money as measured in those of other countries and so give to international trade the immeasurable blessing of comparatively stable rates of exchange, which is the chief justification of the gold standard, in spite of the obvious drawbacks to which its critics can point. It is true that gold, owing to the large fluctuations in its rate of output has failed, in the past, to provide the world with a stable measure of value; but the use of the gold standard by the chief commercial countries of the world knit all their currencies together by means of the gold link, made price movements in all of them more or less uniform, and prevented the wild fluctuations in exchange which made foreign trade a gamble during the after-war period, when the gold standard was for the time being abandoned. It may also be hoped that closer co-operation between central banks and a more conscious and general effort towards the stabilization of prices will produce greater stability in spite of fluctuations in the output of gold, until the time arrives when the world is sufficiently civilized to be able to adopt an international paper currency.

When credit has to be expanded, owing to seasonal demands such as occur regularly at the end of June and still more at the end of December, a large business is usually done by the Bank of England in discounts and advances, the other parties to the transaction being generally the discount houses. It is not usual in England for the banks to borrow directly from the central bank—they keep habitually a large amount of money lent, from day to day or for a week, to the discount houses and when they wish to reinforce their holding of cash, they call in part of these funds from the latter, who are thus obliged, if the process goes far enough, to borrow from the Bank of England, either by taking bills to it for discount, or by applying to it for advances. By this method, new credit is created by the Bank of England which is paid in by the discount houses to their banks and increases the latter's holding of "cash at the Bank of England."

The Provision of the Means of Payment.—On the basis of the credit provided, or the notes issued, by the central bank, the other banks in countries such as America and England, with a developed banking system, provide the community with the deposits which are potential money, because they confer on their owners the right to draw the cheques, by which the immense majority of commercial transactions are settled. The central bank issues notes and creates deposits with an eye on the relation between its gold and its liabilities in the form of notes and deposits outstanding. In America a proportion is fixed by law which has to be maintained by the bank subject to the possible payment of a tax. In England there is no law about the amount of deposits that the bank may have in relation to gold reserves, but all notes above a hard and fast line have to be backed by gold. There is much to be said in favour of both systems, and the one adopted in America is generally approved and adopted in other countries; but the difference between them is largely formal and is not nearly so important as the skill and prudence with which the system is handled by those in charge of it. The notes issued by the central bank except the American Federal reserve notes are "legal tender" —that is, have to be accepted by creditors in payment of debts. (In England Treasury notes are legal tender, but it may be hoped that by the time these words are published, this war-time excrescence on the British monetary system will have been abolished, and the Treasury notes fused with the Bank of England's note issue). The credits in the books of the central bank, and the cheques that can be drawn against them are not legal tender; but the credits are counted by the other banks as "cash" and give them the right to demand legal tender from the central bank.

On this foundation of legal tender money and credit at the central bank the other banks (the "commercial banks" as they are sometimes called) build a larger structure of credit by buying securities and making advances to their trade and general customers. Having only been gradually evolved into a central bank, the Bank of England still does a certain amount of business for private customers; but the American Federal Reserve banks, and other central banks set up in the light of modern experience, are usually confined to the task of working for the Government and for the other banks. When a central bank makes advances or buys securities it creates deposits for itself, because whichever of the commercial banks receives the credit so created will add it to its balance at the central bank; but when a commercial bank makes advances or buys securities it creates deposits possibly for itself, if the cheques drawn against the new credit that it makes are handed to its own customers who pay them in to their accounts with it, but more probably for one of its rivals who, however, are at the same time creating deposits for it.

Credit and Industry.—When a customer of bank A borrows from it £10,000, the immediate effect of the transaction is an addition of this sum to the customer's current account on the liabilities side of the balance-sheet and of the same amount to the "loans and advances" item on the assets side, and a consequent slight decline in the proportion between the bank's holding of cash and its total of liabilities. If the customer, who has, of course, borrowed the money to use, draws a cheque for £10,000 in favour of another customer of bank A who pays it in to his account, as he naturally would, then bank A's deposits are perma-

nently increased as long as the advance is outstanding. If, as is more likely, the borrowing customer draws a cheque which goes to a customer of bank B, then bank A's deposits go back to their original figure, and £10,000 of its cash at the central bank is transferred through the machinery of the clearing-house from its account to that of bank B; the final result of the transaction is that bank A shows no change in its liabilities, but has changed £10,000 of its cash at the central bank into "loans and advances," so slightly lowering its proportion of cash to liabilities while the bank B has received an addition of £10,000 both to its deposits and to its cash at the central bank.

By the evolution of this system by which the banks can grant credits, which being transferred by cheque from one to another, increase the total of the deposits which they handle, a magical and unlimited power of creating purchasing power is often attributed to them. But in practical fact this power is limited in many countries by law—as in the United States, where the banks are obliged to maintain a certain proportion between cash and liabilities; and even in England where the law leaves the banks free to conduct their business as their prudence and experience directs them, they are always careful to maintain a proportion between cash and liabilities such as is required by safety and by banking conventions. Since the amount of cash at the central bank that is available for them can be varied by the central bank, thanks to its power to contract and expand credit, the policy of the commercial banks is thus closely affected by that of the central bank, though at times when a country's financial position is abundantly strong, the commercial banks, with a comfortable margin between them and the possibility of stringency, have a good deal of latitude in the conduct of their business. The theory, that the banks exercise a despotic tyranny over industry, and by their distribution of credit, decide what is, and what is not, to be produced, is largely a delusion. In spite of amalgamations, competition among them is still so keen that they cannot afford to refuse any solvent customer the accommodation to which his position entitles him; and their dependence on public confidence is so complete and so vital, that they dare not make advances unless they have reasonable confidence that they will be repaid. In granting credits the only question that they can consider is whether the customer's obligation is likely to be met—in other words whether he is going to use the money in some enterprise which will pay, by satisfying some public demand; and so it is public demand, well or ill exercised, which finally decides who is to get credit, and not the banker, who merely interprets it.

The Loans and Advances, by which the banks foster production and trade, are usually the most important item in the assets which they hold being rather more than half of their deposits. At the same time they are the least liquid of their resources, because though nominally recoverable on demand or at short notice, they cannot be called in at times of stringency without inflicting serious inconvenience on customers whose solvency the banks would be most reluctant to endanger. It is thus on the other items in their assets that the banks have to rely, in order to secure that liquid position which is the ideal of prudent banking. Their holding of legal tender cash and cash at the central bank is their first line of defence and after that come the loans at call and short notice which they make to the discount houses, for financing the stock of bills of exchange carried by the latter, and to the Stock Exchange for financing securities that have not yet found a home or are being carried by speculators for the rise. Stock Exchange loans are usually arranged from one settlement to another and so run (in England) for about a fortnight and are less liquid than the loans to discount houses which run from day to day or for a week. It is on these last that the banks, as has been shown, rely at times of seasonal pressure to reinforce their cash holding, calling them in and so obliging the discount houses to produce fresh credit by borrowing from the central bank. The banks' holding of bills of exchange is another highly liquid item because they can arrange so as always to have a certain proportion falling due day by day or any date they may anticipate pressure. Bills of exchange drawn against commodities of general consumption and accepted by banks and firms (*see* MERCHANT BANKERS) of first-rate standing are the most liquid of investments because they do not have to be sold but are paid when due; and the Treasury bills which, since the war caused a huge increase in the floating debt, now form so large a part of the stock in trade of the discount market, have the same advantages with Government security added. The banks' investments—generally a comparatively small item in their assets—are usually confined to Government stocks and other "gilt-edged" securities.

See also the articles BANKING AND CREDIT; MONEY; BANKS; CHEQUE; BILL-OF-EXCHANGE; MERCHANT BANKERS; and the bibls. attached thereto. (H. WIT.)

THE NEW YORK MONEY MARKET

The focus of the American money market is New York. There are other subsidiary money centres such as Chicago, St. Louis and San Francisco, but the facilities of these secondary markets are not sufficiently extensive to attract a large volume of funds. The growth of a money market is conditioned not only by the opportunities that it offers for the profitable employment of funds but equally by the facility with which it permits their release. New York offers large possibilities in both directions. Security operations in New York require enormous sums. Flotations of new securities on a large scale for governmental and large private business corporations are handled by New York houses. The annual offering of new securities reaches almost ten thousand million dollars. Between the initiation of such new issues and their final absorption by investors large sums are needed by the officiating bankers, and such sums are normally borrowed. Speculative operations in stocks and bonds in the New York market conducted usually on a marginal basis likewise require great sums.

New York is also the bill and commercial paper market of the country. Dealers in bankers' acceptances have their headquarters in New York city. They buy such acceptances or "bills" as fast as these are created, paying for them mostly with borrowed money, and then turn them over to any bank, firm or individual having free funds to invest. Similarly the commercial paper dealers and brokers have their main offices in New York. So-called "commercial-paper" is made up of the single-name promissory notes of large, nationally known firms who finance some of their operations through the creation and sale of these instruments.

Foreign Exchange Market.—The American foreign exchange market centres are in New York. New York banks and banking houses have large foreign departments. They have branches, agencies, offices or correspondents in the chief centres of the world. Foreign exchange of all kinds and in all forms is bought and sold in the New York market. Most interior banks do not have a large enough foreign business to justify the organization of an independent foreign department. Hence for their foreign business they rely on their New York correspondents. For New York this represents the confluence of innumerable streamlets of foreign exchange business which, however, when finally brought together constitute a mighty tide. Rates determined in the New York market are telegraphed to all interior points and supply the basis on which business is done. The conduct of the foreign exchange business, however, requires the constant maintenance in New York of large balances belonging to interior institutions.

New York's position of leadership in manufacturing and commerce contributes to its financial leadership. It is not only the chief manufacturing city of the country but also the principal port, the leading city in wholesale distribution, and the centre of the printing and publishing trades. Large sums are constantly needed in New York to finance its manufactures, its domestic and foreign commerce and its output of newspapers, magazines and books.

Structure of the New York Money Market.—The foundation of the money market is naturally the Federal Reserve system. This system holds the underlying reserves of gold and of other "lawful money." It supplies currency when there is need for it. It supplies gold for export and makes imports of gold available for domestic credit operations. The main dealings of the Federal reserve banks are with member banks and with the Government, although they also carry accounts for foreign banks, and, for exchange and check collection purposes, with domestic, non-mem-

ber banks. They may also engage in open-market operations in bankers' acceptances and in governmental securities. The active conduct of affairs on the supply side of the money market is, however, primarily the affair of the ordinary banks. These are national banks, organized under Federal law, and State banks and trust companies chartered under the laws of New York State. Besides the large banks and trust companies there are also agencies of foreign institutions and domestic and foreign private banking firms of all kinds.

Related Agencies.—Mention must be made of the related agencies. There are money brokers who act for the banks on the floor of the stock exchange; there are acceptance firms and dealers who, for a small commission, help to create, assemble, distribute and perhaps again subsequently to turn over, acceptances in the market; there are the commercial paper houses and the dealers who handle the marketing of single-name promissory notes. Finally reference may be made to a fringe of individual money brokers and middle-men who function as intermediaries between borrowers and lenders.

On the demand side of the market the alignment is equally diverse. First may be mentioned the stock exchange brokers who finance their customers' marginal operations. From 50 to 80% of the funds needed by the brokers for this purpose are obtained from the market in call and time loans. On the demand side also are arrayed the bond and security dealers. They not only arrange for financing new issues but also carry on extensive over-the-counter bond trading. They are heavy borrowers from the banks. The acceptance dealers also figure primarily on the demand side. They borrow on call or on time from the banks and in times of unfavourable money rates they may get direct relief from the Federal reserve bank through the open market.

Classed with the acceptance dealers are the commercial paper houses. They too have to borrow in order to carry their lines of paper pending its final sale to the ultimate purchaser. Finance companies of divers kinds also play a considerable rôle in the market. They handle "instalment" or "conditional sales" paper arising in sundry fields. They finance the dealers in automobiles, pianos, radios and numerous other articles sold in America on the instalment plan.

Lastly may be mentioned the host of other corporations, firms and individuals who require funds. These borrow to some extent on stock exchange collateral, on the security of warehouse receipts covering the great staples, or on some other satisfactory form of property. The prevailing American practice in such firm or individual borrowing, however, is based upon the extension of unsecured "lines" of credit involving the use of the single-name promissory note.

Operation of the New York Market.—The most sensitive element in the New York market is the "call-money" market. Call loans are made principally on stock exchange collateral but to some extent, also, on bankers' acceptances and other acceptable security. They may be negotiated directly with the banks, or obtained through money brokers or at the "money desk" in the stock exchange. The nature of the call loan makes it a very satisfactory short-term investment for the lender. It is not only amply secured but is, as well, subject to repayment at the lender's request. Rates on call loans are relatively low due to the narrowness of the field in which they can be employed as compared with the abundance of funds the market supplies. Owing to the highly competitive nature of the market call rates are extremely sensitive. The money flowing into the call market is made up of temporary surpluses. This money comes from all over the country. While call loans are extended through the New York banks, in many cases these act simply as the agents of out-of-town banks or of other customers. Indeed, the New York institutions often lend in the stock market more of out-town money than they do their own. The members of the stock exchange are also heavy borrowers of time money. These borrowings may be arranged through the money brokers or they may be negotiated by brokerage firms with their own banks.

Acceptances.—Less sensitive than the call-money market is the bill market. This is the market in which primarily bankers' acceptances, but to a slight extent also so-called "trade acceptances," are dealt in. The foundation for the bill market was laid by the Federal reserve act. The market has been built up since 1916. In 1928 acceptances outstanding exceeded one thousand million dollars. Acceptance procedure has developed primarily in connection with foreign trade, but a beginning has been made in applying it also to domestic trade. Acceptances are ordinarily purchased by dealers who offer them for sale to banks, firms and individuals with funds to invest. The bills may change hands several times before maturity. The rate at which acceptances are discounted is spoken of as the "open-market" rate and it is determined by competitive conditions of demand and supply.

The reserve banks are heavy buyers of acceptances. These institutions have constantly endeavoured to develop the acceptance market. They stand ready to take eligible bills without limit at the open-market rate. Dealers in acceptances are thus never left with an unsold surplusage. This attitude on the part of the reserve banks assures the maintenance of an open market. Member banks themselves will often sell holdings of their bills to the Federal reserve banks to replenish reserves. The acceptance market thus helps to promote general flexibility of the credit system.

As one branch of the money-market the acceptance market is strongly influenced by competitive conditions in the call-money market. Funds tend to be diverted from the acceptance market when alluringly high rates prevail in the call market. After a time, however, acceptance rates are sympathetically affected.

The Commercial-paper Market is less important than the "bill" or the acceptance market. The commercial-paper market is peculiar to the United States. Its stock-in-trade is the single-name promissory note issued by large prospective borrowers. Only names of nationally known firms will suffice to give currency to this type of paper in the market. The commercial-paper market is not open in the sense that notes once sold are again offered for sale. In the great majority of cases paper is held by the purchasers until maturity. Promissory notes are primarily attractive to those having funds to invest for a reasonable period of time. The commercial-paper rate is naturally higher than the call money or the bill rate, but it is also steadier.

Government Securities.—Another important factor in the operation of the money market is the government securities market. This division of the money market developed its great significance after the World War. Since then Government finance has been on a stupendous scale. Periodically the Government requires large sums not only for current expenditure but for refinancing, and for the funding of floating obligations. These operations provide a large turn-over in the market. Government receipts and expenditures are so enormous that it also often becomes necessary to issue large amounts of treasury bills in anticipation of revenue. These bills find a ready market and form in consequence a very satisfactory form of temporary investment. The liquidity of Government securities has been greatly stimulated by legal provisions which permit member banks to borrow from the reserve banks, using such securities as collateral and which further permit the reserve banks themselves to buy and sell these governmental issues as considerations of policy may warrant.

The Securities Market in the United States also plays an important rôle in money-market procedure. Reference has already been made to the heavy borrowings by brokers and dealers in investment securities. But beyond this the system of daily settlements on the stock exchange offers attractive opportunities for liquid temporary investments for others. The banks themselves are heavy purchasers of securities. A marked development in this direction has been stimulated by the growth of so-called time deposits—for the withdrawal of which from the banks a 30 day notice by the depositor is necessary. But business firms and individuals also invest temporarily idle working capital in bonds and even in stock, relying on the fact that, subsequently, when such capital is again required for ordinary business operations, these investments can be promptly sold. The security markets thus offer an enormous reservoir, into which idle funds can be drained, and from which, when occasion demands, they can again be pumped.

American Banking Abroad.—The development of American

banking abroad has also profoundly affected the domestic money market. American banks are purchasers of foreign bills and in other ways as well lend funds in foreign centres. There is a considerable shifting of funds back and forth from one international market to another according to the competitive lure of the respective discount rates and the state of the exchanges. In like manner foreign banks buy American bills and carry heavy New York balances. These operations swell the flow and ebb of funds in New York.

Procedure in the New York market is very flexible. Through the effective clearing and transfer system operated by the Federal reserve banks large sums can be rapidly shifted to and from New York. A slackening of demand for funds in the interior thus leads quickly to their transfer to New York where they can be profitably loaned or invested. An increased interior demand for funds is similarly accompanied by a rapid withdrawal from New York. The New York market may thus be regarded as the great national money shock-absorber.

Federal Reserve System.—The Federal reserve system plays an important part in this procedure. Allusion has already been made to its clearing and transfer operations. As pressure develops in the money market the reserve system can be turned to for relief. Member banks may borrow from the reserve banks by giving their own notes secured by U.S. Government issues and by eligible bills. They may also rediscount paper drawn from their portfolios. Additional reserve funds are also supplied to the market indirectly: (*a*) when the government borrows from the reserve banks to meet maturing obligations or to obtain working funds. As these funds are paid out they tend to return subsequently through depositing by the payees, as a part of the member banks' reserve account; (*b*) when bills are sold to the reserve bank through the open market, the funds used to pay for these bills tending also to get into member banks' reserve balances; (*c*) when dealers in U.S. securities sell such securities to the reserve banks under so-called "repurchase agreements"; (*d*) when the reserve banks themselves take the initiative in adding to their holdings of bills and securities.

Supervision.—The Federal reserve system, like other central banks is, at least to some extent, in a position to supervise and to safeguard the money market. The reserve system cannot control operations in detail. It cannot, for example, lend at all in the security markets. The member banks must assume full responsibility for loans to brokers and dealers in connection with investment and speculative operations in securities. But through the control of final reserves and of the discount rate the reserve system may determine the conditions under which member banks can get funds for further expansion. Through its open market operations it can also directly influence the volume of reserve bank credit available. Through its wide powers in foreign operations relating to foreign exchange and to gold movements it can act to safeguard the basic reserve position. Although there are 12 independent reserve banks the important open market operations are conducted mainly through the New York market by a committee representing the system as a whole. Similarly, the exercise of its supervisory powers by the Federal reserve board has tended to give unity in discount procedure. The reserve system thus acts as the foundation of the money market, and as its supervisor and protector. (E. E. A.)

MONFALCONE, a town, province of Trieste, Italy, 20 m. N.W. of Trieste by rail. Pop. (1921) 9,659 (town), 11,838 (commune). It is crowned by the remains of a castle, an important point in the Great War. Its shipbuilding yards have been rebuilt, and it also produces sodium carbonate, and refines oils. About a mile from the castle of Duino, 5 m. to the south-east, the Timiavo (anc. *Timavus*) emerges from its subterranean course of more than 25 m. from the caves of S. Canziano by three different exits in normal times, and by seven in flood time. (Virgil, *Aeneid*, i. 244 speaks of nine.) This natural phenomenon had naturally attracted the attention of the ancients, and their writings are full of allusions to it; there has, it appears, been little change since ancient times. There was a temple to the river god on the site of the old church of S. Giovanni di Duino.

See *The Year's Work in Classical Studies*, 1925–26, 117, 118.

MONFORTE or MONFORTE DE LEMOS, a town of north-western Spain, in the province of Lugo, on the Cabe, a small right-hand tributary of the Sil, and at the junction of the railways from Tuy and Astorga to Corunna. Pop. (1920), 14,076. Monforte is built on a hill surmounted by a ruined mediaeval citadel; it has manufactures of soap and linen, and some trade in livestock.

MONGE, GASPARD (1746–1818), French mathematician, the inventor of descriptive geometry, was born at Beaune on May 10, 1746. He was educated first at the college of the Oratorians at Beaune, and then in their college at Lyons. He was a draftsman in the practical school attached to the military school at Mézières.

In 1768 Monge became professor of mathematics, and in 1771 professor of physics, at Mézières; in 1780 he was appointed to a chair of hydraulics at the Lyceum in Paris (held by him together with his appointments at Mézières), and was received as a member of the *Académie;* his intimate friendship with C. L. Berthollet began at this time. In 1783, quitting Mézières, he was, on the death of É. Bézout, appointed examiner of naval candidates. Although pressed by the minister to prepare for them a complete course of mathematics, he declined to do so, on the ground that it would deprive Mme. Bézout of her only income, from the sale of the works of her late husband; he wrote, however (1786), his *Traité élémentaire de la statique.*

Monge contributed (1770–1790) to the *Mémoires* of the Academy of Turin, the *Mémoires des savants étrangers* of the Academy of Paris, the *Mémoires* of the same Academy, and the *Annales de chimie,* various mathematical and physical papers. Among these may be noticed the memoir "Sur la théorie des déblais et des remblais" (*Mém. de l'acad. de Paris,* 1781), which, while giving a remarkably elegant investigation in regard to the problem of earth-work referred to in the title, establishes in connection with it his capital discovery of the curves of curvature of a surface. The memoir gives the ordinary differential equation of the curves of curvature, and establishes the general theory; but the application to the interesting particular case of the ellipsoid was first made by him in a later paper in 1795.

In 1792 Monge became minister of marine, but he remained so only until 1793. When the Committee of Public Safety made an appeal to the savants to assist in producing the *matériel* required for the defence of the republic he applied himself wholly to these operations, and distinguished himself by his indefatigable activity; he wrote at this time his *Description de l'art de fabriquer les canons,* and his *Avis aux ouvriers en fer sur la fabrication de l'acier.* He took a very active part in the measures for the establishment of the normal school (which existed only during the first four months of the year 1795) and of the Ecole Polytechnique and was at each of them professor for descriptive geometry; his methods in that science were first published in the form in which the shorthand writers took down his lessons given at the normal school in 1795, and again in 1798–1799. His later mathematical papers are published (1794–1816) in the *Journal* and the *Correspondance* of the polytechnic school. On the formation of the Senate he was appointed a member of that body, with the title of Count of Pelusium; but on the fall of Napoleon he was deprived of all his honours, and even excluded from the list of members of the reconstituted Institute. He died at Paris on July 28, 1818.

See B. Brisson, *Notice historique sur Gaspard Monge;* Dupin, *Essai historique sur les services et les travaux scientifiques de Gaspard Monge* (Paris, 1819), which contains (pp. 162–166) a list of Monge's memoirs and works; and the biography by F. Arago (*Oeuvres*, t. ii., 1854).

Monge's various mathematical papers are to a considerable extent reproduced in the *Application de l'analyse à la géométrie* (4th ed., last revised by the author, Paris, 1819); the pure text of this is reproduced in the 5th ed. (revue, corrigée et annotée par M. Liouville) (Paris, 1850), which contains also Gauss's Memoir, "Disquisitiones generales circa superficies curvas," and some valuable notes by the editor. The other principal separate works are *Traité élémentaire de la statique, 8e édition, conformée à la précédente, par M. Hachette, et suivie d'une note, etc., par M. Cauchy* (Paris. 1846); and the *Géométrie déscriptive* (originating, as mentioned above, in the lessons given at the normal school). The 4th edition, published shortly after the author's death, seems to have been substantially the same as the 7th (*Géométrie descriptive par G. Monge, suivie d'une théorie des*

ombres et de la perspective, extraite des papiers de l'auteur, par M. Brisson (Paris, 1847).

MONGHYR, a town and district of British India, in the Bhagalpur division of Behar and Orissa. The town is on the right bank of the Ganges, and has a railway station. Pop. (1921) 46,825. Monghyr, which appears under the form of Mudgagiri in an inscription of the 9th century A.D., was, under the Mohammedans, a place of military importance and frequently the seat of local governors or commandants. Shah Shuja built himself a palace here and in 1761, Nawab Mir Kasim Ali moved his capital here from Murshidabad. The walls and ramparts of the fort are still standing and give Monghyr a unique appearance among the towns of Behar. The fort dates back beyond 1580, when it was repaired by Todar Mal, Akbar's general and governor. Inside it is the tomb of an unknown saint erected in 1497. The house of Gurghin Khan, the Armenian general of Mir Kasim Ali, stands on a small hill 3 m. east of the town. Monghyr was captured by the British in 1763, and it was here that, three years later, Clive quelled "the White Mutiny" of the European officers of the army. Monghyr was formerly famous for its manufactures of firearms, swords and iron articles of every kind. Its chief industry now is the manufacture of cigarettes, which is carried on in a factory of the Peninsular Tobacco company, which employed nearly 3,000 hands in 1925.

The DISTRICT OF MONGHYR has an area of 3,927 square miles. The Ganges divides it into two portions. The northern, intersected by the Burh Gandak and Tiljuga, two tributaries of the Ganges, is a flat, closely cultivated country, subject to inundations. There are many marshes, of which the largest is the Kabar Tal (7 sq.m.). To the south of the Ganges the country is dry and much less fertile, and irrigation is necessary. Some ranges of hills and isolated plains occur in this part of the district. The chief are the Kharagpur hills with a length of 20 m., and an average breadth of 24 m. which rise at Maruk to 1,628 ft. above sea-level, and the Gidheswar (or Gidhaur) hills, which cover about 80 square miles. At Jamalpur (pop. 24,827), 6 m. from Monghyr, are the engineering workshops of the railway company which employ 11,000 workmen. Slate is quarried in the Kharagpur hills; the output in 1921 was nearly 3,000 tons.

MONGOL CAMPAIGNS. This article deals with the military methods of the Mongols during their great period of conquest, and illustrates it by an outline of the chief campaigns in that brief but unparalleled span of 30 years wherein they overran the Asiatic and European continents from the Yellow sea to the Baltic and the Adriatic.

If we study a physical map of Asia and Europe, we can trace a vast belt of open and level territory, though of varying altitudes, which stretches from the Yellow sea in the Far East to the Baltic sea and the Danube in the West. This chain of plains and plateaux is practically unwooded, and only broken by a few well-defined mountain ranges. It is the trough of the world's migrations, the path by which the great racial invasions have come to Europe and to China. Along it have passed the transcontinental routes of commerce, from the early caravans to the Siberian railway. But in even greater volume has it been the channel for armies, for it offers few obstacles to movement, and there uniquely the paramount principle of mobility has full rein.

In the centre of the continent lies the Mongolian plateau, barred by lofty and inaccessible Tibet from the fertile plains of India, but with comparatively easy access to the rich fields of China to the East, and of Western Turkistan and Russia to the West. This bare, bleak enclosure is the birthplace of the Turco-Mongol race, and the conditions of their environment have given the race their special characteristics. The European peoples became seafarers by reason of their lengthy coastlines and close touch with the sea. The Mongolian peoples became horsemen because constant and far-reaching land movement was necessary to obtain pasturage, and a warlike race because the barrenness of the land and the resulting migrations brought them into repeated conflict with other tribes and peoples. Long before the days of Jenghiz Khan, this lateral expansion of the Turco-Mongol race, and their pressure on the peoples who lay to the west, had produced barbarian invasions which overran Europe and overthrew the Roman empire, culminating in the invasions of the Huns.

Organization and Equipment.—Fuller knowledge has dispelled the excuse of mediaeval historians that the Mongol victories were due to an overwhelming superiority of numbers. Quality rather than quantity was the secret of their amazingly rapid sequence of successes. Alone of all the armies of their time had they grasped the essentials of strategy, while their tactical *mechanism* was so perfect that the higher conceptions of tactics were unnecessary.

The supreme command was in the hands of the emperor; but once the plan was decided upon, the subordinate generals executed the actual operations without interference, and with but the rarest communication with the supreme command. The nominal command of the various armies was held by royal princes, but the actual control was exercised by generals of experience, of whom the most famous were Chépé and Sabutai in the western campaigns, and Mukhuli in China.

The organization of the army was on a decimal basis. The strongest unit was the touman, a division of 10,000 troops, which could act as an independent force. The army was made up by a temporary grouping of toumans, generally three. Each touman was composed of 10 regiments of 1,000 men, and each regiment of 10 squadrons, and that again was divided into 10 troops of 10 men apiece. In addition there was a touman *d'élite,* the guard, which usually formed a general reserve in the hands of the commander-in-chief. There were also various formations of auxiliary troops.

For their protective equipment the Mongols had an armour of tanned hide in four pieces, composed of overlapping plates, which were lacquered to prevent humidity. The shield was only used when on sentry duty. Their weapons comprised a lance, a curved sabre with sharpened point, suitable either for cutting or thrusting, and two bows—one for shooting from horseback, and the other, for greater precision, when on foot. They had three quivers, each with a different calibre of arrows for the various ranges. One class could penetrate armour, and the other was suitable against unprotected troops. In addition, their light artillery consisted of various missile-throwing machines, mangonels, and catapults. These were taken to pieces, and formed a pack-artillery. They could fire rapidly and accurately, could go anywhere, and were adequate for open fighting.

Every trooper carried a complete set of tools, individual camp-kettle, and iron ration, for his own maintenance and subsistence in the field. He had also a water-tight bag in which he carried a change of clothes, and which could be inflated for crossing rivers.

Tactics.—The tactics of the Mongol army were rigid in conception, without the possibility of wide variation, but flexible in execution. They were built up on a definite framework of tactical moves, so that they resembled an applied battle drill. The analogy is further heightened by the fact that the different manoeuvres were directed by signals, so that the delays and upsets caused by orders and messages were obviated. The result of these battle drill tactics was seen in an amazing perfection and rapidity of execution. The Mongol force was a machine which worked like clockwork, and this very mobility made it irresistible to troops far more strongly armed and numerous.

The battle formation was comprised of five ranks, the squadrons being separated by wide intervals. The troops in the two front ranks wore complete armour, with sword and lance, and their horses also were armoured. The three rear ranks wore no armour, and their weapons were the bow and the javelin. From these latter were thrown out mounted skirmishers or light troops, who harassed the enemy as he advanced. Later, as the two forces drew near each other, the rear ranks advanced through the intervals in the front ranks, and poured a deadly hail of arrows and javelins on the enemy. Then, when they had disorganized the enemy ranks, they retired into the intervals, and the front ranks charged to deliver the decisive blow. It was a perfect combination of fire and shock tactics, the missile-weapon troops firing and disorganizing the enemy ready for the

shock troops to complete his overthrow.

Their continuous run of victories, usually over superior numbers, were achieved in defiance of most of the canons on which European armies, of the present equally with the past, have based their systems. Nor can these successes be discounted in the way that is common when discussing victories over Asiatic troops, who are regarded as lacking the staying power, discipline, and equipment of European soldiers. Sabutai's warriors proved themselves more than a match for the men-at-arms of mediaeval Europe, who had superiority both of numbers and armour. The Mongol tactics were never to close with the adversary until he was weakened and disorganized by fire. If charged by the heavy European cavalry, they never let themselves be drawn into a clash, but dispersed on a signal, rallied by signal at a distance, and again assailed the enemy with fire, repeating the process until the enemy was "unhinged" and the way paved for a decisive charge. Thus they proved that mobility is the basis of tactics, as of strategy; that lightly armed troops can beat more heavily armed ones if their mobility is sufficiently superior.

Another canon that they violated was that mobile troops, such as cavalry, must needs rest on a stable infantry base. Although cavalry was the decisive arm alike of Alexander and Hannibal, it formed merely the mobile wings hinged on an essentially protective infantry centre, which was the pivot on which it manoeuvred. The prime feature of the Mongol military system was therefore its simplicity, due to the use of a single arm, in contrast to the inevitably complex organization of a combination of several arms which has always characterized European armies. In this way the Mongols solved the ever-difficult problem of co-operation between arms which had radically different qualities and limitations. The single arm they used was that which possessed the highest degree of mobility, and in this lay the secret of their unbroken run of victory. At such local points where greater "locomobility" was needed than mounted troops could achieve, a proportion of the troops were temporarily dismounted and fought on foot.

Invasion of China.—The career of the founder of the Mongol power, Jenghiz Khan, is recounted in the article upon him. After he had established his overlordship over the nomads of the Mongolian steppes, his first major campaigns were in the conquest of the Kin empire in China, 1211–14. He had previously loaned the emperor troops and thereby gained an intimate knowledge of the country and conditions within the Great Wall.

The first invasion, of 1211, was probably not made in much strength. It passed through the wall without difficulty, one of the entrances being opened by treachery, and dispersed the advanced forces of the empire. Then one of the Kin armies was trapped in hill country which it knew less well than the invaders, and Chépé's touman, making a night march round and on to its rear, broke it up. But as the invaders penetrated deeper they found the fortified cities an almost insuperable obstacle both to their methods and to their small numbers, and, in face of the growing strength of the enemy forces, withdrew in the autumn. Next spring this invasion was renewed and this time Jenghiz Khan appears to have used Taitong-Fu as a bait, in the same way as Bonaparte used the fortress of Mantua in 1796—to draw on and annihilate the successive armies which came to its relief. But the reduction of fortified cities remained an obstruction until the campaign of 1214. Then a vast concentric advance by three armies, the centre one moving on to the sea in the rear of Yen-Kin, the Kin capital, brought about such a demoralization that the emperor fled to the south and the chaos in his dominions enabled the Mongols to subdue the disorganized fragments. Leaving his general Mukhuli in control in China Jenghiz Khan himself returned to Karakorum. With his borders now firmly established as far as the river barrier of the Hoang-Ho, his base was secure for an advance towards the west. Here lay the rich and fertile empire of the Shah of Khwarizm (Karismian empire), which embraced what is to-day Turkistan, Persia, and northern India. The Shah's intrigues, combined with Jenghiz Khan's desire for expansion, brought about a conflict, the signal for which was the Shah's folly in putting to death the envoys of Jenghiz.

Invasion of Turkistan.—Like all the Mongol campaigns, the invasion of Turkistan was prepared by the employment of an extensive spy system, combining propaganda among the enemy peoples with a remarkable service of information to the Mongol command. The Shah mobilized all his vassal States, but like Napoleon's opponents in the disposition of his forces he adopted the fatal cordon system. By stringing out his forces in packets all along the line of the Syr Daria, he made himself weak everywhere and restricted himself to a purely defensive rôle.

Then, early in 1220, Jenghiz Khan struck his opening blow, a shrewdly conceived diversion. Chépé, with two toumans, had passed by the southern route from Kashgar into Fergana, and was advancing on Khojent, which covered the southern end of the Syr Daria line. Thus Chépé directly threatened the Shah's right flank, as well as Samarkand and Bukhara, which lay beyond—the two centres of his power. It was a dagger pointing at the heart of the enemy. The Shah reinforced the Syr Daria line, and concentrated some 40,000 at Bukhara, and also at Samarkand. Against this Karismian total of some 200,000 men the Mongols had probably about 150,000 in the invading armies.

Jenghiz Khan had distributed his main striking force into three armies, two under his sons Juji and Jagatai. While Chépé was striking his first blows in Fergana, the three armies which formed the main force traversed a northern route by the Dzungarian Gate, and in February suddenly debouched on the left flank of the Syr Daria line. The two armies of Juji and Jagatai turned south from Otrar, clearing the line of the Syr Daria, capturing the fortresses, and working towards Chépé's detachment, which, after taking Khojent, was seeking to join hands with them. Then, like a thunder-clap, as the Shah's attention was fixed to his front, the news reached him that Jenghiz Khan with his mass of manoeuvre had appeared on his left rear, and was almost at the gates of Bukhara.

This army of 40,000 men, under Jenghiz Khan himself, had followed in the wake of Juji's and Jagatai's armies, crossed the Syr Daria at Otrar, and then disappeared. Masked by the armies of the two princes, its arrival on the scene had passed almost unnoticed. Having crossed the Syr Daria, it vanished into the immense desert of Kizyl-kum. By this dramatic venture of 40,000 to 50,000 men, and even more horses, across a desert, Jenghiz Khan appears to have gained complete secrecy until the moment when he debouched at the southern end and was almost on the top of Bukhara—in rear of the Shah's armies! At one blow the Shah's whole line was turned, and his communications severed with his more distant westerly States, whose forces had still to arrive. Demoralized, the Shah fled and left the garrison of Bokhara to its fate.

Jenghiz Khan captured Bukhara, and then turned east towards Samarkand. Meanwhile, the armies of the princes had joined hands with Chépé, and were converging on Samarkand. The doomed last stronghold of the Karismian power was caught between the hammer of the princes and the anvil of Jenghiz Khan himself, and soon fell. In the brief space of five months Jenghiz Khan had overthrown the mighty Karismian empire, and opened the gateway to the west, towards Russia and towards Europe.

The enemy armies crushed, Jenghiz Khan despatched Sabutai and Chépé westwards in pursuit of the Shah and to open up the path to further conquests. The Shah's son, Jelaladdin, still held out in the south for a time, and then crossed the Indus. Jenghiz followed him up, and in 1221 sent an expedition to Delhi, which took nominal possession of the country that his successors were to hold in reality. Jenghiz devoted his remaining years until his death to consolidating his mighty empire, which stretched from Korea to the Persian gulf.

Invasion of Russia.—Sabutai and Chépé, after accomplishing their mission of pursuit, asked permission for an advance towards the Kiptchak country—*i.e.,* southern Russia. The suggestion found favour with the emperor, and in six months they had advanced as far as Tiflis, crushing the kingdom of Georgia. In the spring of 1221 they pressed on into south Russia as far as the basin of the Donetz. Everywhere they established a stable

military and civil administration. Further, they organized an elaborate system of information to discover the weak points and rivalries of Europe. In this they found the Venetians quite willing to sacrifice the interests of Christian Europe in order to gain an advantage over their great trading rivals, the Genoese. In return for Mongol help in ousting the Genoese trade-centres in the Crimea, the Venetians acted as part of the intelligence service of the Mongols.

In 1223, however, Sabutai and Chépé were recalled by Jenghiz Khan, and returned by the northern end of the Caspian sea. Schemes of European conquest were suspended for a generation owing to the death of Jenghiz Khan in 1227. Disputes over the succession, for which Jenghiz had designated his second surviving son Ogdai, retarded further expansion to the West. Jenghiz Khan had called to his aid, in the administration of the immense newly gained empire, Yeliu Chutsai, a statesman of the former Kin empire. The natural result was to give a Chinese complexion to the policy of the Mongol empire, and to discourage adventures in Europe. But eventually Sabutai's scheme for the invasion of the West came to the front once more. The ground had already been prepared for it by his network of spies and propagandists.

It is probable that the invading force did not number more than 150,000 men, even when it set out, and that as a result of the losses in the preliminary campaigns and the detachments left to guard the communications with the East, little more than 100,000 took part in the Polish and Hungarian campaigns. The troops themselves came mainly from China, as the occupiers of the former Karismian empire were needed for events there. The horses only could be provided from south Russia, which had been organized as a vast remount depot.

In 1239 Central Russia was subdued as far as Moscow, and security was assured to the rear and communications of the invaders. The real objective was Hungary, for its people were the only branch of the Turco-Mongol race who still remained outside the authority of Jenghiz Khan's successors. But the neighbouring powers concerted, if not combined, to resist the invasion. They included Poland, Bohemia, and the Holy Roman empire, to which Hungary acted as a bulwark. With these powers were arrayed the German military orders, whose mission it was to be the outposts of the West against the heathen.

Szydlow and Liegnitz.—In Jan. 1241 Sabutai, with the prince Batu as his nominal superior, concentrated the Mongol forces in the region Lemberg-Przemysl. His intention was to force the passes of the Carpathian barrier, and to march on the Hungarian capital, Gran. But whilst he thus made his main effort against the principal enemy, it was necessary to assure security against interference from the others. An advance into Hungary, with the Poles and Germans ready to fall on his right flank, would be hazardous. It was necessary to crush these threats to his flank, and to ward off any premature intervention from Austria (the empire) or Bohemia. The tremendous victories of Szydlow in Poland and Liegnitz in Silesia have caused some historians to imagine that the Mongol purpose was a general conquest of Europe. But it was no part of Sabutai's strategy to advance into the hilly and wooded regions of western Europe, where the Mongolian horsemen would be at a disadvantage, and their system of tactics unsuitable to the country. The plain of Hungary was his goal, and he kept to it unswervingly.

He divided his force into four armies. Three of these he assigned to the main operation, and the fourth he used to achieve his secondary object—the removal of the danger on his right flank. This army, under Kaidu, moved first, as had Chépé's detachment into Fergana. At the beginning of March 1241 it crossed the Vistula at Sandomir. Then it fell upon the Polish armies of Boleslas and Miecislas at Szydlow and crushed them. Kaidu swept on at hurricane speed, took Cracow, and then Breslau; on April 8 he met at Liegnitz the German forces under Duke Henry of Silesia, together with the orders of the Templars and Hospitallers, and the remains of the Polish troops. A day's march to the south was the army of King Wenceslas of Bohemia. The Mongols, who were inferior in numbers to the troops of Duke Henry, struck on April 9 before the allied armies could effect a junction, and inflicted a terrible disaster. In less than a month the Mongols had covered some 400 miles, fought two decisive battles, taken four great cities, and conquered Poland and Silesia from the Vistula to the borders of Saxony.

Advance into Hungary.—But while they had been fulfilling this mission of security, Sabutai had wiped out the Hungarian army. He advanced into Hungary in three columns, of which the two flank columns traversed the circumference of an elongated circle, while he himself with the central mass started later and went through the diameter Thus he set up his forces in a close-linked and secure system with true economy of force, as was later the Napoleonic method. The dates of departure and the routes were evidently so arranged that the three columns should converge and join hands on the Danube near the Hungarian capital, where the main enemy forces were likely to be met.

The central mass—the last to move—forced the pass of Ruska on March 12, and advanced by the valley of the Theiss to the Danube near Gran. Rarely, if ever, in history has the speed of its advance been approached. Sabutai's advanced guard arrived at the Danube on the 15th, and Sabutai himself with the main body came up two days later. Within a fortnight all three armies had assembled, and Sabutai confronted Bela of Hungary, whose army lay across the Danube.

At this moment, however, Kaidu's detachment had yet to fight the battle of Liegnitz, and Sabutai would be uncertain of the situation as regards the other enemy armies. Moreover, it would have been difficult for him to force the crossings of the river under the eyes of the enemy, nor would it have been wise to fight a decisive battle with the Danube at his back. Hence he executed a true strategic retreat towards his base at Munkacz, luring on his enemy away from the protection of the Danube and the chance of reinforcement. The retirement was carried out slowly, taking six days to reach the Sajo river, half the distance. Then suddenly he delivered his crushing surprise blow. In the night he crossed the Sajo (*q.v.*), and at daybreak he struck. By midday the Hungarian army ceased to exist, Bela was in flight, and more than 70,000 of his men were left dead on the battlefield.

For this battle we have accounts sufficiently reliable to grasp the Mongol tactics. Contemporary observers were impressed, above all, by two features: first, the speed, silence, and mechanical perfection of their evolutions carried out by signals with the black-and-white flags of the squadrons; second, the deadliness of their fire. Their opponents, in the words of a chronicler, "fell to the right and left like the leaves of winter." The armies of the middle ages, until the English archers in the next century, relied almost entirely on shock tactics. But the Mongols, as Plano Carpini says, "wounded and killed men and horses, and only when the men and horses are worn down by the arrows, do they come to close quarters."

After this holocaust, Hungary was occupied without further fighting. There was no attempt to push farther into Europe, apart from one reconnaissance into Austria. But at the end of the year Ogdai died at Karakorum, and the princes were all eager to compete for the succession. As a result the Mongol armies and their leaders decided to return east. The evacuation of Hungary was carried out systematically and without interference, and Europe, wondering at its deliverance, began to enshroud both the causes of its defeats and the strength of its conquerors in a cloud of legend.

(B. H. L. H.)

MONGOLIA, the name given to a vast tableland in Central Asia, the traditional home-country of the Mongol peoples and formerly a definite "dependency" of the Chinese Empire, but now divided into two very distinct cultural and political entities, Inner Mongolia, which is becoming absorbed into China, and Outer Mongolia, a republic in close relations with the Russian Soviet Federation. The later stages of the political evolution and the significance of the present situation can most easily be appreciated in the light of the physical geography of the country, its natural divisions and their respective orientation.

Mongolia in the physical sense is essentially a plateau varying from 3,000 to 5,000 feet in altitude and composed of granites, gneisses and crystalline schists of Archean and Primary age. It

is bordered on the north-west by the extensive mountain-complex of the Altai, Tannu-ola and Sayan groups, and on the north-east by the Trans-Baikalian Highlands. On the south-east it is separated from the Plain of north China by a belt of pronounced scarps whose continuation northwards in the high faulted scarp of the Great Khingan delimits the plateau on the side of Manchuria. On the south-west it abuts against the lofty Nan-shan, the outermost of the great chains which enclose the Tibetan plateau. Only on the west does the Mongolian tableland sink to lower levels in the Jungarian depression and the Tarim basin on either side of the Tien-shan. Physiographically Mongolia falls into three clearly marked divisions:—

1. The central or Gobi region (*see* also under Gobi) on the whole the lowest and most uniform portion of the plateau. It forms an elongated shallow depression within the plateau and has as its rim on the south-east and east the plateau-edge formed by the In-shan series of scarps in Inner Mongolia and the faulted scarp-edge of the Great Khingan; while on the north-west it is delimited by the sloping edge of the broad Altai-Khangai-Kentei mountain-complex. It thus runs with successive decrease of altitude from the foothills of the western Nan-shan in the south-west to the Khingan foothills in the north-east. Isolated and weathered hill-ranges of low altitude characterize the surface of Gobi, which is generally covered with gravel, sand or even marked by bare rock. Rivers are absent save on the northern margin where the Kerulen drains an area really foreign to Gobi—an area of mountains and valleys constituting the first outliers of the Yablonoi mountain-system of Trans-Baikalia.

2. The north-western mountain-complex which has been compared in its character with the Bohemian block in Europe. It is in the nature of an uplifted massif enclosed by mountain ranges (Altai, Khangai, Sayan) in places marked by faulting. It may even be the counterpart, on a smaller scale, of the Tibetan plateau. The general level of the valleys in this region is about 3,000–4,500 feet above sea-level. The whole is well drained by rivers, some of which, *e.g.*, the Kobdo and Tess, enter brackish or salt lakes with no outlet. The largest lake, the Kosso-gol (5,320 feet), close to the Siberian frontier, occupies the highest part of this mountainous region. At least two high basin-areas can be distinguished: a. That of the Yenisei headstreams (or Urianghai basin); entirely mountain-girt by the Sayan on the north, the Tannu-ola on the south. The floor is dissected by rivers but is nowhere less than 1,700 ft. in altitude. b. A series of lake-basins at different levels contained between the Tannu-ola and Altai further south. These are remnants of larger lakes which have shrunk as the result of progressive desiccation. The largest is Ubsa Nor, occupying an extensive plain, while further south is Kirghiz Nor, and a third group round Kobdo (Kaira Ussa and Durga Nor). This sub-region is one of lofty gravel plains penetrating north-westward between the Khangai and Altai. The latter mountain range (or series of ranges) rises abruptly out of the Jungarian depression, in which its southern base lies at an altitude of only 1,000–3,000 feet, to heights of 10–11,000 feet (decreasing eastward). The northern base of the Altai rests on the high plateau at a considerable height (4,260 ft. at Kobdo). Thus the long steep southern scarp-face and the short northern slope to the high plateau behind give this system the character of a series of tilted fault-blocks. The Kentei and other mountain ranges to the west of Urga seem partly to enclose the basin formed by the headstreams of the Selenga-Orkhon.

3. South-eastern Mongolia, on the inner or Chinese side of the Gobi, is like the north-west in being much more diversified in character than the central portion of the plateau. It contains an outer and an inner series of chains. The outer series forms parallel ranges (Suma-Khada, Ta-tsing-shan, Khara-narin-ula and others) which if not homologous with the great Khingan, are at any rate analogous to it and constitute the south-eastern scarp-edge of the whole plateau, sloping gradually north-westward to the Gobi depression. The inner series is made up of denuded fold-chains partly within the line of the Great Wall (in the neighbourhood of Kalgan) and forms the frontier-zone between Mongolia and the alluvial plain of north China. Between these two series is an intermediate zone of lower elevation and this is economically the vital part of "Inner Mongolia." Of a different character, however, is the more or less level Ordos plateau contained within the immense Hwang Ho loop. It has the appearance of an ancient stable block; its surface of sandy or loamy soil is in parts not unsuited for agriculture, especially with irrigation. The surface of Inner Mongolia is marked by numerous small brackish or salt lakes.

Differences in Climate and Vegetation.—The differences here noted between the three major regions of the Mongolian tableland are further accentuated on climatic and vegetational grounds. The plateau as a whole is naturally characterized by dryness and great seasonal range of temperature, *i.e.*, "continentality." During the winter half-year the Asiatic high pressure system is centred over the northern edge of the plateau, while pressure is lowest in June, July, August. The whole area is one of outflowing winter and inflowing summer winds. The latter come from two main directions: west or north-west affecting Outer Mongolia, and south-east (monsoonal) affecting Inner Mongolia. The difference in mean temperature between the north-west and south-east of the plateau is considerable, amounting to about 20° F on the average of the year. But the contrast is much greater in winter than in summer when the temperature is relatively uniform over the whole area. The Altai-Sayan mountain-complex in the north-west partakes essentially of the Siberian climatic régime; the winter cold and annual range of temperature are here at their maximum. The total annual rainfall (including heavy snowfall) averages 10–20 in., but coming as it does from the west is not of the "monsoonal" type. Winds are probably not so strong or frequent as in Gobi, for Urga (on the edge of the region) is reported to have calms on 40% of the days in the year. It has a mean January temperature of 15° F and a mean July temperature of 64° (tempered by altitude) showing an abnormal range. The average annual rainfall here is between 9 and 10 inches, which is less than that of the north-west as a whole. The Gobi represents the classic example of a region with an extreme or continental climate. Winds blow unimpeded almost all the year round, mainly from the north-west. The rainfall is almost negligible in the real Gobi; the dryness is due to the fact that rain-bearing southerly winds have deposited their moisture on the successive high marginal ridges which border the plateau on the south-east.

On the other hand the Pacific influence is reflected in the climate of Inner Mongolia which more than any other part of the plateau is definitely affected by the monsoonal régime of summer. In the winter half-year winds are predominantly from the north-west bringing extreme cold; while dust-storms arising in Gobi are a common feature. The summer monsoon from the south-east brings the rains, averaging from 10 to 15 inches annually along the plateau edge, beyond which they rapidly die away.

The vegetational conditions correspond closely to these contrasts of climate. The north-west has Siberian affinities. On both sides of the Sayan are dense forests of larch, cedar, pine and deciduous woods characteristic of the Siberian flora. These decrease to their southern limits on the northern slopes (only) of the Khangai and Tannu-ola. With this exception the surface of this lofty mountain-complex is marked by prairie-land, furnishing excellent pasture in the wide basin-like valleys or plains. The rivers of the Urianghai basin are abundantly stocked with fish and the meadow-land of the floor of the basin affords very rich pasture; the area also contains valuable mineral deposits, and is capable of supporting a larger population. From the Tannu-ola southwards, the treeless zone extends to the unforested Altai; the gravel surface generally yields dry prairie-land.

The Gobi division, as a whole, must be regarded rather as a poor steppe-land than desert proper. On its northern limits around the Kerulen river, high mountains bearing larch and spruce woods alternate with river valleys which afford areas of good pasture. Steppes succeed southward, merging into the Shamo or Gobi proper which is barren of vegetation save in spring and early summer. Physiographically, climatically and vegetationally Gobi is a very real divide between Inner and Outer Mongolia, whose

affinities in a physical sense are with China proper and Siberia respectively.

The description of Inner Mongolia as a "land of high grasses" implies its pastoral wealth, but much of it has also potential agricultural value. This is particularly true of the fertile zone from the Ala-shan along the alluvial course of the Hwang Ho to the north-east of Kalgan, *i.e.*, along the intermediate belt between the plateau edge and the series of ridges within the Great Wall. The Ordos is a region of stunted steppe vegetation on the whole, but the In-shan series of mountain ridges (*i.e.*, the plateau edge) contains well-watered and sheltered valleys yielding an abundant vegetation.

POLITICAL GEOGRAPHY

From very early times the Mongolian Plateau was inhabited by nomadic groups but the term Mongol is comparatively late. It is apparently derived from *mong* (brave men), the earliest mention of which is in the annals of the Chinese T'ang dynasty (618–907) where reference is made to the *mong-ku* invaders. The original homeland of the historic Mongols was the area between the Onon and Kerulen rivers south-east of Lake Baikal whence they extended their conquests (*see* MONGOLS) until their power reached its zenith in the vast empire of Kublai Khan (13th century). The break-up of their empire and the fall of this dynasty (the Yüan) in China were followed by disintegration in Mongolia, where independent communities under separate chiefs came into existence. Soon afterwards the Manchu dynasty was established in China and, following the policy adopted by the Han and T'ang dynasties, set about the task of controlling the critical steppelands of the interior. The Mongol tribes whose lands were adjacent to the northern frontier of China early submitted but the more remote Khalka and Kalmuk tribes beyond the Gobi Desert were not brought under control until the reign of K'ang-hsi (1661–1721) or even later. Hence the present distinction between Inner and Outer Mongolia was foreshadowed at this period. In 1689, at the Congress of Dolonor, Mongolia accepted Manchu rule and for more than two centuries the entire area was a dependency of the Manchu Empire. But immediately after the fall of the Manchus in the Revolution of 1911, the northern Mongol princes expelled the Chinese officials at Urga and declared their independence under the rule of the Living Buddha. The political distinction between Outer and Inner Mongolia then finally emerged and corresponds essentially to the natural divisions distinguished on physical grounds. The arid, almost empty wastes of the central Gobi separate the two relatively fertile marginal areas to the north and south which form the cores of Outer and Inner Mongolia respectively, the one orientated towards Siberia, the other towards China. In outlook, in political status, the composition of their populations and in the trend of their economic developments, these two divisions are now quite distinct and the term "Mongolia" used in a political or even in an ethnic sense has now little significance save in relation to the northern republic.

Inner Mongolia comprises a broad belt adjacent to the northern border of China from south Manchuria on the east to Kansu on the west. Its northern boundary against Outer Mongolia runs through the heart of the desert to the great Khingan. Its eastern boundary with Manchuria extends beyond the Khingan and runs south-eastwards almost to the coast of the Gulf of Liao-tung to include the broken eastern extension of the plateau. The boundary is parallel to the coast for a considerable distance, leaving to Manchuria only a narrow sill traversed by the main route from Peking to Mukden. Opposite Shan-hai-kwan ("the Gate between mountain and sea") it turns west to follow the line of the Great Wall along the scarplands north-west of Peking. Much of this eastern portion of Inner Mongolia, known as Jehol, is drained towards and geographically related to Manchuria. From Kalgan the southern boundary follows the outermost scarp along the Great Wall and traverses the Ordos plateau, crossing both arms of the gigantic loop of the Hwang Ho. Finally it runs north-west into the desert, forming in this western section the northern border of the Kansu corridor.

The outstanding features of Inner Mongolia are the progressive development of Chinese influence and the replacement of nomadism by agriculture and pastoral farming. In the seventeenth century there were few Chinese outside the Great Wall, nor did the early Manchu Emperors encourage emigration. But the Dynasty in its later years, inspired by fear of Japanese pressure from the east and Russian pressure from the north, adopted the Chinese policy of colonization and of direct control of the Mongol tribal organizations through Chinese officials. The establishment of the Republic was followed by a complete political re-organization of Inner Mongolia, bringing it into integral relationship with China proper. With the addition of the portions of the provinces of Chihli and Shansi which lay to the north of the Great Wall there were formed in 1914 the three administrative areas of Jehol, Chahar and Suiyüan (with capital cities at Jehol, Kalgan and Kweihwating respectively) while the semi-desert region of the extreme west was constituted the military district of Sitao and placed under the control of Kansu. Shortly afterwards the Revolution which terminated the Tsarist régime destroyed Russian influence in the south and allowed the policy of active Chinese assimilation to proceed unchecked. The process has been carried a stage further by the introduction of the *hsien* (county) system and the usual machinery of provincial administration, and the complete incorporation of at any rate Chahar and Suiyüan as provinces of China seems only a question of time. They are included in the northern group, which comprises Hopeh (formerly Chihli) Shansi and Kansu, at present under the control of Yen Hsi-Shan, the Governor of Shansi. (*See* under CHINA: *Administration.*) Jehol is at present in a slightly different category, since it is within the Manchurian sphere. In all essential respects, however, it is becoming as Chinese as Chahar and Suiyüan and this trinity is often known as the "Three North Western Provinces" in contra-distinction to the "Three Eastern Provinces" of Manchuria.

Inner Mongolia may now be regarded as virtually a large extension of China to the north-west. It is of great importance both as an outlet for colonization and a new field for agricultural and pastoral development. The influx of Chinese has naturally been greatest in those districts offering the best prospects for tillage. These include (a) the valleys and terraces lying within the inner belt of scarps in Jehol and Chahar, especially along the route of the Peking-Kalgan-Suiyüan Railway, (b) the intermediate belt between these and the outer scarps which form the plateau edge and (c) the alluvial lands round the northern bow of the Hwang Ho which embraces in the north of Ordos a valuable agricultural plain known as the Ho Tou. In these districts the population is now overwhelmingly Chinese and nomadism has practically disappeared. The agricultural "front" is approximately represented by the plateau edge extending from the In-shan chains towards the great Khingan, beyond which line the scanty grasslands, merging into desert on the northern frontier, still support scattered groups of pastoral Mongols. The central portion of the Ordos plateau, enclosed within the great bend of the Yellow River, represents an "inlier" of this poor steppeland type and is also a pastoral area inhabited by Mongol nomads or semi-nomads, but is now encircled by agricultural lands which are still expanding. Recent estimates place the total population of Inner Mongolia at about one and a half millions, of whom the great majority are Chinese. There is but little intermixture, for where the Chinese farmer arrives with his spade the Mongol withdraws with his herd. Only in very exceptional cases does the Mongol adopt agriculture. Two entirely different economic systems are in conflict and the herder, no longer supported by military force, must give way to the peasant. But much of Inner Mongolia is better adapted for animal rearing than for any other economic use and the Mongols, with improved methods, may yet find their place in the new régime. From time immemorial China has been a great market for Mongolian ponies, and the demand has in recent years been raised by military needs and the increase of horse-racing in the big cities, which has led some of the Mongol herd-owners to take an interest in systematic breeding. With the support of the chiefs an important experiment in dairy-farm-

ing on modern lines but adapted to Mongol methods has been made in Chahar with very considerable success, and Kalgan, Peking and Tientsin are increasingly important as markets for pastoral products of all kinds. The agriculture carried on by the new Chinese colonists (who are so far mainly Mohammedans), or by the large class of seasonal workers from Shansi, is naturally of the type characteristic of North China—oats, wheat, buckwheat, millet, rapeseed, kaoliang, sesamum and beans being the principal crops. The low rainfall makes tillage without irrigation somewhat precarious, but in some districts irrigation is possible on quite a large scale, notably in the Wuyüan district of Suiyüan. Here around the north-western angle of the great Yellow River bend, an extensive system of irrigation canals between the present course and a deserted channel to the north has converted over 150,000 acres of arid land into productive fields. Elsewhere irrigation must mainly depend on wells and storage of water in the mountains. In the non-irrigated lands, dependent upon rainfall, mixed farming, combining stock-raising with the cultivation of the soil, is being strongly urged upon the Chinese settlers, whose natural inclination is to rely exclusively on their crops. It is noteworthy that afforestation is being actively promoted by the authorities in Chahar and Suiyüan. In the aggregate there is a considerable number of small-scale industries, mainly based upon pastoral products. They include the manufacture of rough woollen cloths and rugs, the preparation of felt, furs and leather, soap factories in which the acrid Mongolian "butter" is used, and paper-making from hemp ropes. Kalgan is the chief emporium of the skin and fur trade and the main collecting and distributing centre for Inner Mongolia. (*See* KALGAN.) Peking (Peiping) and Tientsin are the two chief external markets but there is a growing Japanese demand for the pastoral products of this region, more especially cattle.

Transport in Inner Mongolia is still mainly dependent upon camels, horses and ox-carts, using the ancient caravan tracks, but motor and rail traffic is steadily increasing. A feature of recent years has been the construction of motor roads by soldier colonists on the model adopted in Shansi, whose governor (Yen Hsi-Shan) is in charge of Inner Mongolia. Motor services now operate between Kalgan and Urga (Outer Mongolia), Kalgan-Dolonor (200 miles), Kalgan-Pingtichuan (170 miles), Pingtichuan-Pangkiang (250 miles), Paotowchen-Ninghsia in Kansu (400 miles) and another is planned from Kalgan to Jehol. The construction of the Peking-Kalgan-Suiyüan Railway has already been of great value in the development of Inner Mongolia and is noteworthy as having been entirely constructed and maintained by Chinese capital and engineers. It follows the ancient caravan route up the historic Nankow pass and taps not only some of the richest agricultural and pastoral lands but also a mineral district of considerable value. In recent years it has been pushed slowly westwards as far as Paotowchen, the present terminus, on the northern bend of the Hwang Ho. Another important railway is now projected to link Peking with Jehol, the most easterly of the Inner Mongolian "provinces." It is to be in three sections: Peking-Jehol (130 miles), Jehol-Chihfêng (140) and Chihfêng-Tungliao (330), there to connect with the new Chinese railway system in western Manchuria. It should be noticed that the development of Inner Mongolia must inevitably increase the importance of Peking, its natural point of intersection with north China.

Outer Mongolia or the Mongol People's Republic.—The proclamation of the independence of Outer Mongolia and the expulsion of Chinese officials by the Mongol princes assembled at Urga after the fall of the Manchu Dynasty in 1911 have been already noticed. Since then the country has passed through many political vicissitudes and has been the scene of more than one revolution. Its present status, so far as it can be clearly defined, was determined by the events of 1924. In that year the death occurred of the last Khutukhtu or "Living Buddha," the theocratic ruler of the country, who claimed to be the incarnation of a disciple of Buddha. It was almost immediately followed by a revolution fostered by agents of the Soviet Russian power, which was then actively pursuing the policy of recovering control of the central and eastern Asiatic lands formerly belonging to or within the sphere of influence of the Tsarist Empire, but which as a result of the Russian Revolution had been lost for the time being. The Mongol Revolution of 1924 established the Mongol People's Republic and in November of that year a constitution was promulgated in the name of the First Great *Huruldan* (People's Assembly), the object of which was "to inaugurate in the country a republican régime, without a President at the head of the State, all supreme power to be vested in the Great Assembly of the People and in the Government elected by the latter."

The following were declared to be some of the chief objectives of the new régime:

1. "The abolition of the remains of the feudal theocratic régime and the strengthening of the foundations of the new republican order on the basis of a complete democratization of the administration of the State."

2. "All the lands and mineral wealth, forests and waters and their resources . . . (to be) the property of all the people."

3. "The unified economic policy of the country . . . to be concentrated in the hand of the Government and a State monopoly of foreign trade to be introduced."

4. "The labouring people . . . to be armed by means of the creation of the Mongol People's Revolutionary Army and through the military training of all labouring youth."

5. The separation of Church and State and the establishment of the principle that "religion is the private concern of every citizen."

It was decreed that the Great Huruldan or People's Assembly should be composed of the representatives of the "aimaks" (*i.e.,* the old tribal units) and towns, as well as of the units of the army; and that there should be local huruldans corresponding to the "aimaks," "hoshuns," and other territorial divisions, thus preserving certain features of the old social organization for purposes of local government.

In its general character this constitution follows the Soviet model, and the Revolution of 1924 is generally interpreted as marking the absorption of Outer Mongolia into the Russian Federation of Soviet Republics. But technically China has not abandoned her Suzerainty which was even admitted by Russia in the year following the establishment of the Mongol Republic. In a statement on Russian foreign policy in 1925 Commissar Chicherin said: "The Soviet Government recognizes Mongolia as part of the whole Republic of China, enjoying, however, autonomy so far-reaching as to preclude Chinese interference with the internal affairs. . . . It ought to be noted that after several crises the internal situation in Mongolia has settled down and been consolidated on a basis similar to the Soviet system." It would be hazardous to say that Outer Mongolia is being absorbed by "Russia" in the same sense that Inner Mongolia is being absorbed by China, for the attitude of the Mongol people and the ultimate political orientation of Eastern Siberia are both uncertain. All that can safely be asserted is that Outer Mongolia has broken away from China and that her economic relations and political affinities are now with the Soviet Federation.

The Mongol People's Republic is bounded on the north-west by the high crests which form the buttress ranges of the plateau, and extend from the Altai through the Sayan mountains—essentially a natural frontier. The boundary then passes well to the south of Lake Baikal, cutting across the Selenga-Orkhon and Kerulen river-systems which orientate this north-eastern section of Mongolia towards Trans-Baikalia. Its short eastern boundary, abutting on Manchuria, lies to the west of the great Khingan. The southern boundary with Inner Mongolia follows the centre of the Gobi. The total area of the state is probably about 1,000,000 square miles, but the productive regions are concentrated in the north near the Siberian frontier, where the grassland becomes richer and grades into forest on the mountain slopes. In contrast to Inner Mongolia the population is essentially Mongol, comprising two principal tribal groups: the Kalmuks in the west, the Sharra and Khalkhas in the east. These are the purest and most typical of the Mongols, but the Buriat tribes of Trans-Baikalia,

although mixed with other racial elements, are closely related to them and form another point of contact with the Russian sphere. The differences between the Khalkha, Kalmuk and Buriat dialects are comparatively small (*see* Whymant, *A Mongolian Grammar* [1926]). There is hardly any Mongol literature, partly because the written language is very different from the colloquial, and partly because the liturgical lamaist books are written in Tibetan. Lama-Buddhism is everywhere the popular religion. It gradually replaced Shamanism from the time when Kublai Khan adopted Buddhism and instituted the Dalai Lama, the Pope of the Tibetan and Mongolian Buddhists; and its spread was encouraged by the Manchu Emperors as a convenient instrument for taming the wild Mongol nature. Buddhism has indeed appreciably changed the habits and outlook of the Mongols as a whole, converting a race of virile warriors into inoffensive and generally indolent herdsmen. Their potential military strength was further sapped by the Manchu policy of weakening the original tribal organization and bringing it under the control of their officials. It remains to be seen whether the abolition of the theocracy, the revival of military training and association with the Soviet régime may again alter the bias of the national character. The Mongols were formerly the classical example of pure nomads, but, as part of the general change in their mode of life induced by the Manchu policy of restricting tribal organizations to fixed areas, they have in large part settled down, although seasonal movement between winter and summer pastures by individual families is still common. The herds remain the chief source of wealth. According to the latest available information (1928) there are in the Republic approximately 1,340,000 horses, 270,000 camels, 1,500,000 oxen and 10,600,000 sheep. It is also the avowed policy of the Mongolian government to foster the development of local industries by a protective tariff. Trade relations are now almost entirely with the Soviet Federation, and Outer Mongolia only communicates with the outer World through carefully regulated Soviet channels. Not only has the immigration of Chinese been forbidden but the formerly extensive trade between Kalgan and Urga has greatly dwindled. Urga, the chief emporium of the country, now trades chiefly with Kiakhta, on the frontier 170 miles to the north and the terminus of a branch-line from the Trans-Siberian Railway. The trade with Russia is reported to have increased from 7,115,000 roubles in 1925 to 12,186,000 roubles in 1926. The chief exports are wool, skins, furs and horns together with salt and some gold. In addition to many gold mines, of which few are at present worked, there are deposits of copper, tin, iron and silver, but no general statement as to the mineral wealth of the country can be made. Within the Republic communications are mainly restricted to the caravan tracks but contact with Siberia is being developed in various ways. In collaboration with Soviet Russia new telegraph lines have been planned and in part constructed, and steamer services inaugurated on the Selenga and Orkhon rivers. A railway agreement is reported to have been made in September 1926 between the Union of Socialist Soviet Republics and the Mongol People's Republic, by which the former has undertaken to build a railway between Urga and Chita; one-fourth of the constructional expenses is to be borne by the Government of Outer Mongolia and the rest by the Government of the U.S.S.R. which is to have control of the line and liberty to exploit the resources of a belt 100 versts in width on each side of the railway. According to the latest estimates (October 1928) the population of the Mongol Republic contains 579,000 Mongols, 90,000 Russians and 7,000 Chinese.

BIBLIOGRAPHY.—The following works in Russian are the most important: Prjevalsky, *Mongolia and the Land of the Tanguts* (1875), and his *Third and Fourth Journey* (1883 and 1888); G. N. Potanin, *Sketches of North-West Mongolia* (1881–83); *The Tangut-Tibet Border of China and Central Mongolia* (1893 *seq.*); V. Pyevtsoff, *Sketch of a Journey to Mongolia, etc.* (Omsk, 1883); D. Pozdnéeff, *Towns of North Mongolia* (1880); *Mongolia and the Mongols* (1896 and 1899); and the article "Mongolia" in *Russian Encycl. Dictionary*, vol. xix. (1896); G. and M. Grum Grzimailo, *Description of a Journey to Western China* (1898–99); V. Pyevtsoff, K. Bogdanovitch, V. I. Roborovsky and P. K. Kozloff, *The Tibet Expeditions* (1886–1902); V. Obrucheff, *Central Asia, Northern China and the Nanshan* (1900–01); Z. Matusovskiy, *Geogr. Descr. of Chinese Empire* (1888); *Mongolia and Kham* (Imperial Russian Geographical Society's Expedition, 1899–1901). *See* also R. Pumpelly, *Geol. Researches* (Washington, 1866); Ney Elias, in *Journal R.G.S.* (1873); Baron Richthofen, *China* (1877); J. Gilmour, *Among the Mongols* (1883); W. W. Rockhill, *Journey through Mongolia and Thibet* (1894); F. E. Younghusband, *The Heart of a Continent* (1896); W. Karumischeff, *Mongolia and Western China* (Tientsin, 1925); D. Carruthers, *Unknown Mongolia* (1913); P. T. Etherton, *In the Heart of Asia* (1925); R. C. Andrews, *Across Mongolian Plains* (1921); A. Little, *The Far East* (Oxford, 1905); L. Richard, *Comprehensive Geography of the Chinese Empire* (Shanghai, 1905). The *China Year Book;* The *Chinese Economic Bulletin* (weekly) and the *Chinese Economic Journal* (monthly) published by the Chinese Government Bureau of Economic Information. (P. M. R.)

ANTHROPOLOGY

The terms "Mongol" and "Mongolian" have been very much abused owing to the fame of Jenghiz and Kubla Khan, and are, indeed, often applied to all the inhabitants of the Far East. Mongol should, however, be limited to a purely linguistic and national sense and should include only the speakers of Mongol languages, who are connected to a certain extent culturally, and often only distinguished from their cousins the Turks, by difference of language. Physically, although probably to a large extent Armenoid, they have come into contact with a variety of other stocks which have considerably modified the original type, which varies from district to district. Within historical times the Mongols have wandered far and wide over an area which has always been thinly populated. On the other hand, among nomads over a large area there is apt to be less divergence of type than in a settled population of relatively greater density. These two different aspects will serve to explain their remarkable homogeneity which appears in spite of local differences. The racial history of the Mongols as an entity begins with Jenghiz Khan, whose father was the ruler of only 40,000 tents. Jenghiz was born about 1165 "with a piece of clotted blood in his hand." His horoscope foretold a bloody career, and the prophet in this case did not lie. He succeeded in binding the Mongols into a loose political organization, which in its original form did not survive his death, but the fruits of his military genius were sufficient to carry the Mongol horsemen over most of Asia and as far into Europe as the walls of Vienna. Under Kubla Khan the Mongols conquered China and held it for a brief period. Their racial history has, however, always been of varied fortunes; they have advanced westwards and southwards and they have retired again. Under the Mings, Inner Mongolia, one of the most typical Mongol countries, was cultivated by the Chinese, and to-day the Chinese are once more invading with the plough this virgin prairie land, "the country of the long grass." (*See* MONGOLS.)

Racially, these slow movements are probably more important than the greater cataclysmic invasions of the Mongol armies. The Chinese, being sedentary agriculturists, definitely establish their racial type wherever they settle. The nomad Mongol, with his perpetual movement, makes tremendous incursions, but owing probably to the smallness of his numbers in relation to the area occupied does not permanently establish his type where there is racial competition from people who settle a smaller area with a denser population.

The Mongols may be conveniently divided into three groups: the Western Mongols or Eleuts (*q.v.*), who are called Kalmucks by their neighbours; the Central Mongols or Buriats (*q.v.*); and the Eastern or "true" Mongols, the descendants of Jenghiz's soldiers, at present inhabiting Gobi and Inner Mongolia.

Social Organization.—The Mongol social organization is somewhat complicated owing to its dual nature, partly ecclesiastical, partly military (among the Muslim Mongols the ecclesiastical organization does not, of course, exist and their social system is similar to that of the Turks). The lay population is divided into two classes, the serfs and the nobles, to certain families of whom the hereditary princes (Jassak) belong. The clergy include the higher clergy—that is, the living Buddhas who, except in one case, which is hereditary, are chosen at birth as "reincarnations," and the lamas, it being necessary for the religious before taking the vows to obtain the permission of his overlord,—and the ecclesiastical serfs, who are presented by their chiefs to monasteries. The clergy are celibate, but the laity are polygamous, to a greater

or lesser extent, and at least in Inner Mongolia to-day about two males out of three take vows. The laity are organized for the most part on a military basis, the religious being excused service.

The unit of organization is the *bak* or group, a small conglomeration of tents on the steppe, governed by an elected elder. A number of groups form a banner under its hereditary prince, usually the eldest son of the last prince, although certain princes, known as "seal-less" princes, and some nobles have no banner. The adult males are also organized into troops of horsemen and the latter into regiments. The prince has complete control over the persons of his subjects, although to a certain extent the old steppe law has been modified by the Russians and Chinese in their respective territories. Its first and foremost principle is military; disobedience to the khan or his subordinates is immediately punished by death. Otherwise crimes are punished by a payment, usually in kind, cattle, sheep or camels, to the sufferer or his group. The banners are grouped together into a confederacy, which forms part of the heritage of a single princely house, and was formerly ruled by the ancestor of all the princes who now hold the more or less independent banners which compose it. The Manchus somewhat modified this system by introducing leagues with elected princes, managing to secure the election of their nominee, most of the confederacies more or less corresponding to existing confederacies.

The mode of life is intimately associated with geographical conditions. The food quest is limited practically entirely to the products of their herds; chiefly of sheep and ponies. They have two types of houses. The travelling tent is a simple ridge pole tent, covered with dark felt. The more permanent tent or *yurt* consists of a lattice framework standing upright to about a man's height, on top of which is a sloping frame which forms the roof; a space is left open at the top to allow the smoke to escape, and the top is supported by a central pole. The whole frame, roof and sides, is covered by thick felts and anchored by ropes thrown over the whole structure and tied at the bottom to large stones. The yurt can be dismantled in about half an hour. The Mongol villages consist of a small collection of tents, usually situated in a subsidiary valley, to be near wells in the main valley, but protected from the great winds of the plains. The village usually possesses some sort of corral to protect the weaker animals from wolves. Another important feature is the great pyramid of dried dung which in this treeless country supplies the place of wood for burning. The flocks supply milk, mutton, wool, skins, and as a by-product of the milk a simple fermented liquor and a distilled and fiery spirit, usually called *arrack,* a word which, however, is applied in Turkish to grape brandy and practically means a spirituous liquor. Huge shaggy and very fierce dogs effectually keep off stray marauders and wolves and act as scavengers, eating up all the bodies of dead animals. The sheep are kept near the village both because they are looked after by the children and because their droppings are so valuable. The pony herds are kept farther away. The Mongols almost live in the saddle, riding upright and shifting the weight from one leg to the other. The ponies in immediate use are kept tied up near the village, one especially fast and carefully trained beast being always at hand to act as the "lassoo" pony. When a beast is wanted from the herd a rider mounted on this pony takes a rod with a noose at the end, picks out the beast he wants to take, rides up and drops the noose over its head, tightens the noose and plays it as a fisherman, riding it round in circles till it gives in. The lassoo pony must be sufficiently fast to keep a neck ahead of any pony to be captured. The horsemanship of the Mongols can be best judged by the ride of one of their best men, who did the 1,500 miles from Ulliassetai to Peking in eight days, changing ponies at each of the posting places, 15m. or so apart, which used to be kept up along the imperial routes. Any man on a pony picked out of the herd will think nothing of doing a hundred miles in one day. Along the trade routes camels are used, usually as pack animals, but sometimes for draught; elsewhere, however, the pony is the indispensable associate of the Mongols. They do a good deal of trade, especially in horseflesh, and by these means supply additions, such as grain and sugar and tea to the products of their herds. In the *taiga* region, where game is more easily approached, many of the men are hunters. The craft of silver work is highly developed. Every married woman wears an elaborate head-dress of silver and stones, worked by the Mongols themselves. Although modern rifles are being introduced into Mongolia as a result of the recent wars, their true weapon, which is still used ceremonially, is a bow made of horn backed by sinew. It is overstrung, *i.e.,* in making the bow it is so moulded that the belly of the bow when unstrung is directed backwards, instead of forwards as it is when the bow is strung. Unlike so many other peoples in a similar stage of culture, the Mongols do not put all their amusements and recreation into certain feasts, but are always ready to try their horses with any available person, and take immense pleasure both in the casual race, whenever opportunity offers, and the more organized races, such as those which take place at Urga, where, in order to test the speed of the horses, only small children are allowed to ride.

Religion.—Apart from the immigrant Chinese, two types of religion are prevalent in this region, Islam and Buddhism. The followers of the former religion include both Mongols and Turks. They are, as in China, always a turbulent element in the population. They are often somewhat fanatical, and on the whole fairly strict, even to the extent of not smoking cigarettes, a practice which has become so general over the Muslim world. Observations made along the border land a few years ago by Buxton suggest that the Muslims are spreading to a certain extent at the expense of the Buddhists, probably owing, among other things, to the low birth-rate of the latter, but there do not appear to be any definite statistics. This increase among the Muslims is especially noticeable in the new towns which are springing up on the site of ancient cities which have fallen into ruin in the last few hundred years (since the great invasions of the Mongols in the 13th century). In a land where learning is not a conspicuous feature, some of these Muslims have a slight knowledge of Arabic, and, probably associated with their religion, a somewhat wider knowledge of the world than their neighbours. Apart from their turbulence, it would not appear that religious differences were associated with any great difference of cultures, and, indeed, except for the fact that the Mongols on the whole avoid towns, the two cultures have very many points in common. Buddhism in Mongolia is similar to that in Tibet (*q.v.*) and presents no special local features. There are, however, certain local differences of interest. The lamaseries form the only permanent habitations in this land of nomads, but the lamas are not confined to their convents, and in practice large numbers of them are wanderers. The older shamanistic religion exists side by side with the higher and more orthodox faith. Among a pastoral people the Buddhist objection to the destruction of life cannot exist, and the slaughter of animals, and even their actual sacrifice, an idea entirely repugnant to Buddhist ideals, forms an important part of many Mongol ceremonies, including that of marriage. Over much of Mongolia there are ancient *obos* or stone altars, placed especially on conspicuous, rocky outcrops. Ceremonies take place at these *obos* at intervals. In the remoter districts shamanistic rites still take place, usually towards nightfall. A fire is lit outside the tent and animals are sacrificed. The chief performer, man or woman, begins by reciting traditional spells and gradually works into a hysterical condition, during which he may see visions, and finally falls unconscious on the ground. In contrast to the regular Buddhist priests, however, except in Uriankhai there do not seem to be any regular shamans, their place being taken by anyone who is of such a mental condition as to be able to perform the ceremony; this matter is, however, not certain.

The general features of the mode of life of the inhabitants of Mongolia contrast very strongly with that of their most intimate neighbours the Chinese. They entirely lack any real form of cohesion, and though the Mongol princes have at times been able to combine and conquer immense territories, the death of the khan has usually been the signal for the break-up of his dynasty. To-day their life can be seen probably most typically in the region south of Gobi, a region which at various times has been given over to Chinese agriculturists, in the Ming dynasty, for instance. The effect of the building of the Great Wall of China was to turn the tide of the nomad westwards. The Chinese are pushing many miles

beyond the wall, into a country which is suited naturally to pastoral nomadism, and though the nomad cannot exist when the agriculturist has passed by, any slight change in environment which compels the agriculturalist to retire results in the land returning once more to pasture.

BIBLIOGRAPHY.—Sir H. H. Howarth, *History of the Mongols* (1876); A. Little, *The Far East* (1905); D. Carruthers, *Unknown Mongolia* (1913); M. A. Czaplicka, *The Turks of Central Asia* (1919, bibl.); L. H. D. Buxton, *Geographical Journal*, lxi. (1923), J.R.A.I. lvi. (1926); *The Eastern Road* (1924). (L. H. D. B.)

EXPLORATIONS

The existence of an Asiatic centre of origin or homeland where ancestral types of mammalian life developed millions of years ago and spread westward to Europe and eastward to America had long been a matter of purely palaeontological theory. In 1900 Prof. Henry Fairfield Osborn, president of the American Museum of Natural History, New York, summarized his conviction of the truth of the theory and plotted on a map the regions in which he believed the great orders of mammals had originated. (*Science*, April 13, 1900, p. 567.) His belief, however, was entirely based upon inductive reasoning, for the fossil history of Asia was unknown.

Central Asian Expeditions.—This prophecy was responsible for the original conception of the central Asiatic expeditions. After ten years of zoological work in various parts of Asia, plans took shape to test the theory by scientific exploration of the little known central Asian plateau. The main problem was to discover the geologic and palaeontologic history of central Asia; to find whether or not it had been the nursery of many of the dominant groups of animals, including the human race; and to reconstruct its past climate, vegetation and general physical conditions, particularly in relation to the evolution of man. It was necessary that a group of specialists be taken into central Asia *together* in order that the knowledge of each man might supplement that of his colleagues. Probably no archaeologist could have dated the culture and unravelled the story of the dune-dwellers, a prehistoric race which was discovered, without the assistance of other scientists. This was indeed the first expedition of such magnitude to employ these methods. The fossil history of central Asia was completely unknown. The British had made some discoveries of importance in India. In China fossil teeth and bones had long been sold for medicine and a few had been studied by English and German scientists. Some interesting and important finds had been made in Java, Persia and Asiatic Russia. But these all came from the edge of the interior continent. Literally, the only fossils known from the central Asian plateau were a few "rhinoceros" teeth discovered by the Russian explorer, Obruchev, in 1894–96. Mongolia is isolated in the heart of a continent; and there is not a single mile of railway in the country, which is nearly half as large as western Europe. The climate is extremely severe; the temperature drops to −40° to −50° and the plateau is swept by bitter winds from the Arctic. Effective palaeontological work can be conducted only from the beginning of April to October. In the Gobi desert, which occupies a large part of Mongolia, food and water are scarce and the region is so inhospitable that there are but few inhabitants.

The physical difficulties could only be overcome by some means of rapid transportation and that transportation the motor car successfully supplied. The automobiles could run into the desert, as soon as the heavy snows had disappeared, at the rate of 100 m. a day, penetrate to the farthest reaches of Mongolia and return when cold made work impossible. Camels, which other explorers had used, average 10 m. daily. Thus, approximately ten years' work could be finished in one season. A supporting caravan of camels, with food and petrol (gasolene), must go out months before the motor parties. The expedition of 1925 had 125 camels carrying 4,000 gal. of petrol, 100 of oil, 3 tons of flour, 1½ tons of rice and other food in proportion. The caravan was to leave petrol and food at two depots and wait at a well 800 m. out in the desert.

The 1925 expedition of 40 men comprised the following branches of science: palaeontology, geology, palaeobotany, archaeology, topography, zoology and photography. The foreign staff included 12 Americans and 2 British; in the native staff there were 26 Chinese and Mongols, some being highly trained assistants. With so many branches of science represented it was improbable that all the men could find work in the same place at the same time. Therefore, the expedition was divided into four units, each with a car complete with its own driver, interpreter, cook and camp gear; any unit could leave the base camp and maintain itself independently for several weeks if necessary. As a matter of fact the expedition was almost continually divided except on long marches to new localities; frequently there were four camps from 20 m. to 100 m. apart.

General Survey.—It became evident that the first season must be devoted to a general survey of several thousand miles of country to locate and appraise its value for the especial purposes of the expedition without attempting exhaustive work in any of them. The next year could then be one of intensive study, the amount of time to be devoted to each locality be carefully planned in advance, and the staff adjusted accordingly. Since the main object of the expedition was to test the theory of central Asia as the chief theatre of mammalian evolution and distribution, palaeontology was most important during 1922–23.

Contrary to expectations, rich fossil deposits were discovered immediately. Four days after starting in 1922 it was found that the main trail between Kalgan, China and Urga, the capital of Mongolia, which had been traversed by several geologists, runs directly through three rich fossil beds—one Oligocene and one Eocene, of the age of mammals, and one Cretaceous, of the age of reptiles. The palaeontological work of the expedition, which was carried on under the direction of Walter Granger, "revealed the high central Asiatic plateau as the home of most of the terrestrial dinosaurian reptiles of Upper Jurassic and of Cretaceous time. In brief, these discoveries establish Mongolia as a chief center of northern terrestrial life-history from the close of the Jurassic time onwards to the very close of Pleistocene time" (Osborn).

Since the middle of the age of reptiles, Mongolia has been continuously a high, dry continent. As a result, fossils "revealed especially the hitherto unknown high continental life of Cretaceous and Tertiary times" and showed that Gobia, as Grabau has named this ancient central Asian continent, was then sparsely forested, with limited rain supply and luxuriant with life, although it is now one of the most arid and inhospitable regions of the world. It was "extremely favourable to the evolution of reptiles, mammals, insects and plants hitherto known only along the Cretaceous shorelines of Europe and the Cretaceous sea-borders of the centre of America" (Osborn).

Dinosaur Eggs.—Among the several thousand fossil specimens obtained it is difficult to select those of first importance scientifically, but in popular interest the dinosaur eggs stand foremost. These were discovered among dinosaur remains in a rich deposit almost in the centre of Mongolia near a well known to the Mongols as *Shabarakh Ussu*, the "Place of the Muddy Waters." The beds consist of fine red sandstone of Lower Cretaceous age and are extremely rich in skulls and skeletons of a hitherto unknown dinosaur, *Protoceratops andrewsi*. Bits of shell were discovered in 1922 but were not recognized as dinosaurian. The following year, on July 13, George Olsen found the first complete eggs. Three had broken out of a small sandstone ledge and lay exposed. Other shell fragments were partially embedded in the rock; just under the shelf were the projecting ends of two more eggs. Subsequently the block was found to contain 13 eggs in two layers lying with the ends pointing toward the centre, exactly as they had been left by the dinosaur when she covered them with sand for the last time millions of years ago. The skeleton of a small dinosaur was found, lying 4 in. above the eggs in the loose sediment on top of the rock. The specimen represented a toothless species, *Oviraptor philoceratops*. It is possible that this little dinosaur existed by feeding on the eggs of its relatives and was about to rob the nest when it was buried by a sudden sandstorm. The eggs first discovered are 8 in. long by 7 in. around. They are rather more elongate and flattened than those of modern

reptiles and differ greatly in shape from the eggs of any known bird, living or fossil. The dry country and the loose, extremely fine, sand probably explain how such delicate objects as eggs were so beautifully preserved. After they had been deposited in a shallow "nest" scooped out of the sand the dinosaur covered them with a thin layer of sediment and left them to be hatched by the warmth of the sun. In a sudden wind storm, many feet of sand might have been heaped upon the eggs. Air and sun were thus cut off and incubation abruptly ceased. The weight of sediment eventually cracked the shells and the liquid contents ran out. Simultaneously the fine sand sifted into the interior forming the solid cores which are present in all the specimens. The loose sediment of the entire region was eventually consolidated into red-sandstone, the matrix in which all the eggs are enclosed. Two of those from the original discovery were somewhat broken exposing the delicate skeletons of embryonic dinosaurs. It is probable that other eggs contain the bones of unhatched young, for there were found several skulls of baby dinosaurs which evidently had been out of the egg only a few days before death.

In 1923 the expedition discovered about 25 eggs, whole or in parts, and, in 1925, 40 more. That year produced by far the largest and finest eggs, as well as the smallest, representing several species and genera. One type, probably laid by a small carnivorous dinosaur, is not more than 5 in. long, is very elongate and has an extremely thin, smooth shell.

There were also bits of egg-shell probably representing one of the larger iguanodont, duck-billed dinosaurs from another region in Mongolia which awaits further exploration. Only in these two localities of the world have dinosaur eggs been discovered up to 1928, with the possible exception of a few somewhat doubtful shell fragments from Rognac, southern France. Shabarakh Ussu also yielded 75 skulls and 14 dinosaur skeletons, probably the finest preserved material of the sort. One superb series of *Protoceratops* skulls represent almost every stage of growth from the newly hatched young up to very old individuals.

The Baluchitherium.—Another discovery, second only in popular interest to the dinosaur eggs, was the skull and parts of the skeleton of the gigantic aberrant rhinoceros *Baluchitherium*, the largest land mammal known to have existed. First information of this extraordinary beast was given by C. Forster Cooper of Cambridge university, who found a neck vertebra and foot bones in 1911 in Baluchistan. But it was not until the discovery in Mongolia of an almost complete skull in 1922 that the real characteristics of the animal became known. In 1925 were found the four legs and feet of another individual that evidently had been trapped in quicksand and buried alive. It is estimated that the *Baluchitherium* stood 13 ft. high at the shoulders, that it was about 24 ft. long and that with its prehensile upper lip it could pull down tree branches 22 ft. in the air. It lived during the Oligocene period of the age of mammals and appears to have been confined to Asia.

Placental Mammals.—From the standpoint of pure science possibly the most important specimens obtained by the expeditions were seven Cretaceous mammal skulls found at Shabarakh Ussu in the same formation which contained the dinosaur eggs. They represent the oldest truly placental mammals known. They were not larger than a small rat and crawled about in the middle of the Cretaceous era, the closing period of the age of reptiles, when dinosaurs still flourished. They may be regarded as the first attempt of nature to establish the insectivorous, herbivorous and carnivorous groups of mammals which were to become the dominant creatures of the earth.

Geology and Climate.—The geological work of the expeditions yielded most important results, the chief among them probably being the unravelling of the hitherto unknown major elements of geologic history of the Mongolian region and the working out of a fairly complete geologic column. It was learned that the structure of the Mongolian plateau consists of two great series of formations, separated by a profound unconformity. Those below the unconformity form a floor of ancient complex rock upon which the later sediments rest; many of these are fossil bearing. The geologists identified and described an enormous granite bathylith or underlying floor. This is not only important to "pure science" but it supports the inference that valuable mineral deposits are more likely to be found about the margins of the bathylith than in the area of broad exposure. The region has a basin-like character. There have been several mountain-making periods, several erosion periods and several revivals of volcanism.

The Gobi is essentially a rock desert with a very thin veneer of shifting sand and much bare rock. Interpretation of the strata indicates that this region has been continuously a continental area since early Mesozoic times; the sediments deposited since are all of continental type and not marine, being either fluvial, lacustrine or aeolian.

The reading of the history of climatic changes is one of the most important and interesting results of the expeditions and is the most extensive effort of its kind yet attempted in central Asia. The results achieved by Huntington in his study of the climatic changes of Pleistocene and recent time in other parts of Asia stand confirmed. Evidence is conclusive that this region has been arid and semi-arid in its climatic habit for many millions of years, but that there have been cycles of greater and less aridity. There is no indication that the regions ever experienced glaciation. In Pleistocene time, glacial epochs were represented in the Gobi region by changes to more humid climate, and inter-glacial epochs by return to desert conditions. The close of the glacial period and the beginning of recent time were marked by a change from comparative humidity to the desert climate of to-day. But even in recent time the climate has not been uniform; neither has the curve of change been smooth. There have been smaller changes within the longer cycles. Even within the last great arid cycle there have been epochs when the Gobi region was comparatively fruitful and could support a numerous population, separated by other epochs of more strictly desert habit and difficult conditions for animal life.

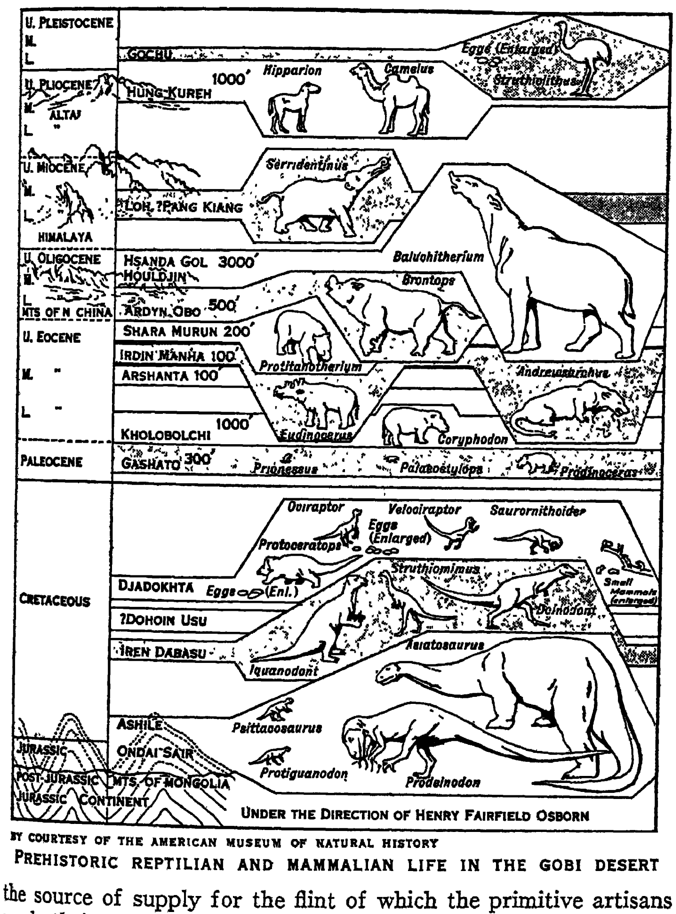
Archaeological Work, which was directed by Mr. N. C. Nelson, was not begun until the last expedition in the season of 1925. Rich results have rewarded the very beginning of the investigation of the central Asian plateau. During 1923, the Jesuits, Father Teilhard de Chardin and Father Licent, discovered abundant evidences of Palaeolithic man in extensive deposits of Mousterian implements at three different localities in the Ordos desert. No human remains were found with the exception of a single incisor tooth which has recently come to light, having remained unidentified among the collections of four years. Previous to this, Dr. J. G. Andersson had traced a widespread Neolithic and pre-Chinese culture in various parts of northern and western China proper. In 1926 two human teeth were described from a basal Pleistocene cave deposit in the Western hills about 15 m. from Peking, excavated under the direction of Dr. Andersson. In 1927 an additional molar tooth from the same deposit and doubtless from the same individual, a child about eight years old, was discovered during excavations conducted jointly by the Chinese Geological Survey and the Peking Union Medical college under the direction of Dr. Davidson Black. These teeth rank with the oldest human remains known to science.

Because caves and rock-shelters, so common in Europe, are virtually non-existent in Mongolia, archaeological work there is particularly difficult. Nevertheless, almost everywhere along the 1,000 m. route of the expedition from near Kalgan to the outlying ranges of the Altai mountains more or less superficial traces of two prehistoric cultures were discovered. In sight of the Altai, where workable artifact materials such as jasper, chalcedony and agate were abundant, there are evidences of long-standing occupation. In the Gobi desert were found five cultural horizons, not including the living Mongols. The most recent in age were monuments consisting of rectangular and circular rock enclosures, from 3 to 150 ft. across. Most of these are burial-places and several contained skeletal remains of a brachycephalic people. In one grave, Nelson discovered a skeleton with its head lying on a saddle, bows and arrows tipped with iron, bits of fabric and iron saddle trimmings. Near the graves were frequently pictographs pecked on the face of the rock. These represent human beings, camels, horses, cattle, stags, antelopes, ibexes and mountain sheep;

the stag is now absent there.

The meagre data obtained do not warrant any precise conclusions about this interesting culture but it seems probable that it is an expansion of the remarkable mound culture of Bronze and Iron age times uncovered by Russian investigators in the Upper Yenesei country. As such its Mongolian antiquity can scarcely exceed 2,000 years.

The "Dune Dwellers."—The most important archaeological discovery was a culture camp near the eastern spur of the Altai mountains within half a mile of the dinosaur egg beds. In fact, these primitive artisans used for necklace ornaments the broken shells of dinosaur eggs as well as those of *Struthiolithus*, the giant ostrich of the Stone age of Mongolia. No human fossils have been found, but it is established that the Stone age tribes spread over the borders of the Gobi desert region during the Ice age, establishing their workshops near large lakes bordering the Altai mountains. These Neolithic and Mesolithic people have been named by Mr. Nelson the "dune dwellers" or the "Shabarakh culture" because of the occurrence of their artifacts in old dead and indurated sand deposits called the "Shabarakh formation." It yields a combination of characters which appear to be distinctly Gobian. Thousands of flint artifacts and flakes were found here, both upon the surface and deeply embedded in the formation itself, and there are definite indications that this was a favourite camping place for many thousands of years. The geologists are certain that a lake had existed, probably intermittently, in this great basin furnishing water for the inhabitants. Moreover, 36 m. west was discovered



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

PREHISTORIC REPTILIAN AND MAMMALIAN LIFE IN THE GOBI DESERT

the source of supply for the flint of which the primitive artisans made their tools and weapons. That this culture was wide-spread is evident, for at nearly every place where the Shabarakh formation appeared, artifacts were present.

A still older upper Palaeolithic culture was discovered in two localities on old erosion surfaces composed of Quaternary gravels. It consisted of stone implements of Mousterian and Aurignacian types which resemble those found by Teilhard and Licent in the Ordos.

The Eolithic, or "Dawn Stage," of man's handiwork appears to be well represented in a number of places in Mongolia. There, on old erosion surfaces, composed of Quaternary gravels, lie thousands of fractured rocks and pebbles more or less weathered but showing successive stages of flaking. Whether or not any of these apparent artifacts actually are the result of human handiwork or whether they are all the work of natural agencies is difficult to determine; if any are of human origin they are of immense importance Nelson and Granger also spent two winters working along the Yangtze river in Szechuan, and in Yünnan province, and extended the pre-Chinese culture originally discovered by Andersson; but no remains of Palaeolithic man were found.

Zoology.—A small collection of birds was made; but investigations in zoology were confined to mammalogy, herpetology and ichthyology. The Asiatic expeditions in China proper and Mongolia have brought to the American Museum of Natural History 9,900 mammals, 11,666 reptiles and batrachians and 10,000 fish. Many new species have been discovered and important facts regarding the relationships and probable derivation of European and American living types demonstrated.

Photography occupied an important part in the expedition's activities. Every phase of the extensive work was recorded in still and motion pictures, as were also the life and customs of the natives. That the central Asian plateau was a great theatre of evolution for northern terrestrial life is now well established: that primitive men have existed in Mongolia since the close of the Pleistocene is certain: that this region was the home of early human types seems probable. The major geographical features of the Gobi have been determined, and a surveyed line of more than 1,000 m. has been run north-west through the heart of the desert. In the future similar investigations will be made in inner Mongolia, south of the Altai mountains. Rich sedimentary fossil bearing basins almost certainly lie in the western Gobi, and this region may yield important results in the study of human ancestry. *See* ASIA: *Archaeology*. (R. C. AN.)

History.—Mongolia has been the source of many invasions and raids into China, the most noted being the Mongol conquest in the 13th century. The Manchus extended their power over the country and made it part of the Chinese empire. The Mongols took advantage of the Chinese revolution of 1911 to oust the Chinese authorities from Urga and to declare their independence under the Hutukhtu (Living Buddha). This gave Russia her opportunity, and in 1912 she pledged her assistance in maintaining the independence of the Urga Government in return for special privileges. By an exchange of notes, China acknowledged the autonomy of Mongolia and Russia recognized that the Chinese were still suzerain. Chinese suzerainty was represented at Urga by a resident-general with deputies in three other places. Upon the collapse of Russia in 1918 the Chinese took steps to increase their power, and in 1919 Hsu Shu-tseng was appointed defence commissioner and coerced the Mongols into cancelling their autonomy. Early in Feb. 1921 Baron Ungern von Sternberg, leading a force made up of several nationalities and professing antagonism to the "Reds" in Russia, expelled the Chinese from Urga. The Living Buddha now returned, and an independent Mongol Government was proclaimed, with Ungern as chief military adviser. Ungern's troops revolted, he was defeated, captured and executed by Red forces (Aug. 1921), and Soviet Russia, while recognizing the Urga Government as independent, kept troops there. A treaty (Nov. 5, 1921) provided for Russian influence. By the Russo-Chinese treaty of May 31, 1924, Russia recognized Outer Mongolia as a part of China and agreed to withdraw her forces. However, the Mongols continued to claim their independence of China and in Nov. 1924 adopted a constitution of the soviet type, and Russia remained dominant. (*See* MONGOLS.)

BIBLIOGRAPHY.—W. Karamuishev, *Mongolia and Western China; Social and Economic Study* (1925); *The China Year Book, 1926; The Christian Occupation of China* (1922); *Outer Mongolia: Treaties and Agreements* (Carnegie Endowment for Inter. Peace, 1921).

(K. S. L.)

MONGOLIAN LANGUAGE AND LITERATURE.

The Mongolian language, with Turki-Tatar and Tungus-Manchu, belongs to the Altaic family of languages. It has, roughly, three

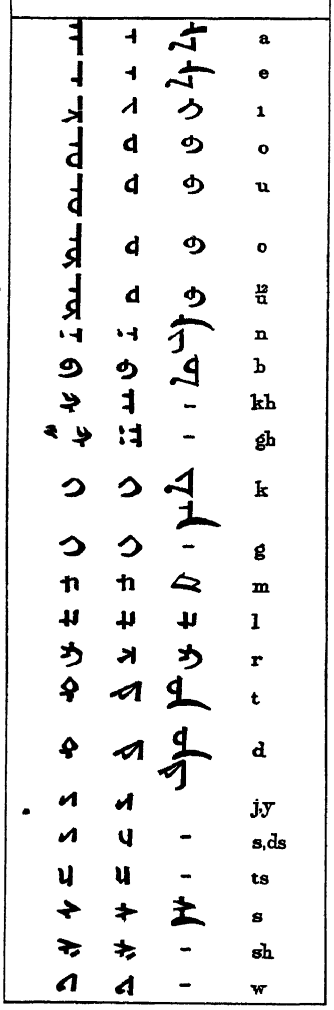
dialects: East Mongolian (Khalkha), West Mongolian (Kalmuk), and Buriatic, which differ but slightly.

The literary language is written vertically downwards, the lines following from left to right. The alphabet is very imperfect: *ger* (house) and *ker* (how), *urtu* (long) and *ordu* (palace), for instance, are written alike.

The word-order is almost the reverse of that of English. Nouns have six oblique cases: gen. *-yin, -ü(n)*; dat.-loc. *-dü(r), -e;* Acc. *-(y)ı;* ablat.*-eče;* instrum. *-ber, -iyer;* co-operat. *-lüge.* So also the pronouns *bi* (I), *či* (thou), *bide* (we), *ta* (ye), *ene* (this), *tere* (that), etc., but with certain modifications. The nominative of a noun is usually marked by *inu, anu* or *ber,* while the plural is expressed by *-ner, -(ü)d, -s,* etc. Adjectives are often used substantivally and are not declined for comparison. Verbs are conjugated for tenses and moods, but person and number are not expressed: ind. pres. and fut. *-mü(i)*, etc.; past *-be(i)*, etc.: optat. *-sü(gei)*, etc.; cond. *-basu, -besü.* The present participles are *-gči,* past part. *-gsen,* and fut. part. or infinitive *-qu, -kü.* Various adjunctive forms and the gerund ending in *-ǰü, -ged, -tele, -rün,* etc., are used. Negation is expressed by the adverbs *ülü, ese, ügei* and *buu* (imperative), and interrogation by *uu.* There are no prepositions, only postpositions. The sentences are joined by certain adjunctive and participial forms of the verb.

(E. D. R.)

MONGOLIAN LANGUAGE.



Literature.—Mongolian literature (including MANCHU), as an indigenous growth, is comparatively slight. A vast body of Buddhist and Confucian literature exists in excellent style, but most of the truly native literature is in the colloquial. Collections of native songs and folk-tales exist but these are not held in high esteem by the literati. The Mongolian *Siddhi-kür*, a collection of Buddhist tales, has been of use in restoring partly lost Indian originals. A number of Chinese novels and folk-stories have been translated in such a way as to obscure their real origin: the Mongol imagination is very vivid when dealing with fairy-tale themes. The Buddhist succession of hells gives the Mongol writers ample scope for the creation of weird and grisly characters, most convincing in their presentation. Historical works such as that of Sanang Setzen (17th century), a history of the Eastern Mongols and the *Altan Tobchi* stand very high in native and foreign esteem. The *Üliger ün dalai* (Sea of Comparisons) is the most important of all the religious works in Mongolian, while heroic literature is best represented by *Gesser Khan*, a legend of the hero of that name, with the poetic *Jangariad* as second favourite. Most of these works exist in excellent Russian and German translations, though some are only partly translated.

From the early part of the 17th century official documents were written in Chinese and Manchu, these two versions often carrying a Mongolian translation. The two words *San Ho* frequently found at the beginning of Chinese titles indicate that the work is trilingual, and the classics as well as popular works of fiction and poetry were early issued in this form. Before 1650 most of the existing dynastic histories of the Chinese empire had been translated into Manchu. One of the earliest independent works in Manchu was the *Han I Araha Ampasai Mutzilen Pe Dara Pure Bitkhe* (An address, from the Emperor to the Magistrates, on Moral Training) published in 1655. Strangely enough, very few works on the Tatars themselves were written, a noteworthy treatise being the *Jagôn gosai tung-tzi sutchung ga weileghe bitkhe* or Essay on the origin of the 8 Banners. The *Jalan Jalan i hafu puleku* or Mirror of Successive Generations gives a vivid historical picture of Tatar ambitions, and in this period only one work is known to us dealing with the Mongols, the *Kalkai dulimbi chugun gosa* (The Banners of the Khalkha Mongols). Works appeared on the arts of war and government and detailed account of Chinese embassies to different Tatar tribes. In the early 18th century bilingual collections of metaphors, proverbs and literary allusions began to appear and in 1732 was published the *Manju Nikan ghergen Kamtsiha sing li bitkhe* (Natural Philosophy in Manchu and Chinese).

From 1750 onwards various imperial commissions were engaged in translating commentaries on the orthodox classics and the text of heterodox philosophers. Where existing translations were deemed faulty new ones were undertaken at the charge of the Imperial Treasury and for over a century publication was continuous. In the last 80 years, however, little has been done to increase the bulk of literature in Manchu and Mongolian; one Mongolian newspaper has made its appearance but publication in the classical tongue (except for a few Scripture versions and Bible histories) ceased several decades ago. Chinese is rapidly becoming the native tongue of those who do not still cling to the debased Tibetan in use among the lamas, and has been recognized for some years as the literary tongue of Manchuria and Mongolia.

BIBLIOGRAPHY.—G. J. Ramstedt, *Kalmückische sprachproben* (i. 1909, ii. 1919); I. J. Schmidt (Mongolian and German), *Geschichte der ost. Mongolen,* etc. (Sanang Setzen) (1829); I. J. Schmidt, *Gesser-Khan* (trans. 1839); Bobrovnikov, *Djangariad* (Russ. trans. 1854); Pozdneyev, *The Popular Literature of the Mongolian Tribes* (Russ. 1880). Manchu: *Sanho pi ssŭ shu* (introduction) (Peking, 1820); J. Klaproth, *Chrestomathie Mandchou* (1828); M. F. A. Fraser, *Tanggu Meyen and other Manchu Reading Lessons* (for folk stories) (1924).

(A. N. J. W.)

MONGOLS, the name of one of the chief ethnographical divisions of the Asiatic peoples (*see* also TURKS). The early history of the Mongols, like that of all central-Asian tribes, is extremely obscure. Even the meaning of the name "Mongol" is a disputed point, though a general consent is now given to Schott's etymology of the word from *mong,* meaning brave. From the earliest and very scanty notice we have of the Mongols in the history of the T'ang dynasty of China (A.D. 619–690), and in works of later times, it appears that their original camping-grounds were along the courses of the Kerulen, Upper Nonni and Argun rivers. But in the absence of all historical particulars of their origin, legend, as is usual, has been busy with their early years. The Mongol historian, Sanang Setsen, gives currency to the myth that they sprang from a blue wolf; and the soberest story on record is that their ancestor Budantsar was miraculously conceived of a Mongol widow. By craft and violence Budantsar gained the chieftainship over a tribe living in the neighbourhood of his mother's tent, and thus left a heritage to his son. Varying fortunes attended the descendants of Budantsar, but on the whole their power gradually increased, until Yesukai, the father of Jenghiz Khan, who was eighth in descent from Budantsar, made his authority felt over a considerable area. For the extension of Mongol dominion under his son *see* JENGHIZ KHAN.

Ogdai Khan.—Over the whole of the vast region stretching from the banks of the Dnieper to the China Sea, Jenghiz Khan set his second surviving son Ogotai, or Ogdai, as khagan, or chief khan, while to the family of his deceased eldest son, Juji, he assigned the country from Kayalik and Khwarizm to the borders of Bulgar and Saksin "where'er the hoofs of Mongol horse had tramped"; to Jagatai, his eldest surviving son, the territory from the borders of the Uighur country to Bukhārā; while Tulē, the youngest, received charge of the home country of the Mongols,

the care of the imperial encampment and family, and of the archives of the State. The appointment of Ogdai as his successor, being contrary to the usual Mongol custom of primogeniture, caused some bitterness among the followers of Jagatai, but Ogdai was finally led to the throne by his dispossessed brother amid the plaudits of the assembled Mongols. Once fairly on the throne he set himself vigorously to follow up the conquests won by his father. At the head of a large army he marched southwards into China to complete the ruin of the Kin dynasty, which had already been so rudely shaken, while at the same time Tulē advanced into the province of Honan from the side of Shensi. Against this combined attack the Kin troops made a vigorous stand, but the skill and courage of the Mongols bore down every opposition, and over a hecatomb of slaughtered foes they captured Kai-fêng Fu, the capital of their enemies. From Kai-fêng Fu the emperor fled to Ju-ning Fu, whither the Mongols quickly followed. After sustaining a siege for some weeks, and enduring all the horrors of starvation, the garrison submitted to the Mongols, and at the same time the emperor committed suicide by hanging. Thus fell in 1234 the Kin or "golden" dynasty, which had ruled over the northern portion of China for more than a century.

His first essay in extending the empire in the fertile provinces of China meeting with such success, Ogdai remembered the obligation laid upon him by his father's conquests in Western Asia. Jelāl-ed-dīn had been driven into India when Jenghiz annexed Khwarizm, but he had returned with the support of the sultan of Delhi, reconquered his own domain and advanced westward to Tiflis and Kelat. Ogdai sent 300,000 men into Khwarizm; they marched so rapidly upon the foe that the advance-guards reached Amid (Jelāl-ed-dīn's retreat) before that monarch had any idea of their approach. Accompanied by a few followers, Jelāl-ed-dīn fled to the Kurdish mountains, where he was basely murdered by a peasant. The primary object of the Mongol invasion was thus accomplished; and, unchecked and almost unopposed, they overran the districts of Diarbekr, Mesopotamia, Erbīl and Kelat, and then advanced upon Azerbāijān. In the following year (1236) they invaded Georgia and Great Armenia, committing frightful atrocities. Tiflis was among the cities captured by assault, and Kars was surrendered at their approach. Meanwhile in 1235, Ogdai despatched three armies in as many directions. One was directed against Korea, one against the Sung dynasty, which ruled over the provinces of China south of the Yangtsze Kiang, and the third was sent westward under Batu into eastern Europe.

With irresistible vigour and astonishing speed the Mongols made their way through the forests of Penza and Tambov, and appeared before the "beautiful city" of Ryazan. For five days they discharged a ceaseless storm of shot from their balistas, and, having made a breach in the defences, carried the city by assault on Dec. 21, 1237. Moscow, at this time a place of little importance, next fell to the invaders, who then advanced against Vladimir, which at length succumbed. A dire fate overtook the inhabitants of Kozelsk, near Kaluga, where, in revenge for a partial defeat inflicted on a Mongol force, the followers of Batu held so terrible a "carnival of death" that the city was renamed by its captors Mobalig, "the city of woe." With the tide of victory thus strong in their favour the Mongols advanced against Kiev, "the mother of cities," and carried it by assault. The inevitable massacre followed and the city was razed to the ground.

Victorious and always advancing, the Mongols, having desolated this portion of Russia, moved on in two divisions, one under Batu into Hungary, and the other under Baidar and Kaidu into Poland. Without a check, Batu marched to the neighbourhood of Budapest, where the whole force of the kingdom was arrayed to resist him. While the careless Hungarians were sleeping, Batu launched his attack. Panic-stricken and helpless, they fled in all directions, followed by their merciless foe; the roads for two days' journey from the field of battle were strewn with corpses. The king, Bēla IV., was saved by the fleetness of his horse, though closely pursued by a body of Mongols, who followed at his heels as far as the coast of the Adriatic, burning and destroying everything in their way. Meanwhile Batu captured Budapest, and on Christmas day 1241, having crossed the Danube on the ice, took Esztergom by assault. While Batu had been thus triumphing, the force under Baidar and Kaidu had carried fire and sword into Poland. While laying waste the country they received the announcement of the death of Ogdai, and at the same time a summons for Batu to return eastwards into Mongolia.

While his lieutenants had been thus carrying his arms in all directions, Ogdai had been giving himself up to ignoble ease and licentiousness which ended in his death on Dec. 11, 1241. He was succeeded by his son Kuyuk, who reigned only seven years. On the death of Kuyuk, dissensions which had been for a long time smouldering between the houses of Ogdai and Jagatai broke out into open war, and after the short and disputed reigns of Kaidu and Chapai, grandsons of Ogdai, the lordship passed away for ever from the house of Ogdai. It did not go, however, to the house of Jagatai, but to that of Tulē.

Mangu Khan and Hulagu.—On July 1, 1251, Mangu, the eldest son of Tulē, and nephew to Ogdai, was elected khagan. With perfect impartiality, Mangu showed tolerance to the Christians, Mohammedans and Buddhists among his subjects although Shamanism was recognized as the State religion. Two years after his accession his court was visited by Rubruquis (q.v.) and other Christian monks, who were hospitably received. The description given by Rubruquis of the khagan's palace at Karakorum shows how wide was the interval which separated him from the nomad, tent-living life of his forefathers. On his accession complaints reached Mangu that dissensions had broken out in the province of Persia, and he therefore sent a force under the command of his brother Hulagu to punish the Ismailites or Assassins (q.v.), who were held to be the cause of the disorder. Marching by Samarkand and Karshi, Hulagu crossed the Oxus and advanced by way of Balkh into the province of Kuhistan or Kohistan. The terror of the Mongol name induced Rukneddin Gurshah II., the chief of the Assassins, to deprecate temporarily the wrath of Hulagu by offers of submission, but Rukneddin having been killed, 1256 (*see* Assassins), Hulagu marched across the snowy mountains in the direction of Baghdad to attack the last Abbasid caliph and his Seljuk protectors. On arriving before the town he demanded its surrender. This being refused, he laid siege to the walls in the usual destructive Mongol fashion, and at length, finding resistance hopeless, the caliph was induced to give himself up and to open the gates to his enemies. On Feb. 15, 1258, the Mongols entered the walls and sacked the city (*see* Caliphate *ad fin.*). While at Baghdad Hulagu gave his astronomer, Nāsir ed-din, permission to build an observatory, which, splendidly furnished with armillary spheres and astrolabes, was erected at Maragha. The fall of Baghdad was almost contemporaneous with the end of the Seljuks of Konia as an independent power, though their actual destruction did not take place until 1308 (*see* Seljuks). The Mongol invasion resulted in a famine which desolated 'Iraq-Arabi, Mesopotamia, Syria and Rūm. The Mongols did not starve with the people but went forward through Syria. Aleppo was sacked, Damascus surrendered (1260) and Hulagu was meditating the capture of Jerusalem to restore it to the Christians when news of Mangu's death reached him and he returned to Mongolia leaving Kitboga in command of his Syrian forces.

Hitherto a vassal of Mangu, as is shown by his striking coins bearing the name of Mangu as well as his own, Hulagu was now recognized as ruler of the conquered provinces. He assumed the title of ilkhan, and, although acknowledging the khagan as supreme lord, was practically independent. The title of ilkhan was that borne by his successors, who ruled over Persia for about a century (*v. infra*, "The Ilkhans of Persia").

While Hulagu was prosecuting these conquests in western Asia, Mangu and his next brother Kublai were pursuing a like course in southern China. Southward they even advanced into Tong-king, and westward they carried their arms over the frontier into Tibet. Under the wise command of Kublai all indiscriminate massacres were forbidden, and probably for the first time in Mongol history the inhabitants and garrisons of captured cities were treated with humanity. While carrying on the war in the province of Szechwan Mangu was seized with an attack of dysentery, which proved fatal after a few days' illness. His body was carried into Mongolia on

the backs of two asses, and, in pursuance of the custom of slaughtering everyone encountered on the way, 20,000 persons were, according to Marco Polo, put to the sword.

At the Kuriltai, or assembly of notables, which was held at Shang-tu after the death of Mangu, his brother Kublai (*see* KUBLAI KHAN) was elected khagan. For 35 years he sat on the Mongol throne, and at his death in 1294, in his 79th year, he was succeeded by his son Timur Khan (or Uldsheitu Khan, Chinese, Yuen-chêng). During this reign the division between the Ogdai and Jagatai families and that of the ruling khagan was healed. Uldsheitu was succeeded by his nephew Khaissan, who died in Feb. 1311, after a short reign, and at the early age of 31. His nephew and successor, Buyantu (Chinese, Yen-tsung), was a man of considerable culture, and substantially patronized Chinese literature. Among other benefits which he conferred on letters he rescued the celebrated inscription-bearing "stone-drums," which are commonly said to be of the Chou period (1122–255 B.C.), from the decay and ruin to which they were left by the last emperor of the Kin dynasty, and placed them in the gateway of the temple of Confucius at Peking, where they now stand. After a reign of nine years, Buyantu was succeeded by his son Gegen (Chinese, Ying-tsung), who perished in 1323 by the knife of an assassin. Yissun Timur (Chinese, Tai-ting-ti), who was the next sovereign, devoted himself mainly to the administration of his empire. He divided China, which until that time had been apportioned into 12 provinces, into 18 provinces, and rearranged the system of State granaries, which had fallen into disorder. His court was visited by Friar Odoric (q.v.), who gives a minute description of the palace and its inhabitants.

FROM HENRY YULE, "BOOK OF SER MARCO POLO" (JOHN MURRAY)

KUBLAI KHAN (A.D. 1216–1294), FROM A CHINESE ENGRAVING

The following years were years of great natural and political convulsions. In 1355 a Buddhist priest named Chu Yuen-chang became so impressed with the misery of his countrymen that he threw off his vestments and enrolled himself in the rebel army. His military genius soon raised him to the position of a leader, and with extraordinary success he overcame with his rude levies the trained legions of the Mongol emperor. While unable to defeat or check the rebels in the central provinces, Toghon Timur Khan was also called upon to face a rebellion in Korea. Nor were his arms more fortunate in the north than in the south. Toghon Timur, by a hasty flight, escaped from his enemies and sought safety on the shores of the Dolon-nor in Mongolia. For a time the western provinces of China continued to hold out against the rebels, but with the flight of Toghon Timur the Mongol troops lost heart, and in 1368 the ex-Buddhist priest ascended the throne as the first sovereign of the Ming or "Bright" dynasty, under the title of Hung-wu.

Thus ended the sovereignty of the house of Jenghiz Khan in China. Brave and hardy the Mongols have always shown themselves to be; but the capacity for consolidating the fruits of victory, for establishing a settled form of government, and for gaining the allegiance of the conquered peoples, has invariably been wanting in them.

Not content with having recovered China, the emperor Hung-wu sent an army of 400,000 men into Mongolia in pursuit of the forces which yet remained to the khagan. Even on their own ground the disheartened Mongols failed in their resistance to the Chinese, and at all points suffered disaster. Meanwhile Toghon Timur, who did not long survive his defeat, was succeeded in the khaganate by Biliktu Khan, who again, in 1379, was followed by Ussakhal Khan. During the reign of this last prince the Chinese again invaded Mongolia, and inflicted a crushing defeat on the khan's forces in the neighbourhood of Lake Buyur. This defeat was the final ruin of the eastern branch of the Mongols, who from this time surrendered the supremacy to the western division of the tribe. At first the Keraits or Torgod, as in the early days before Jenghiz Khan rose to power, exercised lordship over the eastern Mongols, but from these the supremacy passed to the Oirad, who for 50 years treated them as vassals. Notwithstanding their subjection, however, the Keraits still preserved the imperial line. Gradually, however, the Mongol tribes broke away from all governing centres, and established scattered communities with as many chiefs over the whole of eastern Mongolia. The discredit of having finally disintegrated the tribe is generally attached to Lingdan Khan (1604–34).

The Chakhars.—By this time the Mongols had recovered from the disaster suffered at the hands of the first Ming ruler. Driven to the north they retired to the banks of the Kerulen, their original home, but as the Chinese became weaker on the frontier they pushed southward and occupied the Ordos country. The Mongol royal family and their immediate surroundings occupied the Chakhar country to the north-west of the Ordos territory, where they became eventually subjugated by the Manchus who overthrew the Ming dynasty in 1644. At times the old vigour and strength seemed to return to the tribe, and we read of successful expeditions being made by the Ordos Mongols into Tibet, and even of invasions into China. The relations with Tibet thus inaugurated brought about a rapid spread of Buddhism among the Mongolians, and in the beginning of the 17th century a Dalai Lama was born among them. In 1625 Toba, one of the sons of Bushuktu Jinung Khan, went on a pilgrimage to the Dalai Lama, and brought back with him a copy of the Tanjur to be translated into Mongolian, as the Kanjur had already been.

Several of the tribes who had originally migrated with those who finally settled in the Ordos territory, finding the country to be so inhospitable, moved farther eastward into richer pastures. Among these were the Tumeds, one of whose chiefs, Altan Khan (Chinese, Yen-ta), is famous in later Mongol history for the power he acquired. During the 16th century he carried on continuous warfare with China, and on peace being made (1571) he was made a prince of the empire. He was as successful also in Tibet, and he brought back Lama prisoners who spread Lamaism through all the Tumeds. Altan died in 1584 and was succeeded by his son Senge Dugureng Timur.

The Khalkha Mongols.—North of the Gobi desert live the Eastern and Western Khalkhas. In the early 17th century the Russians sent an embassy to the khan persuading him to acknowledge allegiance to the tsar. The allegiance was lightly sworn and lightly thrown off, and when the Russians attacked the Khirghiz the Mongols aided the latter. In spite of submission to Russia the Mongols had no protection against Chinese attacks on the south and the Manchus demanded Mongol submission in their turn. When the Kalmucks began to menace them the Khalkhas claimed Chinese protection, and the emperor K'ang-hsi invited all the Khalkha chiefs to meet him on the plain of Dolon-nor. This ceremony resulted in the absorption of the Khalkhas into the Chinese race.

The Torgod.—During the Kin dynasty of China the Keraits, as has been pointed out, were for a time supreme in Mongolia, and it was during that period that one of the earliest recognized sovereigns, Merghus Buyuruk Khan, sat on the throne. A grandson of Merghus was the celebrated Wang Khan, who was sometimes the ally and sometimes the enemy of Jenghiz Khan, and has also been identified as the Prester John of early western writers. In war he was almost invariably unfortunate, and it was with no great difficulty, therefore, that his brother Ki Wang detached the greater part of the Kerait tribes from his banner and founded the Torgod chieftainship, named probably from the country where they settled themselves. Their history for several centuries consists of nothing but a succession of wars with the tribes on either side of them, and it was not until 1672, when Ayuka Khan opened relations with the Russians, that the country obtained an even temporarily settled existence. It was necessary, from the position of the territory, to conciliate either the Russians or the Turks. Frequent invasion from the north led to complaints of the tsar's government and friendly relations with the Krim Khan. Ayuka fought his way to Kazan and, having exacted full vengeance, made

peace with Russia, confirmed in 1722 at a conference with Peter the Great at Astrakhan. Ayuka was shortly succeeded by his son, Cheren Donduk, whose patent to the throne from the Dalai Lama did not protect him from the plots of his nephew, Donduk Ombo, who drove his uncle to St. Petersburg and seized the throne. Donduk Ombo governed wisely and with vigour, and was succeeded by Donduk Taishi, who went to Moscow to attend the coronation of the Empress Elizabeth and to swear fealty to the Russians. He was succeeded by his son Ubasha, who, in the war between his two powerful neighbours in 1769 and 1770, gave valuable assistance to the Russians. He determined to migrate eastward with his people, and on Jan. 5, 1771, he began his march with 70,000 families. In vain the Russians attempted to recall the fugitives, who, in spite of infinite hardships, after a journey of eight months reached the province of Ili, where they were welcomed by the Chinese authorities. Food for a year's consumption was supplied to each family; and land, money and cattle were freely distributed. It is believed that 300,000 persons survived to receive the hospitality of the Chinese. The Torgod prospered, but lost their individuality in absorption into the Chinese race.

The Kalmucks.—Among the Mongol chiefs who rose to fame during the rule of the Ming dynasty of China was Toghon, the Kalmuck khan, who, taking advantage of the state of confusion which reigned among the tribes of Mongolia, established for himself an empire in north-western Asia. He died in 1444 and was succeeded by his son, Yi-hsien, who was vigorous and ambitious. He attacked China and took the emperor (Chêng-t'ung) prisoner. Subsequent defeats made him open negotiations for the restoration of Chêng-t'ung. After Yi-hsien's death the Kalmucks lost much of their power in eastern Asia but still ravaged the Russian borders. In the 17th century Galdan restored some of their authority; taking advantage of a quarrel between the Black and White Mountaineers of Kashgar, he overran Little Bukhārā and left a viceroy there, with his capital at Yarkand. He made an alliance with China and then attacked the Khalkhas, but K'ang-hsi decided to support the Khalkhas. The Chinese marched into Mongolia and met Galdan's forces at Chao-modo where they routed them utterly. For a time Galdan strove to turn the tables on the Chinese but he died in the field, unsuccessful. Tsi-wang Arabtan, his successor, weakened his power by a dispute with the Russians over Little Bukhārā, said to be rich in gold. Peter the Great determined to force his way into the country and to oppose him the Kalmucks assembled in force. Tsi-wang's successor, Amursama, was appointed by the Chinese emperor K'ien Lung, who called him khan of the Kalmucks, and chief of Dzungaria (q.v.). But the real power was vested in Chinese commissioners, and Amursama revolted, dispersed the garrisons stationed in Ili and took Palikun. K'ien Lung sent a large force against the rebel and drove him into Siberia where he died of smallpox. China again absorbed a Mongol tribe, vying with Russia, her chief competitor in Mongol affairs. The Buriats, who occupied much territory on both sides of Lake Baikal, were not absorbed although they became "Russians."

The House of Jagatai.—The dominions given by Jenghiz Khan to his son Jagatai were involved in the quarrels between Kaidu and Kublai for the khaganate, but at the beginning of the 14th century Dua, a great-great-grandson of Jagatai, made himself undisputed lord of the whole region. Shortly after Dua's death the Mongols of eastern Turkistan, descendants of those who had favoured the pretensions of Kaidu to be khagan, separated from their western brethren and chose a son of Dua as their khan. Henceforth the Jagatais were divided into two dynasties, the western reigning at Samarkand, the eastern first at Kashgar and later at Yarkand and Aksu. Kazan (1343–46) was the last independent khan of the western Jagatais; thereafter power fell into the hands of amirs, who, however, continued to place a titular khan on the throne. In 1360 Toghluk-Timur, a grandson of Dua and khan of the eastern Jagatais (the kingdom called by the Persian historians Mogolistan), invaded the territories of the western Jagatais. About this time Timur (q.v.), otherwise Timur-i-leng (Tamerlane), a young amir at the court of the western Jagatais, allied himself with the leaders who had dethroned Kazan, and after the death of Toghluk-Timur became by right of conquest khan of both sections of the Jagatais. After Timur's death the two sections again divided, while a third kingdom, Ferghana, was held by the Timurids (descendants of Timur). At the beginning of the 16th century all three dynasties were swept away by Mohammed Shaībani, head of the Uzbeg Mongols (*v. infra,* "Uzbegs").

The Ilkhans of Persia.—The empire of the ilkhans established by Hulagu lasted nominally until 1353, but after the death of the ilkhan Abu Said in 1335 the real power was divided between five petty dynasties which had been formed out of the provinces conquered by Hulagu. Meantime Islam had made great progress among the Mongols, the third ilkhan, Nikudar Ahmed (reigned 1281–84), having embraced that faith. Upon the western frontiers of their empire bordering on the Syrian possessions of Egypt there was frequent intercourse, sometimes friendly, sometimes warlike, between the ilkhans and the sultans of Egypt (q.v.). Of the petty dynasties which supplanted that of Hulagu, one known as the Jelairids held Baghdad until about 1400. Another dynasty which reigned in Azerbaijan was overthrown in 1355 by the western Kipchaks (*v. infra,* "Golden Horde"). Between 1369 and 1400 Timur had made himself master of the greater part of Persia and established there a second Mongol dynasty, which in turn gave place to that of the Ak Kuyunli (*see* PERSIA).

The Golden Horde.—Of the Mongol tribes who became entirely subject to Russia the principal are those of the Crimea, of Kazan, and Astrakhan; of these the Tatars of Kazan are the truest representatives of the Golden Horde or western Kipchaks, who originally formed the subjects of Batu and Orda. Batu fixed his headquarters on the Volga, and there set up his golden tent from which the horde acquired its name. In 1255 Batu died and was succeeded by his brother, Bereke Khan. During the reign of this sovereign the exactions which were demanded from the Russian Christians by the Mongols aroused the Christian world against the barbarian conquerors, and at the command of Pope Alexander IV. a general crusade was preached against them. The crusaders, lacking unity, were surprised when a Tatar host, led by Nogai and Tulabagha, appeared in Poland. After a rapid and triumphant march the invaders took and destroyed Cracow, and thence advanced as far as Bythom (Beuthen) in Oppeln, from which point they eventually retired, carrying with them a crowd of Christian slaves.

From this time the Mongols became an important factor in European politics. They corresponded and treated with the European sovereigns, and intermarried with royal families. Hulagu married a daughter of Michael Palaeologus; Toktu Khan took as his wife Maria, the daughter of Andronicus II.; and to Nogai Michael betrothed his daughter Irene. Toktu, the second khan in succession to Bereke, is the first Mongol ruler of whom we hear as having struck coins. Those issued during his reign bear the mint marks of Sarai, New Sarai, Bulgar, Ukek, Khwarizm, Krim, Jullad and Madjarui, and vary in date from 1291 to 1312.

The adoption of Islam by the rulers of the Golden Horde drew closer the relations of the Mongols with Constantinople and Egypt. Nāṣir, ruler of Egypt, sent to demand in marriage a princess of the house of Jenghiz Khan. At first his request was refused by the proud Mongols, but the present of a million gold dinars, besides a number of horses and suits of armour, resulted in a princess landing at Alexandria in regal state in 1319. With that religious toleration common to his race, Uzbeg Khan, having married one princess to Nāṣir, gave another in marriage to George the prince of Moscow. Uzbeg protected the Russian churches within his frontiers, and put his seal to his new religious views by marrying a daughter of the Greek emperor, Andronicus III. He died in 1340, after a reign of 28 years. His coins were struck at Sarai, Khwarizm, Mokshi, Bulgar, Azak and Krim, and are dated from 1313 to 1340. His son and successor, Tinibeg Khan, after a reign of only a few months, was murdered by his brother, Janibeg Khan, who usurped his throne, which was snatched from him by violence in 1357. As he lay ill on his return from a successful expedition against Persia he was murdered by his son Berdibeg, who, in his turn was, after a short reign, murdered by his son Kulpa. With the death of Berdibeg the fortunes of the Golden Horde began

rapidly to decline.

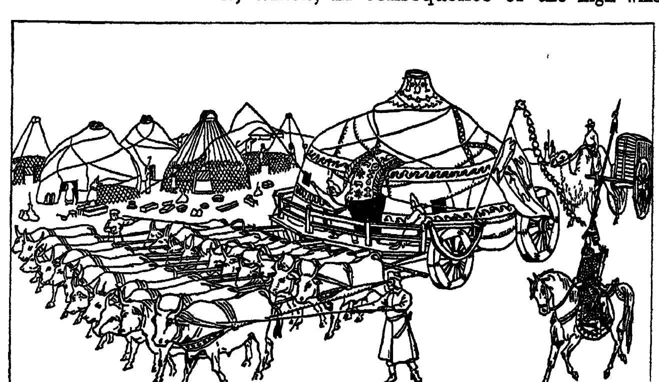
The White Horde or Eastern Kipchak.—While the power of the Golden Horde was dwindling away, the White Horde or Eastern Kipchak, which was the inheritance of the elder branch of the family of Juji, remained vigorous and prosperous. The descendants of Orda, Batu's elder brother, maintained much of the simplicity and vigour of their nomad ancestors, and the throne descended from father to son with undiminished authority until the reign of Urus Khan (1360). Khan Tuli Khoja paid with his life for his temerity in opposing the political plans of his connection with Urus Khan. Toktamish, the son of the murdered man, fled at the news of his father's death and sought refuge at the court of Timur, who received him with honour and at once agreed to espouse his cause. With this intention he despatched a force against Urus Khan, and gained some advantage over him, but, while fitting out another army to make a fresh attack, news reached him of the death of Urus.

He was followed on the throne by his two sons, Tuktakia and Timur Malik, each in turn; the first reigned but for a few weeks, and the second was killed in a battle against Toktamish, the son of his father's enemy. Toktamish seized the throne (1378), not only of Eastern Kipchak but also of the Golden Horde, over which his arms had at the same time proved victorious. He reigned as Nāṣir ed-din Jetal el Mahmud Ghujas Toktamish. His demands for tribute from the Russian princes met with refusal, and Toktamish therefore at once marched an army into Russia. Having captured Serpukhov, he advanced on Moscow. On Aug. 23, 1382, his troops appeared before the doomed city, and a general slaughter followed. The same pitiless fate overtook Vladimir, Zvenigorod, Yuriev, Mozhaisk and Dimitrov. With better fortune, the inhabitants of Pereslavl and Kolomna escaped with their lives from the troops of Toktamish, but at the expense of their cities, which were burned to the ground. Flushed with success, Toktamish demanded from his patron Timur the restoration of Khwarizm, which had fallen into the hands of the latter at a period when disorder reigned in the Golden Horde. On Timur's refusal Toktamish marched an army of 90,000 men against Tabriz. After a siege of eight days the city was taken by assault and ruthlessly ravaged. In the meantime Timur was collecting forces to punish his rebellious protégé. When his plans were fully matured, he advanced upon Old Urgenj and captured it. More merciful than Toktamish, he transported the inhabitants to Samarkand, but in order to mark his anger against the rebellious city he levelled it with the ground and sowed barley on the site where it had stood. On the banks of the Oxus he encountered his enemy, and after a bloody battle completely routed the Kipchaks, who fled in confusion. A lull followed this victory, but in 1390 Timur again took the field. After a considerable delay, owing to an illness which overtook Timur, his troops arrived at Kara Saman. Here envoys arrived from Toktamish bearing presents and a message asking pardon for his past conduct; but Timur was inexorable. He marched forward month after month through the Kipchak country in pursuit of Toktamish. At last, on June 18, he overtook him at Kandurcha, in the country of the Bulgars, and at once forced him to an engagement. For three days the battle lasted, and finally the Kipchaks were completely routed and fled in all directions.

Toktamish, though defeated, was not subdued, and in 1395 Timur found it necessary again to undertake a campaign against him. This time the armies met upon the Terek, and after a fiercely contested battle the Kipchaks again fled in confusion. Timur, threatened by the advancing autumn, gave up further pursuit, and retired with a vast booty of gold ingots, silver bars, pieces of Antioch linen and of the embroidered cloth of Russia, etc. On his homeward march southwards he arrived before Azak, which was then the entrepôt where the merchants of the east and west exchanged their wares. In vain the natives, with the Egyptian, Venetian, Genoese, Catalan and Basque inhabitants, besought him to spare the city. Circassia and Georgia next felt his iron heel, and the fastnesses of the central Caucasus were one and all destroyed. Timur rested for a time in luxurious splendour and then marched against and utterly destroyed Aṣtrakhan. Sarai was similarly treated and Timur having destroyed the empire of Toktamish for the second time returned home.

The Krim Tatars.—The power in the hands of the successors of Toktamish never revived after the last campaign of Timur. They were constantly engaged in wars with the Russians and the Krim Tatars, with whom the Russians had allied themselves, and by degrees their empire decayed, until, on the seizure and death of Ahmad Khan at the beginning of the 16th century, the domination of the Golden Horde came to an end.

The fate which thus overtook the Golden Horde was destined to be shared by all the western branches of the great Mongol family. The khans of Kazan and Kasimov had already in 1552 succumbed to the growing power of Russia, and the Krim Tatars were next to fall under the same yoke. In 1453 Constantinople had been taken by the Osmanli Turks, who, having quarrelled with the Genoese merchants who monopolized the trade on the Black sea, sent an expedition into the Crimea to punish the presumptuous traders. The power which had captured Constantinople was not likely to be held in check by any forces at the disposal of the Genoese, and without any serious opposition Kaffa, Sudak, Balaklava and Inkerman fell before the troops of the sultan Mohammed. It was plain that, situated as the Crimea was, between the two great powers of Russia and Turkey, it must of necessity fall under the direction of one of them. Which it should be was decided by the invasion of the Turks, who restored Mengli Girai, the deposed khan, to the throne and virtually converted the khanate into a dependency of Constantinople. But though under the tutelage of Turkey, Mengli Girai, whose leading policy seems to have been the desire to strengthen himself against the khans of the Golden Horde, formed a close alliance with the grand-prince Ivan of Russia. Mohammed Girai Khan in 1521 marched an army northwards until, after having devastated the country, massacred the people, and desecrated the churches on his route, he arrived at the heights of Vorobiev overlooking Moscow. A treaty was arranged by which the grand-prince Basil undertook to pay a perpetual tribute to the Krim khans. Before long, however, a contention arose over the khanate of Kazan, recovered by the Mongols and lost again to Russia together with Astrakhan in 1555. The sultan, however, declined to accept this condition of things as final, and instigated Devlet Girai, the Krim khan, to attempt their recovery. On arriving before Moscow walls the latter found a large Russian force occupying the suburbs. With these, however, he was saved from an encounter, for just as his foremost men approached the town a fire broke out, which, in consequence of the high wind



FROM HENRY YULE, "BOOK OF SIR MARCO POLO" (JOHN MURRAY)

MEDIAEVAL TATAR HUTS AND WAGONS. A PAVILION OF WANDS, COVERED WITH CLOTH, IS SHOWN; ERECTED ON A LARGE WAGON DRAWN BY 22 OXEN

blowing at the time, spread with frightful rapidity and in the space of six hours destroyed all the churches, palaces and houses, with the exception of the Kremlin, within a compass of 30 miles. Another invasion of Russia, a few years later (1572), was not so fortunate for the Mongols, who suffered a severe defeat near Molodi, 50 versts from Moscow. A campaign against Persia made a diversion in the wars which were constantly waged between the Krim khan and the Russians, Cossacks and Poles. So hardly were these last pressed by their pertinacious enemies in 1649 that they bound themselves by treaty to pay an annual subsidy to the khan.

But the fortunes of war were not always on the side of the Tatars, and with the advent of Peter the Great to the Russian throne the power of the Krim Mongols began to decline. In 1696 the tsar, supported by a large Cossack force under Mazeppa, took the field against Selim Girai Khan, and gained such successes that the latter was compelled to cede Azov to him. By a turn of the wheel of fortune the khan had the satisfaction in 1711 of having it restored to him by treaty; but this was the last real success that attended the Tatar arms. In 1735 the Russians in their turn invaded the Crimea, captured the celebrated lines of Perekop, and ravaged Bakhchi-sarai, the capital. In 1783 the Krim, together with the eastern portion of the land of the Nogais, became absorbed into the Russian province of Taurida.

The Uzbegs.—The Uzbegs on the destruction of the Golden Horde, assumed an important position on the east of the Caspian sea. The founder of their greatness was the khan Abulkhair, who reigned in the 15th century, and who consolidated a power out of a number of small clans. Shaibani Khan, his grandson, proved himself a worthy successor, and by him Baber (q.v.), the Timurid khan of Ferghana, who afterwards founded the Mogul empire in India, was driven from his ancestral dominions. In 1500 he inflicted a severe defeat on Baber's forces, and captured Samarkand, Herat and Kandahar. By these and other conquests he became possessed of all the country between the Oxus and the Jaxartes, of Ferghana, Khwarizm and Hissar, as well as of the territory of Tashkent from Kashgar to the frontiers of China. In the following year, by a dashing exploit, Baber recovered Samarkand, only to lose it again a few months later. During several succeeding years Shaibani's arms proved victorious in many fields of battle, and but for an indiscreet outrage on the territories of the shah of Persia he might have left behind him a powerful empire. The anger, however, of Shah Ismail roused against him a force before which he was destined to fall. The two armies met in the neighbourhood of Merv, where, after a desperate encounter, the Uzbegs were completely defeated. Shaibani, with a few followers, sought refuge in a cattle-pound. But finding no exit on the farther side, the refugees tried to leap their horses over the wall. In this attempt Shaibani was killed (1510). After this defeat the Uzbegs withdrew across the Oxus and abandoned Khurāsān. Farther east the news aroused Baber to renewed activity, and before long he re-occupied Samarkand and the province "beyond the river," which had been dominated by the Uzbegs for nine years. But though the Uzbegs were defeated they were by no means crushed, and ere long we find their khans reigning, now at Samarkand, and now at Bukhārā. As time advanced and European powers began to encroach more and more into Asia, the history of the khanates ceases to be confined to the internecine struggles of rival khans. Even Bukhārā was not beyond the reach of Russian ambition and English diplomacy. Several European envoys found their way thither during the first half of the 19th century, and the murder of Stoddart and Conolly in 1842 forms a melancholy episode in British relations with that fanatical capital. With the absorption of the khanate of Bukhārā and the capture of Khiva by the Russians the individual history of the Mongol tribes in central Asia comes to an end, and their name has left its imprint only on the dreary stretch of Chinese-owned country from Manchuria to the Altai mountains, and to the equally unattractive country in the neighbourhood of the Koko-nor. The Mongols have become scattered nomads engaged in agriculture and caravan trading, and are now for the most part indistinguishable from the Chinese who surround them everywhere.

Bibliography.—D'Ohsson, *Histoire des Mongols* (1834); Sir H. Howorth, *History of the Mongols* (1876, 1878); Cahun, *Introduction à l'histoire d'Asie;* Köhler, *Die Entwicklung des Kriegswesens;* Strakosch-Grossman, *Der Einfall der Mongolen in Mittel-Europa; Ein Beitrag zur somatischen Ethnologie der Mongolen* (Jena, 1902); (for the general reader) Jeremiah Curtin, *The Mongols, a history* (1908). For a complete list of Mongol tribes and Banners *see* Whymant, *A Mongolian Grammar* (appendix) (1926).

(R. K. D.; A. N. J. W.)

MONGOOSE, the name applied to the Indian representatives of the weasel-like mammals of the genus *Herpestes* (*see* Ichneumon). The Indian mongoose (*H. mungo*) is smaller than the Egyptian animal, with fur of a brownish-grey colour, the hairs being largely white-ringed, while the cheeks and throat are more or less reddish. It is especially serviceable in India as a serpent-killer, destroying not only the eggs and young of these creatures but killing the most venomous adult snakes. The mongoose is not immune to the snake's poison, falling a victim as rapidly as any other animal when bitten. By its agility and quickness of eye, it avoids the fangs of the snake while fixing its own teeth in the back of the reptile's neck. Moreover, when excited, the mongoose erects its long stiff hair, and it must be difficult for a snake to drive its fangs through this and the thick skin which all the members of the genus possess. The mongoose is equally dexterous in killing rats and other vermin. For the effects of the introduction of the Mongoose into Jamaica, *see* F. Finn, *Wild Animals of Yesterday and To-day,* 1st edit., London.

MONG PAI: *see* Shan States.

MONG PAN: *see* Shan States.

MONISM, in philosophy, generally denotes any ontological theory according to which all that exists is in some sense one (Gr. μονος, one). The term monism was first introduced by the German philosopher C. Wolff (1679–1754), but came into vogue chiefly through the influence of Haeckel and Ostwald, the leaders of the "Society of Monists" (*Monistenbund*) founded in 1906. Wolff used the term monism simply in contrast to dualism, and he recognized only two kinds of monism, namely, materialism and idealism. Since then, however, the term has received many other applications, and the present varieties of monism are legion. It is not proposed to do more here than to indicate briefly the most important of them. To avoid unnecessary complication and confusion it is perhaps best to follow the more usual tendency and to restrict the term monism to what is sometimes called "substantival" monism. Substantival monism is the view that reality is just one substance or self-existing thing or system, and that all things and events of daily experience are but parts or modifications of this ultimate substance. Besides "substantival" monism there is "attributive" monism, that is the view that reality has but one *irreducible* attribute. Now, attributive monism, as will be seen presently, may or may not be combined with substantival monism, and it may also be combined with substantival pluralism (the view that there is more than one ultimate substance). Idealistic monism combines substantival with attributive monism; Spinoza's monism combines substantival monism with attributive pluralism (that is the recognition of more than one irreducible attribute in ultimate reality); and the monodology of Leibnitz combines attributive monism with substantival pluralism. But to return to the main types of substantival monism. Differences in substantival monism must obviously be correlated with differences in the character attributed to the one ultimate reality which all forms of substantival monism admit. Now the most familiar kinds of reality are those commonly described as the material and the mental (or body and mind, or extension and thought, etc.). Hence the most common differences in ontology, and therefore in substantival monism. are connected with these characters or attributes. The monism which identifies ultimate reality with matter or with physical energy is called *materialism* or *energism* or energetic monism. That which identifies it with mind or experience is called *spiritual* or *psychical* monism; and if it identifies ultimate reality more particularly with reason or thought, it is called *idealistic* or *intellectualistic* monism, and if with will, it is called *voluntarism* or *voluntarist* monism. Then there are varieties of monism which maintain that ultimate reality is itself neither material nor psychical (or spiritual), and that it only expresses itself in these two parallel ways, and may be in many, or infinite other ways. These may be called *dualistic* or *pluralistic* forms of monism according as they combine attributive dualism or pluralism with substantival monism. But they are known by various other names, some of which and the reasons for them may be stated here. One name is *agnostic* monism, because the nature of ultimate reality is unknown, apart from its material and mental manifestations. Another name is *neutral* monism, because ultimate reality is regarded as being itself neither material nor mental, though expressing itself in both these ways. Sometimes it is called the *identity philosophy* or the *mind-stuff theory* (*q.v.*), because the material and mental are regarded

as having something identical or an identical source, or because the same ultimate entity is at once mind and matter. And so on. Before proceeding to other considerations it may be as well to note an important difference between these dualistic or pluralistic types of monism, on the one hand, and the materialistic and spiritualistic types, on the other. According to the former the material and the mental are equally real—neither is reducible to the other. Materialism, on the other hand, reduces the mental to a mere epiphenomenon (or by-product) of matter or physical energy; and idealistic or psychical monism reduces the material to a merely mental appearance. It is true, however, that even the dualistic or pluralistic types of monism show some of them a tendency to stress the mental side and so lean towards idealism, while others stress the material side and so lean towards materialism. The next ground of difference between types of monism turns on the answer to the question whether there is any purposiveness in the processes of ultimate reality? If the answer is affirmative, we have *teleological* monism; if negative we have either *mechanistic* or *naturalistic* monism. Lastly, there is the question of its divinity. If this is denied, we have *atheistic* monism; if it is affirmed, as it is in the monism of Spinoza who identified Nature or the Universe (or Substance) with God, then we have *pantheism* or pantheistic monism.

BIBLIOGRAPHY.—R. Eisler, *Geschichte des Monismus* (1910); A. Drews, *Der Monismus dargestellt in Beiträgen seiner Vertreter*, (1907); E. Haeckel, *Monism* (1895), and *Riddle of the Universe* (1900); S. J. Romanes, *Mind, Motion and Monism* (1895); W. Ostwald, *Monistische Sonntagspredigten* (1911 etc.); A. Worley, *Concepts of Monism* (1907); *see* also articles on authors and subjects mentioned. (A. Wo.)

MONITION or **ADMONITION,** in English ecclesiastical law, an order requiring or admonishing the person complained of to do something specified in the monition, or appear and show cause to the contrary, "under pain of the law and penalty thereof." It is the lightest form of ecclesiastical censure, whether to clergymen or laymen, but disobedience to it, after it has been duly and regularly served, entails the penalties of contempt of court. Monitions of a disciplinary character are either for the purpose of enforcing residence on a benefice or in connection with suits to restrain ritual alleged to be unlawful.

MONITOR: NAVAL, a shallow draught warship mounting one or two very large guns and specially designed for bombarding. Credit for the idea of a vessel of this type may perhaps be given to Captain Cowper Coles who, in 1855, during the Crimean War, mounted a 32 pounder on a raft. Incidentally he also evolved the system of training a gun on a turntable with a winch instead of levering the carriage round with hand-spikes or pulling it right and left with tackles, thereby originating what eventually developed into the modern form of gun mounting.

The most famous ship of this class of her day and the one which gave the name "Monitor" to the type was that built to Ericsson's design in 1861. (*See* below "MONITOR" AND "MERRIMAC," BATTLE OF.)

Monitors in embryo form were to be found in the British fleet in the bomb ketches introduced in the 17th century, afterwards increased in size to bomb vessels known as "bombs." These craft were used in the frequent coastal operations of those days and formed a definite feature amongst the various types which composed the navy. At a later date we find the principle of the design embodied in the old coast defence ships of the "Cyclops" class. These were built as the result of an entirely unsound policy whereby naval units were dotted along the coast with the idea that they produced some measure of local protection, whereas, of course, the money would have been far better devoted to increasing the seagoing fleet. But the conception of a "coast attack" ship as distinct from a sort of mobile defensive fort was an entirely sound one and naval history has repeatedly shown the necessity for such a type. The World War was no exception in this respect. The operations on the Belgian Coast, in the Dardanelles, in the Suez Canal and in various inland waterways all called for small warships of the monitor type, and the British navy was not found to be at all well equipped in this respect. In fact, at the outbreak of hostilities the only craft resembling monitors were the old flat-iron gun-boats like the "Excellent" and the "Bustard," which were at once pressed into service on the Belgian Coast (*q.v.*). There were, however, three shallow-draught gun-boats building in this country for the Brazilian Government and these were immediately purchased and commissioned as the "Humber," "Mersey" and "Severn" for similar service. Before the end of the year, however, under the auspices of Admiral of the Fleet Lord Fisher a number of monitors, large and small, were laid down. They were probably intended by him to be used for his great landing project in the Baltic, but before that could be given serious consideration urgent claims arose for their services in the other war areas already mentioned.

On the Belgian Coast, old sloops, and, from time to time, an old battleship, were, at first, used for coastal bombarding and proved their unsuitability. In the Dardanelles, where old battleships had been mostly employed for this purpose, the toll of their destruction was heavy, and gave striking proof of the unreadiness of the navy for this form of amphibious warfare and of how the lessons of the past had been forgotten in centring thought and effort exclusively on building up the main fleet.

The new monitors, which were built in record time, saw much active service and proved their success as a type both by the effectiveness of their gun fire and by their remarkable immunity from casualties. The larger class, carrying a pair of 12, 14 or 15 inch guns each, were, probably, more often in action than any other vessels carrying turret guns. They were all fitted with bulges to protect them against torpedo attack. One ship, H.M.S. "Terror," was hit by no less than three torpedoes which exploded in quick succession in the fore part, but she succeeded in getting to Portsmouth from the Belgian Coast and was repaired and back on her station in a few weeks. H.M.S. "Erebus," a sister ship, was hit amidships by an explosive boat carrying a very large charge. She steamed to Portsmouth at 12 knots and was back on the Belgian Coast in a fortnight. One large monitor, H.M.S. "Raglan," was caught unawares by the German battle cruiser "Goeben" off Imbros and sunk by gun fire, while a second, H.M.S. "Glatton," was lost through catching fire and having to be torpedoed to avoid her magazines exploding in Dover Harbour. But these were the only casualties out of a fleet of sixteen of this type, of which three have been retained in the post-war fleet (1928). The monitor, as a type, was represented in the United States navy until after the World War, but with the exception of one ship, the "Cheyenne," used (1928) as a training ship, the vessels of this class have been scrapped. (E. A.)

"MONITOR" AND "MERRIMAC," BATTLE OF, a naval engagement which was fought early in the American Civil War, notable as the first conflict between iron-clad vessels. In the spring of 1861 the Federals set fire to several war vessels in the Gosport navy yard on the Elizabeth river (Va.) and abandoned the place. In June the Confederates set to work to raise one of these abandoned vessels, the frigate "Merrimac" of 3,500 tons and 40 guns, and to rebuild it as an iron-clad. The vessel (renamed the "Virginia" though she is generally known in history by her original name) was first cut down to the water-line and upon her hull was built a rectangular casemate, constructed of heavy timber (24 in. in thickness), covered with bar-iron 4 in. thick, and rising from the water on each side at an angle of about 35°. The iron plating extended 2 ft. below the water-line; and beyond the casemate, toward the bow, was a cast-iron pilot house, extending 3 ft. above the deck. The reconstruction of the vessel was completed on March 5, 1862. She drew 22 ft. of water, was equipped with poor engines, so that she could not make more than 5 knots, and was so unwieldy that she could not be turned in less than 30 minutes. She was armed with 10 guns—2 (rifled) 7 in., 2 (rifled) 6 in., and 6 (smooth bore Dahlgren) 9 in. Her most powerful equipment, however, was her 18 in. cast-iron ram.

In Oct. 1861 Capt. John Ericsson, an engineer, and a Troy, N.Y., firm, as builders, began the construction of the iron-clad "Monitor" for the Federals, at Greenpoint, Long Island. For the idea of the low free-board and the revolving turret Ericsson was indebted to Theodore R. Timby (1819–1909), who in 1843 had filed a caveat for revolving towers for offensive or defensive war-

fare, whether placed on land or water. With a view to enable this vessel to carry at good speed the thickest possible armour compatible with buoyancy, Ericsson reduced the exposed surface to the least possible area. Accordingly, the vessel was built so low in the water that the waves glided easily over its deck except at the middle, where was constructed the revolving turret for the guns, and though the vessel's iron armour had a thickness of 1 in. on the deck, 5 in. on the side, and 8 in. on the turret, its draught was only 10 ft. 6 in., or less than one-half that of the "Merrimac." Its turret, 9 ft. high and 20 ft. in inside diameter, seemed small for its length of 172 ft. and its breadth of 41 ft. 6 in., and this, with the lowness of its freeboard, caused the vessel to be called the "Yankee cheese-box on a raft." Forward of the turret was the iron pilot house, square in shape, and rising about 4 ft. above the deck. The "Monitor's" displacement was about 1,200 tons and her armament was two 11 in. Dahlgren guns; her crew numbered 58, while that of the "Merrimac" numbered about 300. She was seaworthy in the shallow waters off the southern coasts and steered fairly well. The "Monitor" was launched at Greenpoint, Long Island, Jan. 30, and was turned over to the Government on Feb. 19. The building of the two vessels was practically a race between the two combatants.

On March 8, about 1 P.M., the "Merrimac," commanded by Commodore Franklin Buchanan (1800–1874), steamed down the Elizabeth accompanied by two one-gun gun-boats, to engage the wooden fleet of the Federals, consisting of the frigate "Congress," 50 guns, and the sloop "Cumberland," 30 guns, both sailing-vessels, anchored off Newport News, and the steam frigates "Minnesota," and "Roanoke," the sailing-frigate "St. Lawrence," and several gun-boats, anchored off Fortress Monroe.

Actual firing began about 2 o'clock, when the "Merrimac" was nearly a mile from the "Congress" and the "Cumberland." Passing the first of these vessels with terrific broadsides, the "Merrimac" rammed the "Cumberland" and then turned her fire again on the "Congress," which in an attempt to escape ran aground and was there under fire from three other Confederate gun-boats which had meanwhile joined the "Merrimac." At about 3.30 P.M. the "Cumberland," which had been keeping up a heavy fire at the Confederate vessels, sank, with "her pennant still flying from the topmast above the waves." Between 4 and 4.30 the "Congress," having been raked fore and aft for nearly an hour by the "Merrimac," was forced to surrender. While directing a fire of hot shot to burn the "Congress," Commodore Buchanan of the "Merrimac" was severely wounded and was succeeded in the command by Lieutenant Catesby ap Roger Jones. The Federal steam frigates, "Roanoke," "St. Lawrence" and "Minnesota" had all gone aground in their trip from Old Point Comfort toward the scene of battle, and only the "Minnesota" was near enough (about 1 m.) to take any part in the fight. She was in such shallow water that the Confederate iron-clad ram could not get near her at ebb tide, and at about 5 o'clock the Confederates postponed her capture until the next day and anchored off Sewell's Point.

The "Monitor," under Lieutenant John Lorimer Worden (1818–97), had left New York on the morning of March 6; after a dangerous passage in which she twice narrowly escaped sinking, she arrived at Hampton Roads during the night of the 8th, and early in the morning of the 9th anchored near the "Minnesota." When the "Merrimac" advanced to attack the "Minnesota," the "Monitor" went out to meet her, and the battle between the iron-clads began at about 9 A.M. on the 9th. Neither vessel was able seriously to injure the other. The "Monitor" had the advantage of being able to out-manoeuvre her heavier and more unwieldy adversary; but the revolving turret made firing difficult, and communications were none too good with the pilot house, the position of which on the forward deck lessened the range of the two turret-guns. The machinery worked so badly that the revolution of the turret was stopped. After two hours' fighting, the "Monitor" was drawn off, so that more ammunition could be placed in the turret. When the battle was renewed (at about 11.30) the "Merrimac" began firing at the "Monitor's" pilot house; and a little after noon a shot struck the sight-hole of the pilot house and blinded Lieutenant Worden. The "Monitor" withdrew in the confusion consequent upon the wounding of her commanding officer, and the "Merrimac" after a short wait for her adversary steamed back to Norfolk. There were virtually no casualties on either side. After the evacuation of Norfolk by the Confederates on May 9, Commodore Josiah Tattnall, then in command of the "Merrimac," being unable to take her up the James, sank her. The "Monitor" was lost in a gale off Cape Hatteras on Dec. 31, 1862.

Though the battle between the two vessels was indecisive, its effect was to "neutralize" the "Merrimac," which had caused great alarm in Washington, and to prevent the breaking of the Federal blockade at Hampton Roads; in the history of naval warfare it may be regarded as marking the opening of a new era—the era of the armoured warship.

See W. Swinton, *Twelve Decisive Battles of the War* (1867); J. R. Soley, *The Blockade and the Cruisers* (1883); *Battles and Leaders of the Civil War*, vol. i. (1887); Frank M. Bennett's *The Monitor and the Navy under Steam*, chap. ii. (Boston, 1900); George Robert Durand, *A Great Naval Battle as Seen by an Eye-Witness* (1913); S. Dana Greene, "The 'Monitor' at Sea and in Battle," *U.S. Naval Inst. Proc.*, vol. xlix., p. 1,839–47 (1923); W. Tindall, "The True Story of the Virginia and the Monitor," *Virginia Mag. of Hist. and Biog.*, vol. xxxi., p. 1–38, 90–145 (1923); S. C. Bushnell, *The Story of the Merrimac and the Monitor* (1924).

MONITORING RECEIVER is a receiver so arranged as to enable an operator to check the operation of a radio transmitting set.

MONK (or MONCK), GEORGE, 1ST DUKE OF ALBEMARLE (1608–1669), second son of Sir Thomas Monk, was born at Potheridge, near Torrington, in Devonshire, on Dec. 6, 1608. In 1626 he served in the expedition to Cadiz, and the next year in the Isle of Ré. At the outbreak of the Irish rebellion he was made colonel of Lord Leicester's regiment. All the qualities for which he was noted—his talent for making himself indispensable, his imperturbable temper and his impenetrable secrecy—were fully displayed in this employment. Monk was appointed governor of Dublin by Leicester, but Charles I. overruled the appointment in favour of Lord Lambert. Ormonde, who viewed Monk with suspicion as one of the two officers who refused the oath to support the Royal cause in England, sent him under guard to Bristol. But he justified himself to Charles in person, and his soldierly criticisms on the Irish War impressed the king, who gave him a command in the corps sent over from Ireland during the English Civil War. He was taken prisoner, at Nantwich (1644), and spent the next two years in the Tower, where he wrote his *Observations on Military and Political Affairs.*

Monk's Irish experience led to an invitation to serve parliament against the Irish rebels. At first as adjutant-general to the Parliamentary lord-lieutenant, his old friend Lord Lisle, and afterwards as governor of Ulster, he rendered great services to his new masters. He made head against the rebels for two years, but in the third (1649) the Parliamentarians, weakened by defections brought about by the execution of the king, lost one place after another, and Monk concluded an armistice with the rebel Owen Roe O'Neill upon terms which he knew would not be ratified. Having been exonerated by parliament, his next command was in Cromwell's army in Scotland. He commanded a brigade at the victory of Dunbar, and when in 1651 Cromwell hurried into England to pursue Charles II., Monk was left to complete the subjugation of the country. After taking Dundee, he retired to Bath in 1652, broken in health.

In Nov. 1652 Monk was appointed one of the three generals of the fleet. He was engaged with Blake and Deane in the battle of Portland (Feb. 18, 1653), and in the action of June 2–3 exercised the general command after Deane's death. A third battle on July 29 and 30, was a decisive victory for the Commonwealth's fleet (*see* DUTCH WARS). On his return he married Anne Clarges, a woman of low extraction, and next year was back in Scotland. After suppressing the Royalist insurrection in the Highlands, he settled down to a steady government of the country for the next five years. In 1655 he received a letter from Charles II., a copy of which he sent to Cromwell, who is said to have replied in 1657: "There be that tell me that there is a certain cunning fellow in Scotland called George Monk, who is said to lye in wait there to

introduce Charles Stuart; I pray you, use your diligence to apprehend him, and send him up to me."

During the confusion which followed Cromwell's death Monk remained watchful at Edinburgh, careful only to secure his hold on his troops. In July 1659 tempting proposals were again made to him by the king, but he would not entertain them. When Booth rose in Cheshire for the king, Monk was on the point of joining forces with him, and a manifesto was prepared. His habitual caution, however, induced him to wait until the next post from England, and the next post brought news of Booth's defeat.

When Fleetwood and Lambert declared against the parliament, Monk refused to join them, and (Oct. 20, 1659) at once took measures of active opposition. Securing his hold on Scotland by a small corps of occupation, he crossed the border with the rest of his army. Holding Lambert in play until his army began to melt away for want of pay, Monk became commander-in-chief of the parliament's forces (Nov. 24). The navy, some of the English garrisons and the army in Ireland declared for the parliament, and the army from Scotland crossed the Tweed on Jan. 2, 1660. Monk entered London on Feb. 3. In all this his ultimate purpose remained mysterious. At one moment he secretly encouraged the demands of the Royalist City of London, at another he urged submission to the existing parliament, then again he refused to swear an oath abjuring the house of Stuart, and further he hinted to the attenuated Long Parliament the necessity of a dissolution. Lastly, acting as the military agent of the infuriated parliament, he took away the gates and portcullises of the city. This angered not only the citizens but his own army, and gave him the lever that he desired to enforce the dissolution of parliament. He was now master of the situation, and though he proclaimed his republican sympathy, it was well known that the new parliament, which Monk was imposing on the remnant of the old, would have a strong Royalist colour. Monk himself was now in communication with Charles II., whose declaration of Breda was based on Monk's recommendations. The new parliament met on April 25, and on May 1st voted the restoration of the monarchy.

With the Restoration the historic interest of Monk's career ceases. Soldier as he was, he had played the difficult game of diplomacy with incomparable skill, and had won it without firing a shot. He was made gentleman of the bedchamber, knight of the Garter, master of the horse and commander-in-chief, raised to the peerage with the titles of Baron Monk, earl of Torrington and duke of Albemarle, and received a pension of £7,000 a year. Monk had been appointed lord-lieutenant of Ireland but he would not leave England. He concurred in the disbandment of the army, and only the regiment of which he was colonel, the Coldstream (Guards), survives to represent the army of the Civil Wars. In 1664 he had charge of the admiralty when James, duke of York, was in command of the fleet, and when in 1665 London was deserted on account of the plague, Monk remained in charge of the government of the city. In the following July, with Rupert, he defeated the Dutch fleet, and in the autumn maintained order in London during the Great Fire. His last service was in 1667, when the Dutch fleet sailed up the Thames, and Monk, though ill, hastened to Chatham where he was unable to oppose their progress. From that time he lived in privacy, and died of dropsy on Jan. 3, 1670. The dukedom became extinct on the death of his son Christopher, 2nd duke of Albemarle (1653–88).

See the *Life* of Monk, by Dr. Gumble, his chaplain (1671), and the memoir and bibliography by C. H. Firth in the *Dict. Nat. Biogr.*

MONK, a member of a community of men living a life under vows of religious observance; the term is properly confined to a member of a Christian community, but is sometimes applied to members of Buddhist and Mohammedan religious brotherhoods. The Greek and Latin name was first used of the hermits, but was early widened to embrace the coenobites. (*See* MONASTICISM.)

MONKEY, a term applicable to all members of the order PRIMATES (*q.v.*) except man and, strictly, the true or anthropoid apes.

MONKEY-NUT: *see* GROUND-NUT.

MONKEY PUZZLE, the name given to the Chile pine (*Araucaria imbricata*) introduced into Great Britain in 1796 and since widely cultivated throughout Europe and the southern United States, especially in California. The tree grows to a height of 150 ft. in the Cordilleras of Chile. The stiff, sharp-pointed leaves, 1 in. to 2 in. long, with broad overlapping (imbricated) bases, persist for many years. The globose cones are from 8 to 8½ in. broad and 7 to 7½ in. long; the wood is hard and durable.

MONKHOUSE, WILLIAM COSMO (1840–1901), English poet and critic, was born in London on March 18, 1840. He was educated at St. Paul's School, and entered the civil service. In 1870–1871 he went on a mission to South America and he served on different departmental committees, notably that of 1894–1896 on the Mercantile Marine Fund. He died in London on July 20, 1901. His first book of poems, *A Dream of Idleness and Other Poems* (1865), is strongly coloured by his admiration for Wordsworth and Tennyson. His other poetical works are *Corn and Poppies* (1890), *The Christ on the Hill* (1898), and the posthumous *Pasiteles the Elder and other Poems*. His most important work was done as an art critic and historian. Much of his work on art was contributed to the *Dictionary of National Biography*, and to periodicals. Separate works are: *The Italian Pre-Raphaelites* (1887), *The Earlier English Water-Colour Painters* (1890 and 1897), *In the National Gallery* (1895) and *British Contemporary Artists* (1899).

MONKSWELL, ROBERT PORRETT COLLIER, 1st BARON (1817–1886), English judge, was born at Plymouth, on June 21, 1817, the son of a merchant. He was educated at Oxford, was called to the bar in 1843, and went the western circuit. He obtained a high reputation by his successful defence of Brazilian pirates in 1845; the conviction was quashed on appeal on a point of law which the judge had refused to reserve. He was elected member of parliament for Plymouth in the Liberal interest in 1852, and in 1859 was appointed counsel to the admiralty and judge-advocate to the fleet. In this capacity he gave in 1862 an opinion in favour of detaining the Confederate rams building in the Mersey, which would have saved his country much money and much credit if it had been acted upon. In 1863 he became solicitor-general, and in 1868 attorney-general, and in 1869 successfully passed a bankruptcy bill. In 1871 he was appointed by Mr. Gladstone one of four new judges upon the judicial committee of the privy council, although it was expressly provided by the act creating these offices that none of them should be filled by a law-officer of the Crown. This prohibition was evaded by making Collier a judge of common pleas, and transferring him after a few days to the privy council. He received a peerage in 1885 and died on Nov. 3, 1886.

MONMOUTH, JAMES SCOTT, DUKE OF (1649–1685), leader of an abortive insurrection against James II. in 1685, was the son of Lucy Walters, who became the mistress of Charles II. during his exile at The Hague. He was born at Rotterdam on April 9, 1649. Charles always recognized him as his son, and lavished on him an almost doting affection. Until the Restoration he was placed under the care of Lord Crofts, by whose name he was known. In July 1662 he was sent for by Charles, and at thirteen came under the protection of Lady Castlemaine. No formal acknowledgement of his relation to the king was made until James's betrothal to Anne Scott, countess of Buccleuch, whom he married in 1665. During 1663 he was made duke of Orkney, duke of Monmouth and knight of the Garter, and on his marriage he and his wife were created duke and duchess of Buccleuch, and he took the surname of Scott. In 1670, on the death of Monk, he was made captain-general of the king's forces. Monmouth was now becoming a person of political importance. The anti-popery spirit was rapidly turning to frenzy, and the succession of James a probability and a terror. Charles was urged to legitimize Monmouth by a declaration of his marriage with Lucy Walters. Every attempt was made, especially by Shaftesbury, to accustom people to this idea, and his position was emphasized by James's second marriage, with the Catholic princess Mary of Modena. From this time his popular title was "the Protestant duke." In 1674 he was made "commander-in-chief";

and at Shaftesbury's instance was placed in command of the army employed in 1675 against the Scottish Covenanters, and was present at Bothwell Bridge (June 22, 1679). In 1678, when Charles was driven into war with Louis, Monmouth took command of the English contingent.

In 1679 the king fell ill, and the dangers of a disputed succession became apparent. The party opposed to Monmouth, or rather to Shaftesbury, prevailed upon Charles to consent to the return of his brother, James, from Brussels. When, after the king's recovery, James went back to Brussels, he received a promise that Monmouth too should leave the country. Accordingly, in Sept. 1679, the latter repaired to Utrecht, but he secretly returned to London two months later, and, as the champion of Protestantism, was well received. The king appeared to be greatly incensed, deprived him of his offices, and ordered him to leave the kingdom at once. This he refused to do, and henceforth was merely forbidden to appear at court.

It was at this time that the exclusionists, who, in the absence of parliament were deprived of their best basis for agitation, developed the system of petitioning. So successfully was this answered by the "abhorrers" that Charles, feeling the ground safer under him, recalled James to London—a step immediately followed by the resignation of the chief Whigs in the council.

Once more, an attempt was made to establish Monmouth's claims, but Charles again publicly declared that he had never been married but to the queen. Monmouth now went to the west of England, visiting the chief members of the country party, and gaining popularity among the people. When the right of James to the succession was again formally acknowledged by Charles in 1680, Monmouth threw himself vehemently into the plans of the exclusionists, speaking and voting for exclusion in the House of Lords. In 1681 the parliament passed a series of resolutions of extreme violence, of which one was that Monmouth should be restored to all his offices and commands; and when Charles summoned a fresh parliament to meet at Oxford the leaders of the exclusionists went thither with troops. Not until the dissolution of this last parliament, in March 1681, did the weakness of Monmouth's cause appear. The deep-seated respect for legitimate descent asserted itself, and a great reaction took place. In November Dryden published *Absalom and Achitophel.* Shaftesbury was attacked, and Monmouth himself did not escape insult in the street and from the pulpit. When he went, in 1682, on a second progress through the western and north-western counties his proceedings were narrowly watched, and he was arrested at Stafford. He was released on bail, and in February 1683, after the death of Shaftesbury, he openly broke the implied conditions of his bail by a third visit to Chichester on pretence of hunting.

The Rye House plot gave an excuse for arresting the Whig leaders; Russell and Sidney were judicially murdered; Monmouth retired to Toddington, and was left untouched. By two submissive letters, he reconciled himself with the help of Halifax both to the king and to James, though he had the humiliation of seeing his confessions and declarations of penitence published in the *Gazette.* His partial return to favour raised the hopes of his partisans; to check these, Algernon Sidney was executed. Monmouth was now subpoenaed to give evidence at the trial of young Hampden. To escape from the difficulty he fled to Holland, probably with Charles's connivance, and though he visited England in Nov. 1684, it is doubtful whether he ever again saw the king. The quiet accession of James II. soon brought Monmouth to the crisis of his fate. Within two months of Charles's death he had yielded to the impetuosity of Argyll and other exiles and to vague invitations from England.

DEFEAT AND CAPTURE

On the 2nd of May Argyll sailed with three ships to raise the west of Scotland; and three weeks later, with a following of only eighty-two persons—of whom Lord Grey, Fletcher of Saltoun, Wade, and Ferguson, the author of the *Appeal from the Country to the City,* were the chief—Monmouth himself set out for the west of England, the stronghold of Protestant dissent. He gained little sympathy, but soon collected an undisciplined body of some 1,500 men, with whom he seized Axminster, and entered Taunton. Meanwhile parliament had declared it treason to assert Monmouth's legitimacy, or his title to the crown; a reward of £5,000 was offered for him dead or alive, and an act of attainder was passed in unusual haste. Troops had been hurriedly sent to meet him, and when he reached Bridgwater Albemarle was already in his rear. From Bridgwater the army marched through Glastonbury to attack Bristol, into which Lord Feversham had hastily thrown a regiment of foot-guards. The attempt miscarried; and, after summoning Bath in vain, Monmouth, with a disordered force, began his retrograde march through Philips Norton and Frome, continually harassed by Feversham's soldiers. At the latter place he heard of Argyll's total rout in the western Highlands. On July the 5th, Feversham entered Sedgemoor in pursuit; Monmouth the same night attempted a surprise, but his troops were hopelessly routed. He himself, with Grey and a few others, fled over the Mendip Hills to the New Forest, hoping to escape by sea, but he was captured close to Ringwood in Hampshire on the 8th.

On the day of his capture Monmouth wrote to James in terms of the most unmanly contrition, ascribing his wrong-doings to the action of others, and imploring an interview. This was granted on the 13th and after another imploring letter to the king, he offered, as the last hope, to become a Roman Catholic; this might have proved successful, but the priests sent by James to ascertain his sincerity declared that he cared only for his life and not for his soul.

He met his death at the scaffold on July 15, 1685, with calmness and dignity. In a signed paper he expressed sorrow for having assumed the royal style, and at the last moment confessed that Charles had denied to him privately, as he had publicly, that he was ever married to Lucy Walters.

See G. Roberts, *Life, Progresses, and Rebellion of James, Duke of Monmouth* (2 vols. 1844), the article in the *Dict. Nat. Biog.* and general bibliography given in *Camb. Mediaeval Hist.* (vol. 5, chaps. 8 and 9, 1908).

MONMOUTH, ROBERT CAREY, 1ST EARL OF (*c.* 1560–1639), youngest son of Henry Carey, 1st Baron Hunsdon, chamberlain, and first cousin of Queen Elizabeth. In 1587 he joined in the attempt to relieve Sluys, in 1588 served as a volunteer against the Spanish expedition, and commanded a regiment in Essex's expedition to Normandy in 1591, taking part in the siege of Rouen. He was knighted by Essex the same year for having by his intercession with the queen procured his recall. In the parliaments of 1586 and 1588 he represented Morpeth; in that of 1593, Callington; and in those of 1596 and 1601, Northumberland. He succeeded to his father's appointment of lord warden of the marches in 1596, which he held till 1598. In March 1603 he witnessed the queen's last illness, which he described in his *Memoirs.* Two years later, he was made governor of Prince Charles, in 1611 his master of the robes, in 1617 his chamberlain, and in 1622 was created Baron Carey of Leppington. In 1623 he followed Charles to Spain, and after the latter's succession to the throne he was created earl of Monmouth in 1626. He died on April 12, 1639.

His *Memoirs* were published first by the earl of Cork and Orrery in 1759, a new edition, annotated by Sir Walter Scott, being printed in 1808.

MONMOUTH (Welsh *Mynwy*), municipal borough, and county town of Monmouthshire, England, 18 m. S. of Hereford, on the G.W. railway. Pop. (1931) 4,731. It is situated at the confluence of the Wye and the Monnow and is almost surrounded by hills. Monmouth (*Monemuta*) was possibly a fort from Roman times. Situated between Severn and Wye its strategic importance was early recognized by the Saxons, while in later years it played a leading part in Welsh border warfare. At the time of Domesday the castle was in the custody of William Fitz Baderon. Henry III. granted it to his son Edmund Crouchback, through whose descendants both borough and castle passed into the duchy of Lancaster. Since the 18th century the dukes of Beaufort have been lords of the borough.

Portions of the town walls remain, and there is an old gateway on the Monnow bridge; but there are only insignificant ruins of the castle, originally a Saxon fortress. The principal buildings

include the churches of St. Mary on an ancient site, and the chapel of St. Thomas, a late Norman structure, and the free grammar-school, founded in 1614.

Monmouth was a borough by prescription as early as 1256, and was governed by a mayor in 1461, but was not incorporated until 1550. This charter was confirmed in 1558, 1606 and 1666. By the act of 1535–36 Monmouth, as county town, obtained representation in parliament; it is now part of one of the county divisions. Wednesday and Saturday markets were confirmed to Monmouth in 1550. Since the 18th century it has been a quiet market town deriving some prosperity from the rise of the adjoining industrial regions as well as an annual three-days' fair.

MONMOUTH, a city of western Illinois, U.S.A., 56 m. S. of Rock Island and 18 m. from the Mississippi river; the county seat of Warren county. It is on Federal highway 34, and is served by the Burlington Route, the Minneapolis and St. Louis, and the Rock Island Southern railways. Pop. (1920) 8,116 (88% native white) and was 8,666 by the Federal census of 1930. It has large potteries and other manufacturing industries; ships several thousand carloads of cattle and hogs to Chicago every year; and is the seat of Monmouth college (United Presbyterian), opened as an academy in 1853, as a college in 1856. Monmouth was settled in 1824, incorporated as a village in 1836 and chartered as a city in 1852.

MONMOUTH COURT HOUSE, BATTLE OF. The battle of Monmouth Court House was fought (June 28, 1778) between the Americans under Gen. Washington and the British commanded by Sir Henry Clinton, who having evacuated Philadelphia (June 18) was marching through New Jersey to Sandy Hook. Washington had decided that for his country's honour and his own reputation he must strike a vigorous blow at the retreating enemy even at the risk of bringing on a general engagement, and ordered Charles Lee with the advanced guard to attack the British rear (June 28), promising to support him with the main body of the army. Lee had claimed this command, as the senior major-general in the army, though it had been originally assigned to Lafayette, and Washington now added to it two brigades, bringing it up to a strength of about 5,000. But Lee had no intention of carrying out the spirit of his orders. An ex-officer of the British army, who had seen much service in the Seven Years' War, he believed the Continental troops to be no match for British regulars in the field and held it madness to risk a pitched battle before the arrival of French troops in America. He contemplated nothing more than a forced reconnaissance. Clinton after a 40 hours' halt at Monmouth Court House (now Freehold) made an early start (June 28). His baggage train of 1,500 wagons led the way under escort of Knyphausen's German division, and Cornwallis's British division formed the rear-guard.

When Lee approached Monmouth he found only a small covering force there. He was executing an elaborate manoeuvre to envelop it, when Cornwallis's division appeared. Clinton had ordered his lieutenant to turn back and strike hard at the attacking force, in order to prevent any attempt to harass his trains. Instead of fighting a delaying action with a force not much stronger than his own on ground well adapted for the purpose and gaining time for Washington to come up, Lee allowed his troops to retreat. He had ordered his right to fall back, but gave no orders to the rest, and they finding themselves in danger of being cut off, also retired. Lee made little effort to check the somewhat disorderly retreat and sent Washington no warning that he was retiring. When the commander-in-chief came up, he was surprised and indignant, and hastened to form a line of battle with the divisions of Greene and Alexander (called by the Americans Lord Stirling) on the right and left, while part of Lee's force rallied under Wayne and checked the pursuit of the British cavalry. Cornwallis brought up his infantry and endeavoured to dislodge Washington but without success. The fiercest fighting was in front of the centre behind a hedge fence held by the heroic Wayne, who repulsed three fierce assaults of British grenadiers. Towards evening Cornwallis fell back. Washington sent forward three brigades to renew the battle, but darkness forestalled them. During the night Cornwallis withdrew, undetected by the American outposts, and overtook Knyphausen near Middletown, where the high ground secured them from further attack. Washington finding the enemy gone attempted no pursuit and presently marched to the Hudson to join Gen. Gates, whilst Clinton's army was conveyed by transports from Sandy Hook to New York. The two combatants resumed the positions, which they had held two years before.

Of the two armies Clinton's seems to have been a little the larger—about 17,000 to 14,000. But not much more than half of the British army was actually engaged. Washington returned 360 casualties and Clinton 358, but the Americans claimed to have buried 249 British dead on the battlefield. Owing to the intense heat nearly 100 men in the two armies died of sheer fatigue. A court-martial suspended Lee from any command in the American armies for twelve months. Subsequently he was dismissed from the American service on account of his attacks upon Washington. In 1860 Lee's letter to Gen. Howe, written when he was a prisoner in British hands, suggesting a plan of campaign for Howe's forces, came to light, and later writers have added to the charge of incompetence and insubordination against Lee that of deliberate treachery. The evidence seems in favour of acquitting Lee of any worse crime than disloyalty to his commander.

See W. S. Stryker, *The Battle of Monmouth* (Princeton, 1927).

MONMOUTHSHIRE, a western border county of England, bounded east by Gloucestershire, north-east by Herefordshire north-west by Brecknock, west and south-west by Glamorganshire (Wales), and south by the estuary of the river Severn. The county falls into two natural regions:—the basin of the Usk (after that river emerges from the gap between the Brecon Beacons, 2,907 ft., and the Black mts., 2,624 ft.), which forms the north-eastern and central portions of the county, and the basins of the river Rhymney and the river Ebbw which drain the south-east slopes of the Brecon Beacons, *i.e.,* the eastern end of the south Wales coal-field. The river Monnow forms the north-east boundary of the county, but its upper waters include a section of the Black mts., within the county boundary on the north side. After the junction of the Monnow with the Wye at Monmouth, the main river becomes the eastern boundary; the upper and middle river Rhymney form its western border. The Monnow, and the Wye as far as Tintern, pass over Old Red Sandstone rocks (a great series of red marls, sandstone and concretionary limestones), which occupy the north-east and central parts of the county, grits and conglomerates of the highest beds giving rise to bold escarpments and lofty plateaux (*e.g.,* The Sugar Loaf, 1,955 ft., Skirrid Fawr 1,596 ft., and Blorenge, 1,838 ft., which almost encircle the town of Abergavenny).

West of the town of Usk, the Old Red Sandstone plain is interrupted by an extensive anticline of older Silurian strata (Wenlock shale and limestone and Ludlow beds), a small inlier of the same rocks appearing at Rhymney near Cardiff. The Rhymney (down to Caerphilly), and the Ebbw (with the Sirhowy and other tributaries) which joins the Usk below Newport, are parallel consequent streams draining the coal-field, which here consists of a series of north-north-west to south-south-east valleys, separated by high ridges of Pennant grit, and related to lines of faulting that are much later than the foldings of the coal-field. These valleys are deep and narrow, and often of U-shaped transverse profile, due to scouring by glaciers from the Brecon Beacons. The Carboniferous limestone, millstone grit, and coal measures (lower coal series, Pennant sandstone and upper coal series) dip westward and succeed each other from east to west. The Coal Measures abound in coal-seams and ironstone and their valleys, densely populated with people formerly occupying higher pastoral districts, now forsaken, give rise to acute social and economic problems. Around the eastern edge of the coal-field a narrow rim of Carboniferous limestone occurs, and is crossed by a western tributary of the Usk at Pontypool. Very striking land forms are seen in the valley of the Wye between Tintern and Chepstow, where Carboniferous limestone again appears on the western rim of the outlying Forest of Dean coal-field (Glos.). Rhaetic and Lias limestones and shales outcrop at Llanwern and

Goldcliff, near Newport. Glacial gravel and boulder clay are found in the valleys, and a broad tract of alluvium borders the Bristol channel from Rhymney to Portskewet, forming a lowland way through Monmouthshire to the Vale of Glamorgan, part of the plain of Gwent.

History and Early Settlement.—Monmouthshire in early times was heavily forested and formed part of the difficult country of the lower Severn. There are evidences of the use of the route to the west (via the south Wales coastal plain) in the Bronze age; finds of flat axes and socketed celts being important in the southern section of the county. The westward route was used by the Romans, who built Caerwent and Caerleon (*q.v.*), the latter of which performed a service similar to that performed by Chester in the north, guarding the coastal route into Wales.

Monmouthshire, at the time of the Heptarchy, formed the Welsh kingdom of Gwent, and no permanent English settlement was effected in the district until close upon the middle of the 11th century. The incursions of the West Saxons began in the 7th century, and Brochmael and Fermael, kings of Gwent, acknowledged Alfred as their lord. In the 9th and 10th centuries the district was frequently harried by the Danes, who in 915, under Ohter and Hwald, sailed round Wessex and Cornwall to the Severn, plundered the banks of the Wye and took prisoner the bishop of Llandaff. In 926 Aethelstan met the kings of the north Britons at Hereford and fixed the Wye as the limit of their territory. In 976 the Danes destroyed Caerleon, at this time the chief town of the district. The early 11th century was taken up with interminable contests between the Welsh princes for the succession in south Wales, and the Welsh Chronicle relates that in 1047 the whole of South Wales lay waste, and in 1049, Griffith, the king of South Wales, assisted Irish pirates in plundering. In 1065 Harold conquered the district between the lower Wye and the Usk.

After the Conquest, this district was bestowed on William Fitz Osborne, earl of Hereford, who built Monmouth castle, and continued the line of defence against the Welsh frontier along the Wye, while a second line of fortifications along the Usk valley marked the continued advance of the Normans, who by 1085 had subjugated almost the whole of Gwent. The lordship of Overwent fell to Hamelin de Baladun, who founded the castle and priory of Abergavenny, and from him passed to Brian Fitz Count and later to Walter Fitz Miles, earl of Hereford. The lordship of Netherwent remained for many centuries with the Clare family. Penhow castle was a stronghold of the family of St. Maur or Seymour, from whom are descended the present dukes of Somerset, and Grosmont and Skenfrith castles of the family of Braose. Gwent still ranked as Welsh territory at the time of Domesday, but the town of Monmouth, the castle of Caerleon, and the district of Archenfeld, are assessed under Herefordshire, and the three hardwicks of Llanwern, Portskewet and Dinam under Gloucestershire. The Norman lords of the present county held their lands "per baroniam," so that the king's writ did not run in them, and the lives and property of the poorer inhabitants were entirely at the mercy of these lords marchers. The county still exhibits remains of 25 Norman castles. The province of Gwent was formerly divided into four cantrefs, each comprising several commotes. Cantref Uwchcoed, or Upper Gwent, comprised the commotes of Erging and Ewyas, now principally in Herefordshire, and the greater part of the present hundreds of Skenfrith, Abergavenny and Usk; Cantref Iscoed, or Lower or Nether Gwent, comprised the present hundred of Raglan and parts of Caldecot and Usk; Cantref Gwentlwg comprised the present hundred of Wentlwg; while the fourth cantref, Cantref Coch, now forms the forest of Dean in Gloucestershire. Leland, (16th century) describes Gwent as comprising the three divisions of low, middle and high "Venteland," and at this period it included 24 lordship marches, each governed by its own ancient laws and customs, and ruled by its own lord. Under the act of 1536 for the abolition of the marches, these 24 lordships were united to form a shire with Monmouth as the shire town, and the sheriff's court held alternately at Monmouth and Newport. The shire was divided into six hundreds—Abergavenny, Caldecote, Raglan, Skenfrith, Usk and Wentlwg—the bounds being subsequently ratified by act of parliament of 1542–43. No sheriffs were appointed until 1541, and the legal authority of the lords marchers was not finally abolished until 1689. The act of 1536 did not expressly separate the county from Wales, and it was only gradually that Monmouthshire came to be regarded as an English county, being included in the Oxford circuit for the first time in the reign of Charles II.

Ecclesiastically Monmouthshire has been almost entirely in the diocese of Llandaff since its foundation in the 6th century. Monmouth was in the diocese of Hereford, and a few parishes formed part of the diocese of St. Davids until 1836, when the whole county was placed under the bishop of Llandaff. It contains, wholly or in part, 134 ecclesiastical parishes.

Architecture.—Of Norman fortresses, the more interesting are: Caldicot, the seat of the De Bohuns, with a round keep of the 13th century, gatehouse and other portions, still partly inhabited; Chepstow, one of the finest examples of the Norman fortress extant, in an imposing situation on a cliff above the Wye; Newport, Abergavenny, the gateway and hall of Grosmont, once the residence of the dukes of Lancaster; and Usk castle, rebuilt by the Clares in the time of Edward IV. Raglan castle, begun in the reign of Henry V., is a very extensive ruin, still in good preservation. Charles I. resided in it after the battle of Naseby, and in 1646 it was delivered up to the parliamentary forces after a stubborn resistance of ten weeks against Col. Morgan and Gen. Fairfax.

At the Reformation Monmouth possessed two hospitals and 15 other religious houses; of these only Llanthony abbey and Tintern abbey (both Cistercian) are important. Llanthony abbey in the Black mts. was founded by William de Lacy in 1103, and the church, dating from about 1200, is one of the earliest examples in England of the Pointed style. The ruins consist of portions of the nave, transept, central tower and choir. Tintern abbey (*q.v.*), founded by Walter de Clare in 1131, occupies a position of great beauty on the Wye, and is amongst the finest monastic ruins in England. Churches worthy of mention are Abergavenny, belonging to a Benedictine priory, and containing a number of old tombs; Chepstow, partly Norman, and possessing a richly moulded doorway; St. Woolos' church, Newport, also Norman; the Norman chapel of St. Thomas, Monmouth, Christchurch, principally Norman; Mathern, Early English, with a tablet to Tewdrig, king of Gwent in the 6th century; and Usk, formerly attached to a Benedictine priory.

Agriculture.—Along the Severn shore the soil is deep and loamy, and admirably suited for the growth of trees. The most fertile land is that resting on the red sandstone, especially along the banks of the Usk, where wheat of fine quality is raised. In the mountainous regions more attention is paid to the grazing than to the raising of crops. There are a considerable number of dairy farms, but sheep-farming is much more largely followed. Only about seven-tenths of the total area of the county is under cultivation. There is a large extent of hill pasture, and a considerable acreage under orchards. The river fisheries of Monmouthshire have been famed from early times, Caerleon with seven fisheries in the Wye and the Usk being mentioned in Domesday.

Mining.—The coal-mines and iron-works which Monmouthshire shares with south Wales are very important. The industry of coal-mining is said to date from the time of Edward I., but the industry lapsed until the construction of the Blaenavon-Newport canal (1792–95). In 1740 Monmouthshire contained only two furnaces, making 900 tons annually. In 1790 three new furnaces were constructed at Blaenavon, and since then the industry has steadily grown. These, in order from east to west, with the principal townships in each are as follows:—Afon Lwyd (Panteg, Pontypool, Abersychan and Blaenavon); Ebbw Fach (Abertillery, Nantyglo and Blaina), joining the Ebbw (Risca, Ebbw Vale); Sirhowy (Bedwellty and Tredegar); Rhymney (New Tredegar and Rhymney). Besides coal, considerable quantities of fire-clay and some iron are raised.

Communications.—The county is served by the G.W. rail-

way. Main lines run from Cardiff (Glam.) north through Newport, Pontypool and Abergavenny to Hereford; south-west along the Severn estuary from Gloucester to Chepstow, Newport (with branch to Caerphilly) and Cardiff; across the centre of the county from Monmouth to Usk, Pontypool and on to Pontypridd (Glam.) All these link up with various valley routes. A line of the L.M.S. railway crosses the north of the county from Abergavenny to Merthyr (Glam.) with branches to Blaenavon and down the Sirhowy. The Crumlin canal from the Ebbw valley, and the Monmouthshire canal from Pontypool converge upon Newport, which is the principal port in the county. The Brecon canal runs north from Pontypool into the valley of the Usk.

The area of the administrative county and associated county borough is 349,569 acres; pop. (1931) 434,821. The county comprises six hundreds. Municipal boroughs are Abergavenny, Monmouth, and Newport, a county borough. Monmouthshire is in the Oxford circuit, and assizes are held at Monmouth, and it has one court of quarter sessions. The boroughs of Monmouth and Newport have commissions of the peace, but no separate court of quarter sessions. The parliamentary divisions are Abertillery, Bedwellty, Ebbw Vale, Monmouth and Pontypool, each returning one member; and the parliamentary borough of Newport returns one member. By the act of 1536 two knights were to be returned for the shire and one burgess for the borough of Monmouth, but the first returns for the county were made in 1547 and for the borough in 1553.

See *Victoria County History, Monmouthshire;* W. Coxe, *An Historical Tour in Monmouthshire,* 2 pts. (1801); N. Rogers, *Memoirs on Monmouthshire* (1708); David Williams, *History of Monmouthshire* (1796); G. Ormerod, *Strigulensia. Archaeological Memoirs relating to the district adjacent to the Confluence of the Severn and the Wye;* M. E. Bagnall-Oakeley, *Account of the Rude Monuments in Monmouthshire* (Newport, 1889); J. A. Bradney, *A History of Monmouthshire* (1904, etc.); also the publications of the Caerleon Antiquarian Association.

MONNIKENDAM, a fishing village of Holland, in the province of North Holland, on an inlet of the Zuider Zee known as the Gouw Zee, 12 m. N.N.E. of Amsterdam. Pop. (1926), 2,537. It was once a commercial town but now it is a tourist centre. Among the notable buildings are the weigh-house (17th century), the bell-tower (1591), formerly attached to the town-hall before this was destroyed in the 18th century, and the church of St. Nicholas, mentioned in a document of 1356, but not completed until the beginning of the 15th century. It contains some carvings and many old tombs.

MONO or **MONACHI,** two Shoshonean Indian groups in central California, of the same dialectic division of that family as the Northern Paiute of Nevada and the Bannock of Idaho. Mono is Spanish for monkey, but Monachi is the term for them among the neighbouring Yokuts. The western Mono, in the pine belt of the Sierra Nevada, are acculturated to the Yokuts below them; the eastern Mono, of Mono and Owens valley across the crest, locally called Paiute, are more similar to their congeners of the Great Basin. The Mono have suffered less from Caucasian contacts than any California tribe, and therefore survive as the most populous native group in the state, there being 1,400 in 1910. The western Mono form a distinct physical type, with narrow heads.

MONOCHORD, an instrument having a single string, used by the ancient Greeks for tuning purposes and for measuring the scale arithmetically. A movable bridge was so contrived as to slide along over the string and stop it at any point.

MONOCOTYLEDONS: *see* ANGIOSPERMS.

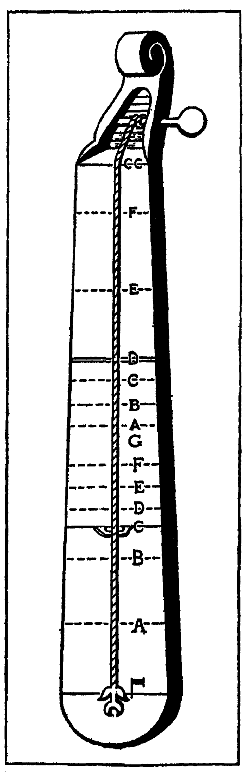
MONOD, ADOLPHE (1802–1856), French Protestant divine, was born on Jan. 21, 1802, in Copenhagen, and was educated at Paris and Geneva. He began his life-work in 1825 as founder and pastor of a Protestant church in Naples, whence he removed in 1827 to Lyons. Here his evangelical preaching, and especially his sermon on the duties of communicants led to his deposition. In 1836 he became professor in the Theological college of Montauban, removing in 1847 to Paris as preacher at the Oratoire. He died on April 6, 1856. Monod was undoubtedly the foremost Protestant preacher of 19th century France.

His chief works are *Sermons* (1844, Eng. trans. 1849); *La Femme* (1848, Eng. trans. 1851) and *S. Paul* (1851, Eng. trans. 1853). Extracts from his correspondence appeared at Paris (1885–1902). *See* A. Richardot, *A. Monod considéré comme prédicateur* (Strasbourg, 1863) and P. Stapfer, *La grande Prédication chrétienne en France* (1898).

FRÉDÉRIC MONOD (1794–1863), his brother, was born at Monnaz, Switzerland on May 17, 1794, and died at Paris on Dec. 30, 1863. Ordained at Geneva in 1818, he spent most of his life in Paris, where with Count Gasparin he founded in 1849 the Union of the Evangelical Churches of France.

MONOD, GABRIEL (1844–1912), French historian, was born at Havre on March 7, 1844, and died at Versailles on April 10, 1912. He studied at the École Normale Supérieure, Paris, and at Göttingen and Berlin before he began to lecture at the École Normale. He wrote a number of important studies on mediaeval history and a *Bibliographie de l'histoire de France* (1888), but his greatest work was done as a teacher. His pupils dedicated to him a volume of *Études d'histoire du moyen âge* (1896). Monod founded the *Revue Historique.*

MONODELPHIA, a term applied by De Blainville in 1816 and 1834 to the highest of his three main subdivisions (subclasses) of the class Mammalia, which embraced all the mammals except the monotremes and marsupials. The name, meaning "single uterus" was given in allusion to the fact that with certain exceptions the lower parts of the right and left ducts that lead down from the ovaries are united into a single womb. This most advanced condition, called "uterus simplex," is found in man, primates generally and many bats. When the fusion of the right and left ducts is complete only at the lower end, the womb being distinctly forked, the term "uterus bicornis" is applied, as in ungulates and insectivores, and when there are distinct traces of the median partition separating the right and left halves, the condition is called "uterus bipartitus" as in carnivores. An alternative title for the group is Placentalia. Eutheria of Huxley is frequently, but incorrectly, used as the equivalent of Monodelphia.



FROM HENRY BODDINGTON, CATALOGUE OF MUSICAL INSTRUMENTS

THE MONOCHORD, AN INSTRUMENT INVENTED BY THE ANCIENT GREEKS TO INVESTIGATE THE MATHEMATICAL RELATIONS OF MUSICAL INTERVALS

MONOGENISTS, the term applied to those anthropologists who claim that all mankind is descended from one original stock (μόνος, single, and γένος, race), and even from a single pair; while polygenists (πολύς, many) contend for a multiple ancestry. Aristotle and Vitruvius saw in climate and environment the natural cause of racial differences, influences far slighter in amount and slower in operation than was supposed. But although the reality of some such modification is not disputed, a remarkable permanence of type is displayed by races long after migration to climates extremely different from that of their former homes. Physically different races, such as the Bushmen and the pure negroid types in Africa, show no signs of approximation under the influence of the same climate; while the coast tribes of Tierra del Fuego and forest tribes of tropical Brazil continue to resemble each other, in spite of extreme differences of climate and food. Darwin is moderate in his estimation of the changes produced on races of man by climate and mode of life within the range of history (*Descent of Man,* pt. i. chs. 4 and 7). A great difficulty of the monogenist theory lay in the shortness of the chronology with which it was formerly associated. It is now recognized (*see* MAN, EVOLUTION OF) that man has existed during a vast period of time.

A. R. Wallace suggested that the remotely ancient representa-

tives of the human race were in their wild state much more plastic than now to external nature. (*Contributions to the Theory of Natural Selection*, p. 319.)

The polygenist theory is not dead. An interesting problem is raised by the discovery that the composition of the blood is transmitted on Mendelian principles, and that there are at least two main varieties of blood. Further advances in physiology may help towards a solution of the question. The multiplicity of languages has been cited as evidence of polygenesis, but language is a social factor—part of the cultural acquisition of mankind—and efforts have been made to prove the common descent of all languages though links are missing and the data allow of other explanations.

BIBLIOGRAPHY.—R. B. Dixon, *Racial History of Man* (1923); G. Keynes, *Blood Transfusion* (1925); H. J. Fleure, *Races of Mankind* (1927).

MONOGRAM, originally a cipher consisting of a single letter, now a design or mark consisting of two or more letters intertwined together. The letters thus interlaced may be either all the letters of a name or the initial letters of the Christian and surnames of a person for use upon note-paper, seals, etc. Many of the early Greek and Roman coins bear the monograms of rulers for whom, or the towns in which, they were struck. The late Latin and Greek words were first applied to the signatures, which took this form, of the emperors of the eastern empire. The signatures of the Frankish kings also took the form of a monogram. The most famous of monograms is that known as the "Sacred Monogram," formed by the conjunction of the two initial letters of χριστός, Christ. The most usual form of this is the symbol ☧ and sometimes the α (alpha) and ω (omega) of the Apocalypse were placed on each side of it. The symbol was incorporated in the *Labarum* (*q.v.*) when the imperial standard was christianized. The interlaced I.H.S. (also called the "Sacred Monogram") apparently possesses no great antiquity; it is said to have been the creation of St. Bernard of Siena in the middle of the 15th century. Monograms or ciphers were often used by the early printers as devices, and are of importance in fixing the identity of early printed books. Similar devices have been used by painters and engravers. The middle ages were, indeed, extremely prolific in the invention of ciphers alike for ecclesiastical, artistic and commercial use. Every great personage, every possessor of fine taste, every artist, had his monogram. The mason's mark also was, in effect, a cipher. As the merchant had as a rule neither right nor authority to employ heraldic emblems, he, therefore, fell back upon plain simple letters arranged very much in monogram form. These "merchants' marks" generally took the form of a monogram of the owner's initials together with a private device. They nearly always contain a cross, either as a protection against storms or other catastrophes, or as a Christian mark to distinguish their goods from Mohammedan traders in the East. There is a fine example of a 16th century gold ring with a merchant's mark in the British Museum. One of the most famous of secular monograms is the interlaced "H.D." of Henri II. and Diane de Poitiers. Upon every building which that king erected it was sown profusely; it was stamped upon the bindings in the royal library, together with the bow, the quiver and the interlocked crescents of Diana. Henri IV. devised a punning cipher for his mistress Gabrielle d'Estrées, the surname being represented by a capital S. with a *trait* or stroke through it.

See Du Cange, *Glossarium* (*s.v. Monogramma*), with plates giving examples of the monograms of early popes, the emperors of the Western Empire, and of other kings.

MONOLOGUE, a passage in a drama in which a personage speaks unconsciously aloud, either alone on the stage or with others keeping silent. The tragedies of the 17th and 18th centuries greatly affected the monologue, which has always, however, been liable to ridicule. There is something of a lyrical character about the monologue in verse; and many of the examples in the tragedies of Corneille are nothing more or less than odes or cantatas. The monologues of Shakespeare and Racine have a more dramatic character. The French critics record as striking examples that of Figaro in Beaumarchais' *Le Mariage de Figaro* and the 160 lines of Charles V. in Victor Hugo's *Hernani*. In the Elizabethan drama, the popularity of Kyd's *Spanish Tragedy*, in which Hieronymo spouts interminably, set a fashion for ranting monologues, which are very frequent in Marlowe and others. After 1600 the practice was much reduced, but it returned in exaggerated form after the Reformation to fall once more into deserved contempt.

MONOMETALLISM, a term applied to a currency system in which one metal only is used as a standard. (*See* MONEY; BIMETALLISM.)

MONOMOTAPA. In old maps of south-east Africa, derived originally from Portuguese and from Dutch sources, an extensive region on the Çuama or Zambezi and to the south of it is styled *regnum monomotapae*. The precise character of the kingdom has been the subject of much discussion, and some modern historians relegate the monomotapa to the realm of myth. But such scepticism is unjustifiable since all Portuguese writers from the beginning of the 16th century onwards reiterated the assertion that there was a powerful rule known far and wide by that title.

The word "monomotapa" is of Bantu origin and has been variously interpreted. Father J. Torrend, *Comparative Grammar of the South African Bantu Languages* (p. 101) renders it "Lord of the water-elephants," and remarks that the hippopotamus is even to the present day a sacred animal among the Karanga. The earliest recorded bearer of the name is Mokomba Menamotapam, mentioned by Diogo de Alcaçova in 1506 as father of the Kwesarimgo Menamotapam who ruled at that date over Vealanga, a kingdom that included Sofala. His capital was called Zumubany, an obvious corruption of the term "Zimbabwe," the residence of any important chief. Portuguese chroniclers not only refer to the territory and the people of the monomotapa as "Mocaranga" (*i.e.*, of the Karanga tribe), but explicitly assert that the "emperor" himself was a "Mocaranga." Consequently, he must have been a negro, and the Dominican who records the baptism of Dom Filippe by a friar of the order in the middle of the 17th century actually states that this "powerful king" was a black man ("com as carnes pretas"). This seems to controvert the assumption that there existed in southern Rhodesia a ruling caste of different racial origin from the general Bantu population.

It is difficult to arrive at an estimate of the extent of territory over which this great negro chief exercised direct or indirect control. The most extravagant theory is naturally that which was expressed by the Portuguese advocates in connection with the dispute as to the ownership of Delagoa Bay. The crown of Portugal based its case against England on the cession of territory contained in a well-known treaty with the monomotapa (1629), and stated that this monarch's dominions then extended nearly to the Cape of Good Hope. A more moderate and usual view is given by Diogo de Couto, who in 1616 speaks of "a dominion over all Kaffraria from the Cabo das Correntes to the great river Zambezi." Several 17th-century writers extend the "empire" to the north of the Zambezi, Bocarro giving it in all "a circumference of more than three hundred leagues." It was "divided among petty kings and other lords with fewer vassals who are called inkosis or fumos." According to these authors, however, including Dos Santos, the paramountcy of the monomotapa was impaired in the 17th century by a series of rebellions. His zimbabwe, wherever it may have been in earlier days, was now fixed near the Portuguese fort of Masapa, only a short distance south of the Zambezi. A Portuguese garrison was maintained in it, and the monarch himself from the year 1607 onwards was little more than a puppet who was generally baptized by the Dominicans with a Portuguese name.

MONONGAHELA, a city situated in Washington county, Pennsylvania, U.S.A., on the Monongahela river, 31 m. S. of Pittsburgh. It is served by the Pennsylvania and the Pittsburgh and Lake Erie railways. Pop. (1920) 8,688; and was 8,675 in 1930. It is surrounded by highly productive coal mines, and has glass works, paper mills, foundries and other manufacturing industries. A town was laid out here in 1792 by Joseph Parkinson. He named it Williamsport, but until its incorporation in 1833 it was commonly called Parkinson's Ferry. It was here that

the Whiskey Insurrection convention met on Aug. 14, 1794.

MONOPHYSITES, the name given to those who hold the doctrine that Christ had but *one* (μόνος) composite *nature* (φύσις) and especially to those who maintained this position in the great controversies of the 5th and 6th centuries. The synod of Chalcedon (*q.v.*) in 451, following the lines of Pope Leo I.'s famous letter, endeavoured to steer a middle course between the so-called Nestorian and Eutychian positions. But the followers of Cyril of Alexandria, and with them those of Eutyches, saw in the Chalcedon decree of two natures only another form of the "Nestorian" duality of persons in Christ, and rose everywhere in opposition. For a century they were a menace not only to the peace of the Church but to that of the empire.

During the period between the Council of Chalcedon and the death of Justinian, the movement on the whole gained in strength, especially in Egypt, and was the cause of civil disturbances in Jerusalem, Alexandria, Antioch, Constantinople and other centres in the East. Justinian himself in his later days adopted it (*see* below); but his successor, Justin II., took no action either way for six or seven years, and then instituted a quiet but thorough system of suppression, closing monophysite churches and imprisoning their bishops and priests.

We find two principal varieties of monophysitism. (*a*) Severus (bishop of Antioch 513) and his followers objected to Chalcedon only because it was an innovation; they fully acknowledged the distinctness of the two natures in Christ, insisting only that they became indissolubly united so that there was only one energy (*μία καινὴ θεανδρικὴ ἐνέργεια*) of Christ's will. Severus laid great stress on the human infirmities of Christ as proving that His body was like ours, created and corruptible; and some of his followers extended the argument to Christ's human soul, which they said was, like ours, limited in knowledge. (*b*) Julian, bishop of Halicarnassus, and his followers, held that Christ's body was so inseparably united with the Logos as not to be consubstantial with humanity; its natural attributes were so heightened as to make it sinless and incorruptible. Some even held that from the moment the Logos assumed the body the latter was *uncreated,* the human being transmuted into the divine nature; and the "adiaphorites" went still further, denying like Stephen Barsudaili, an Edessan abbot, all distinction of essence not even between the manhood and the Godhead in Christ, but between the divine and the human, and asserting that "all creatures are of the same essence with the Creator."

The disintegration caused by monophysitism largely facilitated the rapid and easy victory of Islam in Syria and Egypt. (*See* MONOTHELITES.)

BIBLIOGRAPHY.—*See* the Histories of Dogma by A. Harnack, F. Loofs and R. Seeberg; articles in Hastings, *Encyclopaedia of Religion and Ethics* and Herzog-Hauck, *Realencyclopädie;* Gore, *Dissertations on Subjects connected with the Incarnation,* and *The Incarnation* (Bampton Lectures).

MONOPLANE. An aeroplane with one pair of wings. Some of the earliest aeroplanes were of this type (*e.g.* the machines of

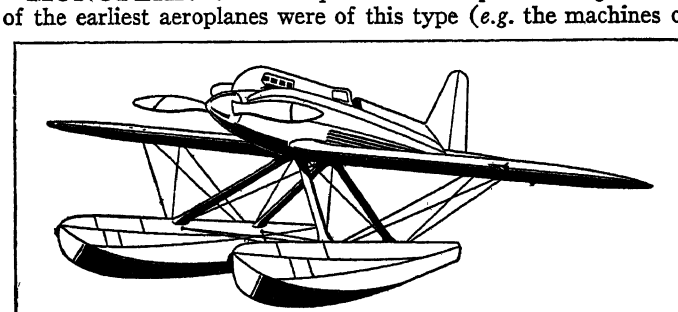


FIG. 1.—THE SUPERMARINE NAPIER MONOPLANE IN WHICH LIEUTENANT S.N. WEBSTER WON THE SCHNEIDER CUP IN 1927

Bleriot and Latham) but the structural advantage of the BIPLANE (*q.v.*) led to its preference by other pioneers (the Wrights, who were the first to fly, Farman, Cody and others). A monoplane is generally heavier and always less compact than the corresponding biplane. Monoplanes were little used during the World War, but the type has been widely adopted since by German, Dutch and American designers, though hardly at all in England. If the wing itself can be made thick enough to contain all the necessary supporting structure, an externally clean design results, and it is due mainly to the discovery of suitable thick wing sections in Germany that the type reappeared. Fig. 1 shows the Supermarine-Napier monoplane which won the Schneider cup in 1927 and fig. 2 the Ryan monoplane in which in May 1927 Captain (later

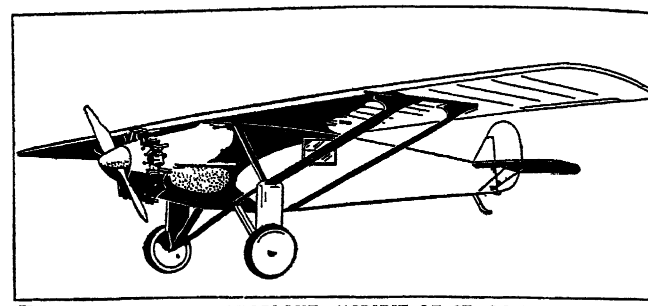


FIG. 2.—THE RYAN MONOPLANE, "SPIRIT OF ST. LOUIS," WHICH COL. LINDBERGH FLEW SOLO FROM NEW YORK TO PARIS IN 33½ HOURS

Col.) Lindbergh flew alone from New York to Paris in 33½ hours. (*See* also AEROPLANE, § 6 and 9.)

MONOPOLY. The term monopoly, in its early usage, was applied to grants from the Crown, to a favourite or as a reward for good service, of the exclusive right to manufacture or sell particular classes of goods. Not until the reign of Henry VIII. does much evidence appear of these grants in the case of either new inventions or familiar articles of trade. Elizabeth granted patents of monopoly so freely that the practice became a grave abuse, giving rise to serious complaints in the House of Commons, and to the suppression of many exclusive rights in 1601. In the first parliament of James I. a "committee of grievances" was appointed and again many monopoly patents were cancelled. Many more, however, were granted by the king, and there grew up a race of "purveyors" who made use of the privileges granted them under the great seal for various purposes of extortion. After the introduction of several bills, and several attempts by James to compromise the matter by orders in council and promises, the Statute of Monopolies was passed in 1624. This Statute made all monopolies illegal, except such as might be granted by parliament, or were in respect of new manufactures or inventions, or were exercised by civic corporations or companies and it would no doubt have greatly diminished the evils of monopoly had it not been for subsequent transgressions of the Act based in the main upon these excepting clauses. Under Charles I., the local monopoly of civic corporations began to be used as a cover for national monopolies. This was accomplished by the corporation obtaining from the sovereign a right of "superintendence" over the whole national production of the article, which in practice meant a strangle-hold upon rival producers. The grant of patent rights for new inventions was similarly abused by the according to the patentees of Crown rights of surveillance over all other producers of the commodity; while the title exercised by the Crown over all mines producing gold and silver was used as a basis for monopolistic control over tin, lead, and copper mines, of which the precious metals were an incidental by-product. In 1640, however, the Long Parliament declared most monopolies void, and the Bill of Rights ended, in 1689, the claim of the Crown to override the law.

In its modern usage the term monopoly is applied to the advantage accruing to any undertaking or associated group of undertakings which has the power, however acquired, of fixing the price of its goods or services in the knowledge that those who need them cannot get them in adequate measure elsewhere. Vestiges of the earlier usage remain in the monopoly conferred for a term of years under the patent and copyright laws; in the territorial monopolies accorded by Parliament to railway, gas, water, and electricity companies; in the monopoly exercised by the state in respect of postal, telephone and telegraph services; and in the partial monopoly which may occur where trading is permitted only under licence, as in the case of the sale of alcoholic liquors, wireless broadcasting, the plying of vehicles for public

hire, etc. These monopolies, however, are based on a genuine public interest.

Patent rights are conferred that an inventor may publicly disclose the details of his invention; parliamentary powers are required in order that duplication, inconvenience, and waste may not occur from two or more public utility services operating in the same area; and licences are required in order that certain traffic may be under limitation and control. State-accorded monopolies or quasi-monopolies are usually granted on conditions imposed in the interest of the revenue or the public—on the payment of licence or patent fees, the observance of a tariff scale, or the acceptance of the principle of limitation of profits.

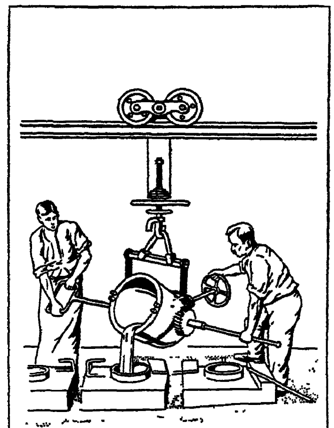
Examples of monopolies are numerous. The village shop is "a monopoly" when there is no rival shop in the neighbourhood. When greyhound racing suddenly became popular, the breeders were able to demand pounds where six months before they would have been glad of shillings. The proprietors of estates near which a railway is driven, or over which an industrial population spreads, find themselves the holders of a commodity which cannot be multiplied and the beneficiaries of a demand for their property in the creation of which they have had no part. A monopoly may be due to the sheer excellence of the services rendered by particular concerns.

The merit or demerit of the monopoly created by deliberate intent is much more difficult to assess. The creation of some degree of monopoly is in some circumstances an essential factor in the suppression of wasteful competition and the intelligent conduct of an industry as one organic whole. That being so, monopoly may be a proper object of pursuit. The National Light Castings Association in its original rules explicitly stated its object to be that of "raising and keeping up the price to the buyer of goods and articles made and/or supplied by its members . . . by so controlling production that prices will rise naturally and inevitably, as they always must do when supply is brought into equilibrium with or is ever so little below demand." All British associations for the regulation of trade pursue, usually under some euphemism, the same object—that of obtaining a degree of monopolistic power by the limitation of competition; and American associations continue to seek lawful expedients by which production and price shall be steadied against the impacts of blind competition. The great consolidation which comes to terms with its great rival, or buys out a troublesome smaller competitor does so in order to secure a greater measure of monopoly. *See* TRUSTS.

Monopoly Power, 80%.—Complete monopoly is not essential to the exercise of monopolistic power. It has been asserted that any consolidation or association which covers 80% of the output of an industry can dictate the prices at which the remaining 20% shall sell its competing products, and so may be described as having an effective monopoly; but that formula cannot be applied indiscriminately, inasmuch as the limiting conditions of control vary greatly from industry to industry. The power over prices of the incomplete monopoly has been attributed to its power to regulate the greater part of the output of the industry, but this view is not tenable; its power over prices rests in fact upon the reluctance of the non-combine firm to incur the combine's aggressive hostility, coupled with a readiness to accept for its limited output the high prices ordained by the combine rather than strive after a larger output at a lower price of its own making. It should further be observed that the power of even a 100% monopoly to raise prices against the consumer is limited. The customer has his own recourses, varying much according to the particular commodity, of going without the article or of resorting to some substitute. The intelligent monopolist, on this score alone, will not raise prices to such an extent as to injure his own net revenues; and in practice he will guard against incurring public odium and possible action by the legislature. Also he must not forget that the knowledge of large profits will cause rivals to spring up, whose destruction will cost him some of his gains.

See W. H. Price, *The English Patents of Monopoly* (1906); W. Cunningham, *The Growth of English Industry* (1907); Hermann Levy, *Monopoly and Competition* (new ed. 1927). (J. H.)

MONORAILS AND TELPHERS. Machines of the type usually known as *monorails* are installations which handle relatively light loads, *i.e.*, from 1 cwt. to 1 ton net, such a device is shown in fig. 1. The trolley can be combined with a lifting block which may be manually, mechanically or electrically operated. *Telphers* are on a similar principle but are always electrically driven. They are divided into *monorail telphers* and *bottom-flange telphers,* the latter being also called *transporters.* In the monorail type the machine travels on a "bulb-headed" or "bridge" rail, secured to the top of an I-beam; in the bottom-flange type the running wheels are duplicated and travel on both sides of the bottom flange of an I-beam. Monorails proper and bottom-flange telphers are both also known as *runways.* All types under the above headings serve, so to speak, for interdepartmental vehicular goods traffic. While ordinary vehicular traffic runs on a pair of rails on the ground, the receptacles or skips of monorails and telphers are suspended from one overhead rail. Overhead traffic has the advantage over that on ground rails in that the track does not encumber the ground, which is a matter of importance, particularly in congested aisles and passages on the factory floor. The overhead rail from which the receptacles are suspended occupies space which is of lesser value. Conditions obtain in many cases which make it absolutely imperative to convey on a path well above ground. Overhead monorail tracks are unobstructed and therefore offer less resistance to the movement of the receptacles, which, having generally only two wheels, run more easily than those on ground rails, which have four, because the friction is less. Monorail receptacles when electrically driven can be at any height above ground, or if pushed by a man walking on the ground they may be just high enough for him to reach them. A single to-and-fro track may be employed when only one unit of the telpher machine, as the rolling stock is called, can be used; but a double or endless track, *i.e.*, joined together at the two terminals, which passes all the points to be served, is the ideal solution, because it provides for one-way traffic and a number of units can travel in unbroken succession. This is of particular importance in the case of overhead traffic, where individual loads are handled rather than a train of several, as is the case with ordinary ground traffic. The track can be so arranged as to lead in and out of shops, also round buildings, at relatively sharp angles and even slight inclines, and may also be provided with branch lines. It may be supported from the ceiling or some other part of the building or, if in the open, from steel or wooden structures. In small installations the track may be a light rail of selected section or it may consist merely of a flat iron bar. The receptacles are suspended from a two-wheeled trolley or runner on the rail. When switches are employed great care must be taken to leave no open track ends, since they might be the cause of serious accidents. A variety of such switches are now on the market.



BY COURTESY OF THE VEREIN DEUTSCHER INGENIEURE

FIG. 1.—MONORAIL AS USED IN A FOUNDRY

The First Telpher.—*The telpher* was invented in 1882 by Professor Fleeming Jenkin, and the name given by him, derives from two Greek words, *tele,* far; and *pherein,* to carry. In working out his invention Professor Jenkin collaborated with Professors Ayrton and Parry. The first installation was erected at Glynde, in Sussex, on Lord Hampden's estate, and was for handling clay from a brick-field. It was a perfect success. The cost of transport was a little under 4d. per ton-mile. The track in this first example, unlike that of the modern telpher, consisted of two steel cables and not a rigid rail. The material was transported by an electrically operated tractor having ten carriers, five of which were pushed and the other five pulled. A modern telpher

is a self-contained, electrically operated unit and consists essentially of a suitable bogie or trolley, running on an overhead rail, from which is supported one receptacle to carry the load. The bogie is fitted with, and propelled by, an electric motor, which collects its current by a small trolley pole from a single, double or triple live rail supported on the track structure. The telpher may be what is known as a "man-telpher" (though frequently driven by a woman), *i.e.* accompanied by an attendant who, from the cab, starts, stops, receives or dumps the load and returns for a further one, or it may be controlled automatically, so that it travels when released at the loading platform to a predetermined, though variable destination, where it dumps its load automatically and returns again to the starting point. Man-telphers are generally fitted with one or two electric winches for picking up loads from ground level at any part of the line and laying them down at any other. Monorail telphers are suitable for heavy loads of, for instance, from 1 ton up to 5 tons net; and the speeds of travel may be anything from 50oft. up to 1,000ft. per minute, according to the nature and length of the run. The lifting speeds range from 60ft. per minute with heavy loads, to 200ft. per minute with light loads and long lifts. For loads up to a maximum of 1 ton the bottom-flange telpher is more suitable. Speeds of travel are slower than those mentioned above. Both types are equally applicable in their particular fields. Theoretically, there is no limit to the conveying distance of a telpher, but for economic reasons the allied "ropeway" (*q.v.*) is generally preferred where distances of a quarter of a mile and over have to be traversed. Monorail telphers are frequent in gas and electricity undertakings.

Automatic Telphers.—Automatic telphers are often provided with a perfect automatic block system, so that each passing telpher establishes its own connections and no second machine can enter the line within a predetermined distance from the one in front, while if that one stops all succeeding machines will keep the same distance apart. These automatic devices are, as yet, very little used in Great Britain; they are, on the other hand, employed frequently on the Continent.

See Herbert Blyth, *Modern Telpherage and Ropeways* (1926).

(G. F. Z.)

MONOTHELITES, in Church history, the name given to those who, in the 7th century, while otherwise orthodox, maintained that Christ had only one will. Their theory was an attempt to effect some kind of solution of the vital unity of Christ's person on the basis of the now firmly-established doctrine of the two natures. The controversy had its origin in the efforts of the emperor Heraclius to win back for the church and the empire the excommunicated and persecuted Monophysites or Eutychians of Egypt and Syria. In Egypt especially the monophysite movement had assumed a nationalistic, patriotic character. It was in Armenia, while on his expedition against Persia, in 622 that, in an interview with Paul, the head of the Severian Monophysites (*q.v.*) there, Heraclius first broached the doctrine that the divine and human natures in Christ, while quite distinct in his one person, had but one activity and operation. Sergius, patriarch of Constantinople, was a strong upholder of the doctrine of one divine-human energy (*μία θεανδρική ἐνέργεια*), and was the emperor's adviser on the whole question. The emperor's action led to such intense and widely-spread controversy that his successor Constans II. issued an edict forbidding all discussion of the questions of the duality or singleness of either the energy or the will of Christ. The scheme of doctrine of the first four general councils, with all its vagueness as to these points, was to be maintained; so far as controversy had gone, the disputants on either side were to be held free from censure; but to resume it would involve penal consequences. This decree secured silence, notwithstanding the protest of the Western Church at the Lateran Council of 649; but with the accession of Constantine Pogonatus in 668 the controversy once more revived, and the new emperor resolved to summon a general council. It met at Constantinople in 680, having been preceded in 679 by a brilliant synod under Pope Agatho at Rome, where it had been agreed to depart in nothing from the decrees of the Lateran synod. The will, Agatho said, is a property of the nature, so that as there are two natures there are two wills; but the human will determines itself ever conformably to the divine and almighty will.

BIBLIOGRAPHY.—*See* the Histories of Dogma by A. Harnack, F. Loofs and R. Seeberg, articles in Hastings' *Encyclopaedia of Religion and Ethics* and Herzog-Hauck, *Realencyclopädie;* Gore, *Dissertations on subjects connected with the Incarnation.*

MONOTREMATA, the lowest existing order of mammals, including the duck-billed platypus of Australia and the echidnas or spiny anteaters of Australia and New Guinea. Unlike all other existing mammals, these animals lay eggs; their right and left oviducts remain separate, not uniting to form a median uterus, and the ducts, leading respectively from the ovaries or testes, from the bladder and from the digestive tract, all open into a single cloaca or common outlet (whence the name Monotremata).

The platypus (*q.v.*) is adapted for semi-aquatic life, having an otter-like form, with webbed feet; it is covered with smooth sleek fur and has a long beaver-like tail. It eats small crustaceans, worms and insect larvae, obtaining them by nuzzling in the mud with its duck-like bill. It has true molar teeth when young, but later these are replaced by horny plates.

The echidna (*q.v.*) lives in dry country, is covered with quills and coarse hair and has a short tail and a long pointed toothless bill with an extensile tongue for feeding upon ants. It is more compactly built than the platypus and has immense strength for digging. The New Guinea echidna (*Zaglossus*) is larger, and has a very long bill and short spines almost covered by long under-fur.

In 1792 the "spiny anteater" of New South Wales, Australia, was described and figured by Shaw, as *Myrmecophaga aculeata,* the impression of the author being that it was related to the South American anteater. In 1799 Shaw published the first description and figures of the duckbill, naming it the *"Platypus anatinus,"* and noting the beaver-like tail and body, the serrated duck-like bill, the small eyes, the ear-holes behind the eyes, the webbed and clawed feet and other details. He came to the conclusion that it must be a resident in watery situations; that it has the habits of digging or burrowing in the banks of rivers, or underground; and that its food consists of aquatic plants and animals.

In 1800 Blumenbach received a stuffed specimen collected by Sir Joseph Banks, which he described under the name *"Ornithorhynchus paradoxus,"* referring it to the Edentata (*q.v.*). The generic name *Platypus* of Shaw had already been invented by another author for a genus of beetles, so that the correct scientific name of the typical species is *Ornithorhynchus anatinus;* but the name platypus is now the common one for the animal.

In 1802 Home published a description of the anatomy of two spirit specimens of the platypus, in which he noted that "the structure of the female organs is unlike anything hitherto met with in quadrupeds. . . ." He was led to examine the corresponding parts in birds and reptiles and found most resemblance to the organs of ovo-viviparous lizards. Later in the same year Home examined the anatomy of the spiny anteater. He at once recognized its affinity to the platypus and included it in the same genus as *"Ornithorhynchus hystrix."* Home also concluded that *Ornithorhynchus* represented a new tribe of quadrupeds, "so that it may be considered as an intermediate link between the classes Mammalia, Aves and Amphibia. . . . Between it and the bird, no link of importance seems to be wanting." Thus arose the misleading and still widely prevalent notion that the platypus is a link between mammals and birds, whereas its true position is more that of a link between mammals and reptiles.

In 1803 Etienne Geoffroy, the colleague of Cuvier, established a new order, Monotremata, characterized by: "Digits clawed, no true teeth; a common cloaca opening to the exterior by a single orifice." In 1809 Lamarck added a class, Prototheria, for the platypus and echidna, deciding that they were not mammals, for they had no mammary glands and were probably oviparous; they were not birds, for their lungs differed, and they had no wings; and they were not reptiles, for they possessed a four-chambered heart. Then followed a long argument whether the monotremes were to be classed as mammals. Finally in 1834 De Blainville arranged the mammals under three subclasses: (1) Ornithodelphia (bird-like uteri): including the monotremes; (2) Didelphia

(double uteri): including the marsupials; (3) Monodelphia (single uteri): including the placental mammals. In 1884 Caldwell obtained evidence enabling him to cable to the British Association meeting at Montreal, "Monotremes oviparous, ovum meroblastic." In 1891 Richard Semon secured monotreme material in Queensland, including new-laid eggs and a series of embryos of the echidna. He deduced that the egg of echidna, unlike the eggs of reptiles or birds, grows within its shell by receiving nutriment through the shell from the uterine tissues of the mother. During the past 20 years H. Burrell, working under Professor Launcelot Harrison, has given accurate descriptions of the underground tunnels dug by the platypus, and of the carefully constructed nests of leaves and grass in which their eggs are laid.

According to J. T. Wilson and J. P. Hill, the ovum of the platypus at the time of fertilization is about three millimeters in diameter; after fertilization it becomes surrounded by an exceedingly thin layer of albumen, and outside this by a thin transparent horny shell. It grows to a length of 16–18mms. before oviposition. The eggs, which resemble those of certain lizards, are usually laid in pairs which stick together. Burrell infers that when the eggs are laid the animal is sitting curled-up and receives them in its forepaws, by which they are placed between the curled-in tail and the abdomen, where they are brooded. For some time after the young are hatched no milk is secreted; the young when born have a very short bill with "lips." There are no teats but the young lick and suck the milk from the surface of the mammary field. In the platypus there is no pouch but in the echidna a "brood pouch" is developed.

While the platypus and the echidna differ widely in habits, external appearance and in skeletal and anatomical characters connected with the difference in "habitus," they have many important features in common. For instance, both possess a peculiar poison-secreting apparatus, in some ways analagous with those of poisonous snakes. The fang, represented by a large horny spur attached to each ankle of the male, is better developed in the platypus than in the echidna. The sharp tip of the spur is perforated by a canal leading to a duct running up the leg to a large gland beneath the skin on the upper surface of the femur. The albuminous secretion is poisonous but not fatal to other mammals. The spurs are used in fighting between the males during the breeding season and also serve for clasping the females.

The existing monotremes are definitely excluded from ancestry to the marsupials or placental mammals by the possession of such curious specializations as the poison gland and tarsal spur. In the other direction there is no known group of extinct Mesozoic mammals from which we may confidently derive the monotremes. Notwithstanding the widespread impression that the monotremes have been derived from the extinct Multituberculata, recently discovered palaeontological evidence weighs heavily against this view. The anatomy of the monotremes reveals many important features of the brain and skeleton in common with the marsupials, to which group indeed they appear to be more nearly related than to the placental mammals.

BIBLIOGRAPHY.—W. H. Flower and R. Lydekker, *An Introduction to the Study of Mammals* (1891); H. Burrell, *The Platypus* (Sydney, 1927); R. Semon, *In the Australian Bush* (London, 1899); J. T. Wilson and J. P. Hill, *Philos. Trans. Roy. Soc.* Lond. (B), vol. 199; D. M. S. Watson, *Philos. Trans. Roy. Soc.* Lond. (B), vol. 207.

(W. K. G.)

MONOTRIGLYPH, in architecture, a term describing the most common intercolumniation (*q.v.*) of the Greek Doric order, in which one triglyph separates the triglyphs over the centres of adjacent columns.

MONOTYPES. A monotype is a unique print, taken either by passing the metal plate on which the picture has been done through a printing press, like an etching or engraving, or by hand-rubbing, like a woodcut, which is less effective, or, perhaps better still, by rubbing with an ivory or bone paper-knife. By the last process the paper can be lifted now and again, so that the progress of the print may be watched, and more or less pressure exerted where it is necessary to emphasize the gradations of dark or light, for the print is really an emotional effect, and it must not be forgotten that the plate has not been engraved at all. The subject has been either painted direct in oils or thick inks at a single sitting, or the plate has been thinly covered with ink or dark paint, not too oily, then the subject has been gradually evolved by the manipulation of the lights with the finger, a rag, or a brush, to suggest form by a full range of tone, as the lights are scraped away in mezzotint. A monotype resembles a mezzotint in effect, with its rich velvety blacks, and subtle half-tones, but to ensure a successful print, it must be taken while the paint is wet. Since only one print can be obtained, the method seems scarcely worth while, except for the fun of the thing. In recent years, many artists have amused themselves with it. Indeed, Sir Hubert Herkomer was an enthusiast, and with his natural zest for experiment he dusted the plate with powder, to suggest the effect of a grain; then he made a mould or electrotype, so that impressions could be taken, but it then, of course, ceased to be a monotype. (*See* also PRINTING.) (M. C. S.)

MONREALE (*monte-reale*, from a palace built by Roger I.), a town, Sicily, province of Palermo, 5m. inland from the city, on the slope of Monte Caputo, overlooking the valley *"La Conca d'oro"* (the Golden Shell), famed for its orange, olive and almond trees. Pop. (1921), 22,511 (town); 23,966 (commune).

A large Benedictine monastery, the church of which was the seat of the metropolitan archbishop of Sicily, was the greatest of all monuments of the Normans in northern Sicily. Begun in 1174 by William II., in 1182 the church was dedicated to the Assumption of the Virgin Mary and made a metropolitan cathedral. The archiepiscopal palace and monastic buildings on the south were surrounded by a massive precinct wall, crowned at intervals by twelve towers. Little now remains except ruins of some of the towers, a great part of the monks' dormitory and frater, and the splendid cloister, completed about 1200.

The plan of the church is Lombardo-Norman. The basilican nave is wide, with narrow aisles. Monolithic columns of grey oriental granite (except one of cipollino), with Corinthian capitals, support eight pointed arches on each side much stilted. There is a high clerestory with wide two-light windows, with simple tracery like those in the nave-aisles and throughout the church. The other half, both wider and higher than the nave, is divided into a central space with two aisles, each of the divisions ending at the east with an apse. The roofs throughout are of open rich coloured woodwork very low in pitch. At the west end of the nave are two projecting towers, with a narthex-entrance between them. A large open atrium, which once existed at the west, has been replaced by a Renaissance portico. The exterior of the aisle walls and three eastern apses is decorated with intersecting pointed arches and other ornaments inlaid in marble. The outsides of the principal doorways and their pointed arches are magnificently carved and inlaid.

The enormous extent (70,400 sq.ft.) and glittering splendour of the glass mosaics covering the interior are remarkable. With the exception of a high dado made of marble slabs with bands of mosaic between them, the whole interior surface of the walls is covered with minute mosaic-pictures in brilliant colours on a gold ground. The mosaic pictures are arranged in tiers, divided by horizontal and vertical bands (in parts of the choir as many as five tiers).

In the central apse at Monreale, behind the high altar, is a fine marble throne for the archbishop. On the north side, in front of the high altar, is a throne for the king. The tomb of William I., the founder's father, and the founder William II.'s tomb, erected in 1575, were both shattered by fire in 1811. On the north of the choir are the tombs of Margaret, wife of William I., and her two sons Roger and Henry, together with an urn containing the viscera of St. Louis of France. The pavement of the triple choir is a very magnificent specimen of marble and porphyry mosaic in *opus alexandrinum.*

Two bronze doors, north and west of the church, are divided into square panels with subjects and single figures, chiefly from Bible history, cast in relief. That on the north is by Barisanus of Trani. The cathedrals at Trani and Ravello also have bronze doors by him. The western door at Monreale, inferior to the northern one both in richness of design and in workmanship, is

by Bonannus of Pisa, for the cathedral of which he cast the bronze door on the south. The one at Monreale is inscribed A.D. MCLXXXVII IND. III. BONANNUS CIVIS PISANVS ME FECIT. The monastic library contains some valuable mss., especially a number of bilinguals in Greek and Arabic, the earliest dated 1144.

See D. B. Gravina, *Il Duomo di Monreale* (Palermo, 1859–65). (J. H. Mi.; T. A.)

MONRO, SIR CHARLES CARMICHAEL, 1st. Bart. cr. 1921 (1860–1929), British soldier, was born on June 15, 1860, and joined the army in 1879. In 1897–98 he saw service at Malakand, in the Mohmand country, in Bajour and in Tirah and he was on the staff in South Africa (1899–1902). He was afterwards commandant of the school of musketry at Hythe, Kent. Having commanded the 2nd Division in the first fighting in 1914, Monro was, at the end of 1914, placed in command of the I. Army Corps, and on a III. Army being organized in July 1915, he was given charge of this. He was chosen in October to take over the command of the Mediterranean Expeditionary Force and to decide whether the campaign in the Gallipoli Peninsula was to be continued. Monro acted with rare decision. Although the Government was disposed to cling to the peninsula, he insisted upon its abandonment, and he was, after some delay, allowed to have his way, with the result that the forces were withdrawn from a most dangerous position without appreciable loss. He returned to the Western Front, but in Oct. 1916 he became commander-in-chief in India. From 1923 to 1928 he was governor and commander-in-chief of Gibraltar. He died in London, on Dec. 7, 1929.

MONRO, DAVID BINNING (1836–1905), English Homeric scholar, was born in Edinburgh on Nov. 16, 1836. He was educated at Glasgow university, and Brasenose and Balliol colleges, Oxford, and was provost of Oriel till his death at Heiden, Switzerland, on Aug. 22, 1905. After producing his *Grammar of the Homeric Dialect* (2nd ed. 1891) he edited the last 12 books of the *Odyssey,* and published a critical text of the poems and fragments (*Homeri opera et reliquiae,* 1896); *Homeri opera* (1902, in the Oxford texts); and an edition of the *Iliad* with notes for schools. He wrote the article on Homer for the 9th edition of the *Encyclopædia Britannica;* also *Modes of Ancient Greek Music* (1894) (see *Classical Review,* Dec. 1894 and Feb. 1895).

See *Memoir* by J. Cook Wilson (1907).

MONROE, JAMES (1758–1831), fifth president of the United States, was born on Monroe's creek, in Westmoreland county, Virginia, on April 28, 1758. His father, Spence Monroe, was of Scottish, and his mother, Elizabeth Jones, of Welsh descent. At the age of 16 he entered the College of William and Mary, Williamsburg, Va., but in 1776 he left college to take part in the Revolutionary War. He enlisted in the Third Virginia regiment, in which he became a lieutenant, and subsequently took part in the battles of Harlem Heights, White Plains, Trenton (where he was wounded), Brandywine, Germantown and Monmouth. In 1780 he began the study of law under Thomas Jefferson, then governor of Virginia, and between the two there developed an intimacy and a sympathy that had a powerful influence upon Monroe's later career.

In 1782 he was elected to the Virginia house of delegates, and though only 24 years of age he was chosen a member of the governor's council. He served in the Congress of the Confederation from 1783 to 1786 and was there conspicuous for his vigorous insistence upon the right of the United States to the navigation of the Mississippi river, and for his attempt, in 1785, to secure for the weak Congress the power to regulate commerce, in order to remove one of the great defects in the existing central government. On retiring from Congress he began the practice of law at Fredericksburg, Va., was chosen a member of the Virginia house of delegates in 1787, and in 1788 was a member of the State convention which ratified for Virginia the Federal constitution. In 1790 he was elected to the United States senate and although in this body he vigorously opposed Washington's administration, Washington in 1794 nominated him as minister to France. It was the hope of the administration that Monroe's well-known French sympathies would secure for him a favourable reception, and that his appointment would also conciliate the friends of France in the United States. His warm reception in France and his enthusiastic Republicanism, however, displeased the Federalists at home; he did nothing, moreover, to reconcile the French people to the Jay treaty (*q.v.*), which they regarded as a violation of the French treaty of alliance of 1778 and as a possible *casus belli.* The administration therefore decided that he was unable to represent his government properly and late in 1796 recalled him.

Monroe returned to America in the spring of 1797, and in the following December published a defence of his course in a pamphlet of 500 pages entitled *A View of the Conduct of the Executive in the Foreign Affairs of the United States.* Washington seems never to have forgiven Monroe for this, though Monroe's opinion of Washington and Jay underwent a change in his later years. In 1799 Monroe was chosen governor of Virginia and was twice re-elected, serving until 1802. At this time there was much uneasiness in the United States as a result of Spain's restoration of Louisiana to France by the secret treaty of San Ildefonso, in Oct. 1800; and the subsequent withdrawal of the "right of deposit" at New Orleans by the Spanish intendant greatly increased this feeling and led to much talk of war. Resolved upon peaceful measures, President Jefferson in Jan. 1803, appointed Monroe envoy extraordinary and minister plenipotentiary to France to aid Robert R. Livingston, the resident minister, in obtaining by purchase the territory at the mouth of the Mississippi, including the island of New Orleans, and at the same time authorized him to co-operate with Charles Pinckney, the minister at Madrid, in securing from Spain the cession of East and West Florida. On April 18, Monroe was further commissioned as the regular minister to Great Britain. He joined Livingston in Paris on April 12, after the negotiations were well under way; and the two ministers, on finding Napoleon willing to dispose of the entire province of Louisiana, decided to exceed their instructions and effect its purchase. Accordingly, on April 30, they signed a treaty and two conventions, whereby France sold Louisiana to the United States (*see* Louisiana Purchase). In July 1803 Monroe left Paris and entered upon his duties in London; and in the autumn of 1804 he proceeded to Madrid to assist Pinckney in his efforts to secure the definition of the Louisiana boundaries and the acquisition of the Floridas. After negotiating until May 1805, without success, Monroe returned to London and resumed his negotiations concerning the impressment of American seamen and the seizure of American vessels. As the British ministry was reluctant to discuss these vexed questions, little progress was made, and in May 1806 Jefferson ordered William Pinkney of Maryland to assist Monroe. The British government appointed Lords Auckland and Holland as negotiators, and the result of the deliberations was the treaty of Dec. 31, 1806, which contained no provision against impressments and provided no indemnity for the seizure of goods and vessels. In passing over these matters Monroe and Pinkney had disregarded their instructions, and Jefferson was so displeased with the treaty that he returned it to England for revision. Just as the negotiations were reopened, however, the questions were further complicated and their settlement delayed by the attack of the British ship "Leopard" upon the American frigate "Chesapeake." Monroe returned to the United States in Dec. 1807, and was elected to the Virginia house of delegates in the spring of 1810. In the following winter he was again chosen governor, serving from Jan. to Nov. 1811, and resigning to become secretary of state under Madison, a position which he held until March 3, 1817. The direction of foreign affairs in the troubled period immediately preceding and during the second war with Great Britain thus devolved upon him. On Sept. 27, 1814, after the capture of Washington by the British, he was appointed secretary of war, and discharged the duties of this office, in addition to those of the state department, until March 1815.

In 1816 Monroe was chosen president of the United States; he received 183 electoral votes, and Rufus King, his Federalist opponent, 34. In 1820 he was re-elected, receiving all the electoral votes but one, which William Plumer (1759–1850) of New Hampshire cast for John Quincy Adams, in order, it is said, that no one might share with Washington the honour of a unanimous election. The chief events of his administration, which has been

called the "era of good feeling," were the Seminole War (1817–18); the acquisition of the Floridas from Spain (1819–21); the "Missouri Compromise" (1820), by which the first conflict over slavery under the constitution was peacefully adjusted; the veto of the Cumberland Road bill (1822) on constitutional grounds; and—most intimately connected with Monroe's name—the enunciation in the presidential message of Dec. 2, 1823, of what has since been known as the Monroe Doctrine (*q.v.*), which has profoundly influenced the foreign policy of the United States.

On the expiration of his second term Monroe retired to his home at Oak Hill, Loudoun county, Virginia. In 1826 he became a regent of the University of Virginia, and in 1829 was a member of the convention called to amend the state constitution. Having neglected his private affairs and incurred large expenditures during his missions to Europe, he experienced considerable pecuniary embarrassment in his later years, and was compelled to ask Congress to reimburse him for his expenses in the public service. Congress finally (in 1826) authorized the payment of $30,000 to him, and after his death appropriated a small amount for the purchase of his papers from his heirs. He died in New York city on July 4, 1831, while visiting his daughter. In 1858, the centennial year of his birth, his remains were reinterred with impressive ceremonies at Richmond, Virginia. Jefferson, Madison, John Quincy Adams, Calhoun and Benton all speak loudly in Monroe's praise; but he suffers by comparison with the greater statesmen of his time. Possessing none of their brilliance, he had, nevertheless, to use the words of John Quincy Adams, "a mind . . . sound in its ultimate judgments, and firm in its final conclusions." Schouler points out that like Washington and Lincoln he was "conspicuous . . . for patient considerateness to all sides." Monroe was about 6ft. tall, but, being stoop-shouldered and rather ungainly, seemed less; his eyes, a greyish blue, were deep-set and kindly; his face was delicate, naturally refined, and prematurely lined. The best-known portrait, that by Vanderlyn, is in the New York City Hall. Monroe was married in 1786 to Elizabeth Kortwright (1768–1830) of New York, and at his death was survived by two daughters.

See *The Writings of James Monroe* (1898–1903), edited by S. M. Hamilton; Daniel C. Gilman, *James Monroe,* in the "American Statesman Series" (Boston, 1883); J. R. Irelan, *History of the Life, Administration and Times of James Monroe,* being vol. v. of his *Republic* (Chicago, 1887); John Quincy Adams, *The Lives of James Madison and James Monroe* (Buffalo, 1850); B. W. Bond, jun., *Monroe's Mission to France, 1794–1796* (Baltimore, 1907); Henry Adams, *History of the United States* (1889–91), containing a full but unsympathetic account of Monroe's career as a diplomatist; and James Schouler, *History of the United States,* vols. ii. and iii. (1894), which estimates his public services highly. For more recent estimates see George Morgan, *The Life of James Monroe* (Boston, 1921); and William A. McCorkle, *The Personal Genesis of the Monroe Doctrine* (1923); and "Text from Messages Enunciating Famous Monroe Doctrine and Roosevelt Corollary," *Cong. Digest,* vol. vi., p. 114–115 (1927).

MONROE, a city of northern Louisiana, U.S.A., the capital of Ouachita parish; on the east bank of the Ouachita river, 96 m. east of Shreveport. It is on Federal highways 80 and 165; has a municipal airport of 140 ac.; and is served by the Arkansas and Louisiana Midland, the Illinois Central and the Missouri Pacific railways, and river barges and steamers. Pop. (1920) 12,675 (44% negroes); and was 26,028 Federal census 1930. West Monroe, on the opposite bank of the river, had a population given as 6,566 in 1930. Monroe is the centre of the largest known gas field in the world, covering 400 sq.m., with an available reserve estimated in 1927 at 2,200,000 million cu.ft. Its trade territory extends over nine parishes. The manufactures in and near the city include pulp and paper, carbon black, printer's ink, lumber and lumber products, brick, candy, brooms and mattresses. The annual payroll is about $8,000,000 and in 1927, bank clearings were $116,068,250. A Spanish settlement (called Ouachita Post, and later Fort Miró) was established here in 1785. It was renamed, after President Monroe, in 1819; incorporated as a town in 1820, and chartered as a city in 1871. In 1902 a commission form of government was adopted.

MONROE, a city of south-eastern Michigan, U.S.A., 35 m. S.W. of Detroit, on Lake Erie, at the mouth of the Raisin river; the county seat of Monroe county. It is on Federal highways 24 and 25, and is served by the Detroit and Toledo Shore Line, the Michigan Central, the New York Central, the Pennsylvania, the Pere Marquette and electric railways. The population was 11,573 in 1920 (90% native white) and was 18,110 in 1930 by the Federal census. It is the seat of St. Mary's college for girls (Roman Catholic; 1910); has extensive nurseries; and is an important manufacturing centre, with an output in 1925 valued at $21,598,284. Fibre and straw-paper board, paper, tile, sash and blinds, furniture, flour, stokers, gasolene engines and furnaces are among the leading products. Monroe was settled by French Canadians in 1783, and was known as Frenchtown. In Jan., 1813, the inhabitants prayed the Americans for protection against the British and their Indian allies, and on Jan. 18 a detachment sent from the army of Gen. James Winchester drove out a small force of British. The general arrived three days later, with more men, but at dawn on Jan. 22 he was surprised by Col. Henry A. Proctor and forced to surrender. In 1815 the town was renamed in honour of James Monroe, then Secretary of State. It was made the county seat in 1817, incorporated as a village in 1827, and chartered as a city in 1837.

MONROE, a city of North Carolina, U.S.A., the county seat of Union county; on Federal highway 74 and the Seaboard Air Line railway, 22 m. S.E. of Charlotte. The population was 4,084 in 1920 (26% negroes) and 6,100 in 1930.

MONROE, a city near the southern boundary of Wisconsin, U.S.A., served by the Chicago, Milwaukee, St. Paul and Pacific and the Illinois Central railways; the county seat of Green county. Pop. (1930) 5,015. It is the centre of a blue-grass region which produces a large part of the "Swiss" and other foreign-type cheeses made in the United States. The output of the county in 1927 was 15,912,320 pounds. The industry was established by a Swiss colony of 155 persons who in 1845 settled in the hills about 15 m. N. of Monroe (because it was more like Switzerland than any other place they had seen in America) and founded the village of New Glarus. After 20 years of great poverty, making a bare living by raising wheat (which exhausted the soil) they seeded the fields with clover and grass, and developed commercially the cheese-making which had been carried on for domestic consumption. Gradually it spread over the county, transforming it into a vast dairy farm, covered with great herds of Holstein and brown Swiss cattle, mammoth barns and tall silos. Monroe was founded in 1832 and incorporated in 1859.

MONROE DOCTRINE, THE, was the fruition of early American policy. There had long been a deep-seated conviction on the part of the people of the United States that the opportunities of a hard-won freedom would be threatened by the ambitions of European powers and that the aims of the new nation could be achieved only by keeping clear of the toils of European politics and strife. It was this conviction of the necessity of maintaining an independent position which led to the declaration of neutrality in 1793, despite the Treaty of Alliance with France which had sprung from the exigencies of the Revolutionary struggle. The words of Washington's Farewell Address were more than a solemn admonition; they stated cherished principles. "The great rule of conduct for us," he said, "in regard to foreign nations, is, in extending our commercial relations, to have with them as little *political* connection as possible. . . . Europe has a set of primary interests which to us have none, or a very remote relation. Hence she must be engaged in frequent controversies, the causes of which are essentially foreign to our concerns. Hence therefore it must be unwise in us to implicate ourselves, by artificial ties in the ordinary vicissitudes of her politics, or the ordinary combinations and collisions of her friendships, or enmities." The people of the United States had watched with deep sympathy the long struggle of their southern neighbours for independence. While Spain maintained a doubtful contest, it was regarded as a civil war, but when that contest became so desperate that Spanish viceroys, governors, and captains-general concluded treaties with the insurgents virtually acknowledging their independence, the United States unreservedly recognized the facts. The republic of Colombia was recognized in 1822, the Government of Buenos Aires

and the States of Mexico and Chile early in 1823. The United States was the first to recognize the independent empire of Brazil in May, 1824, not hesitating because of the political form of the Government, and this was followed by the recognition of the Federation of Central American States in August of the same year. Meanwhile, the Holy Alliance formed by the sovereigns of Austria, Russia and Prussia had sought to enforce the divine right of kings against the progress of liberal principles. Joined by France, they undertook "to put an end to the system of representative government" and after France had proceeded accordingly to restore the rule of Ferdinand VII. in Spain, it was proposed to direct their efforts to the overthrowing of the new Governments erected out of the old colonies of Spain in the western hemisphere.

MONROE'S MESSAGE

This was the situation when, in Aug. 1823, George Canning, British foreign secretary, wrote to Richard Rush, American minister in London, suggesting a joint declaration in substance that the recovery of the colonies by Spain was hopeless; that neither Great Britain nor the United States was aiming at the possession of any portion of these colonies; and that they could not see with indifference any portion of them transferred to any other power. Great Britain, however, had not at that time recognized the new States in Spanish America. President Monroe sought the advice of Jefferson and Madison. Jefferson regarded the question as "the most momentous" which had arisen since that of Independence. "Our first and fundamental maxim," said he, "should be, never to entangle ourselves in the broils of Europe. Our second, never to suffer Europe to intermeddle with cis-Atlantic affairs." Jefferson favoured the acceptance of the British suggestion in some form and Madison took the same view. John Quincy Adams, Secretary of State, opposed a joint declaration. He wished to take the ground "of earnest remonstrance against the interference of the European powers by force with South America, but to disclaim all interference on our part with Europe; to make an American cause and adhere inflexibly to that." Upon the advice of Adams, and after mature deliberation by the president and his cabinet, it was decided to make a separate declaration on the sole responsibility of the United States, and this declaration was formulated in the president's message of Dec. 2, 1823.

Original Statement of the Doctrine.—The doctrine is set forth in two paragraphs of this message. The first of these had a genesis distinct from the situation of the former colonies of Spain. It grew out of the question of Russian claims on the north-west coast of North America. The Russian emperor had issued a ukase in 1821 prohibiting citizens of other nations from navigating and fishing within 100 Italian miles of the north-west coast of North America from Bering straits to the 51st parallel of north latitude. Protests had followed. In July, 1823, Secretary Adams informed the Russian minister that the United States "should contest the right of Russia to any territorial establishment on this continent, and that we should assume distinctly the principle that the American continents are no longer subjects for any new European colonial establishments." It was in connection with this situation that President Monroe, after adverting to the proposal of arranging the respective rights and interests on the north-west coast by amicable negotiations, declared in his message:

"In the discussions to which this interest has given rise, and in the arrangements by which they may terminate, the occasion has been judged proper for asserting as a principle in which the rights and interests of the United States are involved, that the American continents, by the free and independent condition which they have assumed and maintained, are henceforth not to be considered as subjects for future colonization by any European powers."

The other paragraph of President Monroe's message bore upon the situation of the nations to the south of the United States, as follows:

"In the wars of the European powers in matters relating to themselves we have never taken any part, nor does it comport with our policy so to do. It is only when our rights are invaded or seriously menaced that we resent injuries or make preparation for our defence. With the movements in this hemisphere we are, of necessity, more immediately connected, and by causes which must be obvious to all enlightened and impartial observers. The political system of the allied powers is essentially different in this respect from that of America. . . . We owe it, therefore, to candour, and to the amicable relations existing between the United States and those powers, to declare that we should consider any attempt on their part to extend their system to any portion of this hemisphere as dangerous to our peace and safety. With the existing colonies or dependencies of any European power we have not interfered and shall not interfere. But with the governments who have declared their independence and maintained it, and whose independence we have, on great consideration and on just principles, acknowledged, we could not view any interposition for the purpose of oppressing them, or controlling in any other manner their destiny, by any European power, in any other light than as the manifestation of an unfriendly disposition toward the United States. . . . It is impossible that the allied powers should extend their political system to any portion of either continent without endangering our peace and happiness; nor can any one believe that our southern brethren, if left to themselves, would adopt it of their own accord. It is equally impossible, therefore, that we should behold such interposition, in any form, with indifference."

The message, so far as it related to the revolted Spanish colonies, had widespread approval in England. Three years later, Canning made his famous boast that he had "called the New World into existence to redress the balance of the Old." There was, indeed, general agreement between the sentiments of the Governments of Great Britain and the United States as to the Spanish colonies, but this was qualified, as Canning himself had pointed out, by the important difference that the United States had acknowledged the independence of the new Governments and the British Government had not. With the portion of President Monroe's message relating to future colonization, which lay outside the purview of Canning's suggestion, Canning was not in sympathy. This proposal was as new to the British Government as it was to France. The basis of the objection on the part of the United States to future colonization by European powers was found in the fact, as John Quincy Adams said later, when president, that "With the exception of the existing European colonies, which it was in no wise intended to disturb, the two continents consisted of several sovereign and independent nations, whose territories covered their whole surface. By this, their independent condition, the United States enjoyed the right of commercial intercourse with every part of their possessions. To attempt the establishment of a colony in those possessions, would be to usurp to the exclusion of others a commercial intercourse which was the common possession of all." Manifestly, it was not intended to assert that there were no unoccupied lands, for there were vast regions of territory not actually settled by the subjects of civilized powers, but the declaration proceeded in the view "that the several American territorial sovereigns enjoyed by virtue of constructive occupation, exclusive rights of ownership and sovereignty which should be respected."

Later Extension or Modification.—Not only did the statesmen of the United States fear the extension of European colonization, but they viewed with deep concern the possibility of the transfer of American territory from one European power to another, or the transfer of such territory from an American to a non-American power. In 1811, the Congress of the United States passed a resolution as to East Florida, stating that "considering the influence which the destiny of the territory adjoining the southern border of the United States may have upon their security, tranquillity, and commerce," the United States could not, "without serious inquietude, see any part of the said territory pass into the hands of any foreign power." The declarations in the messages of President Polk in 1845 and 1848 were so closely associated with the doctrine announced by Monroe that they may be deemed to fall within the same governing principle. With reference to the case of Yucatan, when the authorities of the country offered to transfer the dominion and sovereignty to the United States and at the same time made a similar offer to Great Britain and Spain, President Polk said: "Whilst it is not my purpose to recommend the adoption of any measure, with a view to the acquisition of the 'dominion and sovereignty' over Yucatan, yet, according to our established policy, we could not consent to a transfer of this 'dominion and sovereignty' to either Spain, Great Britain, or any other European power." President Polk's reference to the transfer of dominion and sovereignty evidently meant

opposition to the acquisition of territorial control by any means and this position has frequently been reiterated by the Government of the United States. In 1912, the Senate of the United States adopted a resolution, apparently having immediate reference to Magdalena bay, "that when any harbor or other place in the American continents is so situated that the occupation thereof for naval or military purposes might threaten the communications or the safety of the United States, the Government of the United States could not see without grave concern the possession of such harbour or other place by any corporation or association which has such a relation to another Government, not American, as to give that Government practical power or control for naval or military purposes." It was explained in support of the resolution that it rested on the principle of self-defence and that it was "allied to the Monroe Doctrine, of course, but not necessarily dependent upon it or growing out of it."

Since the declaration of Monroe, the famous Doctrine has been modified in only two particulars. What was said with Europe exclusively in view, must be deemed applicable to all non-American powers; and the opposition to the extension of colonization was not dependent upon the particular method of securing territorial control, and, at least since Polk's time, may be deemed to embrace opposition to acquisition of additional territory through transfer of dominion or sovereignty. Neither of these modifications changes the doctrine in its essentials and it may thus be summarized as being opposed (1) to any non-American action encroaching upon the political independence of American States under any guise, and (2) to the acquisition in any manner of the control of additional territory in the western hemisphere by any non-American power.

The United States has been alert in opposition to what was believed to involve action of this character. Historic instances are those relating to the Mosquito coast in 1858–60, the French intervention in Mexico ending in 1867, the arbitral settlement of the controversy as to the boundary line between Venezuela and British Guiana in 1895–97, and the disposition of the claims of Germany, Great Britain and Italy against Venezuela in 1902–04.

Character and Purport of the Doctrine.—The Monroe Doctrine is not a legislative pronouncement; it has been approved by action of Congress, but it does not rest upon congressional sanction. It is not defined by treaty, and it does not draw its force from any international agreement. It had, however, the implied endorsement of the treaty making power of the United States in the reservations to the two Hague Conventions of 1899 and 1907, which provided: "Nothing contained in this convention shall be construed as to require the United States of America to depart from its traditional policy of not intruding upon, interfering with, or entangling itself in the political questions of policy or internal administration of any foreign State; nor shall anything contained in the said convention be construed to imply a relinquishment by the United States of America of its traditional attitude toward purely American questions." The doctrine is not like a constitutional provision deriving its authority from the fact that it is a part of the organic law transcending and limiting executive and legislative power. While it is not a part of international law, it rests, as Elihu Root has stated, "upon the right of self-protection and that right is recognized by international law." It was asserted at a time when the danger of foreign aggression was very real, when the new American States had not yet established a firm basis of independent national life and republican institutions were menaced by the threats of Old World powers. But despite changes in conditions it still remains, to be applied if necessary, as a principle of national security. Its significance lies in the fact that in its essentials as set forth by President Monroe and as forcibly asserted by responsible statesmen, it has been for 100 years, and continues to be, an integral part of national thought and purpose expressing a profound conviction which even the upheaval caused by the World War, and the participation of the United States in that struggle upon European soil, did not upset.

The doctrine, as has been stated authoritatively, does not imply, or countenance, a policy of aggression. It does not infringe upon the independence and sovereignty of other American States. It does not attempt to establish a protectorate over Latin American States. The declaration that encroachment by non-American powers upon the independence of American States will be regarded as dangerous to the safety of the United States gives no justification for such encroachment on its part. In stating with extreme vigour the position of President Cleveland's administration in the correspondence with Great Britain relating to the Venezuela boundary, Secretary Olney recognized the limitations of the doctrine and his other statements should be read in the light of their context. He said: "The precise scope and limitations of this rule cannot be too clearly apprehended. It does not establish any general protectorate by the United States over other American states. It does not relieve any American state from its obligations as fixed by international law nor prevent any European power directly interested from enforcing such obligations or from inflicting merited punishment for the breach of them. It does not contemplate any interference in the internal affairs of any American state or in the relations between it and other American states. It does not justify any attempt on our part to change the established form of government of any American state or to prevent the people of such state from altering that form according to their own will and pleasure. The rule in question has but a single purpose and object. It is that no European power or combination of European powers shall forcibly deprive an American state of the right and power of self-government and of shaping for itself its own political fortunes and destinies." President Roosevelt in his annual message of 1901 thus referred to the doctrine: "It is in no wise intended as hostile to any nation in the Old World. Still less is it intended to give cover to any aggression by one New World power at the expense of any other. It is simply a step, and a long step, toward assuring the universal peace of the world by securing the possibility of permanent peace on this hemisphere." And in his annual message of 1906, President Roosevelt said: "In many parts of South America there has been much misunderstanding of the attitude and purposes of the United States toward the other American republics. An idea had become prevalent that our assertion of the Monroe Doctrine implied or carried with it an assumption of superiority and of a right to exercise some kind of protectorate over the countries to whose territory that doctrine applies. Nothing could be farther from the truth."

As the policy embodied in the Monroe Doctrine was distinctively the policy of the United States, the Government of the United States has reserved to itself its definition and application. President Wilson observed: "The Monroe Doctrine was proclaimed by the United States on her own authority. It always has been maintained, and always will be maintained, upon her own responsibility." But it has frequently been stated that the United States would welcome the adoption by the other American republics of a similar policy. President Wilson sought to give the principles of the doctrine a world-wide application. In his address to the Senate on Jan. 22, 1917, he said: "I am proposing, as it were, that the nations should with one accord adopt the doctrine of President Monroe as the doctrine of the world; that no nation should seek to extend its polity over any other nation or people, but that every people should be left free to determine its own polity, its own way of development, unhindered, unthreatened, unafraid, the little along with the great and powerful." The Covenant of the League of Nations refers to the doctrine in Article 21, which provides: "Nothing in this Covenant shall be deemed to affect the validity of international engagements, such as treaties of arbitration or regional understandings like the Monroe Doctrine, for securing the maintenance of peace." Many in the United States did not consider this statement to be an adequate or accurate description of the doctrine, and one of the reservations which the Senate of the United States adopted in its discussion of the Treaty of Versailles declared the Monroe Doctrine "to be wholly outside the jurisdiction of said League of Nations and entirely unaffected by any provision contained in said treaty of peace with Germany" and reserved to the United States the sole right to interpret the doctrine. The treaty failed of ratification, and this reservation may be regarded as an expression of the opinion held by the majority of the members of the Senate. In

replying (Feb. 26, 1920) to a request of the minister of foreign affairs of Salvador for an interpretation of the Monroe Doctrine because of the bearing which such interpretation might have on the attitude of Salvador toward the Covenant, the acting secretary of State of the United States stated that the views of his Government were set forth in the address (Jan. 1916) of President Wilson before the Second Pan-American Scientific Congress. In the course of that address, President Wilson said that "the Monroe Doctrine demanded merely that European Governments should not attempt to extend their political systems to this side of the Atlantic." In Sept. 1928, the Council of the League of Nations, answering an inquiry by the Government of Costa Rica as to the interpretation placed by the League of Nations on the Monroe Doctrine, and the scope given to that doctrine when it was included in Article 21 of the Covenant, stated: "Article 20 stipulates that 'the Members of the League severally agree that this Covenant is accepted as abrogating all obligations or understandings *inter se* which are inconsistent with the terms thereof. . . .' Article 21 gives the States parties to international engagements the guarantee that the validity of such of these engagements as secure the maintenance of peace would not be affected by accession to the Covenant of the League of Nations. In declaring that such engagements are not deemed incompatible with any of the provisions of the Covenant, the Article refers only to the relations of the Covenant with such engagements; it neither weakens nor limits any of the safeguards provided in the Covenant. . . . In regard to the scope of the engagements to which the Article relates, it is clear that it cannot have the effect of giving them a sanction or validity which they did not previously possess. It confines itself to referring to these engagements, such as they may exist, without attempting to define them: an attempt at definition being, in fact, liable to have the effect of restricting or enlarging their sphere of application. Such a task was not one for the authors of the Covenant; it only concerns the States having accepted *inter se* engagements of this kind."

The Monroe Doctrine does not attempt to define in any other respects than those above mentioned the policies of the United States with respect to the other American republics. The construction of the Panama canal has not only established a new and convenient highway of commerce but has created new exigencies and new conditions of strategy and defence. It is the declared purpose of the United States to protect that highway. It is part of American policy not to yield to any foreign power the control of the Panama canal, or the approaches to it, or the obtaining of any position which would interfere with the right of protection on the part of the United States or would menace the freedom of its communications. This position is maintained equally with respect to American and non-American powers. The right asserted by the Government of the United States to afford protection to the lives and property of its nationals, when endangered in areas where governments have ceased properly to function, is maintained although there may be no prospect of non-American interference and no occasion for applying the Monroe Doctrine. Such interposition may have the actual and intended effect of avoiding the interposition of non-American powers and the consequent activities and developments at which the Monroe Doctrine was aimed, but the right of the United States to give appropriate protection to its nationals is regarded as quite distinct from the doctrine. The interest of the United States in the stability, the good order and the peace of its immediate neighbours, its efforts to promote amicable settlements of controversies, and its action under its treaties, may be based upon grounds independent of the Monroe Doctrine, although the success of such endeavours may have an indirect effect in making more remote the contingencies to which the doctrine would apply.

Bibliography.—Sir F. Pollock, "The Monroe Doctrine," *The Nineteenth Century*, vol. lii., pp. 535–553 (New York and London, 1902); W. C. Ford, "Genesis of the Monroe Doctrine," *Mass. Hist. Soc. Proc.*, 2nd sec., vol. xv., pp. 373–429 (1902); G. F. Tucker, *The Monroe Doctrine* (Boston, 1903); J. B. Moore, *A Digest of International Law* (Washington, 1906); A. B. Hart, *The Monroe Doctrine* (New York, 1916); E. Root, "The Real Monroe Doctrine," in *Addresses on International Subjects*, edit. by R. Bacon and J. B. Scott, pp. 105–123 (Cambridge, 1916); C. C. Hyde, *International Law Chiefly as Interpreted and Applied by the United States* (Boston, 1922); W. P. Cresson, *Diplomatic Portraits; Europe and the Monroe Doctrine One Hundred Years Ago* (1923); W. A. MacCorkle, *The Personal Genesis of the Monroe Doctrine* (1923); D. Y. Thomas, *One Hundred Years of the Monroe Doctrine, 1823–1923* (New York, 1923); C. E. Hughes, "Observations on the Monroe Doctrine," *Amer. Jour. Inter. Law*, vol. xvii., pp. 611–628 (Concord, 1923), *The Pathway of Peace* (1924) and "The Centenary of the Monroe Doctrine," *Inter. Conciliation*, no. 194 (1924); A. Álvarez, *The Monroe Doctrine* (New York, 1924); G. H. Blakeslee, *The Recent Foreign Policy of the United States* (New York, 1925); J. H. Latane, *A History of American Foreign Policy* (Garden City, 1927); D. Perkins, *The Monroe Doctrine, 1823–1926* (1927); and C. H. Haring, *South America Looks At the United States* (New York, 1928); Hugh Gordon Miller, *The Isthmian Highway* (New York, 1929); Report of the Committee on Foreign Relations of the United States Senate on the Kellogg-Briand Multi-Lateral Treaty, Jan. 14, 1929. (C. E. H.)

MONROVIA, a city of Los Angeles county, California, U.S.A., 18 m. N.E. of Los Angeles, in the foot-hills of the San Gabriel mountains. It is on the Federal highway 66 (the National Old Trail) and is served by the Pacific Electric, the Santa Fe and the Southern Pacific railways. Pop. (1920) 5,480; and 10,890 in 1930. The city is beautifully situated on a sloping plateau 750–1,400 ft. above sea-level, and is surrounded by orange groves. Fruit-packing is the principal industry. Monrovia was founded in 1886 by W. N. Monroe and was incorporated in 1887.

MONS, the capital of Hainaut province, Belgium. Pop. (1925) 28,085. The town originated probably in the Roman citadel Château-César. About 804 Charlemagne recognized it as the capital of Hainaut. At first the counts occupied the castle of Hornu, leaving Mons to the abbey and the church of St. Waudru. Regnier V. moved to Mons at the beginning of the 11th century, and his only child—a daughter—Richilde, married Baldwin VI. of Flanders. The two countdoms were again divided between Richilde's sons. At the beginning of the 14th century Mons was converted into a trading town by establishment of a cloth market. At the same time the count transferred his principal fortress from Valenciennes to Mons. When the Hainaut title became merged in the duchy of Burgundy, Mons was a stronghold near the French frontier. Its capture, defence and surrender by Louis of Nassau in 1572 and its many sieges in the 17th and 18th centuries attest its troubled history. Mons was converted into an open town in 1862.

The cathedral of St. Waudru, named after the first countess, was built 1450–1600 and contains some good glass as well as a few pictures by Van Thudden. The Hôtel de Ville is about the same age as the cathedral, having been commenced in 1443 and finished in 1467. The tower was added in 1718. There is also a fine belfry with a peal of bells. Mons is now a flourishing town with a good trade in cloth, lace, sugar refinery, etc.; but its chief importance is derived from its proximity to the Borinage (place of boring), district containing mines of the finest coal in Belgium. The military engineering college for the Belgian army is here, and not far from Mons are the battle-fields of Malplaquet (1709) and Jemappes (1792).

Battle of Mons, 1914.—This, the first battle of the British Expeditionary Force took place on Aug. 23, 1914, and next day the heavily outnumbered British army began the historic retreat which, marked by the Battle of Le Cateau (*q.v.*) ended on the Marne (*q.v.*), where the Franco-British counter-offensive turned the invasion. *See* World War: *Battles of the Frontier.*

MONSELICE, a town of Venetia, Italy, province of Padua, 15 m. S. of Padua by rail, 30 ft. above sea level. Pop. (1921) 4,143 (town), 14,243 (commune). It has some interesting buildings including a 13th century cathedral. The town is dominated by a rock crowned by a ruined castle (500 ft.) with five different lines of wall. Ca' Marcello is a fine battlemented palace (13th century) and the Villa Duodo a beautiful 18th century villa.

MONSIEUR, the general title of address in France used vocatively in speaking formally to any male person, like the English "sir" or prefixed to the name like the English "Mr." (Fr., formed from *mon*, my, and *sieur*, lord). It is, however, in France also prefixed to nobiliary, official and other titles; *e.g.*, *Monsieur le président*, *Monsieur le duc d'E.*, etc. It is abbreviated M., not

Mons. As a specific title "Monsieur" (*tout court*) was used from the time of Louis XIV. of the eldest brother of the king, as "Monseigneur" was of the dauphin; as a general title of address it was given to the princely members of a royal house.

MONSIGNOR, a title of honour granted by the pope to bishops and to high dignitaries and officials of the papal household (Italian, *monsignore,* my lord). It is abbreviated *Mgr.*

MONSIGNY, PIERRE ALEXANDRE (1729–1817), French composer, was born at Fauquembergue near St. Omer on Oct. 17, 1729. He received a classical education, and on his father's death went to work in an office in Paris. Through his family connections he became maître d'hôtel to the duke of Orleans and was presently in a financial position which enabled him to study music. His master Gianotti taught him harmony on the Ramean system. Monsigny had a remarkable gift of melody and his operas, though slight, were effectively written. His first, *Les aveux indiscrets,* produced at the *Théâtre de la Foire* in 1759, had an immediate success and he wrote 12 more during the next 18 years. Of these the most popular were *Rose et Colas* (1764) and *Felix, ou l'enfant trouvé* (1777), his greatest success. He lost his money and his employment in the revolution, but was afterwards given a pension and also a post at the conservatoire, from which he retired in 1802. He died on Jan. 14, 1817.

See Grove, *Dictionary of Music and Musicians;* A. Pougin, *Monsigny et son temps* (1908).

MONSOON, originally the name given by the Arabs to those seasonal winds of the Arabian sea which blow for approximately six months from the north-east and six months from the south-west. The name (Arabic *Mausim* or *Mawsim,* season), has been less correctly extended to seasonal winds in other parts of the world, *e.g.,* lower Mississippi States of North America; northern Australia; eastern central Africa. In India the term "monsoon" is specially used for the rain which falls during June to September with the onset of the south-west winds, hence a good monsoon means sufficient rainfall as contrasted with a deficiency for a bad monsoon. The total amount of rainfall bears little definite relation to the strength of the winds. The exact causes of the Asiatic monsoons cannot be conveniently summarized. The usual explanations are that in summer there is a high temperature and consequent low barometric pressure over the land with an indraft of sea air towards the interior, where it forms, or is formed by, great ascending air currents. G. C. Simpson points out that certainly as far as India is concerned the land is much hotter in May before the monsoon sets in than in July when it is at its height; again, the hottest part of India—the north-west—receives no rain during the wet monsoon and statistics prove that the average temperature is much greater in the years of bad monsoons than in the years of good monsoons.

The primary cause is certainly the difference of temperature over land and sea, and the south-west wind is a diverted south-east wind from the south of the Indian ocean which after some 4,000 miles journey is highly charged with water vapour and on reaching the north of India is caught in the box-like arrangement of the mountains. It is forced to rise and heavy rain results. For complete details of the Indian monsoon *see* G. C. Simpson "The South-West Monsoon." *Q.J.R. Met. Soc.* (1921).

MONSTER. In zoology, monsters form the subject of Animal Teratology, a department of morphology treating of deviations from the normal development of the embryo. In man, it is mostly in the first three months of intra-uterine life that those deviations from the normal occur which present themselves as monstrosities at the time of birth.

MONSTROSITIES IN A SINGLE BODY

The abnormality may extend to the body throughout, as in well proportioned giants and dwarfs; or it may affect a certain region or member, as when there is a finger or toe too many or too few. It is common for one malformation to be correlated with others, as in acardiac monsters, in which the non-development of the heart is associated with the non-development of the head, and with other radical defects.

Giants are conventionally limited to persons over 7ft. in height. The normal proportions of the frame are adhered to more or less closely, except in the skull, which is relatively small; but accurate measurements, even in the best proportioned cases, prove, when reduced to a scale, that other parts besides the skull—notably the thigh-bone and the foot—may be undersized though overgrown. The brain-case especially is undersized—the Irish giant in the museum of Trinity College, Dublin, is the single exception to this rule—but the bones of the face, and especially the lower jaw, are on a large scale. Giants are never born of gigantic parents; sterility usually goes with this monstrosity. Their size is sometimes excessive at birth, but more often the indications of great stature do not appear till later; they attain their full height before the twenty-first year.

FABULOUS MONSTERS OF GUIANA, NEAR LAKE PARIME. AFTER A DRAWING BY JOOST SAEGHMAN IN HIS COLLECTION OF VOYAGES, 1663

Dwarfs are conventionally limited to persons under 4ft. They are more likely than giants to have the modulus of the body perfect. Where disproportion occurs in the true dwarf it takes the form of a large-sized head, broad shoulders and capacious chest, and undersized lower limbs. Dwarfs with rickets and achondroplasia are perhaps to be distinguished from true dwarfs; these are cases in which the spine is curved, and sometimes the bones of the limbs bent and the pelvis deformed as the result of disease. As in the case of giants, dwarfs are seldom the progeny of dwarfs, who are usually sterile; the unnatural smallness may be obvious at birth, but is more likely to make itself manifest in the years of growth. Dwarfs are much more easily brought up than giants, and are stronger and longer-lived; they have usually also strong passions and acute intelligence. (*See* DWARF and GIANT.)

Redundancy and Defect in Single Parts.—The simplest case of redundancy is a sixth digit, well formed, and provided with muscles (or tendons), nerves and blood-vessels; it is usually a repetition of the little finger or toe, and may be present on one or both hands, or on one or both feet, or in all four extremities. The want of one, two or more digits is another simple anomaly; and, like redundancy, it is apt to repeat itself in the same family. Among the sense-organs there is a remarkable instance recorded of doubling of the appendages of the left eye, but not of the eyeball itself; the left half of the frontal bone is double, making two eye-sockets on that side, and the extra orbit has an eyebrow and eyelid. The external ear (*pinna*) has also been found double on one side and its orifice has frequently been found doubled in man and lower animals, and the additional ears lie in a definite relation to the branchial clefts of the embryo. Doubling of any of the internal organs or parts of organs may occur and innumerable cases have been recorded.

Defective Closure.—Imperfect closure along either of the embryonic lines of junction may produce various degrees of monstrosity. The simplest and commonest form is harelip with or without cleft palate, which results from defective closure of the ventral laminae at their extreme upper end. Another simple form (*spina bifida*) is a gap left in the neural canal at its lower end; usually the arches of the lumbar vertebrae are deficient, and the fluid that surrounds the spinal cord bulges out in its membranes, producing a soft tumour under the skin at the lower part of the back. More rarely the gap in the arches of the vertebrae is in the region of the neck. If it extend all along the back, it will probably involve the skull also. Deficiency of the crown of the head, and the spine as well, may be not always traceable to want of formative power to close the canal in the middle line; an over-distended condition of the central canal of the cord and brain may prevent the closure of the bones, and ultimately lead to the disruption of the nervous organs themselves; and injuries to the mother, with inflammation set up in the foetus and its appendages, may be the more remote cause. But it is by defect in the middle line that the mischief manifests itself, and it is

in that anatomical category that the malformations are included. The osseous deficiency at the crown of the head is usually accompanied by want of the scalp, brain and membranes.

Returning to the ventral middle line, there may be defects of closure in the breast-bone (fissure of the sternum), at the navel (the last point to close in any case), and along the middle line of the abdomen generally.

Hermaphroditism.—Strictly speaking, a hermaphrodite is a creature containing ovaries and testes. But in all the higher vertebrates, including man, the sex is predetermined in the fertilized ovum, and it is more than doubtful if true hermaphroditism occurs. On the other hand, in the majority of so-called hermaphrodites, there is much doubling and ambiguity in the secondary or external organs and parts of generation. Those parts which are rudimentary or obsolete in the male but highly developed in the female, and those parts which are rudimentary in the female but highly developed in the male tend in the hermaphrodite to be developed equally, and all of them badly.

Cyclops, Siren, etc.—The same feebleness of the formative energy which gives rise to defective closure in the middle line, and to ambiguous sex, leads also to imperfect separation of symmetrical parts. The most remarkable case of the kind is the cyclops monster. At a point corresponding to the root of the nose there is a single orbital cavity, sometimes small and with no eyeball, at other times of the usual size and containing an eyeball more or less complete. In still other cases the orbital cavity extends on each side of the middle line, and contains two eyeballs lying close together.

Another curious result of defective separation of symmetrical parts is the siren form of foetus, in which the lower limbs occur as a single tapering prolongation of the trunk like the hinder part of a dolphin, at the end of which a foot (or both feet) may or may not be visible.

Limbs Absent or Stunted.—Allied to these fused or unseparated states of the extremities is the class in which whole limbs are absent, or represented only by stumps. The trunk (and head) may be well formed, and the individual healthy; all four extremities may be reduced to short stumps either wanting hands and feet, or with the latter fairly well developed; or the legs only may be rudimentary or wanting, or the arms only, or one extremity.

Acardiac and Acranial Monsters.—It sometimes happens in a twin pregnancy that one of the embryos fails to develop a heart and complete vascular system of its own, depending for its nourishment upon blood derived from the placenta of its well-formed twin by means of its umbilical vessels. It grows into a shapeless mass, in which all traces of the human form may be lost.

Reversed Position of the Viscera.—This is a developmental error associated with the retention of the right aortic arch as in birds, instead of the left as is usual in mammals. The position of all the unsymmetrical viscera is transposed. This condition need cause no inconvenience; and it may remain undetected.

The causes of congenital anomalies are difficult to specify. There is no doubt that, in some cases, they are present in the sperm or germ of the parent; the same anomalies recur in several children of a family, and it has been found possible, through a variation of the circumstances, to trace the influence in some cases to the father alone, and in other cases to the mother alone. The remarkable thing in this parental influence is that the malformation in the child may not have been manifested in the body of either parent, or in the grandparents. More often the malformation is acquired by the foetus in the course of development and growth, either through the mother or in itself independently.

DOUBLE MONSTERS

Twins are the physiological analogy of double monsters, and some of the latter have come very near to being two separate individuals. The Siamese twins, who died in 1874 at the age of sixty, were joined only by a thick fleshy ligament from the lower end of the breast-bone (xiphoid cartilage), having the common navel on its lower border; the anatomical examination showed, however, that a process of peritoneum extended through the ligament from one abdominal cavity to the other, and that the blood-vessels of the two livers were in free communication across the same bridge. From double monstrosity, like the Siamese twins, there are all grades of fantastic fusion of two individuals into one down to the condition of a small body or fragment parasitic upon a well-grown infant—the condition known as *foetus in foetu*. These monstrosities may be deviations from the usual kind of twin gestation (one foetus being partially included within the body of the other) or from a rarer physiological type of dual development. In by far the majority of cases twins have separate uterine appendages, and have probably been developed from distinct ova; but in a small proportion of (recorded) cases there is evidence, in the placental and enclosing structures, that the twins had been developed from two rudiments which arise side by side on a single blastoderm. The perfect physiological type of this appears to be two rudiments on one blastoderm, whose entirely separate development produces twins (under their rarer circumstances), whose nearly separate development produces such double monsters as the Siamese twins, and whose less separate development produces the various forms of two individuals in one body.

Symmetrical Double Monsters are subdivided according to the part of the body where the fusion exists—head, thorax, umbilicus or pelvis. One of the simplest cases is a Janus head upon a single body, or there may be two pairs of arms with the two faces. Again, there may be one head with two necks and two complete trunks and pairs of extremities. Two distinct heads (with more or less of neck) may surmount a single trunk, broad at the shoulders but with only one pair of arms. The fusion, again, may be from the middle of the thorax downwards, giving two heads and two pairs of shoulders and arms, but only one trunk and one pair of legs. In another variety, the body may be double down to the waist, but the pelvis and lower limbs single. The degree of union in the region of the head, abdomen or pelvis may be so slight as to permit of two distinct organs or sets of organs in the respective cavities, or so great as to have the viscera in common; and there is hardly ever an intermediate condition between those extremes. Thus, in the Janus head there may be two brains, or only one brain. The pelvis is one of the commonest regions for double monsters to be joined at, and, as in the head and abdomen, the junction may be slight or total. The Hungarian sisters Helena and Judith (1701–23) were joined at the sacrum, but had the pelvic cavity and pelvic organs separate; the same condition obtained in the South Carolina negresses Millie and Christina, known as the "two-headed nightingale," and in the Bohemian sisters Rosalie and Josepha.

Unequal Double Monsters, Foetus in Foetu.—There are some well authenticated instances of this most curious of all anomalies. The most celebrated of these parasite-bearing monsters was a Genoese, Lazarus Johannes Baptista Colloredo, born in 1716, who was figured as a child by Licetus, and again by Bartholinus at the age of 28 as a young man of average stature. The parasite adhered to the lower end of his breastbone, and was a tolerably well-formed child, wanting only one leg; it breathed, slept at intervals, and moved its body, but it had no separate nutritive functions. The parasite is more apt to be a miniature acardiac and acephalous fragment, as in the case of the one borne in front of the abdomen of a Chinaman figured by I. Geoffroy St. Hilaire. Sometimes the parasite is contained in a pouch under the skin of the abdominal wall, and in another class (of which there is a specimen in the Hunterian museum) it has been included, by the closure of the ventral laminae, within the abdominal cavity of the foetus—a true *foetus in foetu*.

Monstrosities in man and animals have attracted attention since the earliest times, and amongst primitive and uncivilized peoples have been regarded as of supernatural origin. The human monstrosities were regarded as having been engendered in women by the devil either in his own form or in the guise of some animal. The belief still to be found amongst uneducated persons that unnatural union between women and male animals, or between men and female animals, may be fertile and produce monsters, is an attenuated form of the satanic legend. The scientific appreciation of monsters has grown with the study of embryology. William Harvey (1651) first referred monstrosities to their proper place as

abnormalities in embryonic reproduction. E. G. St. Hilaire was the first to attempt experimental teratology and to maintain that many monstrosities were the result of influences causing deviations from the normal course of embryonic development. I. G. St. Hilaire, his son, published an elaborate treatise on anomalies (Paris, 1832–37) which remains one of the most valuable records of the subject. A similar treatise with an incomparable atlas of illustrations was issued by W. Vrollik, the great Dutch anatomist, between 1840 and 1849, whilst A. Förster issued in 1861 a textbook with illustrations chiefly from preparations in the museum at Würzburg. The great museums devoted much attention to the collection and display of malformations, and there is a magnificent series in the Museum of the Royal College of Surgeons of England, with descriptive catalogues. In 1891 Camille Dareste published his experiments, chiefly on the developing egg of the fowl, not only showing the probable cause of many of the most common abnormalities, but practically creating a new branch of science, experimental embryology. Teratology has since become an off-shoot of embryology and heredity and must be studied in relation to these subjects.

E. Schwalbe's *Morphologie der Missbildungen* (1906–1909) is a very complete study of the modern developments of teratology, with a list of authorities from the earliest times. (C. Cr.; P. C. M.)

MONSTRANCE, a vessel used in the Roman Church for the exposition of the Host at Benediction (*q.v.*) and also when carried in processions. The earlier monstrances followed the usual shape of reliquaries, viz., a cylindrical crystal case mounted in metal frames, elaborately ornamented and jewelled. In the 16th century the present shape was adopted, viz., a crystal or glass circular disc, more suited to the shape of the sacred wafer.

MONSTRELET, ENGUERRAND DE (*c.* 1400–1453), French chronicler, belonged to a noble family of Picardy. He was for some time bailiff of the cathedral chapter and then provost of Cambrai. He died on July 20, 1453. Monstrelet was present, not at the capture of Joan of Arc, but at her subsequent interview with Philip the Good, duke of Burgundy. Continuing the work of Froissart, he wrote a *Chronique,* which extends to two books and covers the period between 1400 and 1444, when, according to another chronicler, Matthieu d'Escouchy, he ceased to write. A clumsy sequel, extending to 1516, was formed out of various chronicles and tacked on to his work. Monstrelet's own writings, dealing with the latter part of the Hundred Years' War, are valuable because they contain a large number of documents which are certainly, and reported speeches which are probably, authentic.

Among many editions of the *Chronique* may be mentioned the one edited for the *Société de l'histoire de France* by M. Douët d'Arcq (1857–62). *See* A. Molinier, *Les Sources de l'histoire de France,* tomes iv. and v. (1904).

MONTAGNA, BARTOLOMEO (1450–1523), Italian painter, the most eminent master of the school of Vicenza. He was a Brescian by birth. Vasari classes him among the pupils of Andrea Mantegna, but although there can be little doubt of the influence of the great Paduan master on his style, he more probably studied at Venice under the influence of Giovanni Bellini and Vittore Carpaccio. Montagna's style is dignified and austere, his form plastic, his colour exquisitely harmonious. He interpreted his favourite subject, "The Virgin and Child," either alone or attended by saints with a solemn, quiet grandeur. Montagna is first heard of at Vicenza in 1480; he also worked elsewhere, at Praglia near Padua and at Verona (1504–07) where he painted a fresco in the oratory of S. Biagio in the church of SS. Nazaro and Celso, as well as an altar-piece for the church of S. Sebastiano now in the Venice academy. His most important work is probably the great altar-piece of San Michele at Vicenza dated 1499, now in the Brera, Milan. Here the stateliness of the composition, staged under a lofty vault, the nobleness of the enthroned Madonna, the dignity of the attendant saints, the charm of the angels making music at the foot of the throne, are profoundly impressive. It would be impossible here to enumerate the numerous works of Montagna in Vicenza and in many public and private collections. One of his last pictures is the altar-piece, dated 1522, in the cathedral at Cologna Veneta. He died at Vicenza on Oct. 11, 1523. Bartolomeo founded a school of painting at Vicenza, from which sprang Giovanni Speranza, and partly also Giovanni Bonconsiglio and Francesco Ponte, the father of Jacopo Bassano.

His son, Benedetto Montagna (1470–1540), imitated the style of his father in his paintings. He was a distinguished engraver.

See T. Borenius, *The Painters of Vicenza* (1909).

MONTAGNAIS AND NASCAPEE. North of the St. Lawrence, the Montagnais and Nascapee resemble the southern Algonkin (*q.v.*) though their culture is affected by their unfavourable habitat. No crops are raised; they are hunters of caribou rather than fishers, chiefs have little authority, and no trace can be found of any political unit above the simple band. The canoe and wigwam of birch-bark are typical elements of culture, and the painted skin clothing of the Nascapee is distinctive. Life is unusually hard, material culture scanty, and women occupy an inferior place in the social scale.

MONTAGNANA, a town of Venetia, Italy, province of Padua, 30 m. S. of Vicenza by tramway. Pop. (1921), 7,871 (town); 12,151 (commune). It is entirely surrounded by mediaeval walls (1242–60) which are among the most perfect in Italy. The cathedral and S. Francesco are Romanesque-Gothic churches.

MONTAGU (*Family*). Dru of Montaigu or Montagud, the ancestor of the Montagus, earls of Salisbury, came to England with Robert, count of Mortain, half-brother of William the Conqueror. He is found in Domesday among the chief tenants of the count in Somerset, holding the manor of Shepton. This holding is represented in the return of 1166 by the ten knights' fee upon which his descendant, another Dru, is assessed. William Montagu of Shepton is among the knights summoned by Henry III. to the Gascon War and to the Welsh border in 1257. His son Simon, the first of the family to make a figure in history, followed Edward I. in 1277 and in 1282 against Llywelyn ap Gruffydd. In 1298 he was summoned as a baron; and in 1301, as Simon lord of Montagu, sealed the famous letter of the barons to the pope with his seal of the arms of Montagu, the counterseal showing a griffon. His son William (d. 1319), a favourite of Edward II., and seneschal of Aquitaine and Gascony, was succeeded by his eldest son, another William, who in 1330 secretly led the young king's partisans into Nottingham Castle, and carried off the earl of March.

In 1337 Montagu was created earl of Salisbury, and on the death of Thomas of Brotherton in 1338 was made marshal of England. His king employed him in missions to France, Scotland, Germany and Castile, and some time between 1340 and 1342 he led an expedition of his own against the Isle of Man, winning from the Scots the little kingdom to which he had inherited a claim through his grandfather Simon who had been granted the island by a certain Auffray or "Aufrica," who styled herself "Aufreca of Counnoght, heir of the land of Man." The first earl was succeeded in 1344 by William, his son and heir, who was one of the knights-founders of the Order of the Garter, fought at Crécy, and commanded the rearward battle at Poitiers. According to Froissart he attended the young Richard in Smithfield when the king faced the mob after the death of Wat Tyler. His only son was killed in 1383 at a tournament, and in 1393 the earl sold the lordship and crown of Man to William Scrope of Bolton. He was succeeded by his nephew John, the third earl (*c.* 1350–1400), son of Sir John Montagu by Margaret, the heir of the barons of Monthermer. The new earl was notorious as a Lollard, and was accused, after Henry IV.'s accession, of a share in Gloucester's death. He joined Kent, Huntingdon and Rutland in their plot against Henry, and was beheaded with the earl of Kent by the Cirencester mob. His son Thomas (1388–1428) was summoned as an earl in 1409, his father's dignities being restored to him in 1421, by which time his services at Harfleur and Agincourt had earned him French lordships, the lieutenant-generalship of Normandy and the earldom of Perche. He was killed at the famous siege of Orleans. His only daughter, Alice, married Richard Neville, a younger son of the first earl of Westmorland, who was allowed the earldom of Salisbury in right of his marriage. The famous "Richard-Make-a-King," earl of Warwick and Salisbury, was the grandson of the last of the Montagu earls.

Bibliography.—Collinson's *Somerset; G. E. C.'s Complete Peerage; Victoria County History of Somerset* (J. H. Round's introduction to Domesday); Rymer's *Foedera;* Palgrave's *Parliamentary Writs; Rolls of Parliament;* Ramsay's *Lancaster and York; Gesta Henrici V.* (Eng. Hist. Soc.); *Chronicles* of Walsingham, Knighton, Capgrave Wavrin, Froissart, Monstrelet, etc. Inquests, Post mortem, Close, Patent, Charter and Fine Rolls; Dugdale's Monasticon Publications of Somerset Record Society.

MONTAGU, EDWIN SAMUEL (1879–1924), British politician, second son of the 1st Lord Swaythling (*q.v.*), was born on Feb. 6, 1879, and educated at the City of London School and at Trinity College, Cambridge. At Cambridge he was president of the Union and acquired a considerable reputation. When he entered parliament in 1906, as Liberal member for the Chesterton division of Cambridgeshire, he was chosen by Asquith, then Chancellor of the Exchequer, as his parliamentary secretary, and continued in that position when his chief succeeded to the premiership. Early in 1910 he was appointed under-secretary for India, under Lord Morley, and remained in the post, under Lord Crewe till 1914; and so made his first official acquaintance with India under the influence of Lord Morley's reforms and Lord Crewe's Durbar changes of 1911. As both his chiefs were in the Lords, he was the spokesman of the office in the Commons. He went out to India during his tenure of office to see things for himself.

After holding during the World War the posts of financial secretary to the treasury, chancellor of the duchy of Lancaster (1915) and minister of munitions (1916), he returned in 1917 to the India Office as secretary of state and began a tenure of that post which will always be memorable in Indian annals.

He visited India in the following winter for the second time, and held prolonged conferences with the viceroy, Lord Chelmsford, the leading members of the Indian Civil Service, ruling princes and native politicians, and, with the viceroy, received deputations and memoranda from all classes. Ultimately in July 1918 there was published an elaborate report, signed by the viceroy as well as by the secretary of state, recommending a series of constitutional reforms which should give the Indian peoples in time to come a large and real share in their own government. In December 1919 he had the satisfaction of passing through parliament the Government of India bill, which established in India, in accordance with the report, what was called a "dyarchy," a partition of the powers of Government between the civil service and the native population. For events in India which followed *see* India: *History*.

In March 1922 Montagu had to resign his office for having published, without the authority of the cabinet, a telegram from the Government of India urging a more friendly policy towards Turkey. He defended his action by maintaining that cabinet responsibility had been destroyed by Lloyd George's dictatorial methods. At the general election of 1922 he lost his seat in Parliament, and went into the city, becoming vice-chairman of the De Beers Co. He had married in 1915 Beatrice Venetia, youngest daughter of the 4th Baron Sheffield, and he died in London on Nov. 15, 1924.

MONTAGU, ELIZABETH ROBINSON (1720–1800), English leader of society, was born at York on Oct. 2, 1720. In 1742 she married Charles Montagu, cousin of Edward Wortley Montagu and son of the earl of Sandwich. Thanks to her, his Mayfair house became the social centre of intellectual society in London, and her breakfast parties and evening conversaziones gained her the title of "The Madame du Deffand of the English capital." In other quarters the term "blue-stocking" was applied to her guests. From her husband, who died in 1775, she inherited a considerable fortune and large estates. In 1781 she built Sandleford Priory, near Newbury, and Montagu House, now 22 Portman Square, London, the latter from designs by James Stuart. She died on Aug. 25, 1800. There is an admirable portrait of her by Reynolds.

See *Elizabeth Montagu, the Queen of the Blue Stockings: Her Correspondence from 1720 to 1761* (ed. E. J. Climenson, 2 vols., 1906); R. Huchon, *Mrs. Montagu and her Friends, 1720–1800* (Eng. trans., 1907); and *Mrs. Montagu, Queen of the Blues* (ed. R. Blunt, a continuation of E. J. Climenson's book, 2 vols., 1923).

MONTAGU, LADY MARY WORTLEY (1689–1762), English letter-writer, eldest daughter of Evelyn Pierrepont, afterwards duke of Kingston, was baptized at Covent Garden on May 26, 1689. Her mother, who died while her daughter was still a child, was a daughter of William Feilding, earl of Denbigh. Her father was proud of her beauty and wit, and when she was eight years old she is said to have been the toast of the Kit-Kat Club. He took small pains with the education of his children, but Lady Mary was encouraged in her self-imposed studies by her uncle, William Feilding, and by Bishop Burnet. She formed a close friendship, and carried on an animated correspondence with Mary Astell, who was a champion of woman's rights, and with Anne Wortley Montagu, grand-daughter of the first earl of Sandwich. The letters on Anne's side, however, were often copied from drafts written by her brother, Edward Wortley Montagu, and after Anne's death in 1709 the correspondence between him and Lady Mary was prosecuted without an intermediary. Lady Mary's father, now marquess of Dorchester, declined, however, to accept Montagu as a son-in-law because he refused to entail his estate on a possible heir. Negotiations were broken off, and when the marquess insisted on another marriage for his daughter the pair eloped (1712).

The early years of Lady Mary Wortley Montagu's married life were spent in rigid economy and retirement in the country. Her husband was M.P. for Westminster in 1715, and shortly afterwards was made a commissioner of the treasury. When Lady Mary joined him in London her wit and beauty soon made her a prominent figure at court. Early in 1716 Montagu was appointed ambassador at Constantinople. Lady Mary accompanied him to Vienna, and thence to Adrianople and Constantinople. He was recalled in 1717, but they remained at Constantinople until 1718. The story of this voyage and of her observations of Eastern life is told in a series of lively letters full of graphic description. From Turkey she brought back the practice of inoculation for small-pox. She had her own children inoculated, and encountered a vast amount of prejudice in bringing the matter forward.

Before starting for the East she had made the acquaintance of Alexander Pope, and during her absence he addressed to her a series of extravagant letters, which appear to have been chiefly exercises in the art of writing gallant epistles. Very few letters passed after Lady Mary's return, and various reasons have been suggested for the subsequent estrangement and violent quarrel and the *Verses addressed to an Imitator of Horace*. Lady Mary always professed complete innocence. The reason was possibly that Pope had made love to her and been received with laughter. In any case, Pope attacked her again and again with the grossest insults, and her chief ally, Lord Hervey, as well. In return she is credited with a hand in *A Pop upon Pope*. She had a romantic correspondence with a Frenchman named Rémond, who addressed to her a series of excessively gallant letters before ever seeing her. She invested money for him in South Sea stock at his desire, and, as was expressly stated, at his own risk. The value fell to half the price, and he tried to extort the original sum as a debt by a threat of exposing the correspondence to her husband. This disposes of the second half of Pope's line "Who starves a sister, or forswears a debt" (*Epilogue to the Satires*, i. 113), and the first charge is quite devoid of foundation.

In 1739 she went abroad, and although she continued to write to her husband in terms of affection and respect they never met again. At Florence in 1740 she visited Horace Walpole, who cherished a great spite against her, and exaggerated her eccentricities into a revolting slovenliness. (See *Letters*, ed. Cunningham, i. 59.) She lived at Avignon, at Brescia, and at Lovere, on the Lago d'Iseo. She was disfigured by a painful skin disease, and her sufferings were so acute that she hints at the possibility of madness. She was struck with a terrible "fit of sickness" while visiting the countess Palazzo and her son, and perhaps her mental condition made restraint necessary. As Lady Mary was then in her sixty-third year, the scandalous interpretation put on the matter by Horace Walpole may safely be discarded. Her husband spent his last years in hoarding money, and at his death in 1761 is said to have been a millionaire. His extreme parsimony

is satirized in Pope's *Imitations of Horace* (2nd satire of the 2nd book) in the portrait of Avidieu and his wife. Her daughter Mary, countess of Bute, whose husband was now prime minister, begged her to return to England. She came to London, and died in the year of her return, on Aug. 21, 1762. The general opinion of her was that as a letter-writer she was second only to Mme. de Sévigné. However that may be, there could hardly be two people more unlike. Lady Mary's letters are vivid, downright and scandalous; their interest lies not so much in the works as in the scenes and incidents of her wandering life.

Her son, EDWARD WORTLEY MONTAGU (1713–1776), author and traveller, inherited something of his mother's gift and more than her eccentricity. He was born in May 1713, twice ran away from Winchester School, and the second time made his way as far as Oporto. He was then sent to travel with a tutor in the West Indies, and afterwards with a keeper to Holland. He made, however, a serious study of Arabic at Leyden (1741), and returned twenty years later to prosecute his studies. His father made him a meagre allowance, and he was heavily encumbered with debt. He was M.P. for Huntingdon in 1747, and was one of the secretaries at the conference of Aix-la-Chapelle. In 1751 he was involved in a disreputable gaming quarrel in Paris, and was imprisoned for eleven days in the Châtelet. He continued to sit in parliament, and wrote *Reflections on the Rise and Fall of the Antient Republics* . . . (1759). His father left him an annuity of £1,000, the bulk of the property going to Lady Bute. He set out for extended travel in the East, lived at Venice and died at Padua on April 29, 1776.

Lady Mary's "Town Eclogues" were published in a pirated edition as *Court Poems* in 1716. Of her famous *Letters* from the East she made a copy shortly after her return to England. She gave the MS. to Benjamin Sowden, a clergyman of Rotterdam, in 1761. After Lady Mary's death this was recovered by the earl of Bute, but meanwhile an unauthenticated edition, supposed to have been prepared by John Cleland, appeared (1763), and an additional volume, probably spurious, was printed in 1767. The rest of the correspondence printed by Lord Wharncliffe in the edition of her letters is edited from originals in the Wortley collection. This edition (1837) contained "Introductory Anecdotes" by Lady Bute's daughter, Lady Louisa Stuart. A more critical edition of the text, with the "Anecdotes," and a "Memoir" by W. Moy Thomas, appeared in 1861. A selection of the letters arranged to give a continuous account of her life, by Mr. A. R. Ropes, was published in 1892; and another by R. Brimley Johnson in "Everyman's Library" in 1906. *See* also George Paston, *Lady Mary Wortley Montagu and her Times* (1907), which contains some hitherto unpublished letters. Lady Mary's journal was preserved by her daughter, Lady Bute, till shortly before her death, when she burnt it. There is a full and amusing account of Edward Wortley Montagu in Nichols's *Anecdotes of Literature*, iv. 625–656; L. Melville, *Lady Mary Wortley Montagu* (1925); Iris Barry, *Portrait of Lady Mary Wortley Montagu* (1928).

MONTAGU, RALPH, 1ST DUKE OF (*c.* 1638–1709), English diplomatist, was the second son of Edward, 2nd Baron Montagu of Boughton (1616–84), whose peerage was one of several granted in the 17th century to different members of the Montagu family (*q.v.*). Appointed master of the horse to Queen Catherine, wife of Charles II., he soon acquired a reputation for gallantry at the court. He took an active part in the negotiations in which Louis XIV. purchased the neutrality of England in the war between France and Holland. In 1678 he was elected member of parliament for Northampton, but on the dissolution of parliament attempted unsuccessfully to fly to France. He supported the movement for excluding the duke of York from the succession and for recognizing Monmouth as heir. His elder brother having predeceased his father, Ralph became Baron Montagu of Boughton on the death of the latter in 1684. Notwithstanding his former intrigues he gained the favour of James II. on his accession to the throne, but this did not deter him from welcoming William of Orange, who created him Viscount Monthermer and earl of Montagu in 1689. His position was further strengthened in 1705 by the marriage of his son to Mary, daughter of the great duke of Marlborough. In the same year he was raised to the dukedom as duke of Montagu and marquess of Monthermer. He died on March 9, 1709. His London residence, Montagu House, Bloomsbury, was bought by the government in 1753 to hold the national collection of antiquities, and on its site was built the British Museum. At the death of his son John in 1749, the title became extinct.

See A. Boyer, *History of the Reign of Queen Anne*, vol. viii. (1703–13); Burke, *Genealogical History of Dormant* (etc.) *Peerages* (1883); and article in *Dict. Nat. Biog.*

MONTAGU (or MOUNTAGUE), **RICHARD** (1577–1641), English divine, was born at Dorney, Buckinghamshire, and educated at Eton and King's college, Cambridge. He was appointed to the deanery of Hereford in 1616, but exchanged it next year for a canonry of Windsor, which he held with the rectory of Petworth, Sussex. He was also chaplain to James I. Like Laud, he disliked the extremes of Calvinism and Romanism. About 1619 he came into collision with some Roman Catholics in his parish, and Matthew Kellison (1560?–1642) attacked him in a pamphlet entitled *The Gagg of the Reformed Gospell* (Douai, 1623). Montagu replied with *A Gagg for the New Gospell? No. A New Gagg for an Old Goose* (1624). The publication of the *Immediate Addresse unto God alone* (1624) incensed the Puritans, who appealed to the House of Commons, but Montagu was protected by the king. After the appearance of his famous *Appello Caesarem* (1625), in which he vindicated himself from the divergent charges of Arianism and popery, his case frequently came before parliament and conferences of bishops, but his influence at court and with Laud saved him. He was consecrated bishop of Chichester in 1628, and became bishop of Norwich in 1638. He died on April 13, 1641.

MONTAIGNE, MICHEL DE (1533–1592), French essayist, was born, as he himself tells us, between eleven o'clock and noon on Feb. 28, 1533. The patronymic of the Montaigne family, who derived their title from the château at which the essayist was born and which had been bought by his grandfather, was Eyquem. Montaigne is not far from Bordeaux, with which the Eyquem family had for some time been connected. Pierre Eyquem, Montaigne's father, had been engaged in commerce (a herring-merchant Scaliger calls him, and his grandfather Ramon had certainly followed that trade), had filled many municipal offices in Bordeaux, and had served under Francis I. in Italy as a soldier. He married Antoinette de Louppes (Lopez), descended from a family of Spanish Jews. The essayist was the third son. By the death of his elder brothers, however, he became head of the family. He had also six younger brothers and sisters. Montaigne was put out to nurse with a peasant woman, and had his sponsors from the same class. He was taught Latin orally by servants who could speak no French, and many curious fancies were tried on him, as, for instance, that of waking him every morning by soft music.

At six years old Montaigne was sent to the collège de Guienne at Bordeaux, then at the height of its reputation. At thirteen Montaigne began to study law, probably at Toulouse. In 1548 he was at Bordeaux during one of the frequent riots caused by the gabelle, or salt-tax. Six years afterwards he was made a counsellor in the Bordeaux parlement. In 1558 he was present at the siege of Thionville, in 1559 and 1561 at Paris, and in 1562 at the siege of Rouen. He was also much about the court, and he admits that in his youth he led a life of pleasure, if not exactly of excess.

In 1565 Montaigne married Françoise de la Chassaigne, whose father was, like himself, a member of the Bordeaux parlement. Three years later his father died, and he succeeded to the family possessions. Finally, in 1571, he retired to Montaigne, having given up his magistracy the year before. His health, never strong, had been further weakened by hard living. He resolved, accordingly, to retire to a life of study and contemplation, though he indulged in no asceticism except careful diet. He lived on excellent terms with his wife, and bestowed some pains on the education of the only child (a daughter Léonore) who survived infancy.

THE ESSAYS

In his father's lifetime, and at his request, he had translated the *Theologia naturalis* of Raymund de Sabunde, a Spanish schoolman (published 1569). On first coming to live at Montaigne he edited the works of his deceased friend Étienne de la Boétie. But the years of his studious retirement were spent on a work

of infinitely greater importance. Garrulous after a fashion as Montaigne is, he gives us no clear idea of any original or definite impulse leading him to write the famous *Essays*. It is very probable that if they were at first intended to have any special form at all it was that of a table-book or journal. The earlier essays, those of the first two books, differ from the later in one most striking point, in that of length. Speaking generally, the essays of the third book average fully four times the length of those of the other two. This of itself would suggest a difference in the system of composition. These first two books appeared in 1580, when their author was 47 years old.

They contain, as at present published, no fewer than ninety-three essays, besides an exceedingly long apology for the already mentioned Raymund Sabunde, in which some have seen the kernel of Montaigne's philosophy. The book begins with a short *avis* (address to the reader), opening with the well-known words, *"C'est icy un livre de bon foy, lecteur,"* and sketching in a few lively sentences the character of meditative egotism which is kept up throughout. His sole object, he says, is to leave for his friends and relations a mental portrait of himself, defects and all; he cares neither for utility nor for fame. The essays then begin, without any attempt to explain or classify their subjects. Their titles are of the most diverse character. Sometimes they are proverbial sayings or moral adages, such as "Par divers moyens on arrive à pareille fin," "Qu'il ne faut juger de notre heur qu'après la mort," "Le profit de l'on est le dommage de l'aultre." Sometimes they are headed like the chapters of a treatise on ethics: "De la tristesse," "De l'oisiveté," "De la peur," "De l'amitié." Sometimes a fact of some sort which has awaked a train of associations in the mind of the writer serves as a title, such as "On est puni de s'opiniastrer à une place sans raison," "De la bataille de Dreux," etc. Occasionally the titles seem to be deliberately fantastic, as "Des puces," "De l'usage de se vestir." Sometimes, though not very often, the sections are in no proper sense essays, but merely commonplace book entries of singular facts or quotations, with hardly any comment.

In 1571 he had received the order of Saint-Michel; in 1574 was with the army of the duke de Montpensier; two years later was made gentleman-in-ordinary to Henry III., and next year again to Henry of Navarre. He visited Paris occasionally, and travelled for health or pleasure to Cauterets, Eaux Chaudes and elsewhere. But his health grew worse and worse, and he was tormented by stone and gravel. He accordingly resolved to journey to the baths of Lucca. Late in the 18th century a journal found in the château of Montaigne, giving an account of this journey, was published in 1774; part of it is written in Italian and part dictated in French, the latter being for the most part the work of a secretary or servant. The ms. disappeared early, and the work is almost destitute of literary interest. At Rome he received news of his election as mayor of Bordeaux with a peremptory royal endorsement enjoining residence, and after some time journeyed homewards.

The memory of his father, however, and the commands of the king induced Montaigne to accept the mayoralty; and he seems to have discharged it neither better nor worse than an average magistrate. He was re-elected at the close of his term. His second term of office terminated in 1585; and in 1588 after a visit of some length to Paris, the third book of the *Essays* was published, together with the former ones considerably revised. The new essays, as has been remarked, differ strikingly from the older ones in respect of length; and the whimsical unexpectedness of the titles reappears in but two of them: "Des Coches" and "Des Boiteux." They are, however, identical with the earlier ones in spirit, and make with them a harmonious whole—a book which has hardly been second in influence to any of the modern world.

HIS POSITION IN LITERATURE

This influence is almost equally remarkable in point of matter and in point of form. Montaigne is one of the few great writers who have invented a literary kind. The essay as he gave it had no forerunner in modern literature and no direct ancestor in the literature of classical times. In matter of style and language Montaigne's position is equally important, but the ways which led him to it are more clearly traceable. His favourite author was beyond all doubt Plutarch, and his own explicit confession makes it undeniable that Plutarch's translator, Jacques Amyot, was his master in point of vocabulary and (so far as he took any lessons in it) of style. Montaigne, however, followed with the perfect independence that characterized him. He was a contemporary of Ronsard, and his first essays were published when the innovations of the Pléiade had fully established themselves. He adopted them to a great extent, but with much discrimination, and he used his own judgment in latinizing when he pleased. In the same way he retained archaic and provincial words with a good deal of freedom, but by no means to excess.

Perhaps the only actual parallel to Montaigne in literature is Lamb. There are differences between them, arising naturally enough from differences of temperament and experience; but both agree in their attitude—an attitude which is sceptical without being negative and humorous without being satiric. There is hardly any writer in whom the human comedy is treated with such completeness as it is in Montaigne. There is discernible in his essays no attempt to map out a complete plan, and then to fill up its outlines. But in the desultory and haphazard fashion which distinguishes him there are few parts of life on which he does not touch, if only to show the eternal contrast and antithesis which dominate it. The exceptions are chiefly to be found in the higher and more poetical strains of feeling to which the humorist temperament lends itself with reluctance and distrust, though it by no means excludes them. The positiveness of the French disposition is already noticeable in Rabelais; it becomes more noticeable in Montaigne. He is always charming, but rarely inspiring.

Montaigne did not very long survive the completion of his book. On his way to Paris for the purpose of getting it printed he stayed for some time at Blois, where he met De Thou. In Paris itself he was for a short time committed to the Bastille by the Leaguers, as a kind of hostage, it is said, for a member of their party who had been arrested at Rouen by Henry of Navarre. But he was well known to and favoured by both Catherine de' Medici and the Guises, and was very soon released. In Paris, too, at this time he made a whimsical but pleasant friendship with Marie de Jars de Gournay (1565–1645), one of the most learned ladies of the 16th and 17th centuries, who became his "fille d'alliance" (adopted daughter), a title which she bore for the rest of her long life. When Henry of Navarre came to the throne of France, he wished Montaigne, whom he had visited in 1584 and 1587, to come to court, but this was refused. It would seem that he returned from Paris to his old life of study and meditation and working up his *Essays*. No new ones were found after his death, but many alterations and insertions. He was attacked with quinsy, which brought about paralysis of the tongue, and he died on Sept. 13, 1592. He was buried, though not till some months after his death, in a church in Bordeaux, which after some vicissitudes became the chapel of the collège.

When Mlle. de Gournay heard of the death of Montaigne she undertook with her mother a visit of ceremony and condolence to the widow, which had important results for literature. Mme. de Montaigne gave her a copy of the edition of 1588 annotated copiously; at the same time, apparently, she bestowed another copy, also annotated by the author, on the convent of the Feuillants in Bordeaux, to which the church in which his remains lay was attached. Mlle. de Gournay thereupon set to work to produce a new and final edition with a zeal and energy which would have done credit to any editor of any date. She herself worked with her own copy, inserting the additions, marking the alterations and translating all the quotations. But when she had got this to press she sent the proofs to Bordeaux, where a poet of some note, Pierre de Brach, revised them with the other annotated copy. The edition thus produced in 1595 has with justice passed as the standard, even in preference to those which appeared in the author's lifetime.

Unluckily, Mlle. de Gournay's original does not appear to exist and her text was said, until the appearance of MM. Courbet and Royer's edition, to have been somewhat wantonly corrupted, especially in the important point of spelling. The Feuillants copy is in existence, being the only manuscript, or partly manuscript, authority for the text. This manuscript was edited in 1803 by Naigeon, the disciple of Diderot; but, according to later inquiries, considerable liberties were taken with it. The first edition of 1580, with the various readings of two others which appeared during the author's

lifetime, was reprinted by MM. Dezeimeris and Burckhausen in 1870. That of Le Clerc (3 vols., 1826–28) and in a more compact form that of Louandre (4 vols., 1854) have been most useful; but that of MM. Courbet and Royer (1872–1900) is at present the standard; a more recent edition is by P. Villey (1922). The *Journal,* long neglected and still (*vide supra*) doubtful, was re-edited by Professor A. d'Ancona (Città di Castello, 1895) and translated into English by W. G. Waters (1903). The *Oeuvres complètes* were edited by A. Armaingaud in 1924. Modern books of importance are P. Bonnefon's *Montaigne, l'homme et l'oeuvre* (1893) and P. Stapfer's *Montaigne* (1895) in the *Grands écrivains,* the latter a book of remarkable excellence. Edmé Champion's *Introduction aux essais* may also be noticed, and Professor Dowden's *Montaigne* (1905), which has an excellent bibliography. The somewhat earlier *Montaigne* of M. E. Lowndes (Cambridge, 1898) is noteworthy in especial for its attention to his life and character.

In England Montaigne was early popular. It was long supposed that the autograph of Shakespeare in a copy of Florio's translation showed his study of the *Essays.* The autograph has been disputed, but divers passages, and especially one in *The Tempest,* show that at first or second hand the poet was acquainted with the essayist. The book best worth consulting on this head is J. Feis's *Shakespeare and Montaigne* (1884). Towards the latter end of the 17th century, Cotton, the friend of Izaak Walton, executed a complete translation, which, though not extraordinarily faithful, possesses a good deal of rough vigour. It has been frequently reprinted with additions and alterations; W. C. Hazlitt's edition (1892) was reprinted in 1923. Reprints of Florio are also numerous. One in the "Tudor Translations" (1893) has an introduction by G. Saintsbury; a recent translation of the essays is by E. J. Trechmann (2 vols., 1927). An English biography of Montaigne by Bayle St. John appeared in 1858, and Walter Pater's unfinished *Gaston de Latour* borrows from Montaigne and his story. The most noteworthy critical handling of the subject in English is unquestionably Emerson's in *Representative Men. See* also E. Sichel, *Michel de Montaigne* (1911); J. Prevost, *La Vie de Montaigne* (1926).

MONTALEMBERT, CHARLES FORBES RENÉ DE (1810–1870), French publicist, historian, and academician (1851), was born on March 15, 1810. Montalembert's father, Marc René, emigrated, fought under Condé, and subsequently served in the English army; he married Elise Rosée Forbes, and his eldest son, Charles, was born in London. At the Restoration of 1814 Marc René returned to France, was raised to the peerage in 1819, and became ambassador to Sweden (where Charles completed his education) in 1826. He died in 1831, a year after the overthrow of the legitimate monarchy. Charles de Montalembert was a Liberal, in the English sense, but was unable to support the Government of Louis Philippe on religious grounds. He wished to see the Church free from the control of the State, and passionately attacked the monopoly of public instruction by which the monarchy fortified its position. Montalembert was formally charged with unlicensed teaching. He claimed the right of trial by his peers, and made a notable defence (1832). On the other hand, he thought that the Church should not obstinately oppose new ideas. He collaborated with his friends, Lamennais and Lacordaire, in the newspaper *l'Avenir.* The Ultramontane party was roused by their boldness, and Montalembert and his two friends then left for Rome. This famous pilgrimage proved useless to mitigate the measures which the Roman curia took against the *Avenir.* Its doctrines were condemned in two encyclicals (*Mirari vos,* 1832, and *Singulari vobis,* 1834), and Montalembert submitted. After the revolution of 1848 he sat in the Chamber of Deputies till 1857. He was recognized as one of the most formidable opponents of the empire. Meanwhile his Liberal ideas had made him irreconcilable enemies among the Ultramontanes, notably Louis Veuillot, editor of *L'Univers.* Montalembert answered his attacks by reviving the *Correspondant* (1855), in which he opposed both the fanatical party of Pius IX. and the *Syllabus,* and the more or less free-thinking Liberals of the *Revue des deux mondes.* After the promulgation by the Vatican council of the dogma of papal infallibility he would not allow himself to be seduced from obedience to the pope; he now severed his connection with Père Hyacinthe (Loison) as he had with Lamennais, and made the submission expected of him to the council. He died on March 13, 1870.

Montalembert's first historical work, *La Vie de Ste Elisabeth de Hongrie* (1836), is not so much a history as a religious manifesto. His studies of monarchism in the West bore fruit in his *Moines d'occident* (1860), which was unfinished at the time of the author's death, but was completed later from some long fragments found among his papers (vols. vi. and vii., 1877).

Bibliography.—Mrs. Oliphant, *Memoir of Count de Montalembert, peer of France, deputy for the department of Doubs* (1872). Mrs. Oliphant also translated into English the work *Moines d'occident. See* also the vicomte de Meaux, *Montalembert* (1897); L. R. P. Lecanuet, *Montalembert, d'après son journal et sa correspondance* (3 vols., 1895–1902), a work filled with important documents; Léon Lefébvre, *Portraits de croyants au XIX^e siècle: Montalembert, Auguste Cochin, François Rio* (who was Montalembert's professor of philosophy), *A. Guthlin* (1905); and *Lettres d'Alphonse d'Herbelot à Charles de Montalembert et à Léon Cornudet* (1828–30).

MONTALEMBERT, MARC RENÉ, Marquis de (1714–1800), French military engineer and writer, was born at Angoulême on July 16, 1714, and entered the French army in 1732. He fought in the War of the Polish Succession on the Rhine (1733–34), and in the War of the Austrian Succession made the campaigns of 1742 in Bohemia and Italy. In the years preceding the Seven Years' War, Montalembert devoted his energies to the art of fortification, to which Vauban's *Traité de l'attaque* attracted him, and founded the arsenal at Ruelle, near his birthplace. On the outbreak of war he became French commissioner with the allied army of Sweden, with the rank of brigadier-general. He constructed the field fortifications of Anklam and Stralsund. In 1761 he was promoted *maréchal de camp,* and began the works on which his fame rests. Montalembert's fortress has been aptly described by an English author as an "immense battery." The intricacies of trace by which Vauban and Cormontaigne sought to minimize the power of the attack are abandoned in favour of a simple tenaille plan so arranged that the defenders can bring an overwhelming fire to bear on the works of the besieger.

Montalembert, who himself drew his idea from the practice of Swedish and Prussian engineers, furnished the German constructors of the early 19th century with the means of designing entrenched camps suitable to modern conditions of warfare. The "polygonal" method of fortification is the direct outcome of Montalembert's systems. In his own country the caste-spirit of the engineer corps was roused to defend Vauban, and though Montalembert was allowed to construct some successful works at Aix and Oléron, he was forbidden to publish his method, and given but little opportunity for actual building. After fifteen years of secrecy he published in Paris (1776–1778) the first edition of *La Fortification perpendiculaire.* At the time of the Revolution he emigrated for a time. After his return Carnot often called him into consultation on military affairs, and, in 1792, promoted him general of division. He died in Paris on March 29, 1800. His wife, Marie Josephine de Comarieu, was the hostess of one of the best-known *salons* of Louis XVI.'s time. He withdrew his candidature to the *Institut* in favour of General Buonaparte.

Besides his masterpiece, he wrote *L'Art défensive supérieure à l'offensif* (1793; in reply to attacks made upon his earliest work, *La Fortification perpendiculaire,* of which in later editions it forms part); *Mémoire historique sur le fonte des canons* (Paris, 1758), and other works on the same subject; *Correspondance pendant la guerre de 1757–1760* (London, 1777); *Rotation des boulets* (Acad., 1755); and *Rélations du siège de S. Jean d'Acre* (Paris, 1789). *See* Tripier, *La Fortification déduite de son histoire* (Paris, 1866).

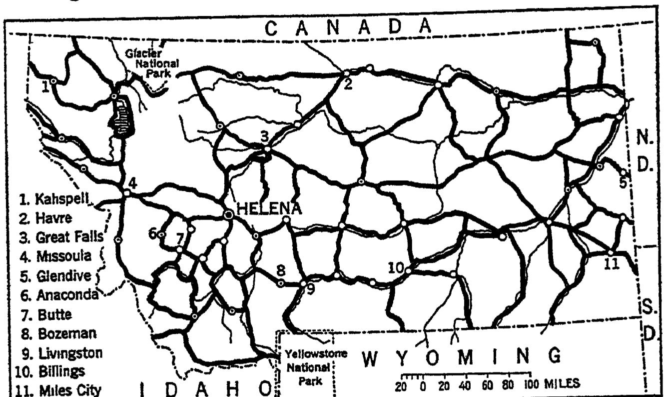
MONTANA (5,120 ft.), a village in the canton of Valais, Switzerland, at the south foot of the Bernese Alps. It is connected with Sierre (on the Simplon line) by a funicular railway. It is a health resort and tourist centre and has 791 inhabitants.

MONTANA, the "Treasure State," is situated in the north-western part of the United States of America between lat. 44° 26′ and 49° N. and long. 104° and 116° W. of Greenwich. It is bounded north by the Canadian provinces of British Columbia, Alberta and Saskatchewan; east by North Dakota and South Dakota; south by Wyoming and Idaho; west by Idaho. In size it ranks third among the States of the Union, having a land area of 146,131 sq.m. and a water area of 866 sq. miles. Its greatest length is 556 m., and its width is about one-half as much. The Territory was organized in 1864, and admitted to the Union in 1889. Its name, given to it by James M. Ashley, who sponsored the bill for its territorial organization, means "mountainous regions."

Physical Features.—The Rocky Mountains cross the State from north-west to south-east, and with their spurs and outlying ranges occupy two-fifths of its area in the west and south-west;

the remaining portion is occupied chiefly by the Great Plains. The continental divide follows the boundary line between Montana and Idaho west and north-west from Yellowstone Park in Wyoming to Ravalli county, then turns southeast through Deer Lodge and Silver Bow counties, then northward to Lewis and Clark county, and from there extends north-north-west into Canada.

The great Bitter Root range of mountains, formed by a great



MAP SHOWING THE MAIN ROADS OF MONTANA

fault, rises abruptly from the Bitter Root basin, and between its long rocky ridges with peaked or saw-toothed crest lines glaciers have cut canyons with high and often precipitous walls. North beyond the Bitter Root mountains is the Cabinet range, and in the extreme north-west are the Kootenai mountains. East of Flathead lake the Mission range rises sheer from the valley floor to sharp magnificent peaks. Between these ranges are broad valleys whose waters flow by the Clark's fork of the Columbia to the Pacific ocean. The north branch of the Clark's fork, the Flathead river, gathers its waters from the Swan and Mission ranges and the western slope of the main range, and flowing south through Flathead lake, the largest in the State, joins the Missoula in Paradise valley to form the Clark's fork. The Missoula comes from the south-east, where, near the town of Missoula, it is formed by the union of the Bitter Root, draining the Bitter Root valley from the south, and the Hell Gate coming down through Hell Gate pass from Deer Lodge valley to the eastward. Through the latter valley the transcontinental lines of the Northern Pacific and Chicago, Milwaukee and St. Paul railways are built. The continental divide contains peaks more than 10,000 ft. in altitude, but in general it is low, with several passes less than 6,000 feet. Along this divide, just south of the Canadian border, and embracing spurs of the divide with a total area of 915,000 ac., is Glacier National park, containing some of the most rugged scenery in the United States. Deep between the precipitous mountains are long, narrow mountain lakes, fed by glaciers hung on the shoulders of the peaks above them. The State also contains one of the favourite entrances to Yellowstone Park. Just north of Yellowstone Park are the Absarokas and Beartooth ranges, the latter containing Granite peak (12,850 ft.), the highest elevation in the State.

The Great Plains slope from about 4,000 ft. above the sea at the foothills of the mountains to 2,000 ft. in the north-east section of the State. Rising from them like islands are a number of isolated mountain groups, such as the Highwoods, Bear Paws, Little Rockies, Big Snowy mountains and well named Sweet Grass hills. The valleys of the principal streams are deeply eroded, and in their bottom lands contain a black clayey loam, making excellent farm lands which can be irrigated. Between the valley floor and the dry bench lands a fringe of steep bluffs with intersecting coulées is found. The bench lands usually have a thick layer of sandy loam resting on gravel, and it is here that the so-called "dry-land farming" of the State is done. With the exception of a small part of Glacier park and Teton county, which is drained by the Belly and St. Mary's rivers into Hudson bay, the State east of the divide is drained by the Missouri river and its tributaries into the Gulf of Mexico. The Missouri is formed by a union of the Jefferson, Madison and Gallatin rivers. Flowing north from Three Forks, it is joined from the west by the Sun and Teton rivers, and from the north-west by the Marias river. Turning then to the eastward and flowing across the State, it is joined from the south by the Judith and the Musselshell and from the north by the Milk rivers. Finally, just beyond the eastern boundary, it is joined by the Yellowstone, which with its tributaries, the Big Horn, Powder and Tongue rivers, drains the whole southeastern quarter of the State. The channel of the Missouri is generally erratic and its bed sandy and shifting. Its waters are muddy. The Yellowstone, in contrast, is a stream of bright, clear water running over a gravelly bed.

The average altitude of Montana is 3,400 ft., with more than one-half of the State lying under 3,000 feet. This low average, much lower than that of any other Rocky mountain State, to some extent offsets its northern position and tempers the climate.

Climate.—In the west the climate is generally delightful, it being there greatly affected by the warm, dry "Chinook" wind which blows from the Pacific ocean; to some extent the wind modifies the temperature nearly to the eastern border.

The mean annual temperature ranges from 37° in the north-east to 47° in the sheltered valleys among the mountains. The amount of precipitation is greater in the north-west and on the mountains which, standing in isolated groups upon the plains, are frequently in summer the focus of local thunder showers. The average annual precipitation ranges from 10 to 15 in. on the Great Plains to 20 in. or more in the north-west and in limited areas in the higher mountain region. Nearly one-half of the rain falls during the four months from May to August inclusive.

Fauna.—The buffalo, or bison, which formerly ranged the plains in large herds, were almost exterminated, but were represented by a herd of 459 animals (1923) on the national bison range of 20,000 ac. in western Montana. Moose and elk are found only occasionally in the wilder regions; mountain sheep, antelopes, black and grizzly bears, wolves, pumas and lynx are also becoming rare. Black-tailed and mule deer are still favourite game for sportsmen. Geese, ducks and grouse are numerous. Trout, salmon, grayling and whitefish inhabit many of the lakes, rivers and mountain streams, and a Government fish hatchery at Bozeman, Gallatin county, restocks depleted waters.

Flora.—The Great Plains are covered for the most part with bunch grass only, which grows in tufts, leaving the ground visible between, and except in May and June presents a yellow and withered appearance. Mixed with the bunch grass are buffalo grass and blue-joint and occasional patches of sagebrush. The bluffs along the principal river valleys, especially those in the south-east, are bare, but on the bottom lands along the rivers and streams considerable patches of cottonwood and willows are common. On the higher parts of the mountains are barren rocks where the growth of timber is scant; but many of the lower mountain slopes, especially those along the western border, are clothed with heavy timber, chiefly yellow pine, red fir and tamarack.

Government.—The State is governed under a constitution adopted in 1889. To amend this constitution an affirmative vote of two-thirds of the members of each house of the legislature is required, followed by an affirmative vote of a majority of the electors voting thereon at the next general election; or, as an alternative method, by a like vote of each house of the legislature and of the electorate, a convention may be called to revise or amend it, a revision or amendment in this manner requiring the ratification of the electorate not less than two months nor more than six months after the adjournment of the convention.

The officers of the executive department are the governor, lieutenant-governor, secretary of State, attorney-general, treasurer, auditor and superintendent of public instruction, each of whom is elected for a term of four years. The governor, with the advice and consent of the senate, appoints various administrative officers, the more important being the register of lands, the State forester, the State engineer, the dairy commissioner, the commissioner of labor and industry, and the mine inspectors. He may veto any bill passed by the assembly, or in the case of a bill making appropriations of money he may veto any item of it, and no bill or item of an appropriation which he vetoes within five days (Sunday excepted) after it has been presented to him can become a law or a part of a law unless passed over his veto in

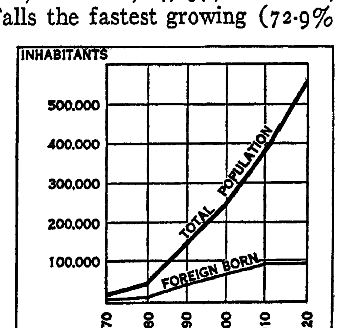
each house by a two-thirds vote of the members present.

The legislature consists of a senate and a house of representatives, meeting regularly on the first Monday of January in odd-numbered years only. Senators are elected, one from each county, for a term of four years; representatives are elected, one or more from each county according to population, for a term of two years. The senators in 1927 numbered 56, and the representatives 102. The action of the legislature is much restricted by the Constitution, a long list of cases being named in which that body is prohibited from passing any local or special laws. In 1906 an amendment to the State Constitution authorized a limited initiative and referendum. The administration of justice is entrusted to a supreme court, 18 district courts, and at least two justices' courts in each organized township, besides police and municipal courts. The supreme court is composed of a chief justice and four associate justices elected for a term of six years. It holds four sessions a year at Helena and has limited original and plenary appellate jurisdiction. For most district courts there is only one judge, but for the more populous districts there are two judges; they are all elected for four years. Montana has two representatives in the U.S. Congress, elected from two separate districts.

Population.—In 1920 Montana's population was 548,889; in 1910, 376,053; and in 1900, 243,329. Between 1900 and 1910 the increase was 54·5%; between 1910 and 1920, 46%. An average of estimates by four different methods made by the State bureau of vital statistics gives 520,148 for 1925, a decrease of nearly 30,000 since 1920. There were 42,626 fewer people on farms, and 10,781 fewer farms than in 1920. By 1930 conditions had improved but the population was 537,606, a loss of 11,283.

In 1910 there were 226,872 males and 149,181 females; in 1920, 299,941 males and 248,948 females. Of the total population 97·3% are white, 2% Indian and the rest negro and oriental. The Indian population in 1920 was 12,374, an increase of 2,298 over 1910. The Indians belonged to the Blackfeet, Crow, Salish (Flathead), Sioux, Assiniboine, Gros Ventres and Northern Cheyenne tribes. The reservations on which they formerly lived have been broken up and the land allotted to individual members of the tribes.

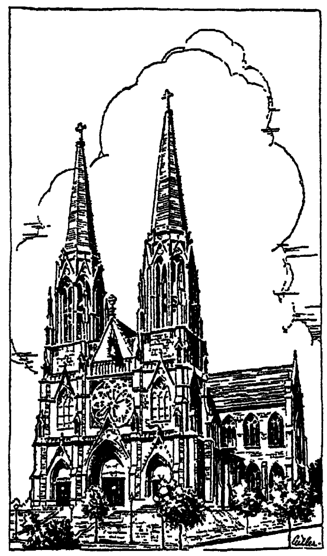
In 1920, 93,620 were foreign born, 101,918 born of foreign parents, and 62,919 of mixed foreign-born and native parentage. The largest groups of foreign born were 20,131 from Scandinavian countries, 19,577 from the United Kingdom, 7,875 from Germany and 5,203 from Russia. The urban population in 1920 was 172,011 or 31·3%; the rural 376,878 or 68·7%. There were six cities in 1930 with a population of 10,000 or more; Butte, 39,532; Great Falls, 28,822; Billings, 16,380; Missoula, 14,657; Anaconda, 12,494; Helena, 11,803. Great Falls the fastest growing (72·9% increase 1910–20), is also the youngest; it was founded in 1883.



GRAPH OF GROWTH OF POPULATION IN MONTANA, AND FOREIGN PERCENTAGE

Finance.—The State legislature biennially fixes the rate of taxes for State purposes. In 1920 the people by a referendum vote fixed the annual tax at 3½ mills for a ten-year period. Of this, 1½ mills is for the support of the four units of the State university, and the remaining 2 mills for the general State fund. In 1921 the legislature passed a small tax on oil and coal production, and in addition a tax of one cent a gallon on gasolene, which was raised to 2 cents a gallon in 1923 and to 3 cents in 1927. In 1923 an effective inheritance tax was passed. One of the chief issues of Montana's politics has been the taxation of mines and their output. The mines, in proportion to their resources, paid a not excessive share of the taxes, and the agricultural and live stock interests contributed heavily. In 1924 the people were able to pass an initiative measure providing for a graduated tax of from 0·25% to 1% of the gross product of metal mines. Half of this tax and of the inheritance tax goes to the school fund, and half to the general fund. The gasolene tax goes to the State highway commission.

The State had a bonded indebtedness in 1926 of $5,559,000, $675,000 of which were capital building bonds, and the remainder educational bonds. The assessed valuation of all the taxable property in the State in 1926 was $1,376,623,060, and the taxable valuation $435,510,159. On this valuation $1,946,032 was levied for State purposes, $9,502,456 for county purposes, $10,555,556 for school purposes and $3,413,404 for city and town purposes, making a grand total of $26,380,466.


BY COURTESY OF THE CHAMBER OF COMMERCE, HELENA
ST. HELENA CATHEDRAL, HELENA

In 1925 there were 235 banks in the State, 85 of them national banks. Their total resources or liabilities were $160,583,000; loans and discounts, $78,337,000; investments, $39,364,000; capital, surplus and undivided surplus, $18,787,000. Savings deposits were $75,541,000 in 1920, $49,111,000 in 1924 and $55,579,000 in 1925.

Education.—In 1925–1926 there were 2,883 elementary schools with an enrolment of 95,494 pupils and 192 high schools (19 of them county high schools) with an enrolment of 20,941. School revenue from all sources totalled $12,543,512, 50·79% of it coming from district taxes, 21·6% from a general 6 mill county tax, 13·6% from a county high school tax, and 13·85% from school lands and special State taxes. School expenditures for the year were $12,419,374—$7,178,599 of which was for instruction, $2,497,819 for plant operation and maintenance, and the rest for miscellaneous purposes. Of the public school income $1,091,472 came from the public school lands.

There are four State institutions of higher learning, the University of Montana at Missoula, the College of Agriculture and Mechanic Arts at Bozeman, the School of Mines at Butte, and the State Normal school at Dillon. All are under one administrative head called the chancellor. Intermountain and St. Charles colleges are in Helena.

Agriculture and Live Stock.—The types of farming best suited to the varying climate and soils of the State are yet to be determined. For a long time it was believed that only in the mountain valleys could crops be grown without irrigation, and before 1890 the farming was done there. Between then and 1905 expansion was chiefly on irrigated land, and since 1905 it has been on dry lands. In 1923, 90% of the wheat, 80% of the oats, ⅘ of the barley and most of the maize were grown on dry lands. On irrigated land the acreage and the value of tame and wild hay exceeded those of all other crops. Sugar beets were grown only on irrigated land. The first irrigation consisted of crude private ditches direct from the mountain streams to the land, and land situated in a position to be thus watered was the first to be settled. A number of the modern developments are Federal undertakings, notably the Huntley project in Yellowstone county, the Lower Milk river project, the Sun river project, and the Lower Yellowstone project. In 1920, 10,807 farms had 1,681,729 ac. actually under irrigation or 10·5% of the irrigated land of the United States. Capital invested in irrigation totalled $52,143,363 or $18.94 an acre. The average cost per acre for operation and maintenance in 1919 was $1.26, while the average gross value per acre of all crops grown on irrigated land was $35.03, as against $18.30 per acre for all land cropped in the State.

The acreage of farm land jumped from 13,546,000 in 1910 to 35,071,000 in 1920, and in 1925 back to 32,740,000. The number of farms decreased from 57,677 in 1920 to 46,906 in 1925. In the same period the average size per farm increased from 608·1 ac. to 698 ac., showing that live stock ranches were again absorb-

ing the homesteads. In 1920 the value of farm land was $691,912,000, in 1925 $387,090,000. The farms mortgaged were 20·6% in 1910, and 59·5% in 1920. The figures reveal the crisis which agriculture has passed through in recent years. In 1925, wheat to the value of $48,243,000 was raised ($16,000,000 less than in 1924), with a crop value per acre of $14.98; oats to the value of $7,608,000 ($11.92 per acre); corn $6,255,000 ($15.68 per acre); potatoes $6,048,000 ($172 per acre); and barley $2,359,000 ($15.12 per acre). The total value of all crops was $161,700,000 in 1927, compared with $136,984,000 in 1924 and $89,872,000 for the 1919–23 average. Indian corn has made the most rapid proportional increase. Most of it is used for silage and roughage, but certain varieties have been acclimated so that they mature. Rye, barley and oats are also increasing in acreage and are consumed mainly on the farm as feed. The quality of wheat is superior to that of any other State. In 1922 84% of the crop was officially estimated as grade No. 1, and for the three-year period 1920–22, 74·4% fell into the same class.

In 1919, cattle shipments reached a new peak of 641,337 head. Part of that year's immense shipment was the result of a severe drought. That and a still more severe winter following and the general deflation of prices constituted a series of blows from which stockmen have been slow to recover. Dairying has made steady progress. In 1920 sheep suffered from the same reverses as cattle, but recovered sooner because of a sharp increase in wool and lamb prices in 1922. In 1925, the wool clip was 20,871,000 lb. and the average weight of fleece 8·7 lb., compared with an average of 7·6 lb. for the country as a whole. Horses, the source of a large share of the State's live stock income between the years 1898 and 1918, are no longer in active demand. Swine have proved very profitable. Montana farms are also raising more poultry than ever before, especially turkeys.

Mining.—Next in importance to agriculture is the mining industry. In 1919 it employed 16,129 men and paid $25,724,000 in wages. For the same year the value of the State's mineral output was $49,924,000, while in 1925 it was $79,261,284. Copper is now the leading mineral, representing about 60% of the value of the State's metal production. The output in 1925 was 268,910,847 lb., valued at $38,185,340; in 1926, 257,271,936 lb., valued at about $36,000,000. The whole output is from a limited district of several square miles in Butte. Since operations began in the early '80s, this area has produced 27% of the copper production of the nation. The Anaconda Copper Co., the largest organization in 1928 for mining, smelting, refining and fabricating copper, with a capital stock of $150,000,000, has its principal mines here. At Anaconda is located one of the largest non-ferrous smelters in the world, which treated 2,882,903 tons of copper ore and 478,993 tons of zinc ore in 1926. The political life of Montana has been strongly influenced by the copper industry. Montana ranks in second place among the States in production of silver, the amount in 1925 having been 13,158,191 troy oz., valued at $9,131,784. Most of it is recovered as a by-product in refining the copper and zinc ores of the Butte district. In 1916 an electrolytic process was devised whereby zinc ores, before considered only a detriment in the refining of copper, could be reduced on a paying basis. Zinc now rivals silver for second place in importance and bids fair soon to exceed it. The production in 1925 amounted to 115,316,000 lb., valued at $8,764,086. The Anaconda Copper Co. in 1926 enlarged the capacity of its zinc plant at Great Falls 33⅓%. Gold is an important mineral, though also recovered incidentally in the process of smelting and refining copper and zinc. The 1925 production of 84,022 oz. was valued at $1,736,900. The greatest, best developed and most available domestic reserves of high-grade manganese ore in the Union are also in Montana. During the World War, production of this was heavy, but low-priced ore from foreign lands has since reduced the amount to about 50,000 tons annually. Montana also produces about one-half the national output of white arsenic used in fighting the boll weevil pest on cotton plants. In 1925 the State ranked sixth in the production of lead, with an output of 37,530,000 pounds. Coal is found in almost every part of the State, the reserves of the State being estimated by the U.S. geological survey to contain 409,000,000,000 tons or 11·5% of the total coal reserves of the nation. The coal includes 381,000,000,000 tons of lignite. Annual production of coal averages about 3,000,000 tons. Much is used in the State by the railway, mining and manufacturing industries. The manufacture of the lignite into briquettes has opened a way to the utilization of these valuable deposits commercially. On Yogo creek in the Judith basin is a sapphire mine that produces one-half of the national output in precious stones. The quality of the blue sapphires is unexcelled by those of any other district in the world. Since the mine was opened in 1898, it has produced gems worth about $12,000,000. Oil was discovered in commercial quantities in 1919. The production for 1926 was 7,645,000 bbl., valued at $11,800,000.

Lumbering.—The timber stand in Montana was estimated in 1925 at 54,000,000,000 board ft. (9,598,000,000 yellow pine, 21,987,000,000 Douglas fir and larch, 941,000,000 white pine, 21,474,000,000 others, including lodgepole). Of this stand, national forests contain 38,000,000,000 board ft.; State forests 2,000,000,000 board ft.; and private forests, 14,000,000,000 board feet. The rate of cutting in 1923–27 was about 400,000,000 board ft. annually. Destruction by fire has averaged 187,644,000 board ft. or 102,878 ac. annually. In contrast the annual growth estimate is 859,000,000 board feet. In 1922 there were 141 active sawmills in the State cutting approximately 400,000,000 board ft., the lumber representing a value of approximately $10,000,000.

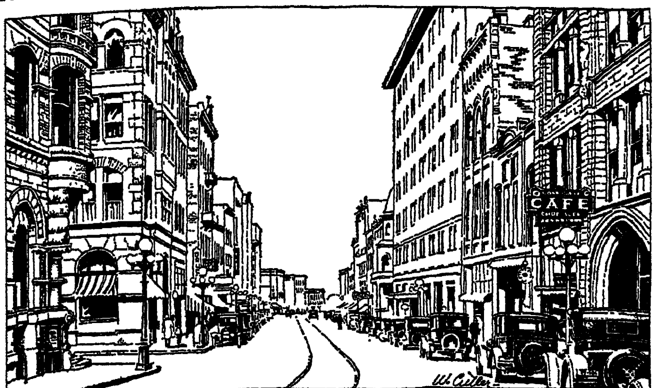
Manufactures.—The vast supplies of water-power in Montana give hopes of great industrial development. The hydro-electric plants in 1923 had a capacity of 400,000 h.p., an increase of 120,000 in three years. Much of this was used for the operation of electric trains. The potential hydro-electric development is estimated at 4,000,000 horse-power. In 1920 Congress passed a bill authorizing the secretary of the interior to lease the undeveloped power sites, and the completion of the developments will add greatly to the electric power available. In 1909 the total value of manufactures was $73,000,000; in 1925 it had increased to $205,474,257. In 1920 there were 195 lumber mills, 75 flour mills, 31 creameries, seven cheese factories and two canning factories.

Transportation.—Montana is served by three transcontinental railways: the Great Northern traversing the north; the Northern Pacific traversing the south; and the Chicago, Milwaukee and St. Paul paralleling the Northern Pacific through the mountains, but running north of it for the most part across the plains. At Butte the Oregon Short Line from Utah connects with all three, and at Billings the Burlington from Wyoming and the southeast with the Northern Pacific and the Great Northern. Three transcontinental highways cross the State, the Roosevelt highway in the north and the Yellowstone and National Park highways in the south. There were 7,957 m. of State highway in 1924, of which 7,237 were unsurfaced. Expenditures by the State highway department in 1924 (including Federal aid) were $1,788,000.

History.—That part of Montana lying east of the continental divide became a part of the United States with the purchase of Louisiana from France in 1803. The smaller region west of the divide belonged to the Oregon country, which was held jointly by the United States and Great Britain until the treaty in 1846 gave the United States sole title south of the 49th degree of latitude.

Montana may have been seen by white men as early as 1742, depending on whether the "high," "well-wooded" mountains reached by the expedition under Pierre and Chevalier de la Verendrye, French traders from Canada, were the Big Horn range, the Laramie range or the Black Hills. The next exploration was by the Lewis and Clark Expedition, which reached the eastern borders of the State in April 1805. They ascended the Missouri to the confluence of the three streams that form it, which they named the Jefferson, Madison and Gallatin rivers. Ascending the Jefferson, they crossed the divide to the Bitter Root valley, which they descended until Lo Lo Pass gave them an opportunity to go beyond the Bitter Root range into Idaho. On their return they re-entered Montana by the same pass and then divided their party. Lewis led one division up the Big Blackfoot river and crossed by Lewis and Clark pass to the Missouri near Great Falls. Clark,

with the other division, ascended the Bitter Root and, crossing the headwaters of the Missouri, reached the Yellowstone, which he was the first to explore. The parties met again at the confluence of the Yellowstone and Missouri. The reports of this expedition stimulated the Missouri fur traders to extend their operations into the region. Manuel Lisa in 1807 built a trading post on the Yellowstone at the mouth of the Big Horn river, the first building



BY COURTESY OF THE CHAMBER OF COMMERCE, HELENA

MAIN STREET, FORMERLY "LAST CHANCE GULCH," IN HELENA, MONTANA

in Montana. The same year one of his men, John Colter, losing the trail in the upper Yellowstone country, discovered the future Yellowstone Park. After 1807 Lisa's traders made annual trips into the region. West of the divide David Thompson, of the North-West Company, explored the Kootenai river in 1808; the same autumn he sent Finan McDonald to build a trading house at Kootenai Falls, the first building on the western slopes of the State. Thompson himself built Salish House, a more permanent post, on Clark's Fork the following year. For the next half century the fur trade dominated the region. That on the eastern slope was soon monopolized by the American Fur Company. Kenneth McKenzie was put in charge of the "Upper Missouri Outfit" of this company in 1827, and from Ft. Union, which he built in 1829 near the confluence of the Missouri and Yellowstone rivers, he ruled the traders and Indians of the vast territory. The trade west of the divide was controlled by British interests.

Iroquois Indians, employed by the fur companies to teach the mountain Indians to hunt for furs, taught them also the Catholic religion. The Salish Indians sent four separate delegations to St. Louis to bring back the "Black Robes," and Father P. J. De Smet returned with the last of these in 1840. In 1841 he founded St. Mary's Mission in the Bitter Root valley.

A number of settlers trickled into the Bitter Root valley between 1850 and 1860, but the real rush of immigration came only when gold was discovered. The first strike was made in 1858 on Gold creek by James and Granville Stuart, and in 1861 and 1862 a little colony of pioneers was panning the sands of the stream. The latter year saw a richer strike made on Grasshopper creek, in the Beaverhead country, where Bannack sprang up, the liveliest town in the region in 1863. Also in 1863 gold was discovered in Alder Gulch, one of the richest placer areas the world has known, where Virginia City grew up and soon outdistanced all its rivals. At Virginia City in 1864 the first newspaper, *The Montana Post,* appeared. The same year Last Chance Gulch, the site of the future capital city of Helena, was discovered. And finally, in that year Montana was organized as a separate Territory, Sidney Edgerton was appointed its first governor, and the first legislature met at Bannack.

New placer discoveries were constantly made during the next few decades of Montana's history until there were camps in hundreds of gulches. By 1876 gold to the value of $144,400,000 was produced. Metalliferous quartz was discovered at Helena, Philipsburg and Butte, at the last two places containing silver veins. The Philipsburg district was especially prosperous until the decline of silver values forced many of the mines to close. Not until the early '80s was the copper discovery made at Butte which was to result in the place becoming one of the world's greatest mining camps. The large influx of miners brought difficulties with the Indians. It had been to the interest of the fur traders and the missionaries to keep peace with and among the various tribes, but no such mutual benefit relations existed between the Indians and the gold hunters. The Sioux and Cheyennes united in trying to prevent immigrants from passing over the Bozeman trail, and this important short cut to Montana from the Platte had to be closed by the Government. The Sioux were again on the war-path in 1876, because the miners had invaded their Black Hills reserve, and that year they annihilated Gen. Custer's five companies of cavalry on the Little Big Horn river. So many of the Indians were killed, however, that their power was broken. The Government began to make treaties with the different tribes, in which the boundaries of the Indian country were carefully defined; the Indians were ordered to stay on these reservations. The last disturbance came in 1877 when Chief Joseph of the Nez Percés refused to stay on the reservation and attempted to escape with his followers into Canada. After giving desperate battle in the Big Hole country and conducting a masterly retreat over more than 1,000 m., he was surrounded in the Bear Paw mountains, and was forced to surrender to Gen. Miles.

During all these years the eastern three-fifths of the State was unsettled, and settlement came only when agriculture and the live stock industry began to expand eastward. The first stock and the first crops were raised near the mines and sold to the mining camps. Prices were high, and disappointed miners found the production of food a lucrative business. The first drive of cattle from Texas to Montana was made in 1869. The first rail shipments were trailed from western Montana to the Union Pacific at Ogden, Utah. After the Indians were quieted in 1877, most of the shipments were driven to Cheyenne, Wyo. The completion of the Northern Pacific railway through the State (1879–83) immensely stimulated the cattle industry. In 1885, 79,089 head were shipped to market; in 1891, 250,000 head; and from then to 1912, the shipments amounted to more than 200,000 head annually. Sheep raising was developed in Montana even before the cattle industry, because it was not so dependent upon transportation. Large quantities of wool were shipped by flatboat down the Missouri and Mississippi rivers to New Orleans and thence by steamer to Boston. Sheep increased from 4,212 in 1870 to 249,978 by 1880, to 1,990,000 in 1890, and to 6,170,000 in 1900, when the wool clip of Montana exceeded that of any other State. In the first decade of the present century the encroachment of the homesteaders began to be felt by the stockmen, many of whom sold out as agricultural development increased land values.

Before 1890 the comparatively little farming was subsidiary to the live stock industry. Farming was developed first in the Bitter Root and Gallatin valleys. By 1880 it showed a tendency to creep eastward into the Judith basin and down the Yellowstone. Oats were the chief crop, the stage lines and military posts affording a home market for it. The construction of the Northern Pacific extended the area of rural settlement eastward along the Yellowstone as far as Glendive. Wheat could now be raised for shipment. Farms increased from 1,519 in 1880 to 5,603 in 1890 and to 13,370 in 1900, when there were 1,736,701 ac. of improved land. Over one-half of this acreage was irrigated, while in 1920 only 15% of the 11,007,278 ac. of improved land were irrigated. This shows the tremendous influx of dry-land homesteaders in the two decades. In 1900 little farming was done in eastern Montana except in the Yellowstone and Milk river valleys; but by 1910 the bench lands back of the river valleys were being settled, and between 1910 and 1920 every eastern county in the State, except Cascade, showed an increase in rural population of 50% or over. By 1920, 37.5% of the State's total area was devoted to farms.

From the beginning of Statehood (1889) up to 1928 Montana has had only two Republican governors, Richards (1893–97) and Dixon (1921–25). In presidential elections the State has fluctuated between the Democrats and Republicans (five times Republican and four times Democrat).

Bibliography.—The important State publications are the *Biennial Reports* of the superintendent of public instruction, the register of State lands, the State forester, the State board of health, and the State board of equalization; the *Annual Reports* of the State treasurer and the agricultural experiment station; the publications of the depart-

ments of agriculture, labour and industry; the *Bulletins* of the agricultural experiment station; the *Montana Farm News;* the University of Montana *Bulletins* (including the bureau of mines and metallurgy series); and the *Contributions to the Historical Society of Montana* (1873–1923). H. F. Sanders, *History of Montana* (1913); K. H. Fogarty, *The Story of Montana* (1916); and Tom Stout, *Montana, Its Story and Biography* (1921) are the best general histories. *See* also T. J. Dimsdale, *The Vigilantes of Montana* (1866); H. M. Chittenden, *History of the American Fur Trade of the Far West* (1902); A. L. Stone, *Following Old Trails* (1913); and G. Stuart, *Forty Years on the Frontier* (1925). (T. J. W.)

MONTANELLI, GIUSEPPE (1813–1862), Italian statesman and author, was born at Fucecchio in Tuscany, and in 1840 was appointed law professor at Pisa. In 1847 he founded a newspaper called *L'Italia,* the programme of which was "Reform and Nationality." In 1848 he formed a ministry at Leopold's invitation, and on Jan. 10, 1849, induced the grand duke to establish a national constituent assembly. But Leopold, alarmed, fled from Florence, and Montanelli, Guerrazzi and Mazzini were elected "triumvirs" of Tuscany. Like Mazzini, Montanelli advocated the union of Tuscany with Rome. But after the restoration of the grand duke, Montanelli, who was in Paris, was tried and condemned by default; he remained some years in France, where he became a partisan of Napoleon III. On the formation of the kingdom of Italy he returned to Tuscany and was elected member of parliament; he died in 1862.

His most important literary work is his *Memorie sull' Italia e specialmente sulla Toscana dal 1814 al 1850,* in 2 vols. (Turin, 1853).

See Assunta Marradi, *G. Toscanelli e la Toscana dal 1815 al 1862* (1909).

MONTAÑES, JUAN MARTINEZ (*c.* 1580–1649), Spanish sculptor, was born at Alcala-la-real, in the province of Granada. His master was Pablo de Roxas, his first known work (1607) being a boy Christ, now in the sacristy of the *capella antigua* in the cathedral of Seville. The great altar at Santiponce near Seville was completed in 1812. Montañes executed most of his sculpture in wood, covered with a surface of polished gold, and coloured. Other works were the great altars at Santa Clara in Seville and at San Miguel in Jerez, the Conception and the realistic figure of Christ crucified, in the Seville cathedral; the figure of St. John the Baptist, and the St. Bruno (1620); a tomb for Don Perez de Guzman and his wife (1619); the St. Ignatius and the St. Francis of Borja in the university church of Seville. Montañes died in 1649. His works are more realistic than imaginative, but this, allied with an impeccable taste, produced remarkable results. The equestrian statue of King Philip IV., cast in bronze by Pietro Tacca in Florence and now in Madrid, was modelled by Montañes. He had many imitators, his son Alonzo Martiñez, who died in 1668, being among them.

See B. Haendeke, *Studien zur Geschichte der spanischen Plastik* (Strasburg, 1900); F. Gómez, *Historia de la escultura en España* (Madrid, 1885).

MONTANISM, a somewhat misleading name for the movement in the 2nd century which, along with Gnosticism, occupied the most critical period in the history of the Early Church. It was the overthrow of Gnosticism and Montanism that made the "Catholic" Church. In this article an account will be given of the general significance of Montanism in relation to the history of the Church in the 2nd century, followed by a sketch of its origin, development and decline.

1. From the middle of the 2nd century a change began to take place in the outward circumstances of Christianity. The Christian faith had hitherto been maintained in a few small congregations scattered over the Roman empire. These congregations were provided with only the most indispensable constitutional forms. This state of things passed away. The Churches soon found numbers within their pale who stood in need of supervision, instruction and regular control. The enthusiasm for a life of holiness and separation from the world no longer swayed all minds. In many cases sober convictions or submissive assent took the place of spontaneous enthusiasm. Then, in addition to this, Christians were already found in all ranks and occupations—in the Imperial palace, among the officials, in the abodes of labour and the halls of learning, amongst slaves and freemen. Should the Church take the decisive step into the world, conform to its customs, and acknowledge as far as possible its authorities? Or ought she, on the other hand, to remain a society of religious devotees, separated and shut out from the world? That this was the question at issue is obvious enough now, although it could not be clearly perceived at the time. It was natural that warning voices should then be raised in the Church against secular tendencies and that the well-known counsels about the imitation of Christ should be held up in their literal strictness before worldly Christians. The Church as a whole, however, under pressure of circumstances rather than by a spontaneous impulse, decided otherwise. She marched through the open door into the Roman state, and settled down there to Christianize the state by imparting to it the word of the Gospel, but at the same time leaving it everything except its gods. On the other hand, she furnished herself with everything of value that could be taken over from the world without overstraining the elastic structure of the organization which she now adopted. With the aid of its philosophy she created her new Christian theology; its polity furnished her with the most exact constitutional forms; its jurisprudence, its trade and commerce, its art and industry, were all taken into her service; and she contrived to borrow some hints even from its religious worship. With this equipment she undertook, and carried through, a world-mission on a grand scale. But believers of the old school protested in the name of the Gospel against this secular Church. They joined an enthusiastic movement which had originated in a remote province, and had at first merely local importance. There, in Phrygia, under the leadership of a prophet known as Montanus, the cry for a strict Christian life was reinforced by the belief in a new and final outpouring of the Spirit—a coincidence which has been observed elsewhere in Church history—as, for instance, among the early Quakers and in the Irvingite movement. These zealots surrendered themselves to this guidance. In so doing, however, they had to withdraw from the Church, to be known as "Montanists," or "Kataphrygians," and thus to assume the character of a "heresy." Their enthusiasm and their prophesyings were denounced as demoniacal; their expectation of a glorious earthly kingdom of Christ was stigmatized as Jewish, their passion for martyrdom as vainglorious and their whole conduct as hypocritical. Nor did they escape the more serious imputation of heresy on important articles of faith; indeed, there was a disposition to put them on the same level with the Gnostics. The effect on themselves was what usually follows in such circumstances. After their separation from the Church, they became narrower and pettier in their conception of Christianity. Their asceticism degenerated into legalism, their claim to a monopoly of pure Christianity made them arrogant.

2. Such is, in brief, the position occupied by Montanism in the history of the ancient Church. The rise and progress of the movement were as follows.

At the close of the reign of Antoninus Pius—probably in the year 156 (Epiphanius)—Montanus appeared at Ardabau in Mysia, near the Phrygian border, bringing revelations of the "Spirit" to Christendom. The burden of the new prophecy seems to have been a new standard of moral obligations, especially with regard to marriage, fasting and martyrdom. But Montanus had larger schemes in view. He wished to organize a special community of true Christians to wait for the coming of the Lord. The small Phrygian towns of Pepuza and Tymion were selected as the headquarters of his church. Funds were raised for the new organization, and from these the leader and missionaries, who were to have nothing to do with worldly life, drew their pay. Two women, Prisca and Maximilla, were moved by the Spirit; like Montanus, they uttered in a state of frenzy the commands of the Spirit, which urged men to a strict and holy life.

For twenty years this agitation appears to have been confined to Phrygia and the neighbouring provinces. But after the year 177 a persecution of Christians broke out simultaneously in many provinces of the Empire. Like every other persecution it was regarded as the beginning of the end. It would seem that before

this time Montanus had disappeared from the scene; but Maximilla, and probably also Prisca, were working with redoubled energy. And now, throughout the provinces of Asia Minor, in Rome, and even in Gaul, amidst the raging of persecution, attention was attracted to this remarkable movement. The desire for a sharper exercise of discipline, and a more decided renunciation of the world, combined with a craving for some plain indication of the Divine will in these last critical times, had prepared many minds for an eager acceptance of the tidings from Phrygia. And thus, within the large congregations where there was so much that was open to censure in doctrine and constitution and morals, conventicles were formed in order that Christians might prepare themselves by strict discipline for the day of the Lord. As a rule, the bishops were resolute enemies of the Montanistic enthusiasm. It disturbed the peace and order of the congregations, and threatened their safety. Moreover, it made demands on individual Christians such as very few could comply with.

Early in the last decade of the 2nd century two considerable works appeared in Asia Minor against the Kataphrygians. The first, by a bishop or presbyter whose name is not known, was written apparently about the year 193. The other was written by a certain Apollonius forty years after the appearance of Montanus, consequently about 196. From these treatises we learn that the adherents of the new prophecy were very numerous in Phrygia, Asia and Galatia (Ancyra), that they had tried to defend themselves in writing from the charges brought against them, that they possessed a fully developed independent organization, that they boasted of many martyrs, and that they were still formidable to the Church in Asia Minor. Many of the small congregations had gone completely over to Montanism, although in large towns, like Ephesus, the opposite party maintained the ascendancy. Every bond of intercourse was broken, and in the Catholic Churches the worst calumnies were retailed about the deceased prophets and the leaders of the societies they had founded. In many Churches outside of Asia Minor a different state of matters prevailed. Those who accepted the message of the new prophecy did not at once leave the Catholic Church in a body. They simply formed small conventicles within the Church. Such, for example, appears to have been the case in Carthage (if we may judge from the Acts of the martyrs Perpetua and Felicitas) at the commencement of the persecution of Septimius Severus about the year 202. But even here it was impossible that an open rupture should be indefinitely postponed. The bishops and their flocks gave offence to the Montanists on so many points that at last it could be endured no longer. The latter wished for more fasting, the prohibition of second marriages, a frank, courageous profession of Christianity in daily life, and entire separation from the world; the bishops, on the other hand, sought to make it as easy as possible to be a Christian, lest they should lose the greater part of their congregations. And lastly, the bishops were compelled more and more to take the control of discipline into their own hands, while the Montanists insisted that God Himself was the sole judge in the congregation. On this point especially a conflict was inevitable; and it was at this juncture that Tertullian, the most famous theologian of the West, left the Church whose cause he had so manfully upheld against pagans and heretics. He too had come to the conviction that the Church had forsaken the old paths and entered on a way that must lead to destruction.

The writings of Tertullian afford the clearest demonstration that what is called Montanism was, at any rate in Africa, a reaction against secularism in the Church. There are no other indications that Montanism in Carthage was a very different thing from the Montanism of Montanus. Western Montanism, at the beginning of the 3rd century, admitted the legitimacy of almost every point of the Catholic system. It allowed that the bishops were the successors of the apostles, that the Catholic rule of faith was a complete and authoritative exposition of Christianity, and that the New Testament was the supreme rule of the Christian life. Montanus himself and his first disciples had been in quite a different position. In his time there was no fixed, divinely instituted congregational organization, no canon of New Testament Scriptures, no anti-Gnostic theology, and no Catholic Church. There were simply certain communities of believers bound together by a common hope, and by a free organization, which might be modified to any required extent. When Montanus proposed to summon all true Christians to Pepuza, in order to live a holy life and prepare for the day of the Lord, there was nothing whatever to prevent the execution of his plan except the inertia and lukewarmness of Christendom. But this was not the case in the West at the beginning of the 3rd century. At Rome and Carthage, and in all other places where sincere Montanists were found, they were confronted by the imposing edifice of the Catholic Church, and they had neither the courage nor the inclination to undermine her sacred foundations. This explains how the later Montanism never attained a position of influence. In accepting, with slight reservations, the results of the development which the Church had undergone during the fifty years from 160 to 210 it reduced itself to the level of a sect. Tertullian exhausted the resources of dialectic in the endeavour to define and vindicate the relation of the "spiritual" to what he called the "psychic" Christians; but no one will say he has succeeded in clearing the Montanistic position of its fundamental inconsistency.

Bibliography.—Ritschl's investigations in his *Entstehung der altkatholischen Kirche,* 2nd ed. 1857, superseded previous work. The later works, of which the best and most exhaustive is that of N. Bonwetsch, *Die Geschichte des Montanismus* (1881), all follow the lines laid down by Ritschl. *See* also Gottwald, *De montanismo Tertulliani* (1862); Réville, "Tertullien et le montanisme" in the *Revue des deux mondes* (Nov. 1, 1864); Stroelin, *Essai sur le montanisme* (1870); De Soyres, *Montanism and the Primitive Church* (London, 1878); W. Cunningham, *The Churches of Asia* (London, 1880); Renan, "Les Crises du Catholicisme Naissant" in *Rev. d. deux mondes* (Feb. 15, 1881); H. Weinel, *Die Wirkungen des Geistes und der Geister im nachapostol. Zeitalter* (Freiburg, 1899); G. G. Selwyn, *The Christian Prophets* (London, 1900); and articles in Hastings' *Encyclopaedia of Religion and Ethics* and Herzog-Hauck, *Realencyklopädie.* Special points of importance in the history of Montanism have been investigated by Lipsius, Overbeck, Weizsäcker (*Theol. Lit.-Zeitung,* Nov. 4, 1882); Harnack, *Das Mönchthum, seine Ideale und seine Geschichte,* 2nd ed., 1882; Eng. trans., 1901; and *Z. f. Kirchengesch.* iii. 369–408, and H. J. Lawlor (*Journal of Theological Studies,* July 1908). Weizsäcker's short essays are extremely valuable, and have elucidated several important points previously overlooked. (A. Ha.; X.)

MONTARGIS, a town of central France, capital of an arrondissement in the department of Loiret, 47 m. E.N.E. of Orléans by rail. Pop. (1926), 12,129. Montargis was formerly the capital of the Gâtinais. Having passed in 1188 from the Courtenay family to Philip Augustus, it formed part of the royal domain. In 1528 Francis I. gave it as dowry to Renée d'Este, daughter of Louis XII., the famous Huguenot princess; from her it passed to her daughter Anne, and through her to the dukes of Guise; it was repurchased for the Crown in 1612. From 1626 till the Revolution the territory was the property of the house of Orléans. Montargis is particularly noted for its successful defence against the English in 1427. Both Charles VII. and Charles VIII. held court in the town.

The town is traversed by the Vernisson, by numerous arms of the Loing, and by the Briare canal, which unites with the canal of Orléans a little below it. It has a church (Ste. Madeleine), dating in part from the 12th century and including a Renaissance choir, and still preserves portions of its castle (12th to 15th centuries), which, previous to the erection of Fontainebleau, was a favourite residence of the royal family. Montargis is the seat of a sub-prefecture, and has tribunals of first instance and of commerce. It manufactures rubber, tar, asphalt, chemical manures, carriages, furniture, hosiery, boots and shoes. The town is an agricultural market, and its port has trade in coal, timber, sheep and farm produce, and skins.

MONTAUBAN, a town of south-western France, capital of Tarn-et-Garonne, 31 m. N. of Toulouse by the Southern railway. Pop. (1926) 18,346. The town stands on the right bank of the Tarn at its confluence with the Tescou. With the exception of Mont-de-Marsan, Montauban is the oldest of the *bastides* of southern France. Its foundation dates from 1144 when Alphonse Jourdain, count of Toulouse, granted it a liberal charter. The inhabitants were drawn chiefly from Montauriol, a village which

had grown up around the neighbouring monastery of St. Théodard. In the 13th century the town suffered much from the ravages of the Albigensians and from the Inquisition, but by 1317 it had recovered sufficiently to be chosen by John XXII. as the head of a diocese of which the basilica of St. Théodard became the cathedral. By the Treaty of Brétigny (1360) it was ceded to the English; but in 1414 they were expelled by the inhabitants. In 1560 the bishops and magistrates embraced Protestantism, expelled the monks, and demolished the cathedral. About ten years later it became one of the Huguenot strongholds, and formed a small independent republic. It was the headquarters of the Huguenot rebellion of 1621, and was vainly besieged by Louis XIII. for 86 days; nor did it submit until after the fall of La Rochelle in 1629, when its fortifications were destroyed by Richelieu. In the same year the plague cut off over 6,000 of its inhabitants. The Protestants again suffered persecution after the repeal of the Edict of Nantes.

A remarkable early 14th century bridge of brick connects the town with the suburb of Villebourbon. The *hôtel de ville,* 17th century with some older portions, on the site of a castle of the counts of Toulouse and once the residence of the bishops of Montauban, stands at the east end of the bridge. It contains a valuable library, and a museum including most of the work of Jean Ingres, the celebrated painter, who was born at Montauban. The Place Nationale is a square of the 17th century, entered at each corner by gateways giving access to a large open space surrounded by houses carried on double rows of arcades. The cathedral possesses the "Vow of Louis XIII.," one of the masterpieces of Ingres, and the church of St. Jacques (14th and 15th centuries) has a handsome octagonal tower. Montauban is the seat of a bishop, a prefect and a court of assize. It has tribunals of first instance and of commerce, a chamber of commerce and a board of trade arbitrators, and schools of commerce and viticulture. The commercial importance of Montauban is due rather to its trade in agricultural produce, horses, game and poultry, than to its industries, which include nursery-gardening, cloth-weaving, cloth-dressing, flour-milling, wood-sawing, and the manufacture of furniture, "swanskins," silk-gauze and straw hats. The town is a junction of the railways of the Southern and Orléans companies, and communicates with the Garonne by the Canal of Montech.

MONTAUSIER, CHARLES DE SAINTE-MAURE, Duc de (1610–1690), French soldier, was born on Oct. 6, 1610, being the second son of Léon de Sainte-Maure, baron de Montausier. His parents were Huguenots, and he was educated at the Protestant College of Sedan under Pierre du Moulin. He served brilliantly at the siege of Casale in 1630. Having served under Bernard of Saxe-Weimar in Germany in 1634 he returned to the French service in 1636, and fought in the Rhenish campaigns of the following years. He was taken prisoner at Rantzau in November 1643, and only ransomed after ten months' captivity. On his return to France he became a lieutenant-general. Montausier is famous for his courtship of Julie Lucine d'Angennes, daughter of Madame de Rambouillet, famous in the annals of French literature because of the *Guirlande de Julie,* a garland of verse consisting of madrigals by Montausier, Jean Chapelain, Guillaume Colletet, Claude de Malleville, Georges de Scudéry, Pierre Corneille (if M. Uzanne is correct in the attribution of the poems signed M.C.), Philippe Hubert, Simon Arnauld de Pomponne,[1] Jean Desmarests de Saint Sorlin, Antoine Gombaud (*le nain de la Princesse Julie*) and others. It was copied by the famous calligraphist N. Jarry in a magnificent ms., on each page of which was painted a flower, and was presented to Julie on her fête day in 1641.

Montausier had bought the governorship of Saintonge and Angoumois, and became a Roman Catholic before his marriage. The Parisian public regarded him as the original of Alceste in the *Misanthrope*. Montausier received from Louis XIV. the order of the Saint Esprit, the government of Normandy, a dukedom, and in 1668 the office of governor of the dauphin, Louis. He initiated the series of classics *Ad usum Delphini,* directed by the learned Huet, for the use of his pupil. He died on Nov. 17, 1690.

See Père Nicolas Petit, *Vie du duc de Montausier* (1729); Puget de Saint Pierre, *Histoire du duc de Montausier* (1784); Amédée Roux, *Un Misanthrope à la cour de Louis XIV. Montausier* (1860); O. Uzanne, *La Guirlande de Julie* (1875); E. Fléchier, *Oraisons funèbres du duc et de la duchesse de Montausier* (Paris, 1691); and contemporary memoirs.

[1](1618–1699), a son of Arnauld d'Andelly and minister of foreign affairs in succession to Lionne.

MONTBÉLIARD, a town of eastern France, capital of an arrondissement in the department of Doubs, 49 m. N.E. of Besançon on the P.L.M. line between that town and Belfort. Pop. (1926), 9,895. Montbéliard stands at the confluence of the Luzine and the Allaine. Forts on outlying hills connect it with Belfort on the one side and (through Blamont and the Lomont fortifications) with Besançon on the other. The castle of the counts of Montbéliard was rebuilt in 1751, but the Tour Bossue and the Tour Neuve, dating from 1425 and 1594, are preserved. Most of the inhabitants are Protestant, and the church of St. Martin, built early in the 17th century, now serves as a Protestant place of worship. The old market-hall and some old houses of the 16th century also remain. Montbéliard is the seat of a sub-prefect and has a board of trade arbitrators, a chamber of arts and manufactures and a museum of natural history.

After 1870 a considerable impetus was given to its prosperity by Alsatian immigrants. Its industries include watch and clock making and dependent trades, cotton spinning and weaving, the manufacture of hosiery, textile machinery, furniture, spare parts for motor cars, tools, nails and wire and brewing. There is commerce in wine, cheese, wood and Montbéliard cattle.

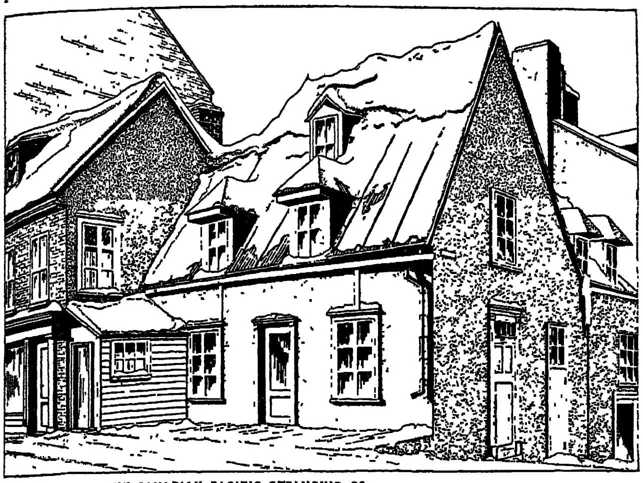
After belonging to the Burgundians and Franks, Montbéliard (*Mons Peligardi*) was, by the treaty of Verdun (843), added to Lorraine. In the 11th century it became the capital of a countship, which formed part of the second kingdom of Burgundy and latterly of the German Empire. Its German name is Mömpelgard. In 1397 it passed by marriage to the house of Württemberg, to whom it belonged till 1793. It resisted the attacks of Charles the Bold (1473), and Henry I. of Lorraine (1587 and 1588), duke of Guise, but was taken in 1676 by Marshal Luxemburg, who razed its fortifications. The tolerance of the princes of Württemberg attracted to the town at the end of the 16th century a colony of Anabaptists from Frisia. In 1793 the inhabitants voluntarily submitted to annexation by France. In 1871 the battle of the Lisaine between the French and Germans was fought in the neighbourhood and partly within the walls.

MONTBRISON, a town of east-central France, capital of an arrondissement in the department of Loire, France, 21 m. N.W. of St. Étienne, on the railway from Clermont to St. Étienne. Pop. (1926) 6,769. Montbrison belonged to the counts of Forez during the middle ages. It stands on a volcanic hill overlooking the Vizezy, a right-hand affluent of the Lignon du Nord. The principal buildings are the once collegiate church of Notre-Dame d'Espérance, founded about 1220 but not finished till the 15th century, and the 14th century building known as the Salle de la Diana (Decana), restored by Viollet-le-Duc. Montbrison is the seat of a sub-prefect, and of a tribunal of first instance. There are liqueur-distilleries, mineral waters, and flour-mills, and silk ribbons are manufactured; there is considerable commerce in grain.

MONTCALM, LOUIS-JOSEPH DE MONTCALM-GOZON, Marquis de (1712–1759), French general, born near Nîmes, on Feb. 29, 1712. He was strictly brought up under the tutorship of a kinsman, Louis Dumas, becoming a good classical scholar and the master of a vivid and nervous, though unconventional French style. At the age of 15 he received a commission in the regiment at Hainaut. He first saw active service on the Rhine in the War of the Polish Succession. In 1735 he succeeded to his father's titles and property, and in the following year married Angelique-Louise Talon du Boulay, by whom he had ten children. In 1743, during the War of the Austrian Succession, he became colonel of the regiment of Auxerrois, and three years later he distinguished himself at the battle of Piacenza, where he was wounded five times and taken prisoner. In 1747 he was raised to the rank of brigadier, and at the end of

the war given the command of a cavalry regiment. The next few years he spent with his family at Candiac; but early in 1756 he was chosen to command the French regular troops in Canada, with the rank of major-general. He reached Quebec on May 13.

Montcalm's commission gave him no authority over the greater part of the military resources of Canada, and he was in all respects subordinate to the governor-general, the Marquis de



BY COURTESY OF THE CANADIAN PACIFIC STEAMSHIP CO.

GENERAL MONTCALM'S HEADQUARTERS DURING HIS DEFENCE OF QUEBEC, 1759

Vaudreuil, who from the first was jealous, suspicious and critical. The tempers of the two were wholly incompatible, and the prospects of the colony were gravely prejudiced by their ever-increasing animosity towards each other. Montcalm was also embarrassed by the corrupt practices of a gang of government officials, headed by the intendant, François Bigot. Nevertheless, he enjoyed three years of striking success. If it was Vaudreuil who suggested the undertaking, it was Montcalm who, with great judgment and energy, forced the surrender of the English post at Oswego in the summer of 1756, thus restoring to France the undisputed control of Lake Ontario. Next year he took the offensive towards the south, and on August 9, after a siege of but five days, captured Fort William Henry, at the head of Lake George, with its garrison of 2,000 men. His victory was marred by the slaughter of many of the prisoners by his Indian allies—a catastrophe which he deplored and strove at the risk of his life to arrest, but which he might have prevented by taking a few obvious precautions.

Montcalm's greatest feat was achieved on July 8, 1758, when with about 3,800 men he repulsed the attack of Abercromby's 15,000 on the breastwork and abbatis which the French had hastily constructed at Ticonderoga. The victory, however, was due to Abercromby's stupidity as much as to Montcalm's skill; and Vaudreuil was not altogether unreasonable in criticizing him for making no attempt to exploit his success. The French had now definitely lost the initiative, and in 1759 Montcalm had to defend Quebec itself against Wolfe. As his army, though superior in numbers, was inferior in quality to his opponent's, Montcalm remained strictly on the defensive in his entrenched lines between the St. Charles and Montmorency rivers. For more than two months he baffled the besiegers, and on July 31 beat off an ill-considered attack on his works near the Montmorency Falls. In the end, however, he was outwitted, though it is fair to say that, but for Vaudreuil's interference, he would have greatly strengthened the guard near the point where the British scaled the Heights of Abraham. In the battle which followed, Montcalm behaved with conspicuous gallantry, and was mortally wounded while trying to rally his broken army. He died in Quebec next day, Sept. 14, and was buried in the chapel of the Ursuline convent.

Montcalm was a devout Catholic. He was a good husband and father, and, judged by the contemporary standards of his class, his private life was remarkably upright and honourable. His impetuous temper and hasty speech gained him many enemies, yet his personal charm and integrity usually won the affection of his associates and subordinates. His devotion to his country is beyond dispute.

See F. Parkman, *Montcalm and Wolfe*, 2 vol. (1899); A. G. Doughty and G. W. Parmelee, *The Siege of Quebec and Battle of the Plains of Abraham*, 6 vol. (1901–02); H. R. Casgrain, *Montcalm et Lévis*, 2 vol. (1898), *Wolfe and Montcalm* (Makers of Canada Series, 1905); W. Wood, *The Fight for Canada* (1905); M. Santai, *Montcalm au combat de Carillon* (1909); T. Chapais, *Le Marquis de Montcalm* (1911). (W. T. W.)

MONTCEAU-LES-MINES, a town of east-central France, in the department of Saône-et-Loire, 14 m. S. by W. of Le Creusot on the P.L.M. railway. Pop. (1926) 8,109. It is the centre of the Blanzy coal basin, on the Canal du Centre, connected with the coalfield by numerous lines of railway. There are spinning, weaving and hosiery factories, iron and copper foundries and engineering shops making textile machinery.

MONT CENIS, a pass (6,893 ft.) in Savoy (France) which forms the limit between the Cottian and Graian Alps. A carriage road (1803–1810) was built across it by Napoleon, while a light railway was opened alongside the road in 1868, but was destroyed in 1871, on the opening of the tunnel. This tunnel (highest point 4,249 ft.) is really 17 m. west of the pass, below the Col de Fréjus. From Chambéry the line runs up the Isère valley, but soon bears through that of the Arc or the Maurienne past St. Jean de Maurienne to Modane (61 m. from Chambéry). The tunnel (8 m. long) leads to Bardonnèche, some way below which, at Oulx (18 m. from Modane) the line joins the road from the Mont Genèvre. Thence the valley of the Dora Riparia is followed to Turin (64½ m. from Modane). The motor road mounts the Arc valley for 16 m. from Modane to Lanslebourg, whence it is 8 m. to the hospice, a little way beyond the summit of the pass. The descent lies through the Cenis valley to Susa (37 m. from Modane) where the road joins the railway. To the south-west of the Mont Cenis is the Little Mont Cenis (7,166 ft.) which leads from the summit plateau (in Italy) of the main pass to the Étache valley (in France) and so to Bramans in the Arc valley (7 m. above Modane). This pass was crossed in 1689 by the Vaudois, and by some authors is believed to have been "Hannibal's Pass."

MONTCHRETIEN, ANTOINE DE (1575 or 1576–1621), French dramatist and economist, son of an apothecary at Falaise named Mauchrestien, was born about 1576. In one of his numerous duels he killed his opponent, and took refuge in England. Through the influence of James I., to whom he dedicated his tragedy, *L'Ecossaise,* he was allowed to return to France, and established himself at Auxonne-sur-Loire, where he set up a steel foundry. In 1621 he joined the Huguenot side in the civil wars. He raised troops in Maine and Lower Normandy, but was killed in a skirmish near Tourailles on Oct. 8, 1621. In 1615 he published a valuable *Traité de l'économie politique,* based chiefly on the works of Jean Bodin.

His dramas are *Sophonisbe* (1596), afterwards remodelled as *La Cartaginoise; L'Ecossaise, Les Lacènes, David, Aman* (in 1601); *Hector* (1604). As plays they have little technical merit, but they contain passages of great lyrical beauty.

The tragedies were edited in 1901 by M. Petit de Julleville with notice and commentary; the *Traité de l'économie politique* in 1889 by Th. Funck Brentano.

MONTCLAIR, a town of Essex county, New Jersey, U.S.A., about 15 m. N.W. of lower New York City, on the Erie and the Lackawanna railways. The population was 28,810 in 1920 (18% foreign-born white); in 1930, 42,017. It is a delightful residential suburb, on the slopes of the Orange mts., the altitude ranging from 215 to 665 feet. It has excellent public and private schools, and is the seat of a state normal school (1908). The lower part of Montclair was settled in 1675 and gradually became known as Cranetown. In 1812 Bloomfield, in which it lay, was organized as a separate township, and in 1868 West Bloomfield (as Cranetown by this time was called) together with Speertown (settled by the Dutch) was incorporated as Montclair, which in 1894 became a town.

MONT-DE-MARSAN, a town of south-west France, capital of the department of Landes at the confluence of the Midou and the Douze, 92 m. S. of Bordeaux. Pop. (1926), 9,126. Mont-de-

Marsan, the first of the Bastides (*q.v.*) of the middle ages was founded by Pierre, vicomte de Marsan, as the capital of his territory in 1141. In the 13th century it passed to the viscounts of Béarn, and was united to the French Crown on the accession of Henry IV. Most of the buildings are in the older quarter, on the peninsula between the two rivers forming the Midouze. A 14th century keep, now used for military purposes, was built by Gaston Phoebus. The town is the seat of a prefect, court of assizes and of a tribunal of first instance. The industries include distillation of turpentine and resinous oils, the founding and forging of metal, wood-sawing, and manufactures of machinery and straw envelopes for bottles. There is trade in resin, wine, brandy, timber and live stock.

MONTDIDIER, a town of northern France, capital of an arrondissement in the department of Somme, 23 m. S.E. of Amiens by rail. Pop. (1926) 4,601. The town, on a hill on the bank of the Don, dates from the Merovingian period, and perhaps owes its name to the imprisonment of the Lombard king Didier in the eighth century. Held first by its own lords, afterwards by the counts of Crépy and Valois, Montdidier passed to the Crown in the 12th century, at the end of which it was granted a charter of liberties. The town was laid in ruins during the World War. It has a sub-prefecture.

MONT-DORE-LES-BAINS, a watering-place of central France in the department of Puy-de-Dôme, situated at a height of 3,440 ft., on the right bank of the Dordogne not far from its source, and 31 m. by road S.W. of Clermont-Ferrand. Pop. (1926) 1,775. The Monts Dores close the valley towards the south. The thermal springs of Mont Dore were known to the Romans. Bicarbonate of soda, iron and arsenic are the principal ingredients. Baths of high temperature are a feature. From the elevation and exposure of the valley, the climate of Mont-Dore-les-Bains is severe, and the season only lasts from June 15 to Sept. 15.

MONTEAGLE, WILLIAM PARKER, 4TH BARON, and 11TH BARON MORLEY (1575–1622), was the eldest son of Edward Parker, 10th Baron Morley (d. 1618), and of Elizabeth, daughter and heiress of William Stanley, 3rd Baron Monteagle (d. 1581). He received knighthood when with Essex in Ireland in 1599, and in 1601 with Catesby and others, took part in the latter's rebellion in London, when he was punished by imprisonment and a fine of £8,000. In 1602 he supported the mission to Spain inviting Philip III. to invade England. However, he acquiesced in James I.'s accession and assisted the earl of Southampton in securing the Tower for the king. He was taken into favour, and received a summons to attend the parliament of Nov. 5, 1605, as Lord Monteagle. On Oct. 26, 1605, he received the celebrated letter giving warning of the gunpowder plot, probably written by Francis Tresham, Lady Monteagle's brother. After having it read aloud by Ward, a gentleman in his service and an intimate friend of Winter, one of the chief conspirators, he took it to Whitehall and showed it to Lord Salisbury and other ministers. On Nov. 4, he accompanied Lord Suffolk, the lord chamberlain, to the vault under the parliament house, where Guy Fawkes was found. Monteagle received £700 a year for his services in averting the disaster. In 1609 he was chosen a member of the council of the Virginia Company and subscribed to its funds. The same year "disorders in his house" are reported, probably referring to his harbouring of Roman Catholic students from St. Omer. In 1618, on the death of his father, he was summoned to parliament as Baron Morley and Monteagle. He died on July 1, 1622, at Great Hallingbury, Essex.

MONTEBELLO, a city of Los Angeles county, California, U.S.A., 8 m. E. of Los Angeles, on the Santa Fe and the Union Pacific railways. The population was 5,498 in 1930 by the Federal census. It lies near an oil field of the same name which was discovered in 1916, adjoins the Union Pacific Industrial Section and is the headquarters of extensive nurseries and cut-flower industries. The State Flower and Horticultural Exhibition is held here annually in October. The city was founded about 1915 and was incorporated in 1920. It is governed by a board of trustees.

MONTE CARLO: *see* MONACO.

MONTE CASSINO, an isolated hill overhanging the town of Cassino (*see* CASINUM). Hither St. Benedict migrated from Subiaco in A.D. 529, and established the monastery that became the metropolis of Western monachism. It was sacked by the Lombards (580–590), rebuilt in 720, destroyed by the Saracens in 884, and restored seventy years later. It was most influential under Desiderius (who became Pope Victor III. in 1087) and Oderisius (1059–1105). The abbot became overlord of an extensive territory and bishop of several dioceses. At the dissolution of monasteries in 1866 Monte Cassino became a national monument and the monks were recognized as custodians. There are rich archives, and a large secondary school with 250 boys.

See L. Tosti, *Storia della badia di M.C.* (1841; 2nd ed., 1888).

MONTECATINI, a much-frequented mineral spa of Tuscany, Italy, in Val di Nievole, province of Lucca, 7 m. W. by S of Pistoia, 105 ft. above sea-level. Pop. (1921) 6,319 (Bagni di Montecatini); 3,367 (Montecatini). The springs are saline, and range in temperature from 82·4° to 86° F. The water is both drunk and used for bathing by some 80,000 visitors annually, and is exported in bottles.

MONTE CORVINO, GIOVANNI DI (*c.* 1247–1328), Franciscan missionary, traveller and statesman, founder of the earliest Roman Catholic missions in India and China, and archbishop of Peking. In 1272 he was commissioned by the emperor Michael Palaeologus, to Pope Gregory X., to negotiate for the reunion of Greek and Latin churches. From 1275 to 1289 he laboured as a missionary in the Nearer and Middle East. In 1289 he was sent out as Roman legate to the Great Khan, the Ilkhan of Persia, and other leading personages of the Mongol world, as well as to the "emperor of Ethiopia" or Abyssinian negus. Arriving at Tabriz, then the chief city of Mongol Persia, and indeed of all Western Asia, Monte Corvino moved down to India to the Madras region or "Country of St. Thomas," from which he wrote home, in Dec. 1291 (or 1292), the earliest noteworthy western account of the Coromandel coast. He next appears in "Cambaliech" or Peking, and wrote letters (of Jan. 8, 1305, and Feb. 13, 1306), describing the progress of the Roman mission in the Far East, in spite of Nestorian opposition; alluding to the Roman Catholic community he had founded in India, and to an appeal he had received to preach in "Ethiopia" and dealing with overland and oversea routes to "Cathay," from the Black sea and the Persian gulf respectively. In 1303 he received his first colleague, the Franciscan Arnold of Cologne; in 1307 Pope Clement V. created him archbishop of Peking, and despatched seven bishops to consecrate and assist him; three only of these arrived (1308). Three more suffragans were sent out in 1312, of whom one at least reached East Asia. A Franciscan tradition maintains that about 1310 Monte Corvino converted the Great Khan (*i.e.*, Khaishan Kuluk, third of the Yuen dynasty; 1307–11); this has been disputed, but he unquestionably won remarkable successes in North and East China. Besides three mission stations in Peking, he established one near the present Amoy harbour, opposite Formosa. At his death, about 1328, heathen vied with Christian in honouring him. He was apparently the only effective European bishop in the Peking of the middle ages.

The mss. of Monte Corvino's *Letters* exist in the Laurentian library, Florence (for the Indian Epistle) and in the National library, Paris, 5006 Lat.—viz., the *Liber de aetatibus*, fols. 170, v.–172, r. (for the Chinese). They are printed in Wadding, *Annales minorum* (A.D. 1305 and 1306) vi. 69–72, 91–92 (ed. of 1733, etc.), and in the *Münchner gelehrte Anzeigen* (1855), No. 22, part iii. pp. 171–175. English translation, with valuable comments, are in Sir H. Yule's *Cathay*, i. 197–221. *See* also Wadding, *Annales*, v. 195–198, 199–203, vi. 93, etc., 147, etc., 176, etc., 467, etc., C. R. Beazley, *Dawn of Modern Geography* (1897 etc.) iii. 162–178, 206–210. (C. R. B.)

MONTECRISTO (anc. Oglasa), an island of Italy, belonging to the province of Leghorn, 25 m. S. of Elba (highest point 2,126 ft. above sea-level; area about 6 sq.m.). It contains the ruins of a Camaldulensian monastery, abandoned in 1553, and is the private property of the king of Italy, who has a shooting-lodge there. The fame of the island is due to *Le Comte de Montecristo,* by the elder Dumas (*q.v.*).

MONTECUCCULI, RAIMONDO, COUNT OF (1609?–1680), prince of the Holy Roman Empire and Neapolitan duke of

Melfi, Austrian general, born Feb. 2, 1608 or 1609, at the castle of Montecucculo in Modena. At the age of sixteen Montecucculi began as a private soldier under his uncle, Count Ernest Montecucculi, a distinguished Austrian general (d. 1633), but seeing continuous service in Germany and the Low Countries, he rose by 1634 to a colonelcy. In 1639 he was taken prisoner at Melnik and detained for two and a half years in Stettin and Weimar. In captivity he studied military science, geometry, history and architecture and planned his great work on war. On his release he distinguished himself again in Silesia, and in Lombardy (1643). On his return to Germany he was promoted lieutenant-field-marshal and obtained a seat in the council of war. In 1645–46 he served in Hungary, on the Danube and Neckar, and in Silesia and Bohemia. The victory of Triebel in Silesia won him the rank of general of cavalry, and at Zusmarshausen in 1648 his rearguard fighting rescued the imperialists from annihilation. For some years after the peace of Westphalia Montecucculi was chiefly concerned with the business of the council of war, though he went to Flanders and England as the representative of the emperor, and to Sweden as the envoy of the pope, and at Modena his lance was victorious in a great tourney. In 1657, soon after his marriage with Countess Margarethe Dietrichstein, he saw further active service. He became field-marshal in the imperial army, and with the Great Elector of Brandenburg completely defeated Rakoczy and his allies (peace of Oliva, 1660). From 1661 to 1664 Montecucculi defended Austria against the Turks, whom he defeated so completely at St. Gotthard Abbey, on the Raab, that they made a truce for twenty years (Aug. 1, 1664). He was given the Golden Fleece, and became president of the council of war and director of artillery. He also devoted much time to the compilation of his various works on military history and science. When the war broke out against France, he received command of the imperial forces. In 1673 he completely out-manoeuvred his great rival Turenne on the Neckar and the Rhine. He retired from the army when, in 1674, the Great Elector was appointed to command in chief, but the brilliant successes of Turenne in the winter of 1674 and 1675 brought him back. After Turenne's death Montecucculi invaded Alsace, where he engaged in a war of manoeuvre with the great Condé. The siege of Philipsburg was Montecucculi's last achievement in war. The rest of his life was spent in military administration and literary and scientific work at Vienna. In 1679 the emperor made him a prince of the empire, and shortly afterwards he received the dukedom of Melfi from the king of Naples. Montecucculi died at Linz on Oct. 16, 1680, as the result of an accident. He shared with Turenne and Condé the first place amongst European soldiers of his time. His *Memorie della guerra* profoundly influenced the age which followed his own.

AUTHORITIES.—The *Memorie della guerra,* etc., was published at Venice in 1703 and at Cologne in the following year. A Latin edition appeared in 1718, a French version in 1712, and the German *Kriegsnachrichten des Fürsten Raymundi Montecuccoli* in 1736. Many memoirs on military history, tactics, fortification, etc., written in Italian, Latin and German, remain still unedited in the archives of Vienna. The collected *Opere di Raimondo Montecuccoli* were published at Milan (1807), Turin (1821) and Venice (1840), and include political essays and poetry.

See Campori, *Raimondo Montecuccoli* (Florence, 1876); Spenholtz, *Aureum vellus seu catena,* etc. (Vienna, 1668); Paradisi, *Elogio storico del conte Raimondo Montecucculi* (Modena, 1776); Pezzl, *Lebensbeschreibung Montecucculis* (Vienna, 1792); Hormayr, *Oesterreichischer Plutarch,* XIII. (Vienna, 1808); Würzbach, *Biographisches Lexikon des Kaiserthums,* etc., pt. 19 (Vienna, 1868); *Die Hofkriegsraths, präsidenten* (Vienna, 1874); Weingärtner, *Heldenbuch* (Teschen. 1882); Grossmann, *Archiv für öst. Geschichte* (Vienna, 1878); *Allgemeine deutsche Biographie,* vol. xxii. (Leipzig, 1885). Important controversial works are those of Turpin and Warnery, two distinguished soldiers of the 18th century (*Commentaires sur les mémoires,* etc. [Paris], 1769, and *Commentaires sur les comm. . . . du comte Turpin,* Breslau, 1777). A critical estimate of Montecucculi's works will be found in Jähns *Gesch. der Kriegswissenschaften,* ii. 1162–78 (Leipzig, 1890).

MONTEFIASCONE, a town and episcopal see, province of Viterbo, Italy, built on a hill (2,077 ft.) on the S.E. side of the Lake of Bolsena, 70 m. N.W. of Rome by rail. Pop. (1921), 6,362 (town); 10,035 (commune). The cathedral (1519) is one of the earliest structures by Sammicheli. In it the Old Pretender was married to Clementine Sobieski (1719); San Flaviano (built in 1032, repaired and enlarged in the Gothic style late in the 14th century), is a curious double church.

MONTEFIORE, SIR MOSES HAIM (1784–1885), Jewish philanthropist, was born at Leghorn on Oct. 24, 1784, of a family of Jewish merchants who had settled at Ancona and Leghorn in the 17th century. His uncle purchased for him the right to practice as one of the 12 Jewish brokers licensed by the city of London, and Montefiore entered the Stock Exchange, where he amassed a fortune sufficient to enable him to retire in 1824. By his marriage with Judith, daughter of Levi Barent Cohen, whose sister was the wife of Nathan Mayer Rothschild, a close business connection between the houses of Rothschild and Montefiore was established. From his 43rd year Montefiore devoted all his energies to ameliorating the lot of his co-religionists. On his return from his first pilgrimage to Palestine in 1837, which resulted in a friendship with Mohammed Ali, Montefiore assisted the British Jews in their struggle to obtain full political and civil rights. In 1837 he became the City of London's second Jewish sheriff, and was knighted.

In 1838, accompanied by Lady Montefiore, he started on a second voyage to Palestine, in order to submit to Mohammed Ali a scheme for Jewish colonization in Syria. Though political disturbances rendered his efforts again unsuccessful, the year 1840 brought Montefiore once more before Mohammed to plead for some Jews imprisoned at Damascus. He obtained their release, and also wrung a decree from the Porte giving Jews throughout Turkey the utmost privileges accorded to aliens. In 1846 the threatened re-issue in Russia of an Imperial ukase (first promulgated in 1844) ordering the withdrawal of all Jews from within 50 versts of the German and Austrian frontiers, caused Montefiore to interview the tsar, and he succeeded in getting the ukase rescinded. On his return, Queen Victoria, on the recommendation of Sir Robert Peel, made him a baronet. In 1859 a case of injustice brought Montefiore to the gates of the Vatican, and four years later he obtained from the Sultan, Abdul Aziz, the confirmation of his predecessor's decrees in favour of the Jews. The year 1864 found him in Morocco combating an outbreak of anti-Semitism; 1866 in Syria, relieving the distress resulting from a plague of locusts and an epidemic of cholera; and 1867 in Rumania, pleading the cause of the Jews with Prince Charles. His seventh and last pilgrimage to the Holy Land was made in 1875, of which he wrote an account in his *Narrative of a Forty Days' Sojourn in the Holy Land,* published in that year. The last decade of his life was passed upon his estate near Ramsgate, in Kent, where he died on July 28, 1885. Montefiore was a strictly orthodox Jew, scrupulously observant of the Scriptures; in his grounds he had a synagogue built where services were held twice a day, a college where ten rabbis lived and expounded the Jewish law, and a mausoleum for himself and Lady Montefiore, who died in 1862.

See *The Diaries of Sir M. Montefiore and Lady Montefiore, 1812–1883* (1890, 2 vols.); Lucien Wolf, *Sir M. Montefiore* (1884); E. Wolbe, *Sir M. Montefiore* (1909).

MONTÉGUT, JEAN BAPTISTE JOSEPH ÉMILE (1825–1895), French critic, was born at Limoges on June 14, 1825 and died in Paris on Dec. 11, 1895. He began to write for the *Revue des deux mondes* in 1847, contributing between 1851 and 1857 a series of articles on the English and American novel, and in 1857 he became chief literary critic of the review. Émile Montégut translated the *Oeuvres complètes* (10 vols. 1868–73) of Shakespeare. Among his numerous critical works is *Ecrivains modernes d'Angleterre* (3rd series, 1885–92).

See A. Laborde-Milaà, *É. Montégut, 1825–1895* (1922).

MONTELEONE DI CALABRIA, city, Calabria, Italy, province of Catanzaro, on an eminence gently sloping to the Gulf of S. Eufemia, 1,575 ft. above sea-level, 70 m. N.N.E. of Reggio di Calabria by rail. Pop. (1921), 12,965 (town); 13,842 (commune). Destroyed by earthquake in 1783, under the French occupation it was rebuilt and made capital of a province. It suffered in the earthquake of 1905. The castle was built by Frederick II. The principal church contains sculptures by the Gagini of Palermo.

Monteleone is the ancient Hipponium, first mentioned in 388 B.C., when its inhabitants were removed to Syracuse by Dionysius. Restored by the Carthaginians (379), occupied by the Bruttii (356), held by Agathocles of Syracuse (294), Hipponium ultimately became, as Vibo Valentia, a flourishing Roman colony, where a branch from Scolacium (Squillace) on the east coast road joined the Via Popilia. A harbour was made by Agathocles at Bivona on the coast. In the modern town there are some Roman remains. The town walls of the Greek city can be traced for their whole extent, about 4 miles. They are well constructed of regular blocks of stone. They belong to the end of the 5th century B.C. and are the finest monument of Greek military architecture in Calabria. Important remains of them have recently been brought to light, and traces of four temples. The Roman town occupied only part of the Greek site; the streets of the modern town still preserve the Roman arrangement. (T. A.)

MONTÉLIMAR, a town of south-eastern France in the department of Drôme, near the Rhône, 93 m. S. of Lyons on the railway to Marseilles. Pop. (1926) 8,320. Montélimar was called by the Romans *Acunum*. At a later period it belonged to the family of Adhémar and received the name Monteil d'Adhémar, whence the present name. Towards the middle of the 14th century it was sold by them partly to the dauphins of Viennois and partly to the pope, and in the next century it came into the possession of the Crown. During the religious wars it valiantly resisted Gaspard de Coligny in 1570, but was taken by the Huguenots in 1587. The ancient castle is now used as a prison. Remains of the ramparts and four old gates, dating from the 14th, 15th and 16th centuries, are also preserved. The industries include tanning and the making of tiles, bricks, hats, lime, farming implements, preserved foods, nougat and wines.

MONTELIUS, OSKAR (1843–1921), Swedish archaeologist, was born in Stockholm on Sept. 9, 1843. He studied at the University of Stockholm, and took the degree of Ph.D. in 1869. In 1888 he was appointed a professor in the Museum of National Antiquities, Stockholm, and in 1913 became State archaeologist. As an archaeologist his aim was to utilize and develop the typological method explained by him in his book *Die Typologische Methode* (1903). He died at Stockholm on Nov. 5, 1921. His works include: *The Civilisation of Sweden in Heathen Times* (1888); *Les temps préhistoriques en Suède et dans les autres pays Scandinaves* (1895); *Kulturgeschichte Schwedens* (1906); and *La civilisation primitive en Italie depuis l'introduction des métaux* (3 vol. 1895–1910).

See *Oscar Montelius, in Memoriam* (Stockholm, 1922).

MONTEMAYOR or **MONTEMÔR, JORGE** (1520?–1561), Spanish novelist and poet, of Portuguese descent, was born at Montemôr o Velho (near Coimbra), whence he derived his name, the Spanish form of which is Montemayor. His reputation is based on a prose pastoral romance, the *Diana* (1559?). It is important as the first pastoral novel published in Spain; as the starting-point of a universal literary fashion; and as the indirect source, through the translation included in Googe's *Eglogs, epytaphes and sonnets* (1563), of an episode in the *Two Gentlemen of Verona*. Montemayor's mastery of Spanish is amazing, and that he pleased his own generation is proved by the 17 editions and two continuations of the *Diana* published in the 16th century, by parodies, imitations and renderings in French and English.

See G. Schönherr, *Jorge de Montmayor, sein Leben und sein Schäferroman* (Halle, 1886); H. A. Rennert, *The Spanish Pastoral Romances* (Philadelphia, 1912).

MONTENEGRO, the Black Mountain, formerly a country of south-eastern Europe, its name being the Venetian variant of the Italian *Monte Nero*. It extended between 41° 55′ and 43° 21′ N. lat., and between 18° 30′ and 20° E. long., with a seaboard of 28 m. on the Adriatic sea. It included most of the basins of the Moratcha, and its feeder, the Zeta, flowing into Lake Scutari, and that of the Piva, while the river Tara formed its north-east boundary. It was mostly difficult mountain-country, with some rich grassy uplands and small cultivable basins around Cettigne, the former village capital, and a fairly rich belt along the Zeta. The north was largely composed of forested heights among which the rivers ran in deep gorges, and to the west of Cettigne stands Mount Lovchen (5,633 ft.), the dark mountain which is the reason for the country's name and the centre of the region's history because it was an asylum for the Serbian nobles after the defeat by the Turks at Kossovo (1389). *See* YUGOSLAVIA.

HISTORY

Mediaeval Period.—Crna Gora, the Black Mountain, better known as Montenegro, which did not become a separate unit of its own till the 14th century, was really a development from one of the earliest of Serb state formations, the so-called Zeta, which comprised the districts round the river of that name, with Skutari and its lake, the Bocche di Cattaro, and a part of what was afterwards Hercegovina. It gradually came to be merged in the mediaeval Serbian State under the Nemanja dynasty (*q.v.*), though retaining a certain rude autonomy under Župans of its own. After the death of Tsar Dušan (1356) the central authority weakened, and a number of great feudal lords asserted their independence. While King Vukašin and Marko Kraljević ruled in part of Macedonia, and Stephen Vukčić established the Duchy of St. Sava, the Balša family, cousins of Tsar Uroš, asserted control in the Zeta, holding Skutari and Dulcigno as their two chief strongholds. The Balša ruled from about 1358 to 1421, offering a refuge in their mountains to Serbs flying from the Turkish advance, and on the other side holding in check the designs of Venice on the Southern Adriatic. They were succeeded by another Serbian dynasty, the Crnojević, which was related to the Albanian hero Scanderbeg, and also allied itself with Venetian patrician families. As the Turks successively conquered Serbia, Bosnia and Albania, the Black Mountain found itself in a position of growing isolation. In 1479 the Venetians surrendered Skutari to the Porte, in 1482 Hercegovina was overrun, and in 1484 Ivo the Black was obliged to burn his tiny capital at Žabljak on the north-eastern shore of the Lake of Skutari, and to withdraw to the more inaccessible village of Cetinje, perched beneath the great peak of Lovčen. Here Ivo laid the independence of Montenegro, founded a monastery and bishopric and won a name in legend and popular poetry, as a kind of Barbarossa or Boabdil who after long slumber in the bowels of the mountain would one day come forth to free the Serbian race. The spirit animating Ivo and his followers is revealed in the law which prescribed that any man leaving the field of battle without orders or showing signs of fear, should be dressed as a woman and then driven by the real women out of the country, as a coward and a traitor. Yet these broken men were not untouched by the new culture from the west: for Ivo's son George bought a printing press from the Venetians and erected it at Obod, where some of the earliest Slav books were printed. Only too soon it had to be melted down to provide leaden bullets against the Turks.

Montenegro Under the Vladikas.—The last Crnojevič resigned office in 1516, and from that date till 1696 the mountaineers were ruled by their Vladikas or Bishops, elected by popular assemblies and consecrated by the Serbian Patriarch of Peć (Ipek). This was a period of perpetual warfare with the Turks and of periodic invasion, Cetinje being captured in 1623 and 1687. By the close of the 17th century Muslim intruders were beginning to levy dues upon the peasants, mosques were being built and there was a certain apostasy to Islam. In 1697 the irreconcilables met the growing danger by granting to the Vladika, Danilo Petrović of Njegoš, the right to select his successor among his own kin and thus found a new dynasty. In 1700 he received consecration from the Serbian Patriarch at his new home in Karlovci (Karlowitz) and in 1702 organized the famous "Montenegrin Vespers," by which almost all the Muslims were massacred and their few survivors forced to be rebaptized. Danilo was the first to establish those relations with Russia which were to become a tradition of his family, and in 1711 took up arms against the Turks at the instance of Peter the Great, with the result that Cetinje was sacked for the third time. In 1716 Danilo visited St. Petersburg and obtained an annual subsidy from the tsar. His two successors Sava and Vasili also paid visits to Russia, and on the latter's death there, in 1766, an impostor named Stephen

the Little obtained the throne of Montenegro by claiming to be the murdered Tsar Peter III., so strong was the appeal of Slav sentiment. After Stephen's murder in 1774 the aged Sava resumed office. His nephew Peter I. (1782–1830), the greatest of the Vladikas, again joined Russia in war upon the Turks, from 1787 onwards, but after peace was left alone to face their vengeance. In 1796 at Krusi he won a great victory over the vizier of Skutari, whose head was long preserved as a trophy in the monastery of Cetinje. After Austerlitz he co-operated with the Russian fleet against the French in Dalmatia and laid siege to Ragusa: but he failed in his design of acquiring the Bocche di Cattaro, which fell to Austria in 1814. At home Peter I. discouraged the blood feud and introduced a rough code of law, and the rudiments of an administration. After his death he was canonized by popular sentiment. His nephew Peter II. (1830–51) was not only remarkable as warrior and statesman, but is recognized as the greatest of Serbian poets (for his two epics "The Mountain Garland" and "Light of the Microcosm"). He established a senate in 1831, was interested in education and showed his belief in national unity by cordial relations with Alexander of Serbia and Ban Jelačić of Croatia. He was buried on the summit of Mount Lovčen.

Nicholas I.—His nephew Danilo II. on accession divested himself of the episcopal office and became Gospodar, or Lord. He twice defended Montenegro against the Turks, defeating them near Ostrog in 1853 and at Grahovo in 1858, thus vindicating that independence which the Porte had challenged. On Aug. 11, 1860, he was murdered at Persano, by an act of private revenge, and was succeeded by his nephew Nicholas (*q.v.*), who in 1862 had to defend his country against a fresh Turkish invasion. In the 14 years of peace that followed he began to transform the rude clan levies into a modern army, and helped by Russian subsidies, established the first secondary schools. In 1868 he granted to Montenegro her first constitution, with a premier and a Cabinet of five: but he remained an autocrat, with full control of policy and revenue, and grew rich at the country's expense. In 1869 he with difficulty held back his people from helping the rising of the Krivošije against Austria: but when in 1875 Hercegovina and Bosnia revolted against the Turks, similar tactics became impossible, and early in July 1876 he and prince Milan of Serbia jointly declared war on behalf of the insurgents. Though more successful than Serbia—he occupied Nikšić and reached the coast at Antivari—he was obliged to conclude an armistice in November, and to await the decision of the Great Powers. The Treaty of Berlin assigned to Montenegro Nikšić, Podgorica, Antivari, Plava and Gusinje: but owing to the stout resistance of the Muslim and Albanian population of the two latter places they were, by a subsequent decision of the Powers (April 18, 1880), restored to Turkey, while the Hoti and most of the Klementi tribes were given to Montenegro. This also proved incapable of execution, and in the end Montenegro received Dulcigno in exchange for Plava and Gusinje. The new settlement could only be enforced after an international fleet under Admiral Seymour had appeared before Dulcigno and after the Turks had reduced the Albanian recalcitrants to order. The Treaty of Berlin contained further clauses restricting Montenegro's right to build ships and railways and placing the maritime control of her coasts in Austria-Hungary's hands: while that Power's occupation of the Sandjak kept Montenegro and Serbia artificially separate for another 34 years.

For 30 years Montenegro enjoyed profound peace under the autocratic rule of Prince Nicholas, who in 1896 celebrated the second centenary of his dynasty and allied himself by marriage with the Russian and Italian dynasties, his fourth daughter Helen becoming Queen of Italy in 1900. In 1900 Nicholas assumed the title of Royal Highness, and on August 28, 1910, proclaimed himself king. In the late '80s he was greeted by Tsar Alexander III. in a public toast as Russia's only friend in Europe: and his Russophil tendencies grew more marked as Milan Obrenović of Serbia threw himself into the arms of Austria-Hungary. It was Russia who arranged the marriage of Nicholas's daughter Zorka with Prince Peter, the exiled head of the rival Karagjorgjević dynasty: and their son Alexander, afterwards king of Yugoslavia, was born at Cetinje. Nicholas had shown his Slav sympathies in early life, and followed the literary tradition of his granduncle by composing a drama entitled *The Empress of the Balkans*, and the popular song "Onamo, 'Namo," with its dream of reoccupying the lost lands of the Serb. As an old man he undoubtedly dreamt of supplanting the Karagjorgjević and uniting the race under the Petrović dynasty.

The Balkan Wars and World War 1912–18.—The great poverty of Montenegro, in marked contrast to the relative wealth of its ruler, led to unrest and emigration: even in normal times it could not produce enough grain for its scanty population. In 1905 Nicholas found it advisable to proclaim a new constitution, providing a parliament of 76 members (14 nominated) but leaving the manner of election to the Ministry of Interior, which thus ordered public voting and exercised great pressure. At first the Progressives under Radulović were allowed to take office, but their reforming zeal at home and their advocacy of union with Serbia soon led to a breach with the prince, who dissolved parliament and henceforth governed by creatures of his own. In 1908 followed the famous Cetinje Bomb Trial, which aimed at discrediting the unionist movement, and which, though remaining a mystery, was known to have had connections with the Zagreb Treason Trial of the following year. Nicholas's assumption of the royal title in 1910 was intended as a fresh move against Serbia, but the course of Balkan events after the Turkish Revolution soon made co-operation between Cetinje and Belgrade again inevitable. Indeed Montenegro not merely joined the Balkan League, but was the first to declare war upon Turkey in October 1912. The lack of heavy guns and the imperfect discipline of his gallant troops compelled Nicholas to resort to Serbian military aid on a considerable scale, before Scutari could be reduced in April 1913. Austria-Hungary insisted upon the surrender of Scutari to the new Albania, and threatened war. Nicholas only yielded to an international naval blockade of the Montenegrin coast, and Serbian troops were withdrawn from the Adriatic. The first Balkan war gave Montenegro and Serbia a joint frontier, the former Sanjak of Novi Pazar being partitioned between them; and Montenegrin troops joined Serbia against Bulgaria in the second Balkan war. Early in 1914 the Montenegrin statesman, Miušković, began serious discussions with Pašić for a financial and customs union between Serbia and Montenegro, a fusion of the two armies, a joint foreign policy and diplomatic representation, but retention of the two dynasties.

These negotiations became known to Vienna, who warned Petrograd that "Austria-Hungary would not remain a silent observer," and regarded union as a challenge to her Adriatic interests. On this, Sazonov advised Pašić to postpone the negotiations. But the movement for union was rapidly becoming irresistible when the World War broke out and the two States found themselves side by side in resistance to Austria-Hungary. Prince Nicholas and his sons were, however, jealous and reserved, blocking the action of the Serbian General Janković, who had been sent at Russia's instance to reorganize the Montenegrin army. In May 1915 Prince Peter had a secret meeting in Dalmatia with the former Austro-Hungarian military attaché, Hubka, and in November, during the invasion of Serbia, Crown Prince Danilo, through his friend Baron de Kruyff in Sofia, made overtures to the Central Powers, offering to cut off the Serbian retreat to the coast in return for territorial concessions to Montenegro in western Serbia and northern Albania.

During the retreat the attitude of the Montenegrin dynasty remained highly equivocal, and the key position of Mount Lovčen was surrendered to the Austrians almost without a struggle. Parliament voted unanimously in favour of holding out to the end with Serbia, but the king negotiated on his own initiative without authorization from his Government, and on Jan. 1916 addressed a telegram of submission to Francis Joseph. Failing to obtain the terms which he had hoped, he and his family, with the premier Miušković, fled to Italy. During the next two years his second son, Prince Mirko, intrigued in Vienna and was connected with various Austrophil projects for a vassal Yugoslav state under the Petrović dynasty; he died in 1918 in an Austrian sanatorium. Meanwhile, King Nicholas resided in France and tried to silence

criticism from the Left by making Radović his premier. But when the latter advocated the formal proclamation of union and a simultaneous abdication of Nicholas and Peter in favour of the Prince Regent Alexander, Nicholas threw himself definitely into the arms of the anti-unionists, and by the end of the war found his court reduced to a tiny clique of personal dependents and adventurers.

Union with Serbia.—When Austria-Hungary collapsed in October 1918 and national councils were erected in all the Yugoslav provinces, the current in Montenegro set more strongly than ever in favour of union. A National Assembly was convoked on November 12 at Podgorica and proclaimed the deposition of the Petrović dynasty and the union of Montenegro with Serbia. On the death of Nicholas the royal title fell into abeyance, as Crown Prince Danilo did not wish to assume it and his nephew Michael was a minor.

The long strain of war increased the already chronic misery tenfold, and acute discontent was aroused by the bad administration, favouritism and centralist tendencies of Belgrade. There were numerous cases of brigandage and party vengeance which were conveniently misrepresented abroad as a movement for independence. In 1924, however, a marked improvement began. In the summer of 1925 King Alexander paid his first official visit to Montenegro, and the remains of his great-great-grand-uncle the Vladika Peter (the greatest of Serbian poets) were transferred to a mausoleum built at the king's expense on the summit of Lovčen by the Dalmatian sculptor Meštrović. (*See* YUGOSLAVIA.)

BIBLIOGRAPHY.—*See* Coquelle, *Histoire du Montenegro* (Paris, 1895); R. Wyon and G. France, *The Black of the Black Mountain* (1911); T. Božović and Jovan Djonović, *Crna Gora i Napredni Pokret* (*Montenegro and the Progressive Movement*) (Belgrade, (1911); T. Božović and Jovan Djonović, *Crna Gora i Napredni Il Montenegro nella guerra europea* (1917); L. Bresse, *Le Montenegro Inconnu* (Paris, 1920); *Le Bulletin Monténégrin* (Paris, 1916–18); N. Saulić, *Crna Gora* (Belgrade, 1924); articles by Miušković, Plamenac and other leading Montenegrins in *Nova Evropa* of Zagreb.

(R. W. S.-W.)

MONTE OLIVETO MAGGIORE: *see* ASCIANO.

MONTEPULCIANO, town and episcopal see, province of Siena, Tuscany, Italy, 44 m. S.E. of it by rail. Pop. (1921), 5,537 (town); 15,959 (commune). The town, 6 m. W. of the station, crowns the summit of a hill (1,984 ft.), and is surrounded by mediaeval walls. Protected by Siena till 1202, it declared for Florence and thenceforward passed from one mistress to the other, until it finally became Florentine (1559). Most of the buildings belong to the Renaissance, except the castle and the 14th-century Palazzo Pubblico. There are fine private houses by Antonio da Sangallo the elder (1455?–1534), Baldassare Peruzzi (1481–1536) and Vignola (1507–1573). The beautiful church of S. Biagio—Sangallo's masterpiece—was built in 1518–45. The cathedral built by Bartolommeo Ammanati (1570), contains a large altar-piece by Taddeo di Bartolo of Siena, and the fragments of the tomb of Bartolommeo Aragazzi, secretary of Pope Martin V., erected by Michelozzo (1427–36). Montepulciano is famous for its wine, and was the birthplace of Politian (*q.v.*) and of Cardinal Bellarmine (1542–1621).

See F. Bargagli-Petrucci, *Montepulciano, Chiusi, &c.* (Bergamo, 1907).

MONTEREAU, a town of northern France, in the department of Seine-et-Marne at the confluence of the Yonne with the Seine, 21 m. S.E. of Melun by rail. Pop. (1926) 8,917. The 13th century church has a façade of the Renaissance period. The industries include the manufacture of porcelain, fire-proof and decorative bricks, boots and shoes and agricultural machines and colours and varnish, and trade is in grain, cattle and agricultural produce. Among the institutions are a tribunal of commerce and a chamber of arts and manufactures. Montereau in the beginning of the 15th century was of some importance. Here, on the bridge over the Yonne, Jean Sans-Peur, duke of Burgundy, was assassinated in the presence of the Dauphin, afterwards Charles VII., in 1419. In 1438 the town was captured by Charles VII., and during the wars of religion it was several times taken and retaken. In 1814 Napoleon gained a victory at Montereau over the Würtemberg troops under Schwarzenberg.

MONTEREY, a city of Monterey county, California, U.S.A., 90 m. S. by E. of San Francisco, at the south-east extremity of Monterey bay, a deep indentation of the coast, 22 m. across from headland to headland and 10 m. wide. It is served by the Southern Pacific railway and (for freight) by coastwise steamship lines other communities on the peninsula. The Presidio of Monterey, is the centre of many historic associations, and since 1881, when the Southern Pacific company built the Del Monte hotel (in the midst of beautiful and extensive grounds, a mile or so to the east), the city, and the rest of the peninsula, have been one of the favourite year-round resorts of the coast. Rocky shores crowned with ancient twisted cypresses and pines, ocean and bays on three sides and sloping tree-clad hills, provide great natural beauty, and the climate is mild and equable, rarely reaching a temperature below freezing or above 80 F. Many artists and writers have their homes here, and at Carmel-by-the-Sea, Pacific Grove, and the other communities on the peninsula. The Presidio of Monterey, partly within the city limits, is an important U.S. army post. The waters of Monterey bay have a great variety and abundance of fish. A fleet of over 100 small boats is engaged in the fishing industry, and there are sardine canneries in the city. The sardine catch in 1927 was 173,881,177 pounds. The commerce of the harbour (381,374 tons in 1925, valued at $19,747,214) is increasing. A municipal wharf was built in 1925. Since 1925 the city has had commission-manager government. Pop. 1930, 9,141.

History.—Monterey Bay was discovered by Viscaino in 1602 and named after the then viceroy of New Spain, and in May 1770, it was rediscovered by Father Junípero Serra and Capt. Gaspar de Portolá. The Franciscan mission of San Carlos was founded here on June 3, 1770. It was moved almost immediately to Carmel valley, where Father Junípero built the church in which his remains now rest. A *presidio* was completed in 1778. Until the coming of the Americans Monterey was the gayest and most ambitious city of California, the principal military, commercial and financial centre. In 1818 it was captured and held briefly by a Buenos Aires privateer. It played an important part in the jealousies that divided the northern and the southern settlements. Except for a short time (1845–47) it was the capital of California until the constitution of the new State was adopted in 1849. It was the county seat until 1872. After the discovery of gold its importance declined and San Francisco took the leading place. The flag of the United States was raised over Monterey for a day in 1842, and again, permanently, on July 7, 1846. The first American newspaper on the coast was published here, and here (in Colton hall in Sept. 1849) met the convention which framed the first Constitution of the State. Colton hall is now used as the city-hall. The first theatre in California, the first brick house and the first house of planed lumber, were built here, and are still standing, as is also the old custom house, which has flown the flags of Spain, Mexico and the United States.

MONTERO RIOS, EUGENIO (1832–1914), Spanish politician, was born at Santiago de Compostela, Corunna, Nov. 13, 1832. In 1864 he was appointed professor of canon law at the university of Madrid, and in 1869 entered the Cortes. He followed Ruiz Zorilla and as Minister of Justice in General Prim's Cabinet he introduced a number of important judicial reforms and drew up the act of abdication of King Amadeo. In 1881 he helped to found the Radical party and became Minister of Justice in 1889. From 1894–5 he was president of the Senate. He was chief of the Spanish delegation which negotiated the Treaty of Paris with the United States at the close of the Spanish-American War of 1898. In 1899 he was again president of the Senate. In 1903 he was elected leader of the Liberal party and in 1905 became Prime Minister. He resigned the leadership of the Liberal party in 1906 and was president of the Senate for the third time from 1909–14. He died at Madrid on May 12, 1914.

MONTERREY, capital of Nuevo Léon, on the Santa Catalina river, 45 m. N.E. of Saltillo, Mexico. At this strongly fortified city, on Sept. 19–24, 1846, occurred one of the hardest fought battles of the war between Mexico and the United States (1846–48). Some 10,000 Mexicans under Gen. Ampudia gar-

risoned Monterrey, against which 3,080 American regulars and 3,150 volunteers commanded by Maj.-Gen. Zachary Taylor advanced. As the Americans approached the town (Sept. 19) they were greeted by a sharp fire. To reduce the stronghold they were equipped with only 4 field batteries, a 24 lb. howitzer and one 10 in. mortar, but information revealed that the western end of the city was vulnerable in flank. Colonel Worth, with about 2,000 men, advanced to that quarter in order to turn Independence Hill and occupy the Saltillo highway, which was the only avenue of retreat southward for the Mexicans. Having moved forward about 7 m. through thick country he was stopped by darkness and a heavy storm. The next day he repulsed a charge of Mexican cavalry, assaulted Federation Ridge, took three forts, and succeeded in sending forward to Independence Hill, the main flank position, about 500 regulars. Meanwhile, at the eastern end of the city, Taylor had not succeeded so well. Col. Garland, being sent forward with little more direction than that he should take his column off to the left, advanced through fields, thickets and crooked streets in the face of a withering fire. The American artillery could do little execution and the units without much centralized leadership were separated. At a crucial moment, however, Col. Jefferson Davis led a charge that took the principal outlying fortress, but the First Ohio regiment farther to the right had to retreat with heavy loss. On the western side of the town, Worth's troops, having crouched at the base of Independence Hill all night in the rain and cold, quietly crawled at dawn toward the summit, where they took the crest and sent the garrison fleeing (Sept. 22). The next morning Col. Quitman, who was occupying the captured works on the east side of the town, started an attack from house to house on his own initiative. Hearing Worth's cannon, which had been dragged to the top of Independence Hill, firing with effect, Quitman's scattered men closed in. Worth, now feeling from the firing heard from Quitman's troops that a general engagement was taking place, started toward the town. Leaving a force to guard the Saltillo highway, he had his men with pickaxes, crowbars and shells with fuses, work from house to house. At noon both sides, weary of the struggle, rested. Night fell with the Mexicans cooped in the Plaza. When the morning came (Sept. 24) the Ohio volunteers, who had taken the place of Quitman's troops, prepared to renew hostilities when a bugle in front sounded a parley. Ampudia proposed an armistice, to which Taylor acceded. In consideration of the receipt of the city by the Americans, the Mexicans were allowed to retain their individual arms, ammunition and six field pieces. The American loss had been heavier than that of the Mexicans.

Bibliography.—J. H. Smith, *The War with Mexico*, vol. i. (1919); G. B. McClellan, *The Mexican War Diary* (1917); C. M. Wilcox, *History of the Mexican War* (1892); W. A. Ganoe, *The History of the United States Army* (1924); Original Correspondence and Reports in Old Files Section, Adjutant General's Office (Washington, D.C.).

(W. A. G.)

MONTE SAN GIULIANO, town and episcopal see, Sicily, province of Trapani, 2 m. E.N.E. of it, on the summit of an isolated bare hill, which rises 2,465 ft. above the sea. Pop. of commune (1921), 31,148; of town, 13,404. The town occupies the site of the ancient Eryx, a city of the Elymi. (*See* Sicily.) It was famous for the temple of Venus Erycina on the summit of the mountain. The town was seized by Pyrrhus in 278 B.C., and by Hamilcar Barcas in 243–241, and was ceded to Rome at the end of the First Punic War. In Roman times the temple possessed territory of its own, and a considerable number of female slaves. Eryx was the residence of the quaestor of the western half of the island, and Verres spent some time here. Considerable portions of the city wall (a Roman reconstruction), are preserved on the north-west (on the east and south are precipitous cliffs). The mediaeval castle, with three lofty towers guarding the entrance, occupies the south-eastern extremity of the town. The cathedral (1314), has a fine porch and Gothic façade.

See J. Kromayer, *Antike Schlachtfelder* iii. 1 (Berlin, 1912), who maintains that the present town occupies only the acropolis, and that the city, which was occupied by Hamilcar, lay further to the north-west.

MONTE SANT' ANGELO, a town of Apulia, Italy, province of Foggia, 10 m. N. of Manfredonia by road, 2,765 ft. above sea-level, on the southern slopes of Monte Gargano. Pop. (1921), 21,547 (town); 23,573 (commune). It has a ruined Norman castle and a famous sanctuary of S. Michele, founded in 491 over a cave in which the archangel is said to have appeared to S. Laurentius, archbishop of Sipontum; the bronze doors, made in Constantinople, bear the date 1076. The octagonal campanile dates from 1273. The portal of S. Maria Maggiore is noteworthy. The Tomba di Rotari is a domed building of the Norman period.

See S. Beltramelli, *Il Gargano* (Bergamo, 1907), well illustrated.

MONTESPAN, FRANÇOISE-ATHÉNAÏS DE PARDAILLAN, Marquise de (1641–1707), mistress of Louis XIV., was born at the château of Tonnay-Charente (Charente-Inférieure) the daughter of Gabriel de Rochechouart, duc de Montmartre. In 1661 she became maid-of-honour to Queen Maria Theresa, and two years later she married L. H. de Pardaillan de Gondrin, marquis de Montespan, by whom she had two children. A beautiful and brilliant woman, she became mistress of Louis XIV. in 1667. The first of the seven children Mme. de Montespan bore to the king was born in March 1669, and was entrusted to Mme. Scarron, the future Mme. de Maintenon, who acted as companion to Mme. de Montespan while the king was away at the wars. The eldest, Louis Auguste, became duc de Maine, the second, Louis César, comte de Vexin, and the third, Louise Françoise, demoiselle de Nantes (afterwards duchesse de Bourbon). These children were all legitimatized in 1673. When Louis's affection showed signs of cooling, Mme. de Montespan resorted to magic. The frequent occurrence of her maid's name in the evidence before the Chambre Ardente threw suspicion on her connection with La Voisin, but the affair was hushed up. (*See* La Voisin, C., for an account of the poisoning affair.)

In 1691, Mme. de Montespan retired to the Convent of St. Joseph with a pension of half a million francs, and honours for the members of her family. She was a generous patron of letters, and befriended Corneille, Racine and La Fontaine. She died at Bourbon l'Archambault on May 27, 1707.

See P. Clément, *Madame de Montespan et Louis XIV.* (1869); monographs by Arsène Houssaye (1865) and by H. Williams (1903); also J. Lair, *Louise de la Vallière* (Eng. trans., 1908); F. Funck-Brentano, *Le Drame des Poisons* (1899); A. Durand, "Un épisode du grand règne," in *Rev. des questions hist.* (Paris, 1868); the contemporary memoirs of Mme. de Sévigné, of Saint-Simon, of Bussy-Rabutin and others; also the proceedings of the Chambre Ardente preserved in the *Archives de la Bastille* (Arsenal library) and the notes of La Reynie preserved in the Bibliothèque Nationale. She figures in V. Sardou's play, *L'Affaire des poisons* (1907).

MONTESQUIEU, CHARLES LOUIS DE SECONDAT, Baron de la Brede et de (1689–1755), French philosophical historian, was born at the château of La Brède, near Bordeaux, in January 1689. His mother was Marie Françoise de Penel, the heiress of a Gascon-English family. She had brought La Brède as a dowry to his father, Jacques de Secondat, a member of a good if not extremely ancient house, which seems first to have risen to importance in the early days of the 16th century. The title of Montesquieu came from his uncle, Jean Baptiste de Secondat, "président à mortier" in the parliament of Bordeaux—an important office, which, as well as his title, he left to his nephew. Montesquieu was in his youth known as M. de la Brède. His mother died when he was seven years old. The boy was educated at the Oratorian school of Juilly, near Meaux, and afterwards at Bordeaux. His father died in 1713, and a year later Montesquieu was admitted counsellor of the parlement. In 1715 he married Jeanne Lartigue, an heiress, plain, somewhat ill-educated, and a Protestant. They appear to have lived on good terms. In 1716 his uncle died, leaving him his name, his important judicial office and his whole fortune.

He continued to hold his presidency for twelve years, and he contributed papers on philosophy, politics and natural science to the Bordeaux Academy. During the earlier years of his presidency he finished the *Lettres persanes,* printed anonymously at Amsterdam, 1721, though Cologne appears on the title-page. In the guise of letters written by and to two Persians of distinction travelling in Europe, Montesquieu satirized unmercifully the social, political, ecclesiastical and literary follies of his day in

France, and indulged in a great deal of the free writing which was characteristic of the tale-tellers of the time. But what scandalized grave and precise readers naturally attracted the majority, and the *Lettres persanes* were very popular, passing, it is said, through four editions within the year, besides piracies. Then the vogue suddenly ceased, or at least editions ceased for nearly nine years to appear. Possibly a formal ministerial prohibition was the cause of this; for, though the regent and Guillaume Dubois must have enjoyed the book thoroughly, they were both shrewd enough to perceive that underneath its playful exterior there lay a spirit of very inconvenient criticism of abuses in church and state. The fact is that the *Lettres persanes* is the first book of what is called the Philosophe movement. It is amusing to find Voltaire describing the *Lettres* as a "trumpery book," a "book which anybody might have written easily." It is not certain that, in its peculiar mixture of light badinage with serious purpose and moderation, Voltaire could have written it himself, and it is certain that no one else at that time could.

Montesquieu composed for, or at any rate contributed to, one of the coteries of the day the clever *Dialogue de Sylla et d' Eucrate,* in which the dictator gives an apology for his conduct. For Mlle. de Clermont he wrote the curious prose-poem of the *Temple de Gnide.* A later *jeu d'esprit* of the same kind, which is almost but not quite certainly Montesquieu's, is the *Voyage à Paphos,* in which his warmest admirers have found little to praise. In 1725 Montesquieu was elected a member of the Academy, but an almost obsolete rule requiring residence in Paris was appealed to, and the election was annulled. In 1726 Montesquieu sold the life-tenure of his Bordeaux office, reserving the reversion for his son, and went to live in the capital, returning, however, for half of each year to La Brède. Fleury, a precisian in many ways, was shocked by the *Lettres Persanes,* and his opposition had to be overcome before Montesquieu was admitted, in January 1728, to the Academy.

Almost immediately afterwards he started on a tour through Europe to observe men, things and constitutions. He travelled through Austria to Hungary, but was unable to visit Turkey as he had proposed. Then he made for Italy, where he met Chesterfield. At Venice, and elsewhere in Italy, he remained nearly a year, and then journeyed by way of Piedmont and the Rhine to England. Here he stayed for some eighteen months, and acquired an admiration for English character and polity which never afterwards deserted him. He returned, not to Paris, but to La Brède, and to outward appearance might have seemed to be settling down as a squire. He altered his park in the English fashion, made sedulous inquiries into his own genealogy, arranged an entail, asserted, though not harshly, his seignorial rights, kept poachers in awe and so forth. But in his great study at La Brède (a hall rather than a study, some 60 ft. long by 40 wide) he was constantly dictating, making abstracts, revising essays, and in other ways preparing his main book. He may have thought it wise to soften the transition from the *Lettres persanes* to the *Esprit des lois,* by interposing a publication graver than the former and less elaborate than the latter. The *Considérations sur les causes de la grandeur et de la décadence des Romains* appeared in 1734 at Amsterdam, without the author's name. This, however, was perfectly well known; indeed, Montesquieu formally presented a copy to the French Academy.

But the author's reputation as a jester stuck to him, and the salons affected to consider the *Lettres persanes* and the new book respectively as the "grandeur" and the "décadence de" M. de Montesquieu; but more serious readers at once perceived its extraordinary merit, and it was eagerly read abroad. A copy annotated by Frederick the Great, was abstracted from the Potsdam library by Napoleon. The book is (putting Bossuet and Giovanni Vico aside) almost the first important essay in the philosophy of history. The point of view is entirely different from that of Bossuet, and it seems entirely improbable that Montesquieu knew anything of Vico. It is grave and destitute of ornament, but extraordinarily luminous. Printed in large type with tolerably abundant notes, it fills but two hundred pages in the standard edition of Montesquieu's works. But no work of the century, except Turgot's second Sorbonne *Discours,* contains, in proportion to its size, more weighty and original thought on historical subjects, while Montesquieu has over Turgot the immense advantage of style.

Montesquieu, though he was now advanced with his magnum opus, *L'Esprit des Lois,* published in the interim new editions of his earlier works, and made frequent visits to Paris. He did not begin the final task of composition till 1743. Two years of uninterrupted work at La Brède finished the greater part of it, and two more the rest. It was finally published at Geneva in the autumn of 1748, in two volumes quarto. Before publication Montesquieu summoned a committee of friends, according to a very common practice, to hear and give an opinion on his work. It consisted of Hénault, Helvétius, the financier Etienne de Silhouette, the dramatist Saurin, Crébillon the younger, and Fontenelle. They unanimously advised the author not to publish a book which has been described as "one of the most important books ever written," and which may be almost certainly ranked as the greatest book of the French 18th century.

Montesquieu, of course, did not take his friends' advice. The *Esprit des lois* represents the reflections of a singularly clear, original, and comprehensive mind, corrected by forty years' study of men and books, arranged in accordance with a long deliberated plan, and couched in language of remarkable freshness and idiosyncrasy. In the original editions the full title runs *L'Esprit des lois: ou du rapport que les lois doivent avoir avec la constitution de chaque gouvernement, les mœurs, le climat, la religion, le commerce, etc.* It consists of thirty-one books, which in some editions are grouped in six parts. Speaking summarily, the first part, containing eight books, deals with law in general and with forms of government; the second, containing five, with military arrangements, with taxation, etc.; the third, containing six, with manners and customs, and their dependence on climatic conditions; the fourth, containing four, with economic matters; and the fifth, containing three, with religion. The last five books, forming a kind of supplement, deal specially with Roman, French and feudal law. The spirit of moderation which distinguishes its views on politics and religion was indeed rather against it than in its favour in France, and Helvétius had definitely assigned this as the reason of his unfavourable judgment. On the other hand, if not destructive it was sufficiently critical, and it raised enemies on more than one side. The book (not altogether with the goodwill of the pope) was put on the Index, and the Sorbonne projected, though it did not carry out, a regular censure. Opposition gradually died away; even Voltaire, who was his decided enemy, was forced at length to speak in public, if not in private, complimentarily of the *Esprit,* and from all parts of Europe the news of success arrived.

Montesquieu enjoyed his triumph rather at La Brède than at Paris. He spent much of his later years in the country, though he sometimes visited Paris, and on one visit procured the release of his admirer La Beaumelle from an imprisonment which La Beaumelle had suffered at the instance of Voltaire. The curious little romance of *Arsace et Isménie,* a short and unfinished treatise on Taste, many of his published *Pensées,* and much unpublished matter date from the period subsequent to the *Esprit des lois.* At the end of 1754 he visited Paris, with the intention of getting rid of the lease of his house there and finally retiring to La Brède. He died on Feb. 10, 1755, and was buried in the church of St. Sulpice.

At the beginning of the next century the vicomte de Bonald classed Montesquieu with Racine and Bossuet, as the object of a "religious veneration" among Frenchmen. The statement requires qualification; it is true of the moderate reforming party in France of the generation after the death of Montesquieu. Professor Saintsbury has said that "the real importance of the *Esprit des lois,* however, is not that of a formal treatise on law, or even on polity. It is that of an assemblage of the most fertile, original and inspiriting views on legal and political subjects, put in language of singular suggestiveness and vigour, illustrated by examples which are always apt and luminous, permeated by the spirit of temperate and tolerant desire for human improvement and happi-

ness, and almost unique in its entire freedom at once from doctrinairism, from visionary enthusiasm, from egotism, and from an undue spirit of system."

The best edition of Montesquieu is that of Edouard Laboulaye (7 vols., Paris, 1875–79), the best biography that of Louis Vian (Paris, 2nd ed., 1879). There is a good modern edition of the *Lettres persanes* by H. Backhausen (2 vols., 1913), for the *Soc. des textes français modernes.* The bibliography of Montesquieu was dealt with by L. Dangeau in 1874. There is known to exist at La Brède a great mass of MS. materials for the *Esprit des lois,* additional *Lettres persanes,* essays, and fragments of all kinds, diaries, letters, notebooks and so forth; in 1891 Baron Charles de Montesquieu published *Deux opuscules* of his ancestors, and in 1899 Baron Gaston de Montesquieu added *Pensées,* etc. See *Correspondance de Montesquieu* ed. F. Gebelin and A. Morize (2 vols., 1914); also Ch. Oudin, *Le Spinozisme de Montesquieu* (1911); and H. Knust, *Montesquieu und die Verfassungen der Vereinigten Staaten von Amerika* (Munich, 1922).

MONTESSORI, MARIA (1869–   ), Italian educationist, was born at Chiaravalle near Ancona. She studied at the University of Rome and graduated in medicine in 1894, being the first woman in Italy to do so. She then took up the subject of educating defective children. From the experience thus acquired, she came to the conclusion that similar methods might be applied to normal children of a lower age, and after a series of experiments on a small scale she extended them to a large number of children in certain private and public infant schools in Rome. Dr. Montessori encountered a good deal of opposition from advocates of orthodox methods in education who regarded her system as destructive of discipline. At the same time she was warmly supported by a certain number of enthusiastic reformers. From 1900 to 1907 Dr. Montessori lectured on pedagogical anthropology at the University of Rome and in 1922 was appointed Government inspector of schools in Italy. Her ideas on education are set forth in *The Montessori Method* (1912), which has been translated into English and other languages. (*See* EDUCATION; MONTESSORI SYSTEM.)

MONTESSORI SYSTEM. The Montessori method is a system of education originated by Dr. Maria Montessori, an Italian doctor of the University of Rome. Her first book, *The Montessori Method,* was published in 1912. It described experiments made with little children (ages 3 to 6) in the slum quarters of Rome, in so-called "Children's Houses" (*Case dei Bambini*) or rooms set apart in the courtyards of large tenement buildings as part of a reformed dwelling scheme inaugurated by E. Talamo. Dr. Montessori began her studies of educational problems with defective children. Working on lines first laid down by the French physician, Dr. Séguin, she achieved startling results; idiot children under her tutelage passing the State examination in reading and writing for normal children. She then turned her attention to the education of normal children, since it seemed to her that if backward children by educational means could be led to overtake normal children, it should be possible to produce still more startling results with the normal child. A year in the *Casa dei Bambini* justified her hopes. These schools became world-famous, and were visited from all parts.

Before starting work with normal children Dr. Montessori had examined the educational systems of Europe, and to her it seemed astonishing to find everywhere the children reduced to immobility in the class-rooms "like rows," as she said, "of butterflies transfixed with a pin." Such children, she declared, were not "disciplined but annihilated." In her schools the contrary practice was established. Freedom of movement was the rule, provided it did not transgress the borders of good manners, social order and harmony. She proved that on these lines an astonishingly perfect discipline can be built up, even with quite tiny children. The children worked happily together moving independently to and fro, as in a well-ordered community of adults. Such "free discipline," as it is now called, is beginning to be everywhere adopted in schools.

But another, and, if anything, more profound aspect of her work lies in the "educational apparatus" or "didactic material" specially provided. Building on the work of Séguin, Dr. Montessori discovered that it is possible to devise objects of a very simple and yet exact type which provoked in the young child a profound reaction of interest and attention, such as she, in common with previous psychologists, had never believed possible. At first, she tells us, she could hardly believe her eyes. Little children of between three and four would repeat an exercise with an air of concentration and indifference to surrounding distractions, that we have been hitherto accustomed to associate only with men of genius. Such a period of "work" might continue from a quarter of an hour to an hour, and then the child would seek other work, upon which he would concentrate in a similar way. Moreover, the child did not seem tired, as after an enforced effort, but rather refreshed and tranquillized. Indeed, disorderly children—those of a type likely at any moment to lapse into some form of indiscipline—invariably acquired inward stability once they had entered upon this form of spontaneous work. The teacher in the second and subsequent years of the class's formation had very little to do in the direction of maintaining order.

This set her the more free for a delicate and exacting portion of her work, the teaching of the children by giving them little, mainly individual, lessons at appropriate moments, and in introducing them to new portions of the material as required. Wherever movements are involved, the teacher shows in *the first instance the precise and best way* of performing the movement. This prevents the formation of an imperfect habit and has universal importance, as all teachers of music or games are aware. Thus children, at an early age, can scrub a table and consider it part of the fun not to spill a drop of water; they can wash-up after meals, wring out and iron their little dusters, etc. Little waiters carry round the dishes at meals, and it is no uncommon sight to see a child of three in sole charge of the soup tureen.

Children in the *Casa dei Bambini* learn to write, read, count and work simple sums before the age of six. Since the publication of her first book, Dr. Montessori has been at work on material for older children, and has now perfected means by which they can individually study grammar, geometry, arithmetical operations with large numbers, fractions and so on. Music and art work is also fully developed. An account of this is given in her book, *The Advanced Montessori Method,* dealing with the ages six to ten.

Dr. Montessori, who is a Roman Catholic, has also evolved methods of religious instruction for use in connection with her system. (*See* also NURSERY SCHOOLS, KINDERGARTEN.)

(C. A. C.)

BIBLIOGRAPHY.—M. Montessori, *Il Metodo della Pedagogia Scientifica* (1913), trans. A. E. George, *The Montessori Method* (1919); *Advanced Montessori Method* (trans. F. Simmonds, 2 vols., 1917); *Dr. Montessori's Own Handbook* (1914). *See* also E. P. Culverwell, *The Montessori Principles and Practice* (1913); E. Y. Stevens, *A Guide to the Montessori Method* (1913); Dorothy C. Fisher, *The Montessori Mother* (1914); W. Boyd, *From Locke to Montessori* (1914); L. Serrano, *La Pedagogia Montessori* (1915); E. Lucentini, *Il metodo Montessori e il metodo Fröbel* (1919); P. Allessiani, *Rousseau e il Metodo Montessori* (1920); C. A. Claremont, *A Review of Montessori Literature* (1919).

MONTEVERDI or **MONTEVERDE, CLAUDIO** (1567–1643), Italian composer, was born at Cremona in May 1567. His attention was early directed to the infant art of instrumental music, and the duke of Mantua gave him his first appointment as viola player, under Ingegneri, a good polyphonic church composer (his *Responsoria* were long ascribed to Palestrina), from whom he learnt composition. In 1602 he succeeded Ingegneri as maestro di capella to the duke; and in 1607 he made a decisive impression with his first opera, *Arianna,* in which was revealed the emotional and dramatic value of a new treatment of discords which, in his unaccompanied madrigals, had merely seemed to indicate the downfall of pure polyphony. This work at once elevated the lyric drama, feebly essayed by Peri's *Euridice* in 1600, to a level of art which musicians were henceforth compelled to take seriously. Still more successful was *Orfeo,* composed in 1608. In *Il Combattimento di Tancredi e Clorinda,* the description of a duel was accompanied by quickly repeated chords on the strings (not, as is usually alleged, a tremolo) which so scandalized the players that all Monteverdi's tact and determination was needed to induce them to play it. He had already written *pizzicato* passages (with the direction "here you put down the bow and pull the string with the finger"). The Amati family

of violin makers at Cremona had begun their work in the nick of time for Monteverdi's purposes; for it is doubtful whether even his resourcefulness could have so effectively revolutionized music if the feeble flat-backed viols had been his only instruments with string and bow. In 1613 Monteverdi became maestro di capella at St. Mark's, Venice, where he composed much sacred music, now lost. In 1632 he became a priest. He produced four more operas before his death, on Nov. 29, 1643.

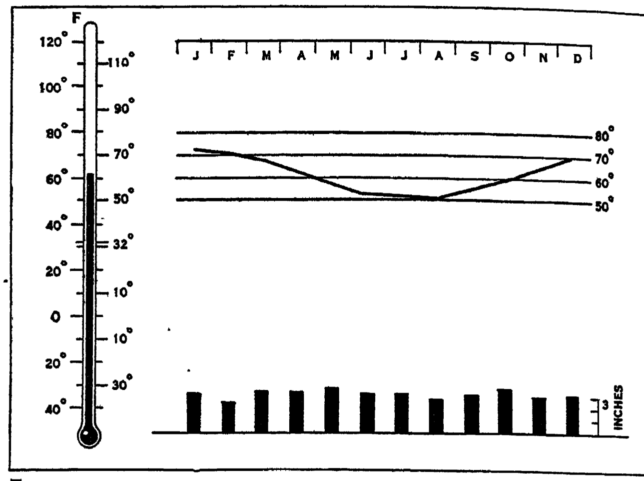
Monteverdi's conspicuous position in musical history gives rise to many misunderstandings as to his artistic merits. In the history of the fine arts it is much easier to write vividly about tendencies than about results. Mature works of art are things in themselves, and demand to be so understood without regard to what comes after them. Resisting interpretation in other terms than their own, they are not easy to describe. But tendencies are always interesting. Accordingly the student finds that the historian whom Palestrina and Bach paralyse into hagiology writes as if Monteverdi were the Wagner of a 17th century more glorious than the 19th. And this is difficult to reconcile with the fact that if all the music of the 17th century were destroyed, not a single concert-goer would miss it. A glance at the score of one of Monteverdi's operas, or at the quotations given in musical histories, produces a disillusion unnecessarily great; we seem to be plunged into a more archaic period than that of the earliest efforts at polyphony. A modern stage performance restores the illusion. But an illusion it remains; for Monteverdi lived in the hey-day of baroque stage-production, and on anything like a faithful reproduction of his stage, it matters little whether we hear his finest rhetoric, or poor Peri's efforts, or the experimental psalmody of modern amateurs who know nothing about music.

Meanwhile good service has been done in the rehabilitation of Monteverdi as an artist, by Malipiero's complete score of all his extant madrigals. In his preface, Malipiero holds up, as a warning to modern critics, the censure of Artusi, and points out that Artusi recanted afterwards. The warning is misplaced. Monteverdi was no Keats, neither was Artusi a *Quarterly* reviewer. Artusi saw, and said, that the treatment of discords in Monteverdi's madrigals was subversive of pure polyphony. This was true, and Monteverdi's reply was that the rules of Zacconi's *Practica di Musica,* which were in conflict with the details (*alcune minime particelli*) of modern music, did not concern him, since he was not writing by accident, but was establishing a *Seconda Pratica* which, at the instigation of Artusi's attack (*Degli Imperfezioni,* etc.) he would call *La Perfettione della Musica Moderna.* In these six books of extant madrigals, it is fascinating to trace the conflicting elements: the decadence of an old style; the too facile exploitation of new formulas; and, now and again, the achievement of something powerful and mature, which, if introduced into a madrigal concert, would make it impossible to continue the programme with orthodox madrigals.

(D. F. T.)

MONTEVIDEO, capital and chief port of Uruguay, and capital of the department of Montevideo, on the northern shore of the Río de la Plata estuary, 120 m. E.S.E. of Buenos Aires, in lat. 34° 54′ 33″ S., long. 56° 12′ 18″ W. Pop. (1927) 418,000. The old section of the city occupies a low, rocky headland that projects westward between the estuary and an almost circular bay which forms the harbour; it was once enclosed with walls and defended by small forts, all of which have been removed. The new sections of the city extend eastward over a beautiful tract of rolling country, and northward around the eastern shore of the bay. The site of the old city resembles a whale's back in shape; it slopes gently to the western extremity of the city and its union with the newer section, on the line of the old ramparts, known as Calle de la Ciudadela. The streets are well paved and have sufficient slope at all points to give easy surface and underground drainage: Montevideo has the reputation of being one of the cleanest cities of the world. The rainfall is ample (about 44 in. a year), and the prevailing winds help to clean the streets. The mean annual temperature is about 62° F. An abundant water-supply is brought from the Santa Lucía river, 32 m. distant, with a receiving reservoir at Piedras, 100 ft. above the level of the Plaza de la Independencia. The older parts of the city are largely devoted to commercial, shipping and financial interests. The Government edifices, large retail shops and most of the fine urban residences are in the *ciudad nueva* (New City). Numerous bus and electric tramway lines extend to suburbs and to the bathing resorts of Ramírez, Maldonado and Pocitos and the Buceo cemeteries on the eastern coast.

Plazas and Buildings.—One of the finest boulevards in South America is the Calle 18 de Julio, extending eastward from the Plaza de la Independencia to the suburbs. There are numerous plazas within the urban limits: Zabala or Rincón, Constitución or Matriz, Independencia, Libertad or Cagancha, Treinta y Tres, Flores and Frutos, and several suburban parks, the Paseo del Prado and Parque Urbano being among the most popular. The Plaza de la Independencia stands at the junction of the old and new towns and is the centre of the city's political and social life. This square is distinguished for a uniform and nearly completed line of colonnades in front of the buildings surrounding it. The Paseo del Prado, which ranks high among the public gardens of South America, is beautifully situated beyond the suburb of Paso Molino, 3 m. from the city. The Paseo was originally the *quinta* (villa) of a German of cultivated tastes named Joseph Buschenthal, who spent a fortune in its adornment. The Parque Urbano, at the Playa Ramírez bathing resort, is a modern creation. The buildings of Montevideo are chiefly of brick and broken stone, covered outside with plaster and stucco, of one to three storeys, with flat roofs, usually surmounted by a square tower, or *mirador*. The roofs, or *azoteas,* are largely used for domestic purposes, or roof gardens. The city contains a large number of handsome edifices, both public and private, among which are the Bolsa, Government House, municipal hall, cathedral, Cabildo, Hospital de Caridad, insane asylum, Italian hospital, Athenaeum, the Club Uruguayo and theatres. The Bolsa (exchange), custom-house, cathedral and Cabildo are in the old town; the Bolsa is a copy of the Bordeaux exchange. The cathedral faces on the Plaza pavement, and these, with a large dome behind, rise far above de la Constitución. Its two square towers stand 133 ft. above the the surrounding buildings and make a conspicuous landmark. The church was consecrated in 1804, and in 1869 was raised to the dignity of a cathedral. Montevideo is now the seat of a small archiepiscopal see with only two suffragan dioceses. Directly across the plaza is the old Cabildo, a plain, heavy-looking two-storeyed edifice of the colonial period, the seat of municipal administration during Spanish rule, but now occupied by the two chambers of the Uruguayan Congress and by the higher police authorities of the city.



TEMPERATURE AND PRECIPITATION IN MONTEVIDEO. THE MERCURY STANDS AT THE NORMAL ANNUAL MEAN TEMPERATURE, THE CURVE SHOWS THE NORMAL MONTHLY MEAN TEMPERATURE THROUGH THE YEAR, AND THE COLUMNS BELOW INDICATE NORMAL MONTHLY PRECIPITATION

Charities and Schools.—The people of Montevideo maintain more than 40 charitable associations, including the Caridad (charity) hospital on Calle 25 de Mayo, and the insane asylum

in the suburb of La Union, both built and largely supported from the proceeds of frequent lottery drawings. They also maintain a beggars' asylum and a foundlings' asylum. The national museum (founded in 1830) and public library (founded 1833) are in one wing of the Solis theatre. There are a British hospital (founded 1857, the present edifice dating from 1867) chiefly for the use of sailors, an Anglican church in Calle Santa Teresa dating from 1847, and a handsome Italian hospital of modern construction. The University of Montevideo has faculties of law, medicine, letters, mathematics, engineering and other groups of studies, including agriculture and veterinary science. The Government maintains normal schools, a school of arts and trades (*artes y oficios*) and a military school.

Commerce.—The harbour of Montevideo consists of a shallow bay, circular in shape, opening to the south-east, and about 2½ m. from shore to shore, and an outer roadstead exposed to the violent winds of this latitude, where the larger ocean-going steamers were compelled to anchor before the construction of the present port works. In 1899 the Uruguayan Government entered into a contract for the dredging of the bay, the construction of two long breakwaters, the dredging of a channel to deep water, and the construction of a great basin and docks in front of the city. Surtaxes were imposed on imports and exports to meet the expenditure, and work was begun in 1901. The entrance channel, with a minimum depth of 24½ ft., permits the admission of large steamers. Another important improvement, for which a concession was given to an English syndicate, is the extension embankment and new shore line on the south side of the city. There are three large dry-docks connected with the port, known as the Mauá (275 ft. long, inside) and the Gounouilhou (300 ft.) on the east side of the bay, and Jackson and Cibils (450 ft.) on the west side at the foot of the Cerro. Four railways terminate at Montevideo, one of them (the Central Uruguay) extending to the Brazilian frontier. Many lines of ocean-going steamers make regular calls at the port and several lines of river steamers operate to Buenos Aires and the ports of the Paraná, Paraguay and Uruguay rivers. The exports consist chiefly of live stock, jerked beef, hides, wool and other animal products, wheat, flour, corn, linseed, barley, hay, tobacco, sealskins, fruit, vegetables and some minor products. Manufactures exist only to a limited extent and chiefly for domestic consumption.

Suburbs.—The suburbs of Montevideo include the fashionable bathing resorts of Playa Ramirez and Pocitos on the coast east of the city, the inland suburbs of Paso Molino and La Unión and the industrial town of Cerro, across the bay. Maldonado, east of the capital, is another popular resort. The Flores island quarantine station is 12 m. east of the city. The station was formerly on Rat island (within the bay), which is now used as a public deposit for inflammables. The chief point of natural interest is the conical hill known as the Cerro, or "mount," from which the city takes its name, on which stands an old Spanish fort from which rises a tower used as a radio station. The hill's elevation is 486 ft. and a lighthouse also rises from within the fort, carrying a revolving light visible 25 m. at sea.

History.—Montevideo was founded in 1726 through the efforts of Don Mauricio Zabala, governor of Buenos Aires, who wished to check the advance of the Portuguese on this side of the La Plata. A small military post had existed there since 1717, but efforts to create a town had been fruitless until Zabala offered to make *hidalgos* of the first settlers and to give them cattle and sheep. The first families to accept this offer came from the Canary islands in 1726 under the direction of Don Francisco Alzeibar; they were followed by others from Andalusia and some of the Spanish-American settlements. Its growth at first was slow, but on the abolition of the Cádiz monopoly in 1778 it became a free port and its trade increased so rapidly that it soon became one of the chief commercial centres of South America. The city was captured in 1807 by a British expedition under Sir Samuel Auchmuty, but was abandoned when the expedition against Buenos Aires under Gen. Whitelocke was defeated. In 1808 the governor of Montevideo established an independent junta, but after the Buenos Aires declaration of independence in 1810 the Spanish forces were concentrated in Montevideo and held it until expelled in 1814 by the Argentine land and sea forces under Gen. Alvear and Admiral Brown. The dissensions following the expulsion of the Spanish and the rivalries of Argentina and Brazil over the possession of Uruguay, then commonly termed the "Banda Oriental," greatly reduced the population of the city and partially destroyed its trade. It was made the capital of the republic in 1828 and had partially recovered its population and trade when the disastrous struggle with Rosas, dictator of Buenos Aires, broke out and the city was subjected to a nine years' siege (1843–52), the investment being conducted by Gen. Oribe, and the defence by General Paz. In 1864–1865 Brazil intervened in the affairs of the republic, blockaded the port, and reinstated ex-president Flores. The war with Paraguay that followed, which lasted until 1870, made Montevideo the base of supplies for the Brazilian army and navy and added largely to its trade and wealth. In addition to the reckless speculation of this period, there were continued political dissensions, repeated dictatorships and financial mismanagement on the part of the Government. Not the least of these burdens were the personal and irregular drafts of some of the executives upon the treasury and revenue officers, particularly the custom-house of this port, upon which the republic depended for the major part of its revenue. The commercial and financial collapse that followed lasted through the greater part of the last three decades of the century; but settled government and improved finances subsequently contributed to a slow but steady recovery in the trade and industrial activities of the city.

MONTEVIDEO, a city of south-western Minnesota, U.S.A., on the Minnesota river, 40 m. from the South Dakota State line; the county seat of Chippewa county. It is on Federal highway 212 and the main line of the Chicago, Milwaukee, St. Paul and Pacific Railroad. Pop. (1920) 4,419; in 1930, 4,319. It is in a rich farming, dairying, and stock-raising region, and has large grain elevators and several manufacturing industries using the products of the surrounding country.

MONTEZUMA II. (1466–1520), Aztec emperor of Mexico, was born in Mexico in 1466. In 1502, upon the death of his uncle, the emperor Ahuitzoll, he was elected his successor. Protracted wars waged against the republic of Tlaxcala, against Guatemala and against the rebellious province of Tehuantepec, as well as expeditions as far as Honduras and Nicaragua, greatly enlarged his empire. In 1518, word was brought to him of the landing of white men (Grijalva and his band) on the Mexican coast and he ordered the shores to be guarded because of the Aztec tradition that shortly before the break-up of the empire the first chief of the dynasty of Quetzalcoatl would appear out of the east. When Cortes and his men arrived the following year they were met by embassies from Montezuma with gifts of propitiation. Cortes marched toward the capital and soon made the emperor a virtual prisoner and used him to aid his designs for conquest. In June 1520, when the Spaniards were attacked by the natives of Mexico City, Montezuma appeared upon the palace roof to order his people to lay down their arms, but he was in turn attacked by them and so dangerously wounded that he died three days later. The people in their anger against him refused him the elaborate funeral ceremonies granted to all previous emperors.

MONTFAUCON, BERNARD DE (1655–1741), French scholar and critic, was born at the Château of Soulage, in France, on Jan. 13, 1655. He entered the army in 1672 and served for two years under Turenne. In 1675 he became a monk, and lived at various abbeys, going to Italy in 1698, and finally retiring to St.-Germain-des-Près, where he produced most of his works, and died on Dec. 21, 1741. His editions of the Fathers include *Athanasii opera omnia* (1690), still the best edition: *Collectio nova patrum* (1706); *Joannis Chrysostomi opera omnia* (1718–38). In addition, he wrote *Diarium italicum* (1702), an account of the libraries of Italy; and *L'Antiquité expliquée et représentée en figures* (1719), which laid the foundation of archaeology. The last two have been translated into English. His *Palaeographia graeca* (1708), illustrated the whole history of Greek writing.

A list of his works will be found in *Bibliothèque des écrivains de la congrégation de Saint-Maur,* by C. de Lame (1882), and in the

article in the *Nouvelle biographie générale*, which gives an account of their scope and character; *see* also Emmanuel de Broglie, *La Société de l'abboye de St.-Germain-des-Prés au 18e siècle: Bernard de Montfaucon et les bernardins* (2 vols., 1891).

MONTFERRAT, COUNT OF, a title derived from a territory south of the Po and east of Turin, and held by a family who were in the 12th century one of the most considerable in Lombardy. In 1147 a count of Montferrat took part in the second crusade. In 1176 William Longsword, eldest of the five sons of Count William III., came to the kingdom of Jerusalem, on the invitation of Baldwin IV. and the baronage, and married the heiress of the kingdom, Sibylla. He died within a few months; but his wife bore a posthumous son, who became Baldwin V. Count William III., himself (uncle to Philip of France and brother-in-law to Conrad III.) afterwards came to the Holy Land to watch over the interests of his grandson; and he was taken prisoner by Saladin at Hittin in 1187. Shortly after the battle of Hittin Count William's second son, Conrad, appeared. Conrad, following the family tradition, and invited by the emperor Isaac Angelus, had gone to serve at the court of Constantinople. He soon became important; married Isaac's sister, and defeated and killed a usurper; but he was repaid by ingratitude and suspicion, and fled to Palestine in 1187. Putting into Tyre he saved the city from the Mohammedan conquest which followed Saladin's victory at Hittin. He established himself firmly in Tyre (refusing admission to Guy, the king of Jerusalem); and from it he both sent appeals for aid to Europe and despatched reinforcements to the crusaders, who, from 1188 onwards, were engaged in the siege of Acre. His elder brother had been the husband of the heiress Sibylla, who had carried the crown to Guy de Lusignan by her second marriage, and on her death Conrad married her younger sister, Isabella, now the heiress of the kingdom, and claimed the crown (1190). The struggle between Conrad and Guy, supported by Philip Augustus and Richard I. respectively, paralysed the energies of the Christians in 1191. After the departure of Philip, Conrad fomented the opposition of the French to Richard, and even intrigued with Saladin against him. But Richard was finally forced to recognize him as king (April 1192). In the very hour of success, however, Conrad was struck down by the emissaries of the Old Man of the Mountain (the chief of the Assassins).

Another son of Count William III., Boniface of Montferrat, the younger brother of Conrad, was chosen leader of the fourth crusade in 1201, on the death of Theobald of Champagne. In the winter of 1201–02 he visited Philip of Swabia; and there he arranged the diversion of the fourth crusade to Constantinople (*see* CRUSADES). Yet in the course of the crusade he showed himself not unsubmissive to Innocent III., who was entirely opposed to such a diversion. After the capture of Zara, however, he joined the crusaders, and played a great part in all the events which followed till the capture of Constantinople by the Latins in 1204. But Baldwin of Flanders was elected emperor over his head; and his irritation was not wholly allayed by the grant of Macedonia, the north of Thessaly, and Crete (which he afterwards sold to Venice). In 1207 he was killed in battle with the Bulgarians. He left a son Demetrius, who assumed the title of king of Thessalonica, which the father had never borne (*cf.* Luchaire, *Innocent III.: La question d'Orient*, p. 190). In 1222 Demetrius lost his kingdom to Theodore Angelus, and the house of Montferrat its connection with the East.

See Savio, *Studi storici sul marchese Guglielmo III. di Monferrato* (Turin, 1885); Ilgen, *Markgraf Konrad von Montferrat* (1880); and also the works of Cerrato (Turin, 1884) and Desimoni (Genoa, 1886).

MONTFORT, the name of a famous French family long seated at Montfort l'Amauri, near Paris. Of them SIMON IV. DE MONTFORT (*c.* 1160–1218), a son of Simon III. (d. 1181), took part in the crusade against the Albigenses. Twice he went to Palestine as a crusader, and in 1209, answering the call of Pope Innocent III., he joined the host which marched against the enemies of the Church in Languedoc. He became vicomte of Béziers and of Carcassonne, and was soon the leader of the crusaders. He took place after place, defeated Raymond VI., count of Toulouse, at Castelnaudary, and about a year later (September 1213) gained a victory over Raymond's ally, Peter II., king of Aragon, under the walls of Muret. Simon then turned his attention to administering and organizing Languedoc. The pope, somewhat reluctantly, confirmed him in the possession of the greater part of the lands of the count of Toulouse, and after two more years of warfare he was killed whilst besieging the city of Toulouse on June 25, 1218.

The count's eldest son, AMAURI DE MONTFORT (1192–1241), was unable to hold his own, although Philip Augustus sent some troops to his assistance in 1222. He abandoned his interests in the south of France in favour of the new king Louis VIII., and in 1239 he went on crusade to the Holy Land, dying soon afterwards at Otranto. In 1230 Amauri was made constable of France.

See A. Molinier, *Catalogue des actes de Simon et d'Amaury de Montfort* (1873); and C. Douais, *La Soumission de la vicomté de Carcassonne par Simon de Montfort et la croisade contre Raimond VI.* (1884).

MONTFORT, SIMON DE, EARL OF LEICESTER (*c.* 1200–1265), English statesman and soldier, was born in France, the fourth and youngest son of Simon IV. de Montfort (*see* above), the leader of the Albigensian crusade. Simon IV., whose mother was an heiress of the Beaumont family, claimed in her right, and received from King John, the earldom of Leicester (1207), only to lose it again through espousing the French side in the wars between that sovereign and Philip Augustus.

The young Simon, of whose youth nothing is recorded, came to England in 1230 and attached himself to Henry III., obtaining with the consent of his sole surviving brother Amauri a re-grant of the family earldom. Simon was for a time unpopular and closely attached to the royal party. He gave, however, an early proof of religious fervour, and of an unbending harshness, by the expulsion of the Jews from his borough of Leicester. In 1238 he married the king's sister Eleanor, the widow of the younger William Marshal. The match was resented by her brother Richard of Cornwall and the baronage on the ground that Eleanor had taken vows of chastity. With some difficulty Earl Richard was pacified; and Montfort obtained the pope's confirmation of the marriage by a personal visit to Rome. In 1239, however, the influence of detractors and a quarrel over some obscure financial transactions in which he appears to have used Henry's name without a formal warrant led to a breach between himself and the king. The earl and his wife went to France; and, though a nominal reconciliation with the king was effected, both departed on crusade with Richard of Cornwall in 1240. Returning in 1241, Simon took part in Henry's disastrous French expedition of 1242, and was readmitted to full favour.

He stood forward in parliament as a mediator between the court party and the opposition, and was keenly interested in Grosseteste's proposals for ecclesiastical reformation. In 1248 he again took the cross, with the idea of following Louis IX. to Egypt, but at the requests of the king and council, he gave up this project to act as governor in the disaffected duchy of Gascony. Bitter complaints were excited by his rigorous suppression of the excesses of the seigneurs and of contending factions in the great communes. Henry yielded to the outcry and instituted a formal inquiry into the earl's administration. Montfort was formally acquitted on the charges of oppression, but his accounts were disputed by the king, and he retired in disgust to France (1252).

The nobles of France offered him the regency of the kingdom, vacant by the death of the Queen-mother Blanche of Castile, but he preferred to make his peace with Henry (1253), in obedience to the exhortations of the dying Grosseteste. He helped the king in dealing with the disaffection of Gascony; but their reconciliation was a hollow one, and in the parliament of 1254 the earl led the opposition in resisting a demand for a subsidy. In 1256–57, when the discontent of all classes was coming to a head, Montfort nominally adhered to the royal cause. He undertook, with Peter of Savoy, the queen's uncle, the task of extricating the king from the pledges which he had given to the pope with reference to the crown of Sicily; and Henry's writs of this date mention the earl in friendly terms. But at the "Mad Parliament" of Oxford

(1258) Montfort with the earl of Gloucester headed the opposition. It is said that he was reluctant to approve the oligarchical constitution created by the Provisions of Oxford, but his name appears in the list of the Fifteen who were to constitute the supreme board of control over the administration. There is better ground for believing that he disliked the narrow class-spirit in which the barons used their victory; and that he would gladly have made a compromise with the moderate royalists. But the king's success in dividing the barons and in fostering a reaction rendered such projects hopeless. In 1261 Henry revoked his assent to the Provisions, and Montfort left the country in despair.

He returned in 1263, at the invitation of the barons, who were now convinced of the king's hostility to all reform; and raised a rebellion with the avowed object of restoring the form of government which the Provisions had ordained. For a few weeks it seemed as though the royalists were at his mercy; but he made the mistake of accepting Henry's offer to abide by the arbitration of Louis IX. of France. At Amiens, in Jan. 1264, the French king decided that the Provisions were unlawful and invalid. Montfort at once resumed the war, and thus exposed himself to accusations of perjury, from which he can only be defended on the hypothesis that he had been led to hope for a genuine compromise. Though merely supported by the towns and a few of the younger barons, he triumphed by superior generalship at Lewes (May 14, 1264), where the king, the Lord Edward, and Richard of Cornwall fell into his hands. Montfort used his victory to set up the government by which his reputation as a statesman stands or falls. The weak point in his scheme was the establishment of a triumvirate (consisting of himself, the young earl of Gloucester and the bishop of Chichester) in which his colleagues were obviously figureheads. This flaw, however, is mitigated by a scheme, which he simultaneously promulgated for establishing a thorough parliamentary control over the executive, not excepting the triumvirs. The parliament which he summoned in 1265 was, it is true, a packed assembly; but it can hardly be supposed that the representation which he granted to the towns (*see* PARLIAMENT and REPRESENTATION) was intended to be a temporary expedient.

The reaction against his government was baronial rather than popular; and the Welsh Marchers particularly resented Montfort's alliance with Llewellyn of North Wales. Little consideration for English interests is shown in the treaty of Pipton which sealed that alliance (June 22, 1265). It was by the forces of the Marchers and the strategy of Edward that Montfort was defeated at Evesham (Aug. 4). For years after his death he was revered by the commons as a martyr, and the government had no little difficulty in reducing the remnants of his baronial supporters. He was undoubtedly harsh, masterful, and ambitious; but no mere adventurer could have won the friendship of such men as Adam Marsh and Grosseteste; their verdict of approval may be the more unhesitatingly admitted since it is not untempered with criticism.

The original authorities are those for the reign of Henry III. The best biographies are those by R. Pauli (trans. C. M. Goodwin, 1876); G. W. Prothero (1877); C. Bémont (1884). *See* also the letters of Adam de Marsh in J. S. Brewer's *Monumenta franciscana*, vol. i. (Rolls series, 1858); H. R. Luard, *Epistolae Roberti Grosseteste* (Rolls series, 1861); F. S. Stevenson, *Grosseteste* (1899); W. H. Blaauw, *The Barons' War* (1871); T. S. Bateman, *Simon de Montfort* (1923); E. F. Jacob, *Studies in the Period of Baronial Reform and Rebellion 1258–67* (1925). (H. W. C. D.; X.)

MONTGAILLARD, JEAN GABRIEL MAURICE ROQUES, COMTE DE (1761–1841), French political agent, was born at Montgaillard, near Villefranche (Haute Garonne), on Nov. 16, 1761. He was educated at the military school of Sorèze, where he attracted the notice of the comte de Provence (afterwards Louis XVIII.). In 1789 he was in Paris as a secret diplomatic agent, and though he emigrated to England after Aug. 10, 1792, he returned six weeks later to Paris, where his security was probably purchased by services to the revolutionary Government. He was again serving the Bourbon princes when he met Francis II. of Austria at Ypres in 1794 and in the same year saw Pitt in London, where he published his *État de la France au mois de mai 1794,* predicting the fall of Robespierre. He was employed by Louis XVIII. to secure Austrian intervention on behalf of Madame Royale (afterwards duchess of Angoulême), still a prisoner in the Temple, and he drew up the proposition made by the prince to Charles Pichegru, the details of which appear in his "Mémoire sur la trahison de Pichegru" (*Moniteur,* April 18, 1804). He is thought to have indicated the possession by the comte d'Antraigues, agent of the princes, of documents compromising Pichegru. In April 1798 he surrendered to Claude Roberjot, the Hamburg minister of the Directory, further papers relating to the matter.

He followed Roberjot to Holland, and there wrote a memorandum urging the immediate return of Bonaparte from Egypt and his assumption of the supreme power. This note reached Alexandria by way of Berlin and Constantinople. But when he ventured to return to Paris he was imprisoned, and on his release he was kept under police supervision. Napoleon, who appreciated his real insight into European politics, attached him to his secret cabinet in spite of his intriguing and mendacious character. The Bourbon restoration made no change in his position; he was maintained as confidential adviser on foreign and home politics, and gave shrewd advice to the new Government. His career ended with the old monarchy, and he died in obscurity at Chaillot on Feb. 8, 1841.

His *Souvenirs,* which must be read with the utmost caution, were edited by Clément de Lacroix (3rd ed., 1895); his *Mémoires diplomatiques* (1805–19) were published by the same editor in 1896. His *État de la France* was translated into English by Edmund Burke. His other writings include *Ma conduite pendant le cours de la révolution française* (London, 1795); *Histoire secrète de Coblentz dans la révolution des français* (London 1795); *De La France et de l'Europe sous le gouvernement de Bonaparte* (Lyons, 1804); *Situation de l'Angleterre en 1811* (1811); *De la restauration de la monarchie des Bourbons et du retour à l'ordre* (1814); and *Histoire de France depuis 1825 jusqu'à 1830* (1839).

MONTGOMERIE, ALEXANDER (*c.* 1550–*c.* 1610), Scottish poet, son of Hugh Montgomerie of Hessilhead, Ayrshire, spent some part of his youth in Argyleshire and afterwards lived for a time at Compston Castle, in Galloway. He was in the service of the regent Morton; thereafter, on the regent's demission of office in 1578, in that of King James VI. In 1583 the grant by the Crown of a pension of 500 marks was confirmed; three years later he set out on a tour through France, Flanders and other countries. He appears to have been imprisoned abroad, and to have lost favour at the Scottish court, and (for a time) his pension. We have no record of his closing years.

Montgomerie's chief poem is the *Cherry and the Slae,* first printed in 1597 (two impressions). It was frequently reprinted in the 17th and 18th centuries, and appeared twice in Latin guise in 1631, in Dempster's *Cerasum et sylvestre prunum, opus poematicum.* It is included in the collected edition of Montgomerie's Poems, by David Irving (1821), and by James Cranstoun, for the Scottish Text Society (1887). A better text, from a ms. in the Laing collection in the University of Edinburgh, was prepared (1907) for the Scottish Text Society by Mr. George Stevenson. The poem, written in the complicated alliterative fourteen-lined stanza, is a confused allegory—the confusion being due to the fact that sections of the poem were written at different times—on Youth's choice between a richly laden cherry-tree on a high crag and a sloe "bush" at his feet. His other poems are: *The Flyting betwixt Montgomery and Polwart* (1629; 1st ed., 1621); a series of 70 sonnets; a large number of miscellaneous poems, amatory and devotional; and *The Mindes Melodie, Contayning certayne Psalmes of the Kinglie Prophete Dayvid, applyed to a new pleasant tune* (Edinburgh, 1605).

MONTGOMERY, GABRIEL, SEIGNEUR DE LORGES, COMTE DE (*c.* 1530–1574), French soldier, became a lieutenant in the king of France's Scottish guards, of which his father was captain. Having inadvertently caused the death of King Henry II. in a tournament (June 30, 1559) he was disgraced and retired to his estates in Normandy. He espoused the cause of the Reformers. In 1562 he allied himself with the prince of Condé, took Bourges, and defended Rouen from September to October 1562 against the royal army. In the third War of Religion he occupied Béarn and Bigorre (1569). Escaping from the massacre of St. Bartholomew, he went to England and returned

with a fleet for the relief of La Rochelle (1573), but soon had to withdraw to Cornwall. Returning to Normandy in 1574, he defended Domfront, which was being besieged by Marshal de Matignon, but was forced to capitulate on May 25. He was sentenced to death and beheaded in Paris on June 26, 1574.

See L. Marlet, *Le Comte de Montgomery* (Paris, 1890).

MONTGOMERY, JAMES (1771–1854), British poet and journalist, son of a Moravian minister, was born on Nov. 4, 1771, at Irvine in Ayrshire, Scotland. Part of his boyhood was spent in Ireland, but he received his education in Yorkshire, at the Moravian school of Fulneck near Leeds. He edited the *Sheffield Iris* for more than 30 years. As a journalist he advocated parliamentary reform, and was twice imprisoned (in 1795 and 1796). His *Wanderer of Switzerland* (1806), describing the French occupation, attracted the attention of Lord Byron, who declared, in a footnote to *English Bards and Scotch Reviewers,* that the book was worth a thousand "Lyrical Ballads." Montgomery wrote several volumes of verse, humanitarian and religious in sentiment. In *Pelican Island,* his last and best work as a poet, he evidently took Shelley as his model. His reputation now rests chiefly on his hymns, about 100 of which are still in current use. In 1835 Peel gave him a small pension. He died at Sheffield on April 30, 1854.

His poems were collected and edited by himself in 1841. The voluminous *Memoirs,* published in seven volumes (1856–58) by J. Holland and J. Everett, contain information on English provincial politics.

MONTGOMERY, RICHARD (1736–1775), American soldier, was born in Co. Dublin, Ireland, in 1736. Educated at St. Andrew's and at Trinity college, Dublin, he entered the British army in 1756, becoming captain six years later. He saw war service at Louisbourg in 1757 and in the Lake Champlain expedition of 1759, and as adjutant of his regiment he shared in the final threefold advance upon Montreal. Later he was present at Martinique and Havana. In 1772 he left the army, settled in New York, and married a daughter of Robert R. Livingston. Three years later he was a delegate to the first provincial congress of New York, and became brigadier-general in the Continental army. He was sent with Schuyler on the Canadian expedition, and, on Schuyler falling ill, the command devolved upon him. Hampered by the inclemency of the season and the gross indiscipline of the troops, he went forward, gaining a few minor successes and met Benedict Arnold's contingent at Point aux Trembles. They pushed on to Quebec barely 800 strong, but an assault was made on Dec. 31, 1775, and almost at the first discharge Montgomery was killed. The body of the American general was honourably interred by the Quebec garrison. Congress caused a memorial to be erected in St. Paul's church, New York, and in 1818 his remains were conveyed thither from Quebec.

MONTGOMERY, ROBERT (1807–1855), English poet, natural son of Robert Gomery, was born at Bath in 1807. He was educated at a private school in Bath, and founded an unsuccessful weekly paper in that city. In 1828 he published *The Omnipresence of the Deity,* which hit popular religious sentiment so exactly that it ran through eight editions in as many months. In 1830 followed *The Puffiad* (a satire), and *Satan.* His name was immortalized by Macaulay's famous onslaught in the *Edinburgh Review* for April 1830. This exposure did not, however, diminish the sale of his poems. *The Omnipresence of the Deity* reached its 28th edition in 1858. In 1830 Montgomery entered Lincoln college, Oxford; he took orders in 1835, and held various preferments. He died at Brighton in 1855.

MONTGOMERY, a town and district of British India, in the Punjab. The town has a station on the North-Western railway about half-way between Lahore and Multan. Pop. (1921), 14,601. It was founded in 1864 on the opening of the railway, and called after Sir Robert Montgomery, then lieutenant-governor. It was then situated in a desolate upland, and though not unhealthy was singularly comfortless until reached by irrigation from the Lower Bari Doab Canal in 1913.

The District of Montgomery lies in the Bari Doab, or tract between the Sutlej and the Ravi, extending also across the latter river. Area, 4,623 sq.m. The district which was formerly a barren wilderness is now, owing to the Lower Bari Doab irrigation, a well cultivated tract. The population in 1921 was 713,786. The principal crops are wheat, pulse, cotton and fodder. Camels are bred for export. The leading manufactures are of cotton and silk, and lacquered woodwork, and there are factories for ginning and pressing cotton.

From time immemorial the Bari Doāb formed the home of a wild race of pastoral tribes. The site of Harappa in this area contains archaeological matter of the highest interest, indicating a very early connection between Indian and Sumerian culture. British influence was first exercised in the district in 1847, when an officer was deputed to effect a summary settlement of the land revenue. Direct British rule was effected on the annexation of the Punjab in 1849. There was a general rising of the wild clans during the Mutiny of 1857, several actions being fought before order was restored.

MONTGOMERY, the capital city of Alabama, U.S.A., and the county seat of Montgomery county; at the head of navigation on the Alabama river, S.E. of the centre of the State. It is on Federal highways 31, 231 and 80; and is served by the Atlantic Coast Line, the Central of Georgia, the Louisville and Nashville, the Mobile and Ohio, the Seaboard Air Line and the Western of Alabama railways. Pop. (1920) 43,464 (46% negroes) and 66,079 in 1930 (Federal census). The city occupies an undulating site, around a sharp bend in the river, in the midst of rich farm lands. The capitol stands on an eminence at the head of the main business street, which (tradition says) was reserved for the purpose from 1819, though Montgomery did not become the capital until 1847. The high-domed central portion (erected 1851) of the present building is one of the finest examples of the classical Georgian architecture in America, and its rotunda was decorated in 1928 by Roderick D. MacKenzie with scenes from the history of the State. Here on Jan. 7, 1861, Alabama voted to secede from the Union; on Feb. 4 the Confederate States of America was organized by delegates from six States; and on the steps of the portico Jefferson Davis took his oath of office. The house occupied by Mr. Davis ("the first White House of the Confederacy") has been moved from its original site to grounds south of the capitol and is used as a museum. At the south-eastern edge of the city is the 62 ac. campus of the Woman's College of Alabama (Methodist Episcopal; 1909), and the State Normal school for negroes is located here. Maxwell field, 1·5 m. outside the city, is a station of the Army Air Corps. The city's assessed valuation of property for 1927 was $37,984,797. It has a commission form of government. Its morning paper, the *Advertiser,* has been published continuously since 1828.

Montgomery is an important concentration point and a market for cotton, mules, yellow pine and hardwood lumber; has a large jobbing and wholesale business; and is one of the principal centres in the country for the manufacture of commercial fertilizer. It has large railroad shops, and various other manufacturing industries, with an aggregate output in 1925 valued at $16,162,380. The hydro-electric developments on the Coosa and the Tallapoosa rivers are within 40 miles. Debits to individual accounts in the city's banks totalled $287,620,000 in 1926. The State fair is held here annually.

In Sept. 1540, De Soto spent a week at the Indian village of Towassi, within the present limits of Montgomery, to let his horses fatten on the green grass along the Alabama river, and a later village, Econchati, was visited by de Bienville and was a British headquarters in 1778. In 1817 Samuel Dexter of Massachusetts and Gen. John Scott of Georgia laid out towns called New Philadelphia and East Alabama, which (together with a third settlement, Alabama Town) were consolidated in 1819 under the present name, in honour of Gen. Richard Montgomery, and incorporated by the legislature sitting at Cahaba. The town was chartered as a city in 1837, became the State capital in 1847, and was the first capital of the Confederacy (until May, 1861) and the seat of Confederate military factories. On April 12, 1865, it was captured by Federal troops.

MONTGOMERY (Welsh *Drefaldwyn*), a municipal borough and the county town of Montgomeryshire (*q.v.*). Pop.

(1931) 918. It is a quiet market town, with a declining population, but its cattle market remains important and well-known. Had it not been for the attraction, via Welshpool, of the railway from Shrewsbury into Wales, the town, situated as it is at the meeting-place of two valley ways (via Minsterley and via Bishop's Castle) from England, would perhaps have renewed its life, and the question of rail connection with England via Craven Arms may be reopened. It is placed within a mile of the English border, marked here by Offa's Dyke, under a steep wooded cliff which dominates the lowland area where the river Camlad, flowing from England, joins the Severn. Above the town rises the Castle hill with the ruins of a castle, built, in the first instance, by the Norman Roger de Montgomery, from whose ancestral home the fortress took its name. The Welsh name (Baldwyn's Town) comes from that of the builder of the second castle on the site, Baldwyn de Boller, who held it for Henry I. The Crown gave it, in the 15th century, to the Herberts of Chirbury, one of whom, in 1644 surrendered it to the Parliamentarians, who dismantled it. The beautiful old parish church is dedicated to St. Nicholas.

MONTGOMERYSHIRE (Welsh *Sir Drefaldwyn*), a county of Wales, bounded N. by Denbigh, N.E. and E. by Shropshire, S. by Radnor and Cardigan, W. and N.W. by Merioneth. Its length from S.E. to N.W. is about 30 m., and from N.E. to S.W. about 35 m. The county occupies, in general, the valleys of the upper Severn and its many tributaries, collected from the plateau under the Berwyn mts. on the north-west by the river Severn, which flows to the north-north-east; while the valley of the Dovey opens on to Cardigan bay in the west. The dissected plateau of the north-west has heights varying from 1,500 ft. towards the Berwyns (which rise to 2,700 ft.) to 500 ft. in the east. In the south-west the county meets Cardigan on the Plynlymon moors (over 2,000 ft.) while Rhyd Hywel and the Kerry hills (1,700 ft.) form the boundary on the south. On the Shropshire border most of the conspicuous Breidden hills (1,324 ft.) are included, and also Corndon hill (1,684 ft.), which forms a part of the group of hill ridges of ancient rock including the Stiper stones and Long Mynd in Shropshire.

Along the eastern border the structure lines run north-east–south-west, and have resulted in three lowland ways from England, those of Llanymynech in the north, Middletown south of the Breidden hills, and of Minsterley between Long Mountain and Stiper stones. The fourth historic way is that of Bishop's castle, formed by a transverse valley (north-west–south-east) cutting across the "grain" of the country. In the Breiddens and in Corndon are large laccoliths of dolerite, quarried for road metal. On the edge of the forest of Clun the Old Red Sandstone crosses the Montgomeryshire border. For the rest the rocks are almost exclusively Ordovician and Silurian, with numerous metalliferous veins (lead, silver and zinc) which have been worked from time to time. The Silurian rocks are mainly Wenlock beds with a fringe of Llandovery rocks, and they lie in the form of a complex syncline down the centre of the county from Lake Vyrnwy to Llanidloes and Newtown.

The moorland plateau of north Montgomeryshire, from the Berwyn range to the Severn valley, is seamed by the deep tributary valleys of Tanat, Vyrnwy, Banwy and Rhiw. The line of the old Cambrian railway (now G.W.R.) from Welshpool, leaving the Severn at Caersws and thence following the Carno river through a low watershed to the upper Dovey valley, separates these moorlands from those of Plynlymon and Rhyd Hywel. The upper Wye valley is included in this corner of the county. The only important Welsh right bank tributary of the Severn, the Camlad, rises in England and joins the main river below Montgomery. Beyond Welshpool the valley opens out and at the Vyrnwy confluence the Severn leaves the county, its broad flood plain merging into the lowlands of north Shropshire.

Glacial deposits cover a large proportion of the county. For the most part the shales and grits of the hilly regions are grass grown, but frequently boggy in the flatter moorland areas. The low entrances from England, the Severn and Rea valleys, are floored with alluvium and, though fertile, are liable to floods.

History.—From the distribution of prehistoric tumuli and sites in the county we learn that the centres of habitation were the open moorlands of north-west, west and south. Finds of stray bronzes indicate that some use may have been made, as a trade and migration route, of the open hill line from the south Shropshire hills to the gap between the mountain ramparts of Plynlymon and Mawddwy and so to Cardigan bay. From the Early Iron Age Montgomeryshire occupied a more important place in prehistoric Wales, for here the hill-camps (which may, however, be of Romano-British construction) are specially thick. It is probably to the occupiers of these camps that we owe the introduction of Brythonic speech, some forest clearing and perhaps village settlement and the making of hillside tracks. The wedge of invasion thus indicated formed the basis for the geographical distinction of the future Powysland and the shire of Montgomery.

The Romans seem not to have occupied Wales in the sense that they occupied the border from Chester to Caerleon. Their stations in Wales were mainly military, though there were doubtless peaceful relations with the natives. In Montgomeryshire there are Roman camps in the notable lowland basins of the lower Vyrnwy (Clawdd Coch), of Montgomery (Caer Flos) and of Caersws, while there was probably a station at Machynlleth, or at any rate at Pennal, just in Merionethshire. Roads from Chester (Deva) and Viroconium met at Caer Flos (the Forden Gaer, excavated in 1927 and following years) and continued to Caersws (excavated in 1912). The large British camp on the Breidden hills (Craig Breidden) is claimed to be the scene of the defeat of the British leader, Caractacus, in A.D. 51.

The post-Roman centuries saw the coming of the Celtic Saints with their civilizing influence, and the foundation of numerous villages (Llan) dedicated to the local saint. The next landmark of importance was the building of Offa's Dyke (8th century), a long line of demarcation between the dominions of the Welsh princes and those of the invading Saxons (*see* Cyril Fox, "Offa's Dyke: A Field Survey," *Archaeologia Cambrensis,* 1926, etc.). Within the county it stretches from Carreghova to Castlewright, with the exception of three miles under the Breidden hills, where the Severn serves as dividing line. By the time of Domesday the English had crossed Offa's Dyke and established their valley villages in the plains of the Severn as far as the river, but the whole border strip remained a battle-ground for centuries, and, until the time of Elizabeth, probably had little population outside the castle towns and moated farms.

From the Welsh side we learn little until the death of Rhodri Mawr in 877, when out of the united Wales were carved three divisions, with Powys as the central part, including what later became Montgomeryshire. Powys castle (*see* WELSHPOOL) was founded in 1108. The Normans, pushing up the valley ways from England, built an outer and inner line of castles in the Marches. The two ways (*see* above) from Minsterley and Craven arms—the latter "Road of the Castles" past Stokesay and Bishop's castle being thronged with historic memories—meet in the basin of the Camlad, where Caer Flos, the Roman camp, was in a sense revived by the Norman castle at Montgomery (*q.v.*), built by Roger de Montgomery in 1074.

Another civilizing force came with the monasteries and other religious foundations of the middle ages, and under the guidance of the monks and that of the numerous Flemish families introduced in the 14th century Powysland became one of the leading wool-producing and manufacturing regions of Wales. The woollen goods were taken to the markets at Shrewsbury and Ludlow. By Tudor times something like order had been established in the Marches, and trade brought fame to the Welsh woollen fabrics The county of Montgomery, based on fundamental physical, linguistic and historic facts, was formed in 1535. English customs and ideas, *e.g.*, the half-timbered houses, spread up the valleys during the late 16th and succeeding centuries. The style eventually reached the western end of the county at Tyn-o-hir above the Dyfi estuary but did not spread into Cardiganshire. At the same time English speech, used at the markets, spread into the valleys replacing the Celtic tongue.

Trade and Communications.—The late 18th and early 19th

centuries witnessed a great development of means of communication, canals and coach roads within the county and trade increased rapidly. In 1794 the Montgomeryshire Canal act was passed, which provided for the construction of a branch canal from the Ellesmere canal to Welshpool, with a future extension to Newtown. Though the canal is now disused, it has carried a vast amount of agricultural produce and coal, timber, lime and flannel goods. The factory system and the new facilities for communication caused the flannel industry to gravitate to the larger centres *e.g.*, Welshpool, Newtown, Llanidloes and Machynlleth (*q.v.*), but it has since declined in all these places. The Cambrian railway, now G.W.R., crosses the county from Llanymynech to Machynlleth, following the Severn valley to Caersws and crossing the watershed to the Dovey valley at Talerddig. All sections of the railway were completed by 1863. From Buttington a joint G.W. and L.M.S. line follows the Middletown gap south of the Breiddens, to Shrewsbury; while from Moat Lane junction, in the Caersws basin, another line gives communication with central Wales via Llanidloes and Builth. Branch lines of the main railway run from Llynclys (in Shropshire) to Llangynog (Tanat valley), from Llanymynech to Llanfyllin, from Welshpool to Llanfair Caereinion, from Abermule to Kerry, from Caersws to the Van Mine, from Cemmaes Road to Dinas and from Machynlleth to Corris.

Another industry now in decay besides that of flannel manufacture is lead mining, formerly carried on extensively in the Llanidloes district in the south and in the neighbourhood of Llangynog in the north. The Van mines near Llanidloes were worth £1,000,000 in 1870. Attempts are being made to resuscitate some mines, and to get metal from the waste tips which disfigure many of the higher hill slopes. Slate quarrying is carried on at Llangynog and in the Machynlleth district, while hard stone for building and road mending is found in various parts. In general Montgomeryshire is a land of hill pastures, with small holdings having sheep rearing as their main occupation. The Kerry Hill breed of sheep, with characteristics embodying those of the Welsh and the Shropshire breeds, is justly famous. The eastern border and the valleys have much rich agricultural land, wheat and oats being the chief crops. Montgomeryshire is said to be the best wooded of all the Welsh counties, hedgerow timber being specially characteristic. The county was formerly a recognized source of oak timber for the navy. Since 1880 there has been much planting of soft woods on the hill slopes below 1,000 ft., the Kerry hills, reached by the branch railway from Abermule, being thickly timbered before 1914. Since then many acres, in part under Government supervision, are being planted each year.

Population.—The area of the administrative county is 510,110 ac., or 797 sq.m., with a population of 48,462 in 1931 (1901, for comparison, was 54,901). Much Welsh is spoken in the mountain regions of west and north, but the towns and lowlands (except the Dovey and upper Severn valleys) are almost exclusively English in speech. The county returns one member to parliament. Llanfyllin (1,449), Montgomery (918), Llanidloes (2,356), Welshpool (5,637) are municipal boroughs, while the urban districts are: Newtown and Llanllwchaiarn (5,152) and Machynlleth (1,892). The county is in the North Wales and Chester circuit, assizes being held alternately at Newtown and Welshpool. Welshpool borough has a separate commission of the peace, but no separate court of quarter sessions. The ancient county (in Bangor, Hereford and St. Asaph dioceses) has 59 ecclesiastical parishes or districts, with parts of 11 others.

MONTGOMERY WARD AND CO., INC., one of the largest mail-order firms and one of the foremost distributors of retail merchandise in the United States, was founded in 1872, by A. Montgomery Ward, the originator of the mail-order method of selling, and the first to put it into practice. The present company was formed in 1919 under the laws of Illinois to succeed a company which had been incorporated in New York (1913) as successor to an Illinois organization. Montgomery Ward and Co. with headquarters in Chicago, distributes goods, through various branches, all over the United States and also conducts an important export trade. The merchandise, of which almost 40,000 items are listed in the company's catalogue, is delivered to patrons by mail from central warehouses strategically situated. Each of these mail-order plants (nine in number, 1929) operates a retail department store where goods are sold over the counter to local residents at mail-order catalogue prices. The largest plant is in Chicago. Merchandise is bought from markets in practically every country in the world. For the production of many lines of goods, the company operates its own factories.

The mail-order business in general increased rapidly in the six years 1923–28, inclusive; during that time the sales of Montgomery Ward and Co. evidenced a greater growth than in all the preceding period of its existence, the number of customers increasing from 3,500,000 to more than 10,000,000. In 1928 approximately one out of every three families in the United States was served. In 1927 net sales passed the $200,000,000 mark for the first time, and in 1928 reached a total of $232,000,000. In 1926 Montgomery Ward and Co. established experimental display stores in several towns through the United States with the object of showing customers what they might order. These were soon converted into regular retail stores and the company embarked on a chain store programme. During 1928, 250 chain stores were opened in cities of over 5,000 population and plans laid gradually to increase the number to 1,500. In addition the company began the same year the establishment of a chain of retail department stores in the large cities. Sixteen such establishments had been opened by Jan. 1, 1929. (G. B. Ev.)

MONTH, originally the period between the two returns of the new moon, now generally called a *lunar month*. The *anomalistic month* is the mean time taken by the moon in passing from one perigee to the next; the *sidereal month* is the mean time in which the moon makes a circuit among the stars; the *tropical month* is the mean time in which the moon traverses 360° of longitude; the *nodical* or *draconic month* is the mean time taken by the moon in passing from one rising node to the next; the *solar month* is one-twelfth of a tropical year. The lengths of the various months are synodic = 29·53059 days; anomalistic = 27·55460, sidereal = 27·32166, tropical = 27·32156, nodical = 27·21222, solar = 30·43685. (For *calendar months* see CALENDAR.)

MONTHOLON, CHARLES TRISTAN, MARQUIS DE (1782–1853), was born at Paris. Entering the army in 1798, he joined the party of Bonaparte, who trusted him and gave him many important missions. He and his wife accompanied the ex-emperor to St. Helena. To Montholon chiefly, Napoleon dictated the notes on his career. With Gourgaud, who was no less vain and sensitive than himself, there was a standing feud, which would have led to a duel but for the express prohibition of Napoleon. Las Cases left the island in November 1816, and Gourgaud in January 1818; but Montholon stayed on at Longwood to the end of the emperor's life (May, 1821).

In 1840 he acted as "chief of staff" in the absurd "expedition" conducted by Louis Napoleon from London to Boulogne. He was condemned to imprisonment at Ham, but was released in 1847; he then retired to England and published the *Récits de la captivité de Napoléon à Ste Hélène*. In 1849 he sat in the Legislative Assembly. He died on Aug. 21, 1853.

See *Recueil de pièces authentiques sur le captif de Ste Hélène: suivi de lettres de MM . . . le Général Montholon, etc.* (1821); *Mémoires pour servir à l'histoire de France sous Napoléon* (ed. Gourgaud and Montholon, 1823; Eng. ed., 1823; new ed., Paris, 1905); *Récits de la captivité de l'empereur Napoléon à Ste Hélène* (2 vols., 1847). Also the Marquise de Montholon's *Souvenirs de Ste Hélène, 1815–16* (1901). Of Montholon's own writings the only one of note is *De l'Armée française* (1834). For the conversations of Montholon with Basil Jackson in 1828, *see* Lieut.-Colonel Basil Jackson, *Notes and Reminiscences of a Staff Officer* (1903). The *Lettres du comte et de la comtesse de Montholon* were edited by Connard (1906).

MONTH'S MIND, in mediaeval England a service and feast held one month after the death of anyone in his or her memory. Bede speaks of the day as *commemorationis dies*. These "Minding days" were of great antiquity, and were survivals of the Norse *minne* or ceremonial drinking to the dead (*see* HEALTH).

MONTILLA, a town of Spain, in the province of Cordova, 32 m. S. of the city of Cordova, by the Cordova-Bobadilla rail-

way. Pop. (1920), 14,868. The peculiar flavour of the pale dry light wine of Montilla gives its name to the sherry known as Amontillado. Montilla was the birthplace of "The Great Captain," Gonzalo or Gonsalvo of Cordova (1453–1515).

MONTLUC (or MONLUC), **BLAISE DE LASSARAN-MASSENCÔME,** SEIGNEUR DE (*c.* 1502–1577), marshal of France, was born at Condom (Gers). He served first as a private archer and man-at-arms in Italy, with Bayard for his captain, fought all through the wars of Francis I., and was knighted on the field of Cérisoles (1544), to which victory he had brilliantly contributed as adviser to the young duke of Enghien. His chief feat was the famous defence of Siena (1555), which he has told so admirably. When the religious wars broke out in France, Montluc, a staunch royalist, held Guyenne for the king. Henry III. made him in 1574 marshal of France, an honour which he had earned by nearly half a century of service and by numerous wounds. He died at Estillac near Agen in 1577. Montluc's eminence above other soldiers of his day is due to his *Commentaires de Messire Blaise de Montluc* (Bordeaux, 1592), in which he described his fifty years of service (1521–1574).

The *Commentaries* are in the collection of Michaud and Poujoulat, but the standard edition is that of the *Société de l'Histoire de France*, ed. by M. de Ruble (5 vols., 1865–72); a critical edition was published by P. Courteault (1911–14). *See* P. Courteault, *Blaise de Montluc, historien* (1908); J. J. de Broqua, *Le Maréchal de Monluc, sa famille et son temps* (1924).

MONTLUÇON, a town of France, capital of an arrondissement, and the most important industrial centre in the department of Allier. Pop. (1926) 35,274. It is on the Cher, 50 m. S.W. of Moulins by rail. The upper town has steep, narrow, winding streets with several buildings of the 15th and 16th centuries; the lower town, traversed by the Cher, produces glass, chemicals, sewing-machines, and iron and steel, and trades in grain, wood, chemicals, candles, earthenware, marble, glass, pneumatics and artificial silk and woollen goods. The Commentry coal-mines and Néris, a town with thermal springs, are to the south-east. Of the churches, Notre-Dame is of the 15th century and St. Pierre has a 12th century transept. The town-hall, with a library, occupies the site of an old Ursuline convent. There is also the castle rebuilt by Louis II., duke of Bourbon, and taken by Henry IV. during the religious wars. The town, which formed part of the duchy of Bourbon, was taken by the English in 1171, and by Philip Augustus in 1181; the English were beaten under its walls in the 14th century. It has a sub-prefecture, a tribunal of commerce, a chamber of commerce and a board of trade-arbitrators.

MONTMORENCY, the name of a French family, derived from Montmorency (Seine-et-Oise). MATTHIEU I., sire de Montmorency, received in 1138 the post of constable, and died in 1160. His first wife was Aline, the natural daughter of Henry I. of England; his second, Adelaide or Alice of Savoy, widow of Louis VI. and mother of Louis VII., and according to Duchesne, he shared the regency of France with Suger, during the absence of the latter king on the second crusade. MATTHIEU II. was made constable in 1218. During the reign of Louis VIII. he fought chiefly in the south of France (Niort, La Rochelle, Bordeaux). On the accession of Louis IX. he supported the queen-regent Blanche of Castile. He died in 1230. His younger son, Guy, in right of his mother, became head of the house of Montmorency-Laval. ANNE de Montmorency (*q.v.*), so named, it is said, after his godmother Anne of Brittany, was the first to attain the ducal title (1551). His eldest son, FRANÇOIS de Montmorency (1530–1579), was married to Diana, natural daughter of Henry II.; another son, HENRI I. de Montmorency (1534–1614), who became duc de Montmorency on his brother's death in 1579, had been governor of Languedoc since 1563. As a leader of the party called the *Politiques* he took a prominent part in the French wars of religion. In 1593 he was made constable, but Henry IV. showed some anxiety to keep him away from Languedoc, which he ruled like a sovereign prince.

HENRY II. (1595–1632), son of duke Henry I., succeeded to the title in 1614, having previously been made grand admiral. He also was governor of Languedoc. In 1625 he defeated the French Protestant fleet under Soubise, and seized the islands of Ré and Oléron, but the jealousy of Richelieu deprived him of the means of following up these advantages. In 1628–1629 he was allowed to command against the duke of Rohan in Languedoc; in 1630 he defeated the Piedmontese, and captured Prince Doria, at Avigliana, and took Saluzzo. In the same year he was created marshal. In 1632 he joined the party of Gaston, duke of Orleans, and placed himself at the head of the rebel army, which was defeated by Marshal Schomberg at Castelnaudary (Sept. 1, 1632); severely wounded, he fell into the enemy's hands, and abandoned by Gaston, was executed as a traitor at Toulouse on the 30th of October.

MONTMORENCY, ANNE, DUC DE (1493–1567), constable of France, was born at Chantilly, and was brought up with the future King Francis I., whom he followed into Italy in 1515, distinguishing himself especially at Marignano. In 1516 he became governor of Novara; in 1520 he was present at the Field of Cloth of Gold, and afterwards had charge of important negotiations in England. He was made marshal of France in 1522, accompanied Francis into Italy in 1524, and was taken prisoner at Pavia in 1525. Released soon afterwards, he was one of the negotiators of the treaty of Madrid, and in 1530 reconducted the king's sons into France. On the renewal of the war by Charles V.'s invasion of France in 1536, Montmorency compelled the emperor to raise the siege of Marseilles; he afterwards accompanied the king of France into Picardy, and on the termination of the Netherlands campaign marched to the relief of Turin. In 1538, on the ratification of the ten years' truce, he was rewarded with the office of constable, but in 1541 he fell into disgrace, and did not return to public life until the accession of Henry II. in 1547. In 1548 he repressed the insurrections in the south-west, particularly at Bordeaux, with great severity, and in 1549–50 conducted the war in the Boulonnais.

Soon afterwards Montmorency was fighting in the north-east. His attempt to relieve St. Quentin resulted in his defeat and captivity (Aug. 10, 1557), and he did not regain his liberty until the peace of Cateau-Cambrésis in 1559. Supplanted in the interval by the Guises, he was treated with coldness by the new king, Francis II., and compelled to give up his mastership of the royal household—his son, however, being appointed marshal by way of indemnity. On the accession of Charles IX. in 1560 he resumed his offices and dignities, and, uniting with his former enemies, the Guises, played an important part in the Huguenot war of 1562. He fell into the hands of the enemy at Dreux, and was not liberated until the treaty of Amboise (March 19, 1563). In 1567 he again triumphed at St. Denis, but was wounded, and died in Paris, on March 15, 1567.

See F. Decrue, *Anne de Montmorency* (1885), and *Anne, duc de Montmorency* (1889).

MONTMORENCY, a town of northern France in the department of Seine-et-Oise, 2½ m. from the right bank of the Seine and 11 m. N. of Paris by rail. Pop. (1926) 9,591. In the middle ages it was the seat of the family of Montmorency. There is a 13th and 16th century church. The town is a well-known resort of Parisians. To the north-east lies the fine forest of Montmorency. Bleaching and dyeing and the manufacture of lime plaster, bricks and tiles are carried on.

MONTORO, a town of southern Spain, in the province of Cordova, 27 m. E. by N. of the city of Cordova, on the Madrid-Cordova railway. Pop. (1920) 18,140. Montoro was the *Epora* of the Romans. It stands on a rocky peninsula on the south bank of the Guadalquivir, here crossed by a fine bridge of four arches dating from the 16th century. Oil is largely manufactured, and there is considerable trade in timber and agricultural products.

MONTPELIER, the capital city of Vermont, U.S.A., and the county seat of Washington county; 40 m. E.S.E. of Burlington, on the Winooski river, Federal highway 2, and the Central Vermont and the Montpelier and Wells River railways. The population was 7,125 in 1920 and 7,837 in 1930. It is in a region of great beauty, within 20 m. of many lakes and the finest scenery of the Green mts. The State house (first occupied in 1836, almost destroyed by fire in 1857, and subsequently rebuilt and enlarged) is of granite from the famous quarries at Barre, 6 m. S.E. The city has several factories and extensive interests

in the granite industry of the region. The town of Montpelier (named after Montpellier, France) was granted to a company of 60 proprietors in 1780. Settlement began in 1787. In 1805 it was chosen to be the capital of the State, and in 1808 the legislature met here for the first time. It was chartered as a city in 1894.

MONTPELLIER, a town of southern France, capital of the department of Hérault, 31 m. S.W. of Nîmes on the P.L.M. railway and 7 m. from the Mediterranean at Cette. Pop. (1926) 69,440.

Montpellier rose into importance after Charles Martel destroyed Maguelonne in 737. In the 10th century its two portions, Montpellier and Montpelliéret, were held from the bishops of Maguelonne by the family of Guilhem. The Guilhems were succeeded, through marriage, by the house of Aragon, a member of which in 1349 sold his rights to Philip of Valois, Montpelliéret having already in 1292 been ceded to the Crown by the bishops. In 1141 Montpellier acquired a charter afterwards materially extended, and the same century saw the rise of its school of medicine. Several of the ablest teachers of that school were members of an important Jewish colony established in the town. Its school of law dates from 1160, and its university was founded by Pope Nicholas IV. towards the close of the 13th century. Louis IX. granted to Montpellier the right of free trade with the whole of the kingdom. The bishopric of Maguelonne was transferred thither in 1536. In the wars of religion the Protestants captured it in 1567 and it supported the duc de Rohan, only submitting after a long siege (1622). The town-walls, except the royal citadel then just built (1624), were razed (1628). Louis XIII. made Montpellier the seat of one of the *généralités* of Languedoc, and the States of that province met there during the 17th and 18th centuries.

Montpellier, the chief town of Languedoc, stands in a fruitful plain near the right bank of the small river Lez. Features of the town are a fine terrace with views of the Mediterranean, the Pyrenees and the Alps, and the famous Botanical garden, founded in 1593. The 14th century Gothic cathedral, once the church of a Benedictine monastery, suffered severely during the religious wars, and the choir has been rebuilt in 13th century style. The monastery, after being converted into the bishop's palace, has since 1795 been occupied by the famous medical school. A gallery devoted to the portraits of professors since 1239 contains one of Rabelais. Close to the medical school is the Tour des Pins, the chief relic of the mediaeval fortifications. The Musée Fabre contains good collections of paintings and sculptures. Montpellier possesses old houses of the 15th and 16th centuries. The Lez is canalized so as to connect Montpellier with the canal du Midi and with the sea at Palavas. The town has a considerable trade in wine, brandy and fruit. Candles, soap, chemicals, casks, chocolate and liquorice are made. The town is the centre of an *académie* (educational division), of a bishop and a prefect, of courts of appeal and assizes, tribunals of first instance and of commerce, a chamber of commerce, a board of trade arbitrators, and the headquarters of the XVI. army corps.

MONTPENSIER, ANNE MARIE LOUISE D'ORLÉANS, Duchesse de (1627–1693), French memoir-writer, was born at the Louvre on May 29, 1627. Her father was Gaston of Orleans, "Monsieur," the brother of Louis XIII. Her mother was Marie de Bourbon, heiress of the Montpensier family. "La grande mademoiselle" was encouraged to look forward to the throne of France as the result of a marriage with Louis XIV. Ill-luck, or her own wilfulness, frustrated numerous plans for marrying her to persons of exalted station, including Charles II. of England, then prince of Wales. She sympathized with the Frondeurs, and in the new or second Fronde she took nominal command of one of the armies on the princes' side, and in her own person took Orleans by escalade. She had to retreat to Paris, where she practically commanded the Bastille and the adjoining part of the walls. On July 2, 1652, the day of the battle of the Faubourg Saint Antoine, between the Frondeurs under Condé and the royal troops under Turenne, Mademoiselle saved Condé and his beaten troops by giving orders for the gates under her control to be opened and for the cannon of the Bastille to fire on the royalists. She then installed herself in the Hôtel de Ville, and played the part of mediatrix between the opposed parties. She was for some years in disgrace, and resided on her estates. In 1657 she reappeared at court. She was now nearly forty, when a young Gascon gentleman named Puyguilhem, afterwards celebrated as M. de Lauzun (*q.v.*), attracted her attention.

In 1670, Mademoiselle demanded the king's permission to marry Lauzun. Louis at first gave his consent, but other members of the royal family prevailed on him to rescind it. Not long afterwards Lauzun, for another cause (*see* Lauzun) was imprisoned in Pignerol, and it was years before Mademoiselle was able to buy his release from the king by settling no small portion of her estates on Louis's bastards. They were then secretly married. But Lauzun tyrannized over his wife, and they were separated. She lived for some years afterwards, gave herself to religious duties, and finished her *Mémoires,* which extend to within seven years of her death (April 9, 1693). These *Mémoires* (Amsterdam, 1729) are to be found in the collection of Michaud and Poujoulat. Her *Eight Beatitudes* were edited by E. Rodocanachi as *Un Ouvrage de piété inconnu* (1908).

See the series of studies on La Grande Mademoiselle, by "Arvède Barine" (1902, 1905).

MONTREAL, a city of the Dominion of Canada, its leading seat of commerce and principal port of entry, as well as the centre of many of its important industries. It is situated on the south-east side of the island of Montreal, at the confluence of the Ottawa and St. Lawrence rivers, in the county of Hochelaga and province of Quebec. The observatory in the grounds of McGill University, in the city, has been determined to be in 45° 30′ 17″ N. lat., and 73° 34′ 40·05″ W. long. The city holds a fine position at the head of ocean navigation, nearly a thousand miles inland, and at the foot of the great system of rivers, lakes and canals upon which much of the commerce of the interior is carried to the Atlantic seaboard. The ship channel below Montreal, the deepening of which was begun in 1844, now permits the passage of ocean vessels drawing 30 ft. at low water. The Lachine canal, begun in 1821, has been enlarged and deepened from time to time. The depth is now 14 feet. This with the canals above opened the way for the shipping and commerce of the Great Lakes. The first Canadian railway, 1836, ran from Laprairie opposite Montreal to St. Johns, near the international boundary. All these public works owed their existence to the enterprise of Montreal citizens. In 1854 work was commenced upon the Victoria Bridge, completed in 1859, which in 1898 was replaced by the Victoria Jubilee Bridge. At the foot of Lake St. Louis the Canadian Pacific Railway crosses the river on a cantilever bridge. A new road-bridge from Montreal to the south shore was under construction in 1928. Montreal is the headquarters of both the great transportation systems, the Canadian National and Canadian Pacific. The latter has an imposing terminal station on Windsor Square, and the former is planning a very large terminal at the city end of the Mount Royal tunnel. During the season of navigation several lines of well-appointed steamers maintain communication with Liverpool, London, Glasgow and other British and European ports, as well as with the principal ports on the river and gulf of St. Lawrence and the Great Lakes.

Buildings.—Built originally along the water-front, Montreal has in the course of years swept back over a series of terraces—former levels of the river or of a more ancient sea—to the foot of Mount Royal. Held there, it has been forced around the mountain on either side. Mount Royal, from which the city derives its name and so much of its natural beauty, is a mass of trap-rock thrown up through the surrounding limestone strata to a height of 753 ft. above the level of the sea. Under the direction of Frederick Law Olmsted it was converted into a magnificent park. The city is substantially built, grey limestone, quarried from the mountain, predominating in the public and many of the private edifices. To the south of the Place d'Armes stands the parish church of Notre Dame, whose Gothic outlines form one of the striking features of the city. The church was built in 1824 to take the place of an earlier structure dating back to 1672. Beside the church stands the historic seminary of St. Sulpice, one of the few remaining relics of the days of French rule. The head office of the Bank of Mont-

real faces Notre Dame church, and several other of the leading banking institutions of the country have their headquarters in this city. In the Place d'Armes stands a striking figure in bronze erected to the memory of Maisonneuve, the founder of Montreal, and the work of a Canadian sculptor, Louis Philippe Hébert. The Roman Catholic Cathedral of St. James stands upon Dominion Square. It is an almost exact reproduction, reduced to one-half the scale, of St. Peter's at Rome. As this church owes its existence to the energy and enthusiasm of Archbishop Bourget, so Christ Church Cathedral, a fine example of the early English style of architecture, is associated with the name of the first resident Anglican bishop of Montreal, Dr. Francis Fulford.

The mixture of races and creeds, which is so striking a characteristic of Montreal life, has not only endowed the city with many beautiful churches, but also with varieties of philanthropic institutions. Each of the several national societies—St. George's, St. Andrew's, St. Patrick's, and that of the French Canadian patron saint, St. Jean Baptiste, to mention no others—looks after the welfare of its own adherents. Of the several hospitals, the most venerable is the Hôtel Dieu, founded in 1644 by Mme. de Bouillon, a French lady of high rank. The original building, in the early days of Ville Marie, stood without the fort, and was fortified to withstand the attacks of the Iroquois. The site is now covered by a block of warehouses on St. Paul Street. The present buildings, completed in 1861, contain both a hospital and nunnery. The Order of the Grey Nuns, founded by a Canadian lady, Mme. d'Youville, in 1737, cares for hundreds of foundlings and aged and infirm people in the great hospital on Guy Street. The Montreal General hospital was founded in 1819 by public subscriptions, and the Royal Victoria Hospital is a monument to the generosity of Lord Strathcona, Lord Mount Stephen and J. K. L. Ross. Besides these should be mentioned the Notre Dame, the Western and the Children's Memorial hospitals.

Schools.—Montreal provides for the education of its young people through two distinct systems of public schools, one for Roman Catholics, the other for Protestants, each governed by a board of commissioners. The schools are maintained by an annual tax based upon the assessment. Unlike the neighbouring province of Ontario, Quebec makes no provision for a state university. But James McGill (1744–1813) left property valued at the time of his death at £30,000 for the foundation of a college. A royal charter conferring university powers was obtained in 1821. During early years slow progress was made, but with the appointment of Sir William Dawson as principal, in 1855, the institution entered on a career of prosperity. It now embraces ten faculties, arts, applied science, law, medicine, dentistry, pharmacy, agriculture, music, commerce and graduate studies. The finely-equipped Macdonald scientific laboratories, with the Redpath Museum and University Library (275,000 vols. in 1928) form part of a noble group of buildings on the campus in Montreal. Two of these were destroyed by fire in 1907 but have since been rebuilt. The University of Montreal (French) embraces the faculties of arts, dentistry, law, medicine, philosophy, science and theology. The college library (50,000 vols. in 1928) has been enriched by a rare collection of Canadian books and manuscripts, bequeathed by Judge Louis François Georges Baby (1834–1906) of Montreal. The administrative buildings of this University were destroyed by fire in 1919. The University will be housed in new and much larger buildings at the foot of Mount Royal. Of other educational institutions in the city the most important is St. Mary's College, founded in 1848 by the Jesuits, and removed to the present building in 1855. The archives boast a notable collection of early Canadian manuscripts. Historical collections are housed in the Chateau de Ramesay, dating from 1704, and in the McCord Museum, McGill University.

Industries.—Montreal's position as the chief port for the trade of the Dominion, is largely due to the foresight of her great merchants. With the gradual opening up of the means of communication by land and water, and the development of her facilities for handling the exports and imports of the country, the city has increased rapidly in importance. In shipments of grain, as well as in dairy produce, Montreal has far outstripped all her rivals. The total grain receipts in 1928 were 217,316,874 bushels. Montreal now stands fifth among the great ports of the world. The port facilities are thoroughly up-to-date and keep pace with the rapidly growing needs of the city. There were 2,900 factories in the city in 1928 including very large flour mills.

Montreal is governed by a Mayor and 35 aldermen, elected every two years. The city returns 13 members to the Dominion House of Commons and 11 to the Provincial legislature of Quebec. The population of the city, according to the census of 1921, was 618,506; 1931, 818,577. With the suburbs, it was estimated at about 1,000,000, more than half French.

History.—The history of the town is steeped in romance. From that first remarkable scene, so graphically described by Francis Parkman, when, on the 18th of May 1642, Maisonneuve and his little band of religious enthusiasts landed upon the spot where the Montreal Customs House now stands, and planted, in the words of the saintly Dumont, a grain of mustard seed destined to overshadow the land, the history of the town was to be intimately associated with missionary enterprise and such heroism as the world has rarely seen. Montreal began as a religious colony, but its very situation, on the outer confines of civilization and at the door of the Iroquois country, forced it to become a military settlement, a fortified town with a military garrison. Similarly its position, even then an ideal one from a commercial point of view, made it the dominating centre of the fur trade. For a hundred years after its foundation these three influences held sway. Within another hundred years, they had become but atoms in a larger and more varied population. The fur trader of New France, merged after the conquest in the fur trader of the North West Company, remained for a time the one picturesque survival of earlier and more romantic days. Finally he too disappeared.

Bibliography.—Francis Parkman, *Jesuits in North America* and *The Old Régime in Canada* (Boston, new ed. 1902); Newton Bosworth, *Hochelaga depicta* (Montreal, 1846; repr. Toronto, 1901); A. Sandham, *Montreal, Past and Present* (Montreal, 1870); W. D. Lighthall, *Montreal after Two Hundred and Fifty Years* (Montreal, 1892); N. M. Hinshelwood, *Montreal and Vicinity* (Montreal, 1904); S. E. Dawson, *Handbook for the City of Montreal* (Montreal, 1888); A. Leblond de Brumath, *Histoire populaire de Montreal* (Montreal, 1890); H. Beaugrand, *Le Vieux Montréal* (Montreal, 1884); Dollier de Casson, *Histoire de Montréal, 1640–1672* (Montreal, 1868, new ed. 1928); J. D. Borthwick, *Montreal, its history, &c.* (Montreal, 1875); W. H. Atherton, *Montreal* (Montreal, 1914). (L. J. B.)

MONTREUIL, GERBERT DE (*fl.* 13th century), French *trouvère*, author of the *Roman de la violette*. He dedicated his poem (*c.* 1221) to the Countess Marie of Ponthieu, wife of Simon, count of Dammartin and a niece of Philip Augustus. The count Gerard de Nevers of the story stakes his domains on the fidelity of his wife Euriant. Lisiard by calumniating Euriant wins the wager, but in the end the traitor is exposed, and, after many adventures, Euriant is reinstated. Another version of the story is given in the *Roman du comte de Poitiers* and in the tale in the *Decameron* (ii. 9) on which Shakespeare founded *Cymbeline*. Lyrics are inserted in the narrative of the *Roman de la violette*, as they had been in the *Conte de la rose* (1200), known also as *Guillaume de Dole*. A prose version, dating from the early 15th century, provided Wilhelmine de Chézy with the material for her libretto of Weber's opera, *Euryanthe* (1823).

MONTREUIL-SOUS-BOIS, a suburb 7 kilometres east of Notre Dame de Paris in the department of Seine, on the slope and summit of a hill, about 1 m. N. of Vincennes. Pop. (1926) 58,425. Montreuil is specially noted for its extensive peach orchards. The manufactures include paint, oils and varnish, glass and chemical products, and biscuits.

MONTREUIL-SUR-MER, a town of northern France, capital of an arrondissement in the department of Pas-de-Calais, 24 m. S. by E. of Boulogne by rail. Pop. (1926), 2,532. The town with its citadel and ramparts stands on a hill on the bank of the Canche. The church of St. Saulve (12th to 16th centuries), a hospital founded in 1200 and rebuilt in the 19th century, with a fine chapel in the Flamboyant style, and the buildings of the old abbey of Ste. Austreberthe, founded in the 11th century, are interesting. Montreuil is the seat of a sub-prefect. The town owes its origin to a seventh century monastery established by St. Saulve,

bishop of Amiens.

The Château de Beaurepaire was the British G.H.Q. from March, 1916, to April, 1919, in the World War.

MONTREUX, a town in the Canton de Vaud, on the shore east of Lake Geneva, Switzerland, stretching from Clarens to Veytaux. The name includes the communes of the Châtelard and Planches. Pop. (1920) 16,721, mostly French-speaking. There are railway stations at Clarens (15 m. S.E. of Lausanne), Montreux and Territet. From Territet and Montreux a mountain railway runs past Glion and Caux nearly to the top of the Rochers de Naye (6,710 ft.), while from Montreux the Montreux Bernese Oberland railway proceeds via Les Avants through the Col de Jaman by tunnel to Zweisimmen in the Bernese Oberland.

MONTROSE, MARQUESSES AND DUKES OF, David Lindsay, 5th earl of Crawford (*c.* 1440–1495), was created duke of Montrose in 1488 (the first dukedom conferred in Scotland on a person not of royal blood), as a reward for loyalty to James III. during the rebellion of Angus and Prince James. He was deprived of his dukedom by James IV., but it was restored in 1489 for life only.

In 1505, William, 4th Lord Graham, whose wife was the duke's niece, was created earl of Montrose; and this title was held by his descendants till 1644, when James Graham, 5th earl, was created marquess of Montrose and earl of Kincardine. This was the celebrated marquess of Montrose (*q.v.*) of the Civil War, whose son, James (*c.* 1631–69), was known as "the Good Marquess." His grandson, the 4th marquess (d. 1742), was lord high admiral of Scotland in 1705, and lord president of the council in 1706. For his services in promoting the union of Scotland with England, he was created duke of Montrose and marquess of Graham in 1707, becoming in the same year one of the first representative peers of Scotland in the parliament of Great Britain. He was one of the regents of the kingdom on the death of Queen Anne, and was appointed a secretary of state by George I. After suppressing the Jacobite rising in 1715, he was made keeper of the great seal in Scotland. His son David was raised to the peerage of Great Britain with the title of Earl Graham. In 1853 James Lindsay, 24th earl of Crawford, claimed the title of duke of Montrose on the ground that the patent granted to his ancestor David Lindsay in 1488 had not been effectively rescinded, but his petition was dismissed.

MONTROSE, JAMES GRAHAM, MARQUESS OF (1612–1650), became 5th earl of Montrose (*see* above) in 1626. He was educated at St. Andrews, and at 17 married Magdalene Carnegie, daughter of Lord Carnegie (afterwards earl of Southesk). Not long after the outbreak of the Scottish troubles in 1637 he joined the party of resistance to Charles I., signed the Covenant in 1638, and successfully suppressed the opposition to the popular cause which arose in the north around Aberdeen and in the country of the Gordons, though he violated the safe conduct he had promised to Huntley, the leader of the rising, by taking him prisoner to Edinburgh. In 1639, after the signature of the Treaty of Berwick, Montrose was one of the Covenanting leaders who visited Charles. He wished that the clergy should confine themselves to their spiritual duties, and that the king, after being enlightened by open communication with the Scottish nation, should maintain law and order without respect of persons. In the Scottish parliament which met in September, Montrose found himself in opposition to Argyll, was opposed to Argyll's policy of making the three estates equal, thus making the middle classes and the Presbyterians a tool for his own ambition; but he failed to win the support of Charles.

Rather than give way, Charles prepared in 1640 to invade Scotland. Montrose, who was the leader of the royalist party known as the "Plotters," which had arisen within the ranks of the Covenanters, was of necessity driven to play something of a double part. In Aug. 1640 he signed the Bond of Cumbernauld as a protest against the "particular and direct practising of a few," in other words, against the ambition of Argyll. But he defended his country, and in the same month displayed his gallantry in the forcing of the Tyne at Newburn. After the success of the invasion, Montrose was summoned before the Committee of Estates charged with intrigues against Argyll, and in June was imprisoned in Edinburgh castle. After the king's visit to Scotland Montrose shared in the amnesty tacitly accorded to all Charles's partisans.

When the Civil War began in England (*see* GREAT REBELLION) Montrose constantly pressed Charles to allow him to make a diversion in Scotland. Hamilton's impracticable policy of keeping Scotland neutral for long stood in the way of Charles's consent. But in Feb. 1644, when a Scottish army entered England to take part against the king, Montrose, now created a marquess, was appointed lieutenant-general in Scotland. After his unsuccessful attempt in April to invade Scotland with about 1,000 men, disguised as a groom, he made his way in August to the Highlands, where the clans rallied to his summons. He defeated his opponents, with great military skill, at Tippermuir, Aberdeen, Inverlochy, Auldearn, Alford, Kilsyth and Dundee.

In the name of the king, who now appointed him lord-lieutenant and captain-general of Scotland, he summoned a parliament to meet at Glasgow with the object of organizing the Lowlands, on Oct. 20, but the parliament never met, for Charles had been defeated at Naseby on June 14, and Montrose was called to his help. David Leslie, the best of the Scottish generals, was promptly despatched against Montrose whom he discovered on Sept. 12, deserted by his Highlanders and guarded only by a little group of followers, at Philiphaugh. His conduct of the war had alienated the Lowlands. Montrose made his way to the Highlands; but he failed to organize an army. In Sept. 1646 he embarked for Norway. In 1647 he went to Paris, but could get no support from Henrietta Maria. Three years later, burning to revenge the death of the king, he was restored by the exile Charles II. to the now nominal lieutenancy of Scotland. Charles however did not scruple shortly afterwards to disavow his noblest supporter in order to become a king on terms dictated by Argyll and Argyll's adherents. In December 1650 Montrose sailed for the Orkneys with 1,200 men, but 1,000 of them were lost by shipwreck. Reaching Scotland, Montrose tried in vain to raise the clans, and on April 27, was routed at Invercarron. After wandering for some time he was surrendered by Macleod of Assynt, to whose protection, in ignorance of Macleod's political enmity, he had entrusted himself. On May 20, he was sentenced to death and was hanged on the 21st. To the last he protested that he was a real Covenanter and a loyal subject.

The principal authorities for Montrose's career are Wishart's *Res gestae, &c.* (Amsterdam, 1647; abridged trans. in the Stuart series, 1903); Patrick Gordon's *Short Abridgment of Britane's Distemper* (Spalding Club); Gardiner's *Great Civil War;* Napier, *Memorials of Montrose* (1856), containing Montrose's poetry, a selection of which has been edited by R. S. Rait (1901); H. Pryce, *The Great Marquis of Montrose* (1912) and J. Buchan, *The Great Marquis of Montrose* (1913).

MONTROSE, royal burgh, parish and seaport, Forfarshire, Scotland. It is 30¾ m. N.E. of Dundee by the L.N.E. railway and is also connected with the L.M.S. railway company's system by a branch to Dubton. Pop. (1931) 10,196. The town occupies a sandy peninsula, and is bounded by the North sea, the North and South Esk, and by Montrose Basin, a tidal lagoon about 7 m. in circuit. In the mouth of the channel of the South Esk lies the island of Rossie, or Inchbrayock, which is connected with the burgh by means of a suspension bridge and by a drawbridge with the south bank near the large fishing village of Ferryden. The harbour lies between the suspension bridge and the sea, and is provided with a wet dock. The links, with three golf-courses, are very fine, and Montrose is a popular resort. Flax and jute spinning, ship-building, fish-curing, brewing and iron founding are carried on, and there are flour and saw mills and rope-works. The fisheries are of considerable importance and there is a large trade, especially in timber (the chief import) and potatoes (the chief export). Montrose is governed by a provost, bailies and council, and unites with Arbroath, Brechin, Forfar and Inverbervie (the Montrose burghs) in returning one member to parliament, a district group that was represented for many years by John Morley. Montrose received its charter from David I., and was made a royal burgh in 1352. It was destroyed by fire in 1244

Here Edward I. accepted John Baliol's surrender of the kingdom on July 10, 1296. Sir James Douglas sailed from the port in 1330 bound for the Holy Land with the heart of Robert Bruce; and here, too, the Old Pretender embarked in 1716 for France. In 1745 the town threw in its lot with the Hanoverians.

MONT ST. MICHEL (LE), a rocky islet of France, off the coast of the department of La Manche, some 6 m. N. of Pontorson. Pop. (1926) 198. It forms a mass of granite about 3,000 ft. in circumference and 165 ft. in height, rising near the mouth of the Couesnon nearly a mile from the shore, to which it is united by a causeway. In the 8th century an oratory was established here by St. Aubert, bishop of Avranches, in obedience to the commands of an apparition of St. Michael. The place soon became a resort of pilgrims from France, Great Britain, Ireland and Italy. In 966 Richard I., duke of Normandy, founded in place of the oratory a Benedictine monastery. In 1203 the monastery was burnt by Philip Augustus, who afterwards furnished large sums for its restoration (La Merveille). St. Louis made a pilgrimage to Mont St. Michel, and afterwards supplied funds for the fortifications. During the last 30 years of the Hundred Years' War the abbey persistently resisted the English. In 1469 Louis XI. instituted the Order of St. Michel which held its meetings in the salle des chevaliers. During the Wars of Religion, the Huguenots were not able to take the fortress, which opened its gates to Henry IV. in 1595 after his abjuration. In 1622 the Benedictine monks of Mont St. Michel were replaced by monks of the Congregation of St. Maur. In the 18th and 19th centuries until 1863 the abbey was used as a prison for political offenders. The fortress-abbey crowns the more precipitous side of the islet towards the north and west, the sloping portion towards the east and south being occupied by houses. A machicolated and turreted wall surrounds the upper part of the rock. The northern and oldest portion of the ramparts dates from the 13th century; on the south they are pierced by a single 15th century gateway. The single street curves from the gateway up to the abbey, ending in flights of steps leading to the donjon or châtelet. It is bordered by old houses, among which is one built by Bertrand du Guesclin in 1366, and contains a 15th century parish church. Limitations of space led to building of the abbey in three storeys. The floor of the church, partly on the rock, partly upon foundations, and, at the east end, over a crypt, is on a level with the uppermost storey of the monastic buildings. North of and below the apse is the building known as Belle-Chaise. It comprises the châtelet (15th century), a square machicolated entrance structure, the adjoining guard-room (15th century) with the salle des officiers above it, and behind all the Tour Perrine. The Merveille (1203–64) on the north consists of two continuous buildings of three storeys, on the east, one above the other, the hospitium (*aumônerie*), refectory and dormitory, on the west, the cellar, knights' hall (salle des chevaliers) and cloister. Of the fine Gothic apartments the chief are the refectory, divided down the centre by columns and lighted by large embrasured windows, and the superb knights' hall, with a vaulted roof supported on three rows of cylindrical pillars. The 13th century cloister is surrounded by double lines of columns carrying pointed arcades, between which floral designs are carved. The exterior wall of the Merveille, 108 ft. high, is supported by 20 buttresses. The church, high above the other buildings, consists of transepts and four bays of the nave of Romanesque architecture and of a choir (1450–1521) in the Flamboyant Gothic style with a triforium surmounted by windows. In 1776 three of the seven bays of the nave were pulled down, and soon after the incongruous western front was added. The finest part of the exterior is the choir, ornamented with carved pinnacles and balustrading. The central tower terminates in a Gothic spire surmounted by a statue of St. Michael.

BY COURTESY OF G.W.H. BRITT

THE STAIRWAY TO THE ABBEY OF MONT ST. MICHEL

MONTSERRAT, an island in the British West Indies, one of the five presidencies in the colony of the Leeward Islands. Pop., mostly negroes (1921), 12,120. It lies 27 m. S.W. of Antigua, in 16° 45′ N. and 62° 7′ W.; is 11 m. long and 7 m. broad, and has a total area of 32½ sq.m. The island is a serrated range of volcanic peaks rising from the Caribbean Sea, their summits clothed with forests; the still active Soufrière (3,000 ft.) in the south being the highest point. The average temperature is 81° F, the hottest weather being usually tempered by cool sea breezes; the rainfall averages 94 in. per annum. Water is plentiful, and the roads are macadamized and well graded. The principal products are cotton and raw and concentrated lime-juice. The legislature of six crown-nominees sends representatives to the general legislature of the colony. Education is compulsory, and the majority of the schools are managed by the Church of England, to which most of the people belong: the Wesleyans and the Roman Catholics also support schools. Plymouth (pop. 1,532), the chief town, stands on an open roadstead.

The island was discovered by Columbus in 1493, who named it after Monserrado, a mountain in Spain. It was colonized by the British under Sir Thomas Warner in 1632, and was taken by the French in 1664. Restored to the British in 1668, it capitulated to the French in 1782, but was again restored in 1784.

MONTSERRAT, a mountain and monastery in Spain, 30 m. N.W. of Barcelona. The mountain is of grey conglomerate; its main axis trends from west-north-west to east-south-east, and its circumference is about 18 miles. The loftiest point is the Turó de San Jeronimo, also called Mirador and La Miranda (4,070 ft.). On the east the base of the Montserrat is washed by the river Llobregat. The Montserrat consists of jagged pinnacles and spires (*peñascos*) rising abruptly from the base of the mass, which is cloven by ravines, and abounds with precipices. It is the *mons serratus* of the Romans, the *monte serrado* of the Spaniards, and is thus named either in allusion to its jagged appearance, or because it is split, as if sawn by the vast fissure of the Valle Malo. This occurred, say the Spanish legends, at the time of the Crucifixion, when the rocks were rent.

The monastery stands 2,910 ft. high on the edge of the Valle Malo. It owes its existence to an image of the Virgin, said to have been carved by St. Luke and brought to Barcelona by St. Peter in A.D. 30. When the Moors invaded the province in 717 the image was taken to Montserrat and hidden in a cave. In 880 Gondemar, bishop of Vich, was attracted to the cave by sweet sounds and smells, and there found the image, which he determined to take to Manresa. But at a certain spot on the mountain the image refused to proceed farther; there it was consequently deposited, and a chapel was erected to contain it. Round the chapel a nunnery was built, and in 976 this was enlarged and converted into a second Benedictine convent. During the Napoleonic wars (1808–14) it was despoiled of treasures. In 1835, as a result of the Carlist insurrection, the convent was deprived of its estates and the number of monks reduced to about 20. In 1874 the convent, which by a grant of Pope Benedict XIII. had been an independent abbey since 1410, was made subject to the bishops of Barcelona.

Nuestra Señora de Montserrat, Patrona de Cataluña ("Our Lady of Montserrat, Patron Saint of Catalonia"), is one of the most celebrated images in Spain, and her church is visited annually by more than 60,000 pilgrims. The image is small, black, and carved of wood, but possesses magnificent robes and jewels.

MONTT, MANUEL (1809–1880), Chilean statesman, was born on Sept. 5, 1809. He had a distinguished career as a scholar, and was introduced into public life during the presidency (1831–41) of Arieto by Diego Portales. Montt distinguished himself by his courage in the crisis that followed upon Portales' assassination in 1837, though only holding a subordinate post in the government. Afterwards he held several ministerial offices, and during the presidency (1841–51) of Bulnes he became minister of justice and public instruction, and later of the interior. He was elected president in 1851 and again in 1856. Though the Liberals chafed

under his rule, and two revolutions, in 1851 and 1859, took place during his administration, he governed Chile with an energy and wisdom that laid the foundation of her material prosperity. He was ably assisted by his minister of the interior Antonio Varas, and it was from the union of the two statesmen that the well-known ultra-conservative faction, the Montt-Varistas, took their name. His presidency was marked by the establishment of railways, telegraphs, banks, schools and training-colleges. On giving up his post in 1861 he became president of the supreme court of justice, a position which he held up to his death on Sept. 20, 1880. His son Jorje (b. 1846) was president of Chile in 1891–96, and a younger son, Pedro (d. 1910), in 1906–10.

MONTT, PEDRO (1848–1910), Chilean statesman, son of Manuel Montt (*q.v.*), was born in Santiago, Chile, in 1848. He graduated in law at the *Instituto Nacional* in 1870, and four years later entered political life. In 1876 he was elected a member of the chamber of deputies, and in 1885 he became its president. During this period began his powerful influence in the public administration and also in the direction of the National party which Manuel Montt had founded. He voyaged to Europe to study the political institutions of the leading European nations. In 1886 he was appointed minister of justice and public instruction and in 1887 minister of industry and public works. In spite of holding these two cabinet offices in the government of President Balmaceda, Montt figured in the parliamentary opposition to him in 1890, and in 1891 took a very active part in the revolution which put an end to his power. He went to the United States first as agent of the Revolutionary Junta and, after the recognition of the new government, remained as Minister of Chile. In 1901 he was an unsuccessful candidate for the presidency, but in 1906, as the candidate of the National Union ticket and supported by all important elements, he was elected by a large majority. During his term he helped to prevent armed conflict between Chile and Argentina, fostered railway development, worked for sound finances and for sanitation and health projects. He was greatly interested in education and during all his political career was a member of the council of public instruction. His interest in books led him to acquire a private library, the largest in Chile at the time of his death. In 1910, his health failing, he went to Europe to seek treatment and died on Aug. 16, at Bremen, Germany.

MONTUCLA, JEAN ÉTIENNE (1725–1799), French mathematician, was born at Lyons on Sept. 5, 1725. In 1754 he published an anonymous treatise entitled *Histoire des recherches sur la quadrature du cercle,* and in 1758 the first part of his *Histoire des mathématiques,* the first history of mathematics worthy of the name. In 1778 he re-edited Jacques Ozanam's *Récréations mathématiques,* afterwards published in English by Charles Hutton (4 vols., London, 1803). He died on Dec. 18, 1799. His *Histoire* was completed by J. J. Le F. de Lalande, and published at Paris in 1799–1802 (4 vols.).

MONTÚFAR, LORENZO (1823–1898), Guatemalan statesman and author, was born in Guatemala city on March 11, 1823 He studied law at the University of Guatemala and joined with other youthful leaders in publishing the radical periodical *Album Republicano.* Opposition to General Carrera led to forced suspension of the publication. Montúfar went to San José, Costa Rica, where he was named a magistrate of the Supreme Court. After being deprived of this office by force, he took his doctor's degree in law and obtained a professorship at the University of Costa Rica. During the presidency of Juan Ramón Mora he was minister of foreign relations in Costa Rica. He was later named rector of the University of Costa Rica. Afterwards he was forced to fly to San Salvador, which government made him minister to Peru. When Carranza became president of Costa Rica he returned to take the position of minister of foreign relations which he retained also during the presidency of Guardia. As minister he negotiated a number of treaties, notably the treaty delimiting the frontier with Colombia. He was later named envoy extraordinary and minister plenipotentiary of Guatemala to Spain. He was distinguished both as a writer and as a jurist. His most important work is the *Reseña histórica de Centro-America* (7 vol., 1878–81). He also wrote *Apuntamientos sobre economia politica* (1887); *Walker en Centro-America* (1887) and was editor of the advanced periodical *Quincenal Josefino.* In 1891 he was an unsuccessful candidate for the presidency of Guatemala.

The *Discursos del Doctor Lorenzo Montúfar* (R. Montúfar, ed.) was published in 1923.

MONTYON, ANTOINE JEAN BAPTISTE ROBERT AUGET, Baron de (1733–1820), French philanthropist, was born at Paris on Dec. 23, 1733. He rose rapidly in the legal profession, and held several important offices of State. He is best remembered for the numerous prizes which he established, and for the Montyon "prix de Statistique" founded in his honour. Though dealing with economic problems, his books are written mainly from the point of view of the philanthropist, and contain little that is of scientific value. During his life he spent his money freely in the alleviation of suffering, and at his death bequeathed 10,000 francs to each of the Parisian hospitals. His most important works are:—*Recherches et considérations sur la population de France* (1778); *Quelle influence ont les diverses espèces d'impôts sur la moralité, l'activité et l'industrie des peuples* (1808); and *Particularités et observations sur les ministres des finances de France, les plus célèbres de 1690 à 1791* (1812).

See Lacretelle, *Discours sur M. Montyon* in *Recueil de l'académie* (1820–29); Quérard, *La France littéraire,* vol. vi. (1834); F. Labour, *M. de Montyon d'après des documents inédits* (1880); G. Dumoulin, *Montyon* (1884); and L. Guimbaud, *Auget de Montyon* (1909).

MONUMENT, a word whose many meanings are all related to its original root, which signifies a memorial. Thus, in surveying, any natural or artificial object to which the description of a boundary is referred, is known as a monument, and any building or other work of art may be referred to as a monument of a certain style or period. The term is also loosely applied to a gravestone or tomb. More specifically, in architecture, a monument is a structure, erected for the primary purpose of commemorating a person or event. (*See* Religious and Memorial Architecture.)

MONUMENTS, PRESERVATION OF (Lat. *monumentum* or *monimentum;* from *monere,* to advise, bring to mind, remind; the German equivalent is *Denkmal*), literally, that which serves to keep alive the memory of a person, an event, or a period. The word is thus applied to a column, statue or building erected for that particular purpose; to all the various memorials which man throughout the ages has raised over the buried dead, the barrows and cairns of prehistoric times, the representation of the living figure of the dead, brasses, busts, etc., or the varying forms, allegorical or otherwise, taken by the tombstones of the modern cemetery. In a wider sense "monument" is used of all survivals of prehistoric man—dolmens, menhirs, remains of lake dwellings, stone circles and the like, buildings large and small, with cities, castles, palaces, and examples of domestic architecture which have any interest, historic or artistic, as well as movable artistic or archaeological treasures either existing in private or public collections or newly discovered by excavation, etc. In a more restricted sense the word "monument" is also applied to a comprehensive treatise on any particular subject—such as the *Monumenta typographica,* or an historical collection such as the *Monumenta Germaniae historica.* In the English law of conveyancing a "monument" is an object fixed in the soil, whether natural or artificial, and referred to in a document, and used as evidence for the delineation of boundaries or the situation of a particular plot of land, etc.

For a description of various kinds of monuments *see* such articles as Archaeology; Stone Monuments, Primitive; Effigies, Monumental; Sculpture; Barrow; Cromlech; etc.; many particular monuments such as Stonehenge, are treated under their respective names, or in the articles on the towns, etc. in which they stand; while the preservation of monuments in various countries is dealt with under the different headings of those countries, *e.g.,* Egypt, Greece.

The present article deals with the preservation, by government action, local or central, of the evidences and remains of past history and civilization; for reference to similar action extended to sites and places of natural beauty and interest, which are known in Germany as *Naturdenkmäler* (natural monuments), consult

Meyers Lexicon, s.v. In 1897 was issued a report (C. 8443, *Miscell. Reports, 2*) from British representatives abroad as to "the statutory provisions existing in foreign countries for the preservation of historical buildings"; while in 1905 *The Care of Ancient Monuments,* by G. Baldwin Brown was published containing an ample bibliography for each country and giving many references to various periodicals in different languages: reference may also be made to *The Care of Natural Monuments* (Cambridge, 1909) by H. Conwentz, Prussian State Commissioner for the Care of Natural Monuments.

The chief question at issue is, how far does the national artistic or historic interest of a monument, in the widest sense of the word, justify the interference of the State with the right of a private owner, whether corporate body or individual, to do what he likes with his own? Nearly every European country has given a decided answer to this question, and it may be noticed, as showing the extreme reluctance to State interference in Great Britain, that a clause, laying on an owner of a monument scheduled under the Monument Act of 1882 the obligation of offering it for purchase to the State if he wished to destroy it, was struck out of that Act.

The main lines followed by legislation or regulation for the preservation of monuments may be briefly indicated. Central organizations of commissions and conservators, with a staff of architects, inspectors, and archaeological or artistic experts for consultation, are established. These may have wide legal powers of enforcing their decisions, or may act chiefly by advice or persuasion. The national treasures are catalogued and scheduled, and the value estimated in an exhaustive inventory, in many cases supplemented by local inventories, a course of procedure that has to a large extent prevented the continuance of the destruction of valuable monuments through ignorance of their value.

The Classement System.—A special form of inventory, carrying with it legal consequences, is that known as the *classement* system; of this form the French is the typical example. In this only the outstanding monuments find a place, and such either become national property altogether, or the protection and preservation is undertaken by the State, or may be left in the hands of the private owner; but in any case the monument cannot be destroyed, restored or repaired without the consent of the central authority. The *classement* system has been criticized as tending to depreciate the consideration paid to such monuments as do not appear in the list—*monuments non-classés.* Great Britain adopted a narrow kind of *classement* in the schedule attached to the 1882 Act. Most States have powers of expropriation or compulsory purchase of private property on grounds of public utility, and English law is no exception—as in the case of the compulsory purchase of land for railways—and now the majority of States have made the protection of monuments a matter of public utility. Further, the exportation of artistic or historic treasures, *i.e.,* movable monuments, has been controlled by the State, notably in the case of Italy and Greece, Turkey and Egypt.

Connected with this side of the question is the control by the State of excavations undertaken by private persons, even on their own property. In Germany considerable protection is effected by the powers given to municipalities to make by-laws, respecting not only the preservation of the monuments, but also the erection of new buildings that may interfere with the monuments or with the general characteristic appearance (*Stadtbild*) of the town. This is also the case in Italy, where there are frequent regulations as to town-planning (*piano regolamento*).

The following is a brief account of the measures adopted in the principal countries of the world for the preservation and protection of their artistic and historic treasures.

Great Britain.—In Great Britain the existing law is contained in the Ancient Monuments Consolidation and Amendment Act, 1913. This Act consolidated the provisions of the previous Acts passed in 1882, 1900 and 1910. The act of 1882, due primarily to Lord Avebury, then Sir John Lubbock, provided that a list of monuments in Great Britain and Ireland should be made to which the Act was to apply; the number of these monuments, the names of which will be found in an appendix to Sir R. Hunter's *Lecture on the Preservation of Places of Interest and Beauty* (1907), was 68, all being of the kind known as prehistoric (barrows, stone-circles, dolmens, etc.) An owner of one of these scheduled monuments might by deed place it in the guardianship of the Commissioners of Works, who were then responsible for its preservation and could protect it even against the owner. The Commissioners might purchase any of the scheduled monuments, but only by agreement, the compulsory clauses of the Lands Clauses Consolidation Acts being expressly excluded, though any purchase was to be made under those acts. An owner of any monument other than those scheduled might place it in the care of the commissioners. The funds for the working of the act were to be provided by parliament, and an inspector of ancient monuments was appointed. General Pitt-Rivers, the first inspector, found that without compulsory powers the act was useless, and for many years did not draw his official salary, while after his death in 1900 the office was left unfilled until 1910. In an Act applying only to Ireland, which was passed in 1892, the commissioners of public works in Ireland were given powers—only to be exercised with the consent of the owner—of applying the act of 1882 to any monument possessing such public interest as might render it worthy of preservation. It is to be noticed that after the disestablishment of the Irish Church certain unused churches of artistic or historic interest were placed in the charge of the Commissioners as national monuments, with a sum of £50,000 to defray expenses. The Irish Commissioners have therefore monuments in their care other than those scheduled in the Acts, and may apply towards the expenses of the preservation of the scheduled monuments any surplus over from the fund above mentioned. The act of 1900 applied the Irish act to Great Britain, and also gave the powers of the Act of 1892 to county councils, allowed the authorities, local or central, to make arrangements for the preservation of monuments with owners or others, including societies, and to receive subscriptions for the same object, and also provided for public access to such monuments as are in the guardianship of the Commissioners under the Act. The Acts of 1892 and 1900, though allowing buildings of historic or other interest to be placed under the care of the commissioners, excluded buildings occupied as a dwelling-place by any person other than a caretaker and his family. The act of 1910 gave to the Commissioners of Works power to acquire by *bequest* buildings of historic or architectural interest. The act of 1900 had given power to acquire such by gift or purchase, and the act of 1882 had given power by bequest also, but only referred to prehistoric remains. The London County Council possesses powers of purchasing by agreement any building of historic or other interest under a General Powers Act of 1898, and exercised these in 1899 by purchasing, in conjunction with the City Corporation, the 17th century house in Fleet Street in which is the room known as "Prince Henry's Council-chamber."

Under the Consolidating Act of 1913 Ancient Monuments Boards were set up for England, Scotland and Wales whose duty is to advise the Commissioners of Works with reference to the treatment of monuments and to report to the Commissioners when they have reason to believe that any monument of national importance is in danger of destruction or removal, or danger from neglect or injudicious treatment. A "monument" or "ancient monument" is defined as including any structure or erection (except an ecclesiastical building for the time being used for ecclesiastical purposes) the preservation of which the Commissioners of Works consider to be a matter of public interest because of its historic, architectural, traditional, artistic, or archaeological importance. The Commissioners, however, may not accept the guardianship of, or issue a preservation order relating to, any monument occupied as a dwelling-house by any person other than the caretaker thereof. They are bound to prepare and publish a list of all monuments the preservation of which is reported by any of the Ancient Monuments Boards to be of national importance, and to inform the owners of their intention to include them and of the penalties incurred for injury or defacement. This is called "scheduling" a monument. The owner of such a monument is

thereafter bound to give the Commissioners one month's notice before he proceeds to demolish, remove (either whole or in part), alter structurally, or make any addition to the monument. Failure to give such notice renders him liable on summary conviction to a fine not exceeding £100, or to imprisonment for three months, or to both.

The Commissioners of Works, or any local authorities within the meaning of the Act, have power (1) to acquire ancient monuments by purchase; (2) to accept the ownership of an ancient monument under a deed of gift or a will; (3) to assume the guardianship of any ancient monument offered to them by the owners.

Where the Commissioners or a local authority acquire or accept a monument they become the legal owners of the buildings and the land on which they stand. Where the Commissioners only assume guardianship, the ownership remains vested in the original owners, though the Commissioners or the local authority, as the case may be, have powers of control and maintenance over it as an ancient monument apart from the owner. The Commissioners of Works may, in the case of any monument of which they are not owners or where they are not guardians, issue a preservation order if the Ancient Monuments Board concerned reports to them that any monument which the Board consider to be of national importance is in danger of destruction, removal or damage from neglect. In very urgent cases the Commissioners may make such an order without receiving a report. A preservation order has effect only for eighteen months unless within that time the order has been confirmed by Parliament, and while it is in force the monument must not be demolished or removed, nor may any additions or alterations be made without the Commissioners' written consent. If no confirmation is made, no further order with regard to the monument can be made for five years. The Commissioners of Works are bound to afford public access to any monument of which they are the owners; but where they are only guardians the public are not entitled to access without the owner's consent, if the deed of guardianship so provides. Persons injuring or defacing any monument of which the Commissioners or a local authority are guardians or which is subject to a Preservation Order, may, on summary conviction, be fined a sum not exceeding £5 and be ordered to repay the cost of repairing the damage, or imprisoned with or without hard labour, for a term not exceeding one month.

Towards the making of a national inventory the first step taken was the appointment in 1908 of three royal commissions, for England, Scotland and Wales respectively, "to make an inventory of the ancient and historical monuments and constructions connected with or illustrative of the contemporary culture, civilization and conditions of life of the people from the earliest times" to the year 1700 in the case of England and 1707 in that of Scotland (for Wales no date is specified), and "to specify those which seem worthy of preservation." The Housing Town-planning Act and the Development and Road Improvement Funds Act (both 1909), excepted the sites of ancient monuments or of other objects of historical interest from compulsory acquisition for the purposes of those Acts. The Finance Act of 1896 granted a qualified exemption from estate duty to pictures, prints, books, mss., works of art, scientific collections and other things not yielding income, as appear to the Treasury to be of national, scientific or historic interest; this exemption only extends where such property is settled to be enjoyed in kind in succession by different persons; if the property is sold or is in the possession of a person competent to dispose of it, it becomes liable to estate duty. The Finance Act of 1909 extended the exemption to legacy and succession duty, removed the restriction to settled property and added "artistic" to "national and historic interest."

Apart from the numerous national and local (usually county) archaeological societies whose proceedings contain invaluable accounts of practically every monument of interest throughout the kingdom, there are three societies directly formed with the object of monument preservation in its widest sense, the Society for the Protection of Ancient Buildings, founded in 1877, the Ancient Monuments Society, with headquarters at the John Rylands Library, Manchester, and the National Trust for Places of Historic Interest or Natural Beauty, which was founded in 1895 with the object of generally promoting the preservation—and particularly the acquisition by gift or purchase—of places of historic interest or natural beauty and holding them in trust for the nation. The last-named was incorporated by the National Trust Act in 1907 and was by that Act empowered to acquire by gift, purchase or devise, sites and buildings to be held in perpetuity for the benefit of the public. It possesses more than 150 properties, amounting to nearly 30,000 acres, and including 30 interesting buildings, among which are the Joiners' Hall at Salisbury, the Old Court House at Long Crendon (Bucks), the Coleridge Cottage at Nether Stowey, and Duffield, Kanturk, Bodiam and Tattershall castles.

In 1926 the Government of Northern Ireland passed an Act modelled very largely on the British Act of 1913.

In the Report of the Ancient Monuments Advisory Committee issued in 1921, it is stated that "legislation for the protection of national monuments in this country [Great Britain] is a thing of very modern growth, as may be realized from the fact that 20 years ago the State could only exercise a very ineffective control over a limited class of prehistoric monuments, while for the care of the great architectural monuments of the country there was no State provision of any kind. The Acts of 1910 and 1913 have considerably improved the position. But even at the present day the conception of the nation's interest in, and consequent duty towards, national monuments is far behind what is embodied in the legislation of other countries, and numbers of monuments of the very first importance are entirely without protection, as far as statutory powers are concerned. The existence, however, of these Acts is in itself a recognition of the principle that the nation has an interest in Ancient Monuments apart from, and in some respects superior to, the interests of the legal owners of the monuments." In the summary of their conclusions, the members of the Advisory Committee said, "It appears that while the definition of a monument is everywhere much the same, a distinction is made in practice between monuments in private ownership and those belonging to public or corporate bodies. The British distinction between monuments in use and those no longer used is not recognized [on the Continent], and we are of the opinion that on logical and practical grounds the advantage is with the Continental conception. Other provisions which are not found in the British law are (1) control of movable objects, (2) preservation of scenery where it affects the amenities of a monument, (3) financial help to private owners for the preservation of monuments in their possession and (4) compensation."

It is of interest to compare the protective measures adopted by certain other countries with those in force in Great Britain.

France.—In France a monument is defined as any movable or immovable object the preservation of which is of public interest from an historical or artistic point of view. If a monument is in danger and the owner will take no action to preserve it, it may be placed under the direct control of the State. This function is termed scheduling and is performed by the Ministry of Fine Arts, becoming immediately operative on notification. If the owner objects, the scheduling must be confirmed by a decree of the Council of State, and compensation is payable if considered due. The owner must lodge his objection within six months. A scheduled monument, if belonging to a public body, may not be alienated without permission, and whether public or private may not be in any way damaged. Penalties are provided.

The Ministry of Fine Arts, or Departments or Communes, may, if it seems to them necessary, expropriate monuments of public interest at an agreed price; but confirmation of this is necessary within six months by a decree of the Council of State declaring public benefit.

Germany.—In Germany, all objects are included which are characteristic of their times, are of value for the understanding of art and its historical development and of history in general or serve to record important historical events. Monuments may be movable or immovable, and everything which is not the property of private persons may come under the law, including all churches and public buildings and the property of universities

and other corporate bodies recognized by the State. Private property is dealt with under the general laws governing building, the State inspectors having to take care that no scheme for new buildings, or building operations of any importance, shall cause damage or disfigurement to ancient monuments. Grants of money are sometimes made to public or private owners to assist them in preserving their monuments, the State reserving, in such cases, a certain amount of control and supervision over the monument for the future. The principal German society is the Gesamtverein der deutschen Geschichts- und Altertumvereine, founded in 1852. This is a general association of all the various societies throughout Germany. There are also many societies in the various towns, as well as local associations more directly concerned with the practical protection and preservation of monuments. The chief periodical—perhaps one of the most important of any dealing with the subject in Europe—is *Die Denkmalpflege,* first published in 1899.

India.—The Archaeological Survey of Upper India was established in 1862, with a director-general at its head, and surveys for other parts of India were also begun later. The chief object of these was the making of an inventory, and the preservation of the monuments was neglected. In 1878 a curator of ancient monuments was appointed. A period of activity with regard to monument preservation set in during the Viceroyalty of Lord Curzon (1899–1904); this culminated in the Ancient Monuments Preservation Act (1904). Besides establishing and placing on a permanent footing the seven "Archaeological Circles" into which British India is now divided this Act empowered the local government of any province to declare any monument to be a "protected monument within the meaning of the Act," and provided that when any monument was thus scheduled no one might injure, remove or alter it under penalty of a fine or imprisonment. Power of expropriation is accorded by the Land Acquisition Act in any case in which a monument is threatened with destruction or injury, or if an owner refuse to come to an agreement with the authority for its guardianship. The Act includes movable antiquities, and the governor-general in Council can prohibit their exportation; control over excavations is also given.

Bibliography.—Besides the Reports and works by G. Baldwin Brown, H. Conwentz, Sir Robert Hunter, and others to which reference is made in the text, *see* the seven *Lists of Scheduled Monuments* issued from the office of H. M. Commissioners of Works, *The Ancient Monuments Consolidation and Amendment Act,* ed. by Henry Jenner, F.S.A. (1913), and the publications of the Royal Commission on Historical Monuments. (S. H. H.; X.)

United States.—With regard to the remains of prehistoric man, earthworks, barrows, etc., some of those States, such as Ohio, which are especially rich in such monuments, have particular laws protecting individual remains, *e.g.,* the earthworks in Warren county. The State exercises control over other remains of interest, *e.g.,* the Eagle earthworks in Licking county. There is also an archaeological and historical society, partly maintained by the State, with the object of the better preservation of the evidences of the prehistoric occupation. In North Dakota a State historical commission was created in 1895 "to collect and preserve the records and relics pertaining to the early history, settlement and development of North Dakota." The sites of the battlefields and statues, etc., erected in commemoration of the War of Independence or the Civil War, are preserved by various methods—by State or municipal regulations, by the action of incorporated bodies or trustees, etc. Most of the States rely on statutory prohibitions of malicious damage to protect their monuments. The Federal Government has set aside various natural features and historic spots as national monuments. *See* National Parks and Monuments, The.

MONVEL (1745–1812), French actor and dramatic writer, whose real name was Jacques Marie Boutet, was born in Lunéville on March 25, 1745. He was a small, thin man without good looks or voice, and yet he became one of the greatest comedians of his time. He made his début in 1770 at the Comédie Française in *Mérope* and *Zénaïde;* he was received *sociétaire* in 1772. For some reason unknown Monvel secretly left Paris for Sweden about 1781, and became reader to the king, a post which he held for several years. At the Revolution he returned to Paris, embraced its principles with ardour, and in 1791 joined the theatre in the rue Richelieu (the rival of the Comédie Française), which, under Talma, with Dugazon, his sister Mme. Vestris, Grandmesnil (1737–1816) and Mme. Desjardins, was soon to become the Théâtre de la République. After the Revolution Monvel returned to the reconstituted Comédie Française with all his old companions, but retired in 1807. Monvel was made a member of the Institute in 1795. He wrote six plays (four of them performed at the Comédie Française), two comedies, and 15 comic operas, seven with music by N. Dezède (1740–92), eight with music by Nicolas d'Alayrac (1753–1809). He also published an historical novel, *Frédégonde et Brunehaut* (1776). He was professor of elocution at the Conservatoire. His two daughters (Mlles. Mars, *q.v.*) were well-known actresses.

MONZA (locally *Monscia*), city, Lombardy, Italy, in the province of Milan, by rail, 8 m. N.N.E. of Milan, with which it is also connected by both steam and electric trams. It lies on the Lambro, a tributary of the Po, 532 ft. above sea-level. Pop. (1921), 42,988 (town); 57,060 (commune). Near the Porta d'Agrate is the nunnery in which the nun of Monza (*see* Manzoni's *Promessi sposi*) was enclosed. The cathedral (590) was enlarged at the close of the 13th century, and the black-and-white marble façade was erected in the 14th by Matteo da Campione. On the left is the brick tower, 278 ft. high (1592–1606). Within the church are the iron crown of Lombardy, supposed to have been beaten out of one of the nails used at the Crucifixion, and the treasury containing the relics of Theodelinda (*see* Lombards), comprising her crown, fan and comb of gold, and the golden hen and seven chickens, representing Lombardy and her seven provinces, and crosses, reliquaries, etc., of the Lombard and Gothic periods. The church of Santa Maria in Istrada (1357) has a rich terra-cotta façade of 1393. The communal palace has pointed arches and a square tower. The royal palace of Monza (1777) lies not far from the town, on the banks of the Lambro, and is used for art exhibitions. A motor-racing track has been constructed in the park.

Monza (anc. *Modicia*) was a village until the time of Theodoric. During the period of the republics Monza was sometimes independent, sometimes subject to Milan. The Visconti built a castle in 1325. Monza has stood 32 sieges, and was repeatedly plundered—notably by the forces of Charles V. At Monza King Humbert I. was assassinated on July 20, 1900; an expiatory chapel was dedicated in 1910.

MONZONITE, the group-name of a type of rocks which have acquired it from their most celebrated occurrence, that of Monzoni in Tirol. The rocks are of granitic appearance, usually rather dark grey in colour and fine to moderately coarse grained. The special characteristic which distinguishes them from granites and ordinary syenites is the presence of basic plagioclase and orthoclase felspars in nearly equal amounts. Labradorite and andesine are present, usually in well-shaped crystals, often zoned; orthoclase forms large irregular plates in which the other minerals are embedded. There is rarely any considerable amount of quartz, though in a few of these rocks this mineral occurs (the quartz-monzonites). Other features are the abundance of augite, and of large bronze-coloured plates of biotite which are of quite irregular shapes and full of enclosures. Hypersthene or bronzite is less common, but hornblende is sometimes abundant. Olivine also may be present; when the rock contains this in notable quantity it may be called an olivine-monzonite.

The monzonites of Tirol show a great variability in appearance, structure and the relative proportions of their minerals. They tend to pass into iolesites and gabbros, and near the margins of the outcrop occur facies very rich in pyroxene (pyroxenites).

Rocks of monzonitic facies occur also in Norway, where they have been described as åkerites. They contain quartz, orthoclase and plagioclase, augite and biotite; hornblende and hypersthene also may be present. Some of them have porphyritic rather than granitic texture, especially near the margins of the laccoliths. From a study of these and other occurrences Brögger proposed to define the monzonites as orthoclase-plagioclase

rocks in which the two chief classes of felspar occur in nearly equal quantities (as distinguished from the orthoclase rocks or granites and syenites and the plagioclase rocks or diorites and gabbros).

At Yogo Peak and Beaver Creek, Montana, there are masses of granitoid rock which bear a close resemblance to the monzonites of Tirol. Two main types occur: (*a*) yogoite, which differs little from monzonite, and (*b*) shonkinite, which is a more basic rock richer in plagioclase and augite; this rock contains olivine and in places passes into dark pyroxenites. In shonkinite also a little nepheline may be present. In the west of Scotland intrusive bosses are known which consist of an olivine-bearing rock closely related to monzonite. It has been called kentallenite because it is quarried at Kentallen in Argyllshire.

The following analyses show the chemical peculiarities of the principal rocks of the monzonite group:—

	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	K_2O	Na_2O
Monzonite, Monzoni .	54·20	15·73	3·67	5·40	3·40	8·50	4·42	3·07
Yogoite, Yogo Peak .	54·42	14·28	3·32	4·13	6·12	7·72	4·22	3·44
Kentallenite, Argyllshire .	52·09	11·93	1·84	7·11	12·48	7·84	3·01	2·04

(C. E. T.)

MOODKEE or **MUDKI,** a town in the Ferozepore district of the Punjab, India. It is situated 26 m. S. of the Sutlej, on the old road from Ferozepore to Karnal, and is notable as the scene of the first battle (Dec. 18, 1845) in the first Sikh war (*q.v.*).

MOODY, DWIGHT LYMAN (RYTHER) (1837–1899), American evangelist, was born in the village of East Northfield, Mass., on Feb. 5, 1837. His father died in 1841, and young Dwight, a mischievous, independent boy, got a scanty schooling. At 17 he became a salesman in a shoe-store in Boston; in 1855 he was "converted"; and in 1856 he went to Chicago and started business there. Beginning with a class gathered from the streets, he opened (1858) a Sunday school in North Market hall, which, largely as a result of his enthusiasm and devotion, grew into a church. He was a man of extraordinary energy and of never failing belief in the power of the Lord to provide. In 1860 he gave up business and devoted himself to city missionary work, and during the Civil War to labours among the soldiers. In 1865–69 he was president of the Chicago Young Men's Christian Association. Ira David Sankey (1840–1908) joined him in Chicago in 1870 and helped him greatly by the composition and sympathetic rendering of the Moody and Sankey *Gospel Hymns*. In a series of notable revival meetings in England and America these two men carried on their campaign, which, according to Moody's admirers, "reduced the population of hell by a million souls." In 1879 Moody opened the Northfield seminary for young women at Northfield, Mass., and in 1881 the adjacent Mount Hermon school for boys; in each a liberal practical education centred about Bible training. In 1889 he opened in Chicago the Bible institute, and there trained Christian workers in Bible study and in practical methods of social reform; he was also the founder of the Bible (or Christian Workers') conference, first held at Northfield in 1880, and the Students' (or College Men's) conference, first held in 1887. He died at Northfield on Dec. 22, 1899. His sermons were colloquial, simple, full of conviction and point. In his theology he laid stress on the Gospel, not on sectarian opinions. His intense sympathy for, and insight into the individual, his infinite practical skill and tact, his genius for organization, his honesty, his singular largeness and sweetness of spirit and his passion for mending and winning souls made him, in spite of his scholastic defects, one of the greatest of modern evangelists.

See the (official) *Life of Dwight L. Moody* (1900), by his son, W. R. Moody; Henry Drummond, *Dwight L. Moody: Impressions and Facts* (1900), with an introduction by G. A. Smith; and Gamaliel Bradford, *D. L. Moody, a Worker in Souls* (1927), which contains a bibliography.

MOODY, WILLIAM VAUGHN (1869–1910), American poet and playwright, was born at Spencer (Ind.), July 8, 1869. After the death of his parents he worked his way through preparatory school and Harvard, where he acted as assistant in English in 1894–95. From 1895 to 1903 he was an instructor at the University of Chicago and, after 1901, an assistant professor. Teaching, the editing of Milton's poems and other classics, and the compilation with Robert M. Lovett of *A First View of English and American Literature* (1902), he endured only as they enabled him to help his family and to secure the leisure he coveted for creative work. He died at Colorado Springs, Oct. 17, 1910. For a time *The Great Divide* (1907) was hailed as "the great American drama," and it still ranks high. His second prose play, *The Faith Healer* (1909), although the material was interesting, was less successful dramatically. His remaining output was verse—a number of short pieces collected first in 1901 and the poetic dramas *The Masque of Judgment* (1900) and *The Fire-Bringer* (1904). The last of the trilogy *The Death of Eve* was left incomplete at his death. Moody had a genuine gift for song, which he carefully cultivated. The richness of his rhythms and the fineness of his lyric sense gave him a high place in American literature.

In 1912 Moody's complete works in three volumes were edited with an admirable introduction by J. M. Manly. *Some Letters of William Vaughn Moody* (1913), edited by D. G. Mason, forms the best possible revelation of his brilliant gifts, of his moods, and of his life during his working years.

MOON, in astronomy, the name given to the satellite of any planet, specifically to the satellite of the earth (a common Teutonic word, *cf.* Ger. *Mond,* Dut. *maan,* Dan. *maane,* etc., and cognate with such Indo-Germanic forms as Gr. *μήν*, Skt. *mās,* Irish *mī,* etc.; Lat. uses *luna, i.e., *lucna,* the shining one, *lucere,* to shine, for the moon, but preserves the word in *mensis,* month; the ultimate root for "moon" and "month" is usually taken to be *me-*, to measure, the moon being a measurer of time).

The Apparent Motion of the Moon.—It is convenient to give first a general idea of the motion of the moon as seen by an observer on the earth. The sidereal month is 27·32 days and in this interval the moon makes, on the average, a complete revolution relative to the stars. In the meantime, the earth is moving in its orbit round the sun and it is not till after the lapse of an additional 2·21 days that the moon is in the same position relative to the sun's direction; the synodic month being 29·53 days.

The moon being an opaque body, shining by reflected light, only that portion of the hemisphere which is illuminated and turned towards the earth can be seen. At new moon, M^1, the hemisphere turned towards the earth is wholly unilluminated by sunlight, while at full moon, M^5, the fully illuminated hemisphere is turned towards the earth. At intermediate phases the hemisphere turned towards the earth is only partially illuminated. Near new moon (on both sides) the moon appears as a narrow crescent with the horns turned away from the sun; near full moon the defective edge is that farthest from the sun's direction, *i.e.*, before full moon the eastern side (left in northern hemisphere) and after full moon the western side. In the diagram the plane of

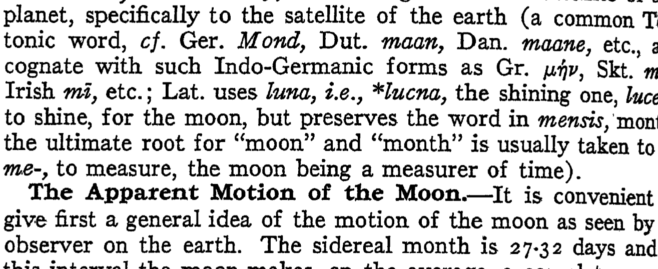
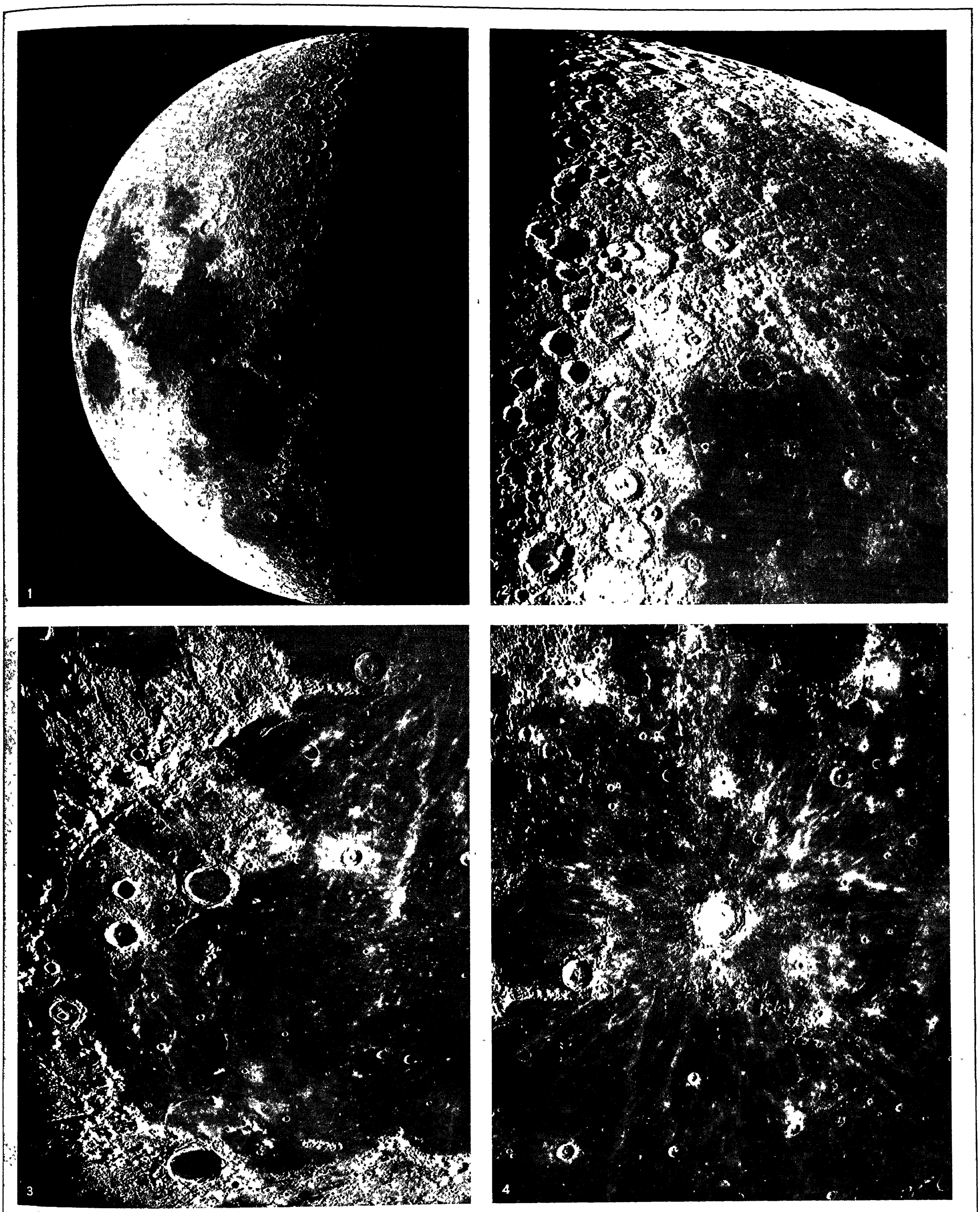


DIAGRAM OF THE PHASES OF THE MOON (M), SHOWN IN EIGHT POSITIONS

The part shown white is illuminated by sunlight, and the phase of the moon is determined by the position of the illuminated hemisphere relative to the direction of the line joining the moon and the earth (E)

the paper may be taken as that of the earth's motion round the sun. The moon's orbit does not lie exactly in this plane but is inclined to it at an angle of about 5°. If this were not so the moon would eclipse the sun at every new moon and would itself be eclipsed by the earth at every full moon. The line NN^1 may be taken as representing the line of intersection of the two planes. This line, known as the line of nodes, is in slow rotation, making about one revolution against the arrows in about 18·6 years. At two seasons each year the sun is near the direction of NN^1 as seen from the earth, and at these seasons eclipses occur. (*See*



BY COURTESY OF (1) THE PARIS OBSERVATORY, (2, 3, 4) THE DIRECTOR OF THE MT. WILSON OBSERVATORY

THE MOON AND ITS CRATERS

These illustrations show the craters (presumably similar to the earth's volcanic craters) with which the moon is pitted, and the dark plains which are called "seas" although actually there is no water on the moon's surface. 1. Moon at first quarter. 2. South Pole and Mare Nubium. 3. Mare Imbrium. 4. The crater Copernicus, showing radiating faults

illustrations and article ECLIPSE.)

To understand the positions in which to expect the moon at any time it is most convenient to consider its position relative to the sun. When the moon is new it is in the same direction as the sun. Consequently it rises and sets with the sun, crosses the meridian with the sun and cannot be seen from the earth. Relatively to the stars the sun moves eastward about 1° per day, while the moon moves about 13° in the same direction. The moon, therefore, appears about 12° farther east of the sun day by day, and 13° farther east of the stars in its neighbourhood. When the moon is one day old it will lie about 12° east of the sun, it will be due south about 48 minutes after the sun and it will describe in the sky the same arc as the sun will do about 12 days later, if it is assumed, as is approximately true, that the orbital planes of the sun and the moon coincide. Similarly when the moon is at first quarter or 90° east of the sun it will be due south 6 hours after the sun and it will describe in the sky the same arc as the sun will describe in three months' time. Consider the case of a moon a week after new on March 21. On that day the sun will rise six hours before noon and set six hours after. At sunset the moon is due south and in the position occupied by the sun at noon on June 21. Consequently, for observers in the northern hemisphere, it will be more than 12 hours above the horizon, rising more than 6 hours before it souths. In the latitude of London it will rise about 8½ hours before it souths, *i.e.*, about 9.30 A.M., and it will not set till about 2.30 the next morning. As is well known, in fairly high north latitudes, the moon near the full rises at nearly the same hour for several nights in the autumn, giving rise to the phenomenon of the harvest moon. The explanation of this is very simple. The full moon in the autumn is in the same part of the sky as the sun is in the spring. Now, in the spring, the time the sun is above the horizon is steadily increasing from day to day. This is happening for the autumn full moon 13 times as fast. Consequently, although on the average the moon is 48 minutes later day by day in southing, its rising is not retarded by anything like this amount. In the spring the phenomenon is reversed, and the rising of the full moon is delayed by more than 48 minutes from day to day. Referring to the diagram, it will be seen that when the moon is near the position M^1 although the hemisphere turned towards the earth is not illuminated directly by sunlight it is illuminated indirectly by light from the illuminated hemisphere of the earth. This light must be about 12 times as bright as the full moon and consequently near the time of new moon, after twilight, the whole hemisphere of the moon can be seen faintly illuminated by "earthshine." This phenomenon can be seen very well in a small telescope.

The moon always presents nearly the same face to the earth, from which it follows that, when referred to a fixed direction in space, it revolves on its axis in the same time in which it performs its revolution. The rate of actual rotation is substantially uniform, while the arc through which the moon moves from day to day varies somewhat. Consequently, the face which the moon presents to the earth is subject to a corresponding variation, the globe, as seen from the earth, slightly oscillating in a period nearly equal to that of revolution. This apparent oscillation is called *libration* and its amount on each side of the mean is commonly between 6° and 7°. There is also a libration in latitude, arising from the fact that the axis of rotation of the moon is not precisely perpendicular to the plane of its orbit. This libration is more regular than that in longitude, its amount being about 6° 44′ on each side of the mean. The other side of the moon is invisible from the earth, but in consequence of the libration about six-tenths of the lunar surface may be seen at one time or another, while the remaining four-tenths are forever hidden from view. It is found that the direction of the moon's equator remains nearly invariable with respect to the plane of the orbit, and therefore revolves with that plane in a nodal period of 18·6 years. This shows that the side of the moon presented to observation is held in position, as it were, by the earth, from which it also follows that the lunar globe is more or less elliptical, the longer axis being directed toward the earth. The amount of the ellipticity is, however, very small.

MOON'S SURFACE

The surface of the moon has been a subject of careful and continuous telescopic study from the time of Galileo. The early observers seem to have been under the impression that the dark regions might be oceans; but this impression must have been corrected as soon as the telescope began to be improved, when the whole visible surface was found to be rough and mountainous. The work of drawing up a detailed description of the lunar surface and laying its features down on maps has from time to time occupied telescopic observers. The earliest work of this kind, and one of the most elaborate, is the *Selenographia* of Hevelius, a magnificent folio volume. This contains the first complete map of the moon. Names borrowed from geography and classical mythology are assigned to definite regions and features. A system was introduced by Riccioli in his *Almagestum novum* of designating the more conspicuous smaller features by the names of eminent astronomers and philosophers, while the great dark regions were designated as oceans, with quite fanciful names: *Mare imbrium, Oceanus procellarum,* etc. This nomenclature has been retained. With the improvement of the telescope more extended maps based on drawings and measurements were constructed by J. H. Schröter of Lilienthal, and by W. Beer and J. H. Mädler in the nineteenth century. The application of photography to astronomy has greatly simplified the recording of lunar formations. Pioneer work was done by J. W. Draper of New York as early as 1850 followed by Bond at Harvard, De la Rue in England and Rutherford in New York. Excellent photographs have been taken at a number of observatories including Lick and Paris. A whole volume of Harvard *Annals* (vol. LI.) is devoted to photographs of the moon showing different portions with varying illumination.

The moon as seen by the naked eye is a beautiful object with bright and dark patches, but as seen in even a small telescope it is magnificent and the various formations stand out as in the photographs. The most interesting time to watch the moon with a telescope is near half moon. The boundary between the bright and dark portions, known as the terminator, then shows a very rugged appearance and even a short stay at the telescope enables one to watch the sun's light catch new mountain peaks. On account of the nearness of the moon it is possible with large telescopes to see objects less than a mile in diameter. The most striking formations on the moon are the craters, which are of all sizes up to 100 miles or more in diameter and are scattered over the surface with great profusion, frequently overlapping. These craters in appearance closely resemble the volcanic craters on the earth, and it is possible that they have a similar origin. They have, however, often so large a diameter compared with height that the analogy may not be so close as at first appears. The typical crater has a surrounding ring rising to anything up to 20,000ft. above the general level. The floor of the crater may be higher or lower than the outside level. Often there may be a central peak or peaks within the crater. The darker areas which are not so much covered by craters have been considered to be seas of lava which have spread over the moon's surface at a later date than that of the formation of most of the craters. Other striking features on the moon are streaks or rays which radiate from a number of craters to many hundreds of miles.

As the moon is devoid of air and water there can be no meteorological variations of the kind experienced on the earth. Changes on the moon's surface could therefore be produced only by the direct action of the sun's rays. It is at once evident that there must be an enormous range in the temperature of the surface rocks of the equatorial regions of the moon which are alternatively exposed to 15 days of solar radiation and then to 15 days of darkness. During the last century attempts were made by Lord Rosse, S. P. Langley and others to measure the moon's heat, but the apparatus available was not sufficiently sensitive. Recently, however, bolometers of sufficient sensitivity have been constructed to measure not only the total heat from the moon, but that in different wave-lengths.

Brightness of the Moon.—Many attempts have been made to estimate the brightness of the moon in comparison with the sun and the stars. The results obtained by Sir John Herschel,

Bond, Zöllner, Pickering and others show a range of over 20%; but the mean result indicates that the sun is about 465,000 times brighter than the average full moon. On account of the varying distance of the moon from the sun and the earth there must be a real variation of over 20%. The variation of the brightness of the moon with its phase is complicated by the nature of the surface and the varying angle of incidence of the sun's light. Although at first quarter half of the hemisphere turned towards the earth is illuminated, it appears only $\frac{1}{8}$ to $\frac{1}{9}$ as bright as full moon and at third quarter it is only $\frac{1}{10}$ as bright. This is only partly due to the fact that near the terminator the sun's rays strike the surface very obliquely. The greatest cause of the relative faintness of the half moon must be the unevenness of the moon's surface so that an important fraction of the surface is in the shadow. The amount of sunlight reflected by the moon is only about one-fourteenth of the total sunlight falling on it. This is a small fraction compared with that for cloud-bound planets, but it is of the order to be expected from a body with no atmosphere and with a rocky surface. Of course, this is only an average value and different areas of the moon differ widely in reflecting power. E. C. Pickering in America was the first to determine the relative brightness of different parts of the moon, and his work has been continued by European observers. They find that the darkest parts of *oceanus procellarum* and *mare crisium* reflect only $\frac{1}{8}$ as much as the very bright crater *Aristarchus.*

The total brightness of the moon is reckoned as equal to about one-quarter of a meter-candle, equal, that is, to a 100 candle-power lamp at a distance of 22 yards.

Constants of the Moon's Size and Motion.—

Synodic month (relative to sun)	29·53059 days
Sidereal month (relative to stars)	27·32166 „
Tropical month (relative to equinox)	27·32156 „
Anomalistic month (relative to perigee)	27·55455 „
Nodal or draconic month (relative to node)	27·21222 „
Mean eccentricity	0·0549
Revolution of perigee (direct)	3232·6 days
„ „ node (retrograde)	6793·5 „
Mean inclination of orbit to ecliptic	5° 8′ 43″
Maximum „ „ „ „ „	5° 20′
Minimum „ „ „ „ „	4° 57′
Inclination of axis of rotation to ecliptic	1° 31′ 22″ (Franz) 1° 32′ 6″ (Hayn)
Lunar parallax	57′ 2″.54
Mean apparent diameter	31′ 7″
Mean distance from earth	238,860 miles
Maximum distance	252,710 „
Minimum distance	221,463 „
Diameter	2159·9 „
„ in terms of earth's diameter	·27227
Mass in terms of that of earth	1:81·56
Density in terms of water	3·33
„ „ „ „ that of earth	0·6043
Ratio of gravity to gravity at the earth's surface	0·165
Maximum geocentric libration in longitude	7° 54′
„ „ „ „ latitude	6° 50′
Fraction of moon's surface always invisible	0·410

LUNAR THEORY

Historical.—In ancient times the moon was a very important body for night illumination and a great deal of attention was given to its motions. The observations made were of an exactitude far in advance of those in other physical sciences. Hipparchus (2nd century B.C.) discovered the eccentricity of the moon's orbit and the motion of the apse. The inclination of the orbit to the ecliptic and the motion of the node were also determined by him. He explained the motion of the moon as uniform in a circular orbit with the earth placed eccentrically and this was amply sufficient for the observations of that time. The numerical values were derived from observations of eclipses. For fixing the quantities which require the lapse of long intervals of time for their accurate evaluation he made use of the oldest eclipse observations available. At the times of eclipses the inequality in longitude due to eccentricity cannot be separated from an important solar perturbation called the evection. Consequently, he got a value of the eccentricity in longitude (true value 6° ·29) erroneous by the amount of the evection (1°·27). The latter inequality was discovered by Ptolemy (fl. A.D. 140). No great improvement in the knowledge of the moon's motion was made, except for slightly improved accuracy in the mean motions till Tycho Brahe (1546–1601) discovered another inequality due to solar attraction, called the variation, which has greatest effect when the moon is 45° or 135° distant from the sun on either side. The coefficient of this term is 0°·66. The explanation of all these inequalities and the construction of an adequate theory of the moon's motion had to wait the discovery of universal gravitation.

Gravitational Theory.—Newton's theory of gravitation was based largely on the comparison of the motion of the moon with bodies falling freely on the earth. The portion of the *Principia* which specially refers to the motion of the moon is contained in propositions 22, 25–35 of book iii. Newton succeeded in proving that the principal periodic inequalities as well as the mean motions of the perigee and node were due to the sun's action, and he added some other inequalities which had not been deduced previously from observation. The result which he obtained for the mean motion of the perigee was only about half the observed value, but it appears from manuscripts that are extant that he succeeded later in explaining the observed motions within 8%. Newton's results were given in a geometrical form but he probably first obtained them by the method of fluctions. No substantial advance was made on Newton's work till Clairaut developed his analytical theory 60 years later. Clairaut's work was followed by that of d'Alembert and Euler in the eighteenth century. A new epoch in the theory was then opened by the work of Laplace.

The analytical methods which have been developed may be divided into three classes.

(1) Laplace and his immediate successors, especially Plana, effected the integration by expressing the time in terms of the moon's true longitude. Then, by inverting the series, the longitude was expressed in terms of the time.

(2) By the second general method the moon's co-ordinates are obtained in terms of the time by the direct integration of the differential equations of motions, retaining as algebraic symbols the values of the various elements. Most of the elements are small numerical fractions: e the eccentricity of the moon's orbit, about 0·055; e', the eccentricity of the earth's orbit, about 0·017; γ, the sine of half the inclination of the moon's orbit, about 0·046; m, the ratio of the mean motions of the earth and moon, about 0·075. The expressions for the longitude, latitude and parallax appear as infinite trigonometric series, in which the coefficients of the sines and cosines are themselves infinite series proceeding according to the powers of the above small quantities. This method was applied with success by Pontécoulant and Sir John Lubbock and afterwards by Delaunay.

(3) The third method seeks to avoid the difficulty by using the numerical values of the elements instead of their algebraic symbols. This method has the advantage of leading to a more rapid and certain determination of the numerical quantities required. It has the disadvantage of giving the solution of the problem only for a particular case, and of being inapplicable in researches in which the general equations of dynamics have to be applied. It leads, however, to the most accurate results for the motion of the moon.

Amongst the applications of the third method an outstanding place is occupied by the researches of P. A. Hansen. His first work, *Fundamenta nova* appeared in 1838 and contained an exposition of his methods. During the twenty years following he devoted a large part of his energies to the numerical computation of the lunar inequalities, the re-determination of the constants of the motion and the preparation of new tables for computing the moon's position. The importance of these tables was impressed upon the British Government by Airy and they were published by the Admiralty in 1857. The theory was published in *"Darlegung der theoretischen Berechnung der in den Mondtafeln angewandten Störungen."* A peculiarity of Hansen's method is that the angular perturbations in the plane of the orbit are added to the mean anomaly in an auxiliary ellipse. The tables were

brought into use for computing the positions of the moon for the *Nautical Almanac* in 1862 when they replaced Burckhardt's Tables (Paris, 1812). They remained in use till 1922, but Newcomb's corrections were introduced in 1883. These corrections were partly theoretical and partly observational. Amongst the general theories of the second class the most noteworthy is that due to C. E. Delaunay.

A completely new theory and set of tables have been constructed by Professor E. W. Brown of Yale during the present century. The method employed may be briefly indicated. The four small quantities, e, $\acute{e}$, γ and m, have been mentioned. The moon's co-ordinates have to be expressed in terms of the powers and products of these. Euler conceived the idea of starting with a preliminary solution of the problem in which the orbit of the moon was supposed to lie in the ecliptic and to have no eccentricity; while that of the sun was circular. This solution being reached, the additional terms were found which depended on the first power of the eccentricities and of the inclination. Then the terms of the second order were found, and so on to any extent. In a series of remarkable papers published in 1877–1888 G. W. Hill improved Euler's method, and worked it out with much more rigour and detail than Euler had been able to do. His most important contribution to the subject consisted in working out by extremely elegant mathematical processes the method of determining the motion of the perigee. J. C. Adams determined the motion of the node in a similar way. The numerical computations were worked out by Hill only to the first approximation. The work of constructing a complete lunar theory by this method was undertaken by Brown who published his results in the Memoirs of the Royal Astronomical Society during the years 1901 to 1908. Thereafter he determined the numerical constants by comparison with the Greenwich meridian observations for the years 1750 to 1910 as worked up by G. B. Airy and P. H. Cowell. The values finally adopted were published in a series of papers published in the *Monthly Notices* of the Royal Astronomical Society during the years 1913 to 1915. Professor Brown, assisted by H. B. Hedrick, then proceeded with the calculation of the tables which were printed by the Cambridge University Press and published by Yale University Press in three volumes in 1919. By the use of various devices the tabulation was simplified so that although the number of terms included is about 1,500 or about five times that of Hansen's Tables the task of calculating an annual ephemeris is no greater. The effect of every known sensible term is included and many terms are also included which must be classed as insensible in comparison with the best modern observations. The principal constants determined by Brown (*Monthly Notices* of the Royal Astronomical Society, vol. lxxv., p. 510) are given below. The epoch is 1899, Dec. 31, Greenwich mean noon, from which T is computed in Julian centuries of 36,525 days; r denotes a revolution or 360°.

$$\begin{aligned}
\text{Mean longitude} &= 270^\circ 26' 11''.71 \\
&\quad + 1336^r\ 307^\circ 53' 26''.06\ T \\
&\quad + 7''.14\ T^2 + 0''.0068\ T^3 \\
\text{Empirical term} &+ 10''.71 \sin(240^\circ.7 + 140^\circ.0\ T) \\
\text{Longitude of perigee} &= 334^\circ 19' 46''.40 \\
&\quad + 11^r\ 109^\circ 2' 2''.52\ T \\
&\quad - 37''.17\ T^2 - 0''.045\ T^3 \\
\text{Longitude of node} &= 259^\circ 10' 59''.79 \\
&\quad - 5^r\ 134^\circ 8' 31''.23\ T \\
&\quad + 7''.48\ T^2 + 0''.008\ T^3
\end{aligned}$$

Eccentricity ·054900489, corresponds to the coefficient 22639″·550 in the principal elliptic term; and sine of half the inclination ·044886967, corresponds to the coefficient 18461″·400 in the principal term in latitude.

The following are all the periodic terms in the moon's longitude as given in Brown's Tables with a coefficient over 212″. The parallactic term is added because of the attention it has attracted. The largest of the planetary terms, due to Venus, has a coefficient of 14″·27 and a period of 273 years. The next largest planetary terms are two or three of the order of 1″. The planetary terms usually have periods of about a month or a few years. The notation is as follows: l, l' are the mean anomalies of the moon and sun, D the excess of the moon's mean longitude over the sun's, F the argument of latitude.

$$\left.\begin{array}{l} +22639''.500 \sin l \\ +\quad 769.016 \sin 2l \end{array}\right\} \quad \text{Largest terms in equation of centre.}$$

$-\ 4586.426 \sin(l-2D)$	Evection.
$-\ 125.154 \sin D$	Parallactic inequality.
$+\ 2369.902 \sin 2D$	Variation.
$-\ 668.111 \sin l'$	Annual equation.
$-\ 411.608 \sin 2F$	Reduction to ecliptic.

In compiling the constants which could be derived directly from observation or by theory from other astronomical constants, the latter method generally has been followed. The term $7''\cdot 14\ T^2$ in the mean longitude was derived from pure theory, but it was known to be too small to fit ancient eclipse observations. The existence of a secular term in the moon's motion had been discovered by Halley. No explanation could then be given as to its origin. Lunar theory then took no account of planetary perturbations and gave no inequality in the moon's motion with a period exceeding 18·6 years. The first explanation of the secular term was given by Laplace who, from the secular change in the earth's orbit, computed a secular term with a coefficient of 10″ in the moon's motion. This agreed with the results derived from ancient eclipses. Laplace's immediate successors, amongst whom were Hansen, Plana and Pontécoulant, found a larger value, Hansen obtaining the value 12″·5. This value was found by himself and Airy to represent fairly well several ancient eclipses. But in 1853 Adams showed that these calculations were only a rough first approximation and that the rigorous theoretical value was only half as large. For some time there was considerable controversy on the subject but finally Adams's result was fully confirmed by Delaunay. The question then arose again as to the reason for the difference between observation and theory. It was pointed out independently by W. Ferrel in 1856 and a few years later by Delaunay that the attraction of the moon on the tidal wave must produce a frictional force tending to slow down the earth and apparently to accelerate the moon.

It will be seen that Brown has introduced one empirical term with a period of about 260 years into his tables in order to make them fit the observations from 1750 onwards more accurately than they otherwise would. When this is done there still remain residuals amounting to ±4″. These cannot be satisfied by one additional periodic term, but they can be satisfied very closely by two periodic terms in a variety of ways. In the *Monthly Notices* of the Royal Astronomical Society (vol. lxxxiii., p. 359) Sir Frank Dyson and Dr. A. C. D. Crommelin have analysed the residuals and found terms with coefficients of 3″·09 and 1″·66 and periods of about 70 years and 59 years respectively. It is not supposed, however, that these periodic terms will succeed in predicting accurately the moon's motion in the future.

It thus appears that the gravitational theory does not exactly explain the moon's motion. Searches for inequalities of long period produced by the action of planets have been carried out very thoroughly. It is now believed that the cause of the difference between prediction and observation lies in a variation of the earth's rate of rotation. If the earth rotates more slowly, the moon appears to go faster. Careful comparison of the observed and predicted positions of the other bodies in the solar system seem to indicate similar irregularities. The cause of a variable rotation of the earth has not yet been cleared up. If due to the action of the moon it will affect the mean motion of the moon so that other bodies in the solar system will not show the same proportional change as the moon; if due to a change in the earth's moment of inertia all bodies will show the same proportional change.

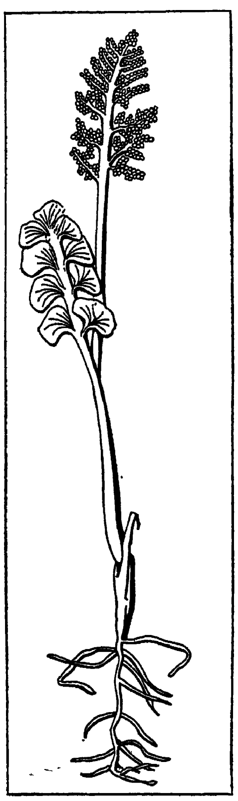
Bibliography.—Works on selenography: Hevelius, *Selenographia sive lunae descriptio* (Danzig, 1647); Riccioli, *Almagestum novum* (Bologna, 1651); J. H. Schröter, *Selenotopographische Fragmente zur genauern Kenntniss der Mondfläche* (Lilienthal, 1791); W. Beer and J. H. Mädler, *Der Mond nach seinen kosmischen und individuellen*

Verhältnissen, oder Allgemeine vergleichende Selenographie (1837); A. Proctor, *The Moon* (1873; the first ed. contains excellent geometrical demonstrations of the inequalities produced by the sun in the moon's motion, which were partly omitted in the second ed.); J. Nasmyth and J. Carpenter, *The Moon, Considered as a Planet, a World and a Satellite* (1903; fine illustrations); E. Neison, *The Moon and the Conditions and Configurations of its Surface* (1876); M. Loewy and P. Puiseux, *Atlas photographique de la lune* (Imprimerie Royale, Paris, 1896–1908); *A Photographic Atlas of the Moon* (Harvard "Annals," vol. LI.); G. P. Serviss, *The Moon* (1908), a popular account illustrated by photographs.

The following are amongst the works relating to the motion of the moon which are of historic importance or present interest: Clairaut, *Théorie de la lune* (2nd ed., 1765); L. Euler, *Theoria motuum lunae nova methodo pertractata* (Petropolis, 1772); G. Plana, *Théorie du mouvement de la lune* (3 vols., Turin, 1832); P. A. Hansen, *Fundamenta nova investigationis orbitae verae quam luna perlustrat* (Gotha, 1838); *Darlegung der theoretischen Berechnung der in den Mondtafeln angewandten Störungen* (Leipzig, 1862); *Tables de la lune* (London, 1857) (Admiralty publication); C. E. Delaunay, *Théorie du mouvement de la lune* (1860–1867); F. F. Tisserand, *Traité de mécanique céleste,* tome iii., *Exposé de l'ensemble des théories relatives au mouvement de la lune* (1894); S. Newcomb, "Researches on the Motion of the Moon" (Appendix to *Washington Observations* for 1875, discussion of the moon's mean motion); "Transformation of Hansen's Lunar Theory," *Ast. Papers of the Amer. Ephemeris,* vol. i.; "Action of the Planets on the Moon," *Ast. Papers of the Amer. Ephemeris,* vol. v. pt. 3; R. Radau, *"Inégalités planétaires du mouvement de la lune"* (*Annales,* Paris observatory, vol. xxi.); *Tables de la lune* (*Annales du Bureau des Longitudes,* vol. vii.); E. W. Brown, "Theory of the Motion of the Moon," *Memoirs of the Royal Astr. Soc.* (1901–1908); "Constants for the Tables," *Monthly Notices* (1913–1915); *Tables of the Moon,* Yale University Press (1919). *See* also Brown's *Introductory Treatise on the Lunar Theory* (Cambridge University Press, 1896) and *Inequalities in the Moon's Motion produced by the Action of Planets* (Cambridge, 1907). (J. JN.)

MOONSEED, in botany, a common name for *Menispermum* (family Menispermaceae), a genus of climbing deciduous shrubs, containing one species in North America and another in Eastern Asia. The former, the Canada moonseed (*M. canadense*), found from Quebec to Manitoba and southward to Georgia and Arkansas, is a handsome plant, with large reniform peltate leaves and yellowish flowers borne in profusion on long pendulous racemes.

MOONSTONE, a variety of orthoclase (*q.v.*) exhibiting a bluish-white or milky opalescence, whence its value as a gem stone. This optical phenomenon is probably connected with a perthitic intergrowth, the colours being interference colours from the enclosed lamellae of albite. The reflecting planes are submicroscopic and crystallographically near $\bar{8}01$ to $\bar{6}01$. Nearly all the moonstone of commerce comes from Ceylon, principally from the Dumbara district, occurring both in acid granulites and pegmatites and in gem gravels. X-ray analysis of a Ceylon moonstone ($Or_{73.5}Ab_{23.9}An_{2.6}$) shows that the schillerization is to be ascribed to the existence of an heterogeneous crystal structure on a minute scale. The system of double spots observable at ordinary temperatures in Laue photographs indicate an intergrowth of two space lattices. With rise of temperature these are seen gradually to approach and become coincident at 1060°, indicating that albite has been reabsorbed in solid solution in the orthoclase. (C. E. T.)



FROM STRASBURGER, "LEHRBUCH DER BOTANIK" (GUSTAV FISCHER)

MOONWORT (BOTRYCHIUM LUNARIA), A SMALL FERN HAVING THE SPORANGIA ARRANGED IN SMALL CRESTED CLUSTERS, WHICH FORM A LONG, LOOSE SPIKE

MOONWORT or **MOON-FERN,** in botany, the popular name of a small fern (*Botrychium Lunaria*), belonging to the family Ophioglossaceae. (*See* FERNS.) It has a tuberous rootstock and a stout fleshy glabrous frond 3 to 6 in. long, with a sterile and fertile portion; the former bears several pairs of close-set, semi-circular or moon-shaped pinnae, the latter is pinnately branched and covered, on the face opposed to the sterile portion, with small globose spore-cases which burst transversely. It is a widely distributed plant in the north and south temperate and cold zones, and is found in pastures and grassy banks in Great Britain and largely throughout northern North America, from Newfoundland to Alaska southward to Connecticut, Michigan, Colorado and British Columbia.

MOORCROFT, WILLIAM (*c.* 1770–1825), English traveller, was born in Lancashire, about 1770, and practised in London as a veterinary surgeon. He became inspector of the Bengal stud of the East India company in 1808. In this capacity he undertook a journey into Central Asia to obtain a stock of Turkoman horses. With Captain William Hearsey he left Josimath, well within the mountains, on May 26, 1812. Crossing the frontier pass of Niti, they struck the main upper branch of the Indus near its source, and on Aug. 5 arrived at the sacred lake of Manasarowar. Returning by Bhutan, he was detained some time by the Ghurkas, and reached Calcutta in November. Moorcroft set out on a second journey in Oct. 1819. On Aug. 14 the source of the Beas (Hyphasis) was discovered, and subsequently that of the Chenab. Leh, the capital of Ladakh, was reached on Sept. 24, and a commercial treaty was concluded with the Government of Ladakh, by which the whole of Central Asia was virtually opened to British trade. Kashmir was reached on Nov. 3, 1822, Jalalabad on June 24, 1824, Kabul on June 20, and Bokhara on Feb. 25, 1825. At Andkhui, in Afghan Turkestan, Moorcroft was seized with fever, of which he died on Aug. 27, 1825, his companion, George Trebeck, surviving him only a few days. But according to the Abbé Huc, Moorcroft reached Lhasa in 1826, and lived there 12 years, being assassinated on his way back to India in 1838. In 1841 Moorcroft's papers were obtained by the Asiatic Society, and published, under the editorship of H. H. Wilson, under the title of *Travels in the Himalayan Provinces of Hindustan and the Punjāb, in Ladakh and Kashmir, in Peshawur, Kabul, Kunduz and Bokhara, from 1819 to 1825.*

See Graham Sandberg, *The Exploraton of Tibet* (1904).

MOORE, ALBERT JOSEPH (1841–1893), English decorative painter, was born at York on Sept. 4, 1841. He was the youngest son of William Moore, of York, a painter of portraits and landscape, three of whose sons John Collingham Moore, Henry Moore, R.A. and Albert were artists. Albert studied under his father and he was a student in the Royal Academy schools for a few months. From 1858 to 1870, he executed decorative work of various kinds, and painted, in 1863, a series of wall decorations at Coombe abbey, the seat of the earl of Craven; in 1865 and 1866 some elaborate compositions: "The Last Supper" and "The Feeding of the Five Thousand" on the chancel walls of the church of St. Alban's, Rochdale; and in 1868 "A Greek Play," an important panel in tempera for the proscenium of the Queen's theatre in Long Acre. His first large canvas, "Elijah's Sacrifice," was completed in Rome at the beginning of 1863. A still larger picture, "The Shunamite relating the Glories of King Solomon to her Maidens," was exhibited in 1866. He died in London on Sept. 25, 1893. Several of his pictures are now in public collections; among the chief are "Blossoms," in the National Gallery of British Art; "A Summer Night" in the Liverpool Corporation Gallery; "Dreamers" in the Birmingham Corporation Gallery; and a watercolour, "The Open Book," in the Victoria and Albert Museum, South Kensington. Artistically he lived in a world of his own creation, a place peopled with robust types of humanity of Greek mould, and gay with bright-coloured draperies and brilliant-hued flowers.

See A. L. Baldry *Albert Moore* (1894).

MOORE, EDWARD (1712–1757), English dramatist and miscellaneous writer, the son of a dissenting minister, was born at Abingdon, Berkshire, on March 22, 1712. He was the author of the domestic tragedy of *The Gamester,* originally produced in 1753 with Garrick in the leading character of Beverley the gambler. He produced clever imitations of Gay and Gray, and with the assistance of George, 1st Lord Lyttelton, Lord Chesterfield and Horace Walpole, conducted *The World* (1753–57), a weekly periodical

on the model of the *Rambler*. Moore collected his poems under the title of *Poems, Fables and Plays* in 1756. He died in Lambeth on March 1, 1757. His *Dramatic Works* were published in 1788.

MOORE, GEORGE (1852–), novelist, eldest son of George Henry Moore, M.P. for Mayo, and his wife Mary Blake, was born at Moore Hall, Co. Mayo, on Feb. 24, 1852. He was at school at Escott, but, like many other great artists, did not take kindly or long to formal education. At the age of 18 he had already decided that art in some form or another was his vocation, and in the year 1870, on the death of his father, he entered the art schools at Paris. Though he was not destined to become a painter, those early years left a permanent mark on his artistic consciousness. Not only did he acquire that penetrating knowledge of pictures which has always distinguished him, but he learned both from the study of line, and from the brilliant painters and writers who became his friends, that relentless integrity of style, which gives each of his paragraphs something of the copper certainty of an etching. While in Paris and while still seeking for his medium he attempted poetry in *Flowers of Passion* (1878), and *Pagan Poems* (1882). Here again, though verse was not to be his method of expression, he still further prepared himself for his relentless economy of manner, more often found in poetry than prose.

Gradually, however, his true bent began to reveal itself, and he returned to England with the avowed intention of liberating English fiction from its Victorian shackles. *A Mummer's Wife* (1885) was in its way as startling a challenge to the contemporary novel as had been the first volume of "Poems and Ballads" to the poetry of its time. Moore took his place immediately as a rebel with a torch, not of an incendiary, but of a new luminary.

In his next considerable work *Confessions of a Young Man* (1888, latest ed. 1908), he took the first step on the path which was to lead to *Avowals* (1919 and 1926), *Hail and Farewell* (3 vols., 1911–14) and *Conversations in Ebury Street* (1924), no less than the gift of a new form to English prose. He turned from that to the three great novels of his prime: *Esther Waters* (1894), *Evelyn Innes* (1898), and *Sister Teresa* (1901). In these with quiet certainty he established the claim he had made in *A Mummer's Wife*. He believed that he had transplanted the French "philosophical" novel. What he had in fact done was to restore the Fielding tradition. He had given back honesty and clarity of vision, and an English almost flawless in its severe simplicity.

He had in the meantime also continued to express his artistic gospel in critical articles which were collected and published in 1891 and 1893 respectively. But the next landmark in his life was the return to Ireland in 1901, a return dictated in part by his detestation of the Boer War. He remained in Ireland until 1910, and though that period was not immediately productive (the only books in that time being *The Untilled Field* (1903), *The Lake* (1905) and *Memoirs of my Dead Life* (1905) it renewed his artistic youth. Imemdiately on his return to London he began the publication of *Hail and Farewell*—those entrancing dialogues which are regarded (wrongly) in certain quarters as his masterpiece. They are not that, but they would have been a masterpiece for anyone but the author of *The Brook Kerith* (1916, 7th revised ed. 1927) and *Heloise and Abelard* (1921). What turned Moore's mind to the gospel story as a subject for treatment is not clear, but at any rate in order to prepare himself for no less a task than re-creating the story of Jesus he visited Palestine. A record of that pilgrimage almost in his own words may be found in *Dialogues and Monologues* (Humbert Wolfe). The result of the journey was *The Brook Kerith* which, with *Heloise and Abelard,* touches a point of almost flawless artistry and nobility that has rarely been reached before in the history of English prose. In both these books he has reconstructed a period, and though to say so is almost hyperbole, in neither is his genius unworthy of its subject. Below these peaks, there were lesser though charming eminences in 1918 with *A Story-Teller's Holiday,* in 1924 with a version of *Daphnis and Chloe,* and in 1926 with an Irish story of the Middle Ages *Ulick and Soracha.* All these, like a note-book of Rembrandt, are full of convincing glimpses of the master.

Having tried painting, poetry, dialogue and the novel, he was not content till he had also attempted the drama. *The Coming of Gabrielle* (1920) was produced, but it was not till 1928, with *The Making of an Immortal* that he had a success in the theatre.

(H. Wo.)

BIBLIOGRAPHY.—His other works are: *A Modern Lover* (1883); *A Drama in Muslin* (1886); *A Mere Accident* (1887, "John Norton," in *Celibates* is a re-writing of this book); *Parnell and his Island* (1887); *Spring Days* (1888); *Mike Fletcher* (1889); *Vain Fortune* (1890); *Impressions and Opinions* (1891); *The Strike at Arlingford* (1893, a play); *Modern Painting* (1893); *Celibates* (1895); *The Bending of the Bough* (1900, a comedy); *Reminiscences of the Impressionist Painters* (1906); *Elizabeth Cooper* (1913, a comedy); *Lewis Seymour and Some Women* (1917. Re-writing of *A Modern Lover*); *The Pastoral Loves of Daphnis and Chloe* (done into English by George Moore, 1924. Later ed., 1927); *see* Susan L. Mitchell, *George Moore* (1916); I. A. Williams, *Bibliography of the Works of George Moore* (1921); J. Freeman, *Portrait of George Moore* (1922).

MOORE, GEORGE FOOT (1851–), American biblical scholar, was born in West Chester, Pa., Oct. 15, 1851. He graduated at Yale College in 1872 and at Union Theological seminary in 1877. In 1878 he was ordained and until 1883 was pastor of the Putnam Presbyterian church, Zanesville, Ohio. He was Hitchcock professor of the Hebrew language and literature in Andover Theological seminary in 1883–1902. In 1902 he became professor of theology and in 1904 professor of the history of religion at Harvard university. His chief critical work dealt with the *Hexateuch,* and more particularly the *Book of Judges* (commentary, 1895; text, translation and notes, 1898; text with critical notes, 1900). He was also the author of *The Literature of the Old Testament* (1913), *History of Religions* (2 vol., 1913–19), *Metempsychosis* (1914) and *Judaism in the First Centuries of the Christian Era* (2 vol., 1927).

MOORE, HENRY (1831–1895), English painter, the ninth son of William Moore, of York, and brother of Albert Joseph Moore, was born in York on March 7, 1831. His artistic education was supervised by his father; he attended the York school of design, and, for a short time the Royal Academy schools. He first exhibited at the Academy in 1853, and was a constant contributor to its exhibitions till his death. At the outset of his career he occupied himself mostly with landscapes and paintings of animals, executed with extraordinary detail in imitation of the prevailing taste of the Pre-Raphaelite Brotherhood; but in 1857, while on a visit to the West of England, he made his first attempts as a sea-painter. His success was immediate, and it had the effect of diverting him almost entirely from landscapes.

Among his most important canvases must be reckoned, "The Newhaven Packet" (bought by the Birmingham Corporation) and "Catspaws off the Land" (bought by the Chantrey Fund trustees) in 1885, "Mount's Bay" (bought by the Manchester Corporation). He was elected A.R.A. in 1885, and R.A. in 1893. He died at Margate on June 22, 1895. He had a rare understanding of wave-form and colour and the subtleties of atmospheric effect.

MOORE, SIR JOHN (1761–1809), British general, the son of John Moore, was born at Glasgow on Nov. 13, 1761. By the duke of Hamilton's influence he obtained an ensigncy in the 51st foot (1776), learned his drill at Minorca, and in 1778 was appointed captain-lieutenant in a new regiment raised by Hamilton for service in the American War. Moore remained in America to the peace of 1783, after which the Hamilton regiment was disbanded. In 1784 he was returned by the Hamilton interest as member of parliament for the united boroughs of Lanark, Selkirk, Peebles and Linlithgow. In parliament, though he never spoke, he seems to have taken his duties very seriously, and to have preserved an independent position, in which he won the friendship of Pitt and the respect of Burke, and (more important still) the friendship of the duke of York. In 1787 he became major in the 60th (now King's Royal Rifles), but in the following year he was transferred to his old corps, the 51st. In 1792 Moore sailed with his corps to the Mediterranean. He was too late to assist at Toulon, but was engaged throughout the operations in Corsica, and won particular distinction at the taking of Calvi, where he was wounded. Soon after this he became adjutant-general to Sir Charles Stuart, with whom he formed a close friendship. After the expulsion of the French Moore became

very intimate with many of the leading Corsican patriots, which intimacy was so obnoxious to Sir Gilbert Elliot (later Lord Minto) that Moore was eventually ordered to leave the island in forty-eight hours, though Elliot wrote in warm terms of his ability. Pitt and the duke of York thought still more highly of Colonel Moore, who was soon sent out to the West Indies in the local rank of brigadier-general. Here he came under the command of Sir Ralph Abercromby, whose most valued adviser and subordinate Moore soon became. In the Santa Lucia expedition he won further distinction by his conduct at the capture of La Vigie and Morne Fortuné, and when Sir Ralph left the island he appointed Moore governor and military commander. In 1798 he accompanied Abercromby to Ireland as a major-general, and during the rebellion was actively engaged in command of a corps in the south, defeating a large force of the Irish, and saving Wexford from destruction after the battle of Vinegar Hill (June 21). His services were in universal request, and Abercromby had him appointed to the command of a brigade destined for the expedition to Holland. At the action of Egmont-op-Zee, on the 2nd of October 1799, his brigade lost very heavily, and he himself was wounded for the fourth time, on this occasion severely. On his return from Holland he was made colonel of the 52nd regiment, with which he was connected for the rest of his career, and which he made one of the finest regiments in Europe.

Throughout the Egyptian expedition he commanded the reserve. The 28th and 42nd regiments in this corps gained great distinction at the battle of Alexandria, where Moore himself was again wounded. He returned to duty, however, before the surrender of the French forces to General Hutchinson, and added so much to his reputation by his conduct in this brilliant campaign that after the short peace came to an end he was appointed to command the force assembled at Shorncliffe camp (1803) as a part of the army intended to meet the projected invasion of Napoleon. Here were trained some of the best regiments of the service, amongst others the 43rd, 52nd and 95th Rifles, the regiments which afterwards formed the famous "Light Division" and won in the Peninsula an unsurpassed reputation, not only for the skilful performance of the duties of light troops, but also for invincible steadiness in the line of battle. These corps (now represented in the army by the 1st and 2nd battalions of the Oxfordshire Light Infantry and the Rifle Brigade) bore the impress of Moore's training for thirty years and more, and as early as 1804, on account of the "superior state" of the 52nd, the king granted the officers exceptional promotion (August 29, 1804).

While at Shorncliffe he renewed his intimacy with Pitt, who was then residing at Walmer Castle, and his close friendship with Lady Hester Stanhope led to the erroneous belief that he was betrothed to her. On his return to office Pitt caused Moore to be made a Knight of the Bath, and about the same time came his promotion to the rank of lieutenant-general. Fox, when he succeeded to office, showed the same appreciation of Moore, and in 1806 sent him to the Mediterranean as second-in-command to his brother, General H. E. Fox. In the various minor expeditions of the time Moore had a share, at first as a subordinate, but soon, when Fox went home on account of ill-health, as commander-in-chief of the British army employed in the Mediterranean.

In 1808 Moore was ordered to the Baltic, to assist Gustavus IV., king of Sweden, against Russia, France and Denmark. The conduct of the king, who went so far as to place Sir John Moore under arrest when he refused to acquiesce in his plans, ruined any chance of successful co-operation, and the English general returned home, making his escape in disguise. He was at once ordered to proceed with his division to Portugal, where he was to be under the command of Sir Hew Dalrymple and Sir Harry Burrard. To Moore, as a general of European reputation, who had held a chief command, the appointment of two senior officers to be over him appeared as a bitter insult, though his resentment did not divert him from his duty. He met his reward, for when, in the excitement caused by the convention of Cintra, Dalrymple and Burrard were ordered home, Moore was left in command of the largest British army that had been employed since the commencement of the war.

It was not long before the Spaniards summoned Sir John Moore's army to assist them against the advance of Napoleon, and the troops were marched into Spain, Salamanca being their rendezvous. There Moore remained for a month, calling up Sir David Baird's corps from Corunna to assist him. Soon, however, the overwhelming success of the emperor's attack threatened to isolate Moore, and it was then that he formed the magnificent resolution of marching northwards against the French line of retreat. The bold and skilful operations which followed this step will be found outlined in the article Peninsular War. Moore's advance paralysed the emperor's victorious armies. Napoleon himself turned against the British army, which was soon in grave danger, but Spain was saved. Under these circumstances took place the famous retreat on Corunna. The indiscipline of a large proportion of the troops made it painful and almost disastrous, but the reserve under Edward Paget, in which served Moore's old Shorncliffe regiments, covered itself with glory in the ceaseless rearguard fighting which marked every step of the retreat. The march ended with the glorious battle of Corunna (Jan. 16, 1809), where, early in the day, Sir John Moore received his death wound. He would not suffer his sword to be unbuckled, though the hilt galled his wound, and so he was borne from the field. His last hours were cheered by the knowledge of victory, and his only care was to recommend his friends, and those who had distinguished themselves, to the notice of the government. He died with the name of Lady Hester Stanhope on his lips. By his own wish he was buried, before dawn on the 17th, in the ramparts of Corunna. The poem by the Rev. Charles Wolfe, "The Burial of Sir John Moore," became one of the most popular in the language.

For many years controversy, largely political, raged over the events of the Corunna campaign, and only at a later period has any examination of Sir John Moore's merits and services been made in a dispassionate spirit. Mistakes were doubtless made in the retreat, but it is sufficient to accept Napoleon's view that they were probably inseparable from the difficulties with which Moore was surrounded. His greatest claim to renown is, however, independent of his conduct of armies in the field. He was the finest trainer of men that the British army has ever known. He had the true gift of the great man, judgment of character. While Wellington, whose work would have been vain but for Moore's achievements, perpetually complained of his officers and formed no school, Moore's name is associated with the career of all who made their mark. The history of the Light Division is sufficient in itself to indicate the results of Moore's training on the rank and file. In opposition to the majority, who regarded the lash and the gallows as the source of discipline, he sought always and by every means to develop the moral qualities no less than the physical. Of the senior officers Hope, Graham, Edward Paget, Hill and Craufurd all felt and submitted to his ascendancy. The flower of the younger generation, Colborne, Hardinge and the Napiers, though they gained their laurels under Wellington and in chief command, were ever proud to call themselves "Sir John Moore's men."

See, besides the works mentioned in the article Peninsular War, J. C. Moore, *Life of Sir John Moore* (1834); *The Diary of Sir John Moore* (ed. by Sir J. F. Maurice, 1904) and the Records of the 52nd (Oxfordshire Light Infantry).

MOORE, JOHN (1729–1802), Scottish physician and writer, was born at Stirling in 1729, the son of a clergyman. After taking his medical degree at Glasgow, he served with the army in Flanders, then proceeded to London to continue his studies, and eventually to Paris, where he was attached to the household of the British ambassador. His novel *Zeluco* (1789), a close analysis of the motives of a selfish profligate, produced a great impression at the time, and indirectly, through the poetry of Byron, has left an abiding mark on literature. Byron said that he intended Childe Harold to be "a poetical Zeluco." Moore's *Journal during a Residence in France* (1793) is the careful record of an eye-witness of the Revolution and is frequently referred to by Carlyle. He died in London on Jan. 21, 1802, leaving five sons, the eldest of whom was General Sir John Moore. James Moore (1763–1834) who wrote Sir John's *Life,* was also an author of medical works.

MOORE, JOHN BASSETT (1860–), American jurist, was born at Smyrna, Del., on Dec. 3, 1860. He graduated at the University of Virginia in 1880, studied law in an office in Wilmington, Del., and was admitted to the Delaware bar in 1883. Two years later he entered the Department of State as a law clerk, and in 1886 was appointed third assistant secretary of State. He was secretary to the conference on Samoan affairs in 1887 and U.S. secretary at the conference on North Atlantic fisheries, 1887–88. He was appointed professor of international law and diplomacy at Columbia university, 1891, frequently being granted leave of absence to accept appointments in the national interest. On the outbreak of the war with Spain in 1898 he was appointed assistant secretary of State, and he acted as secretary and counsel to the U.S. peace commissioners at Paris at the close of the war. Among the later official positions which he filled were those of U.S. agent before the United States and Dominican Arbitration Tribunal, 1904; U.S. delegate to the fourth International American conference at Buenos Aires, 1910; special U.S. plenipotentiary to the Chilean Centenary, 1910; U.S. delegate to the International commission of jurists, Rio de Janeiro, 1912; counsellor to the Department of State, 1913–14; a member of the Permanent Court of Arbitration at The Hague, 1913; U.S. delegate to the Pan-American financial congress, 1915. He was appointed in 1921 a judge of the Permanent Court of International Justice from which he resigned on April 29, 1928, to edit a comprehensive historical collection of treaties. He was also U.S. delegate and chairman of the International Conference on rules for aircraft and radio in time of war held at The Hague, 1922–23.

Moore's publications include *Extradition and Interstate Rendition* (1891); *History and Digest of International Arbitrations* (1898); *American Diplomacy: Its Spirit and Achievements* (1905); *Digest of International Law* (1906); *Four Phases of American Development* (1912); *Principles of American Diplomacy* (1918); *International Law and Some Current Illusions* (1924); and *The Permanent Court of International Justice,* a pamphlet (1924).

MOORE, THOMAS (1779–1852), Irish poet, was born in Dublin on May 28, 1779. His father was John Moore, a prosperous grocer and wine merchant, and his mother's maiden name was Anastasia Codd. In 1793 Tom Moore's name first appeared in print, as a contributor of some verses "To Zelia," to a Dublin periodical, the *Anthologia Hibernica.* In the same year Roman Catholic students began to be admitted to Trinity college, Dublin, and in 1794 Moore's name was entered on the books, curiously enough, as a Protestant. At Trinity he made friends with Robert Emmet, and was nearly dragged into the plots of the United Irishmen. The events of 1798 and the execution of Emmet in 1803 made a deep impression on him. The words of Emmet's address to his judges, asking the charity of silence—"Let no man write my epitaph"—are enshrined by Moore in one of his lyrics, "Oh, breathe not his name!" (*Irish Melodies,* 1808.) The next song in the same collection—"When he who adores thee"—also owes its inspiration to Emmet's fate, and the conscientious orientalism of *Lalla Rookh* does not conceal the pre-occupation of the writer with the United Irishmen when he writes of "The Fire Worshippers," and with Emmet and Sarah Curran when he describes the loves of Hafed and Hinda, especially in the well-known song, "She is far from the Land where her young Hero sleeps." In 1798 Moore graduated, and in the next year left for England to keep his terms at the Middle Temple.

He was a social success in London. He had brought with him from Ireland a translation of the *Odes of Anacreon,* and the prince of Wales accepted its dedication. It was issued in 1800 with notes and a list of distinguished subscribers. Moore's social successes involved him in expenses far beyond his means. His publisher had advanced him money, and he resolved to pay his debt by the anonymous publication of his juvenile poems, *The Poetical Works of the Late Thomas Little, Esq.* (1801), a collection of love poems which Moore afterwards regretted. Through Lord Moira's influence he was, in 1803, appointed registrar of the admiralty prize-court at Bermuda. But he soon tired of the monotonous life, and in 1804, after appointing a deputy, returned to England by way of the United States and Canada. In 1806 he published *Epistles, Odes and other Poems,* chiefly dealing with his impressions of travel. The volume contained the "Canadian Boat Song" ("Faintly as tolls the evening chime"), and some love poems of the same kind as those connected with the name of "Mr. Little."

The success of the satirical epistles in the 1806 volume encouraged Moore to produce further work of a similar kind, *Corruption and Intolerance, Two Poems* (1808), and *The Sceptic: a Philosophical Satire* (1809), but the heroic couplet and the manner of Pope did not suit his talents. At the end of 1806 he went to Dublin, and, with the exception of about six months in 1807 spent at Donington Park, the next three years were spent in Ireland. Here he met Miss Elizabeth Dyke, an actress, who became his wife in March 1811. They lived at first in London, but soon removed into the country, to Kegworth, near Lord Moira's seat, and then to Mayfield Cottage, near Ashbourne, Derbyshire. Moore had to spend much of his time in London, for the popularity of his songs led to an agreement with his publisher to increase the success of these by singing them himself at great houses. The inception of his *Irish Melodies* dates from 1807, and many of the best were written during the three years of his Irish visit. He had already published separate songs, some of them set to music of his own, when William Power suggested to him in 1807 the task of fitting words to a series of Irish airs supplied by Sir John Stevenson. He could not have found a task more exactly suited to his powers, and for a quarter of a century he enjoyed a regular income of £500 a year from Power for writing words to music. The first number of the *Irish Melodies* appeared in 1808, and contained some of his best and most popular work. The rest appeared between 1808 and 1834. In 1816 Stevenson and Moore published *Sacred Songs,* followed by a second number in 1824. The first number of *National Airs* (Melodies from other Nations) appeared in 1818, and was followed by others in 1820, 1822, 1826 and 1827.

After 1812 he broke ground in a new field—political squib-writings. His first butt was the prince regent, once his friend and patron, whose foibles, fatness, love for cutlets and curaçao, for aged mistresses and practical jokes, were ridiculed with the lightest of clever hands. His earlier political poems appeared in the *Morning Chronicle,* but in 1813 he published a thin volume of *Intercepted Letters: The Twopenny Post Bag.* Other volumes of squibs, most of which passed through several editions, followed: *The World at Westminster* (1816), *The Fudge Family in Paris* (1818), *The Journal of a Member of the Pococurante Society* (1820), *Fables for the Holy Alliance* (1823), *Odes on Cash, Corn, Catholics and other Matters* (1828), *The Fudge Family in England* (1835). The only failure among his satirical writings was *Tom Crib's Memorial to Congress* (1819) for which he had made an elaborate study of thieves' argot.

In 1814 he contracted with the firm of Longmans, for 3,000 guineas, to supply a metrical romance on an Eastern subject. Moore retired to a cottage in the neighbourhood of Donington Park, where with the help of Lord Moira's library he read himself slowly into familiarity with Eastern scenery and manners. But he was forestalled by Byron in *The Giaour* and again in *The Bride of Abydos.* The publication of *Lalla Rookh* was deferred until 1817. It was an immediate success. After the completion of *Lalla Rookh,* Moore removed with his family to Sloperton Cottage, Wiltshire, where he was close to Bowood, Lord Lansdowne's country seat. Moore's plans were interrupted by the embezzlement of some £6,000 by the deputy he had left in Bermuda, for whose default he was fully liable. To avoid a debtors' prison Moore retired to the Continent. He visited Byron in Italy, and in Oct. 1819 received from him the first part of the *Memoirs.* The continuation was sent to Moore in Paris the next year, with Byron's suggestion that the reversion of the ms. should be sold. Moore did not remain long in Italy, but made his home in Paris, where he was joined by his wife and children. He was not able to return to England until 1822, when the Bermuda affair was compromised by a payment through Longmans of £1,000.

During his exile he had written another oriental poem, *The Loves of the Angels* (1822), which was hardly less popular than *Lalla Rookh.* He became a contributor of satirical verse to *The*

Times, the connexion lasting until 1827. He now wrote his *Memoirs of the Life of Sheridan,* first contemplated in 1814, which appeared, after some delay, in 1825. The *Memoirs of Captain Rock* (1824), in which he gives a humorous but convincing account of English misgovernment in Ireland, was the result of a tour with Lord Lansdowne in western Ireland. His prose tale, *The Epicurean,* appeared in 1827, and the *Legendary Ballads* in 1830. In 1831 he completed his *Life and Death of Lord Edward Fitzgerald,* probably his best piece of prose work.

The death of Byron in 1824 raised the question of the publication of his *Memoirs.* Moore had parted with them in 1821 to John Murray for £2,000. After they had come into Murray's possession, Moore began to have doubts about the propriety of publishing them, and an arrangement was therefore made that the £2,000 should be regarded as a loan, to be repaid during Byron's lifetime, and that the ms. should be retained as a security. When Byron died the *Memoirs* were still unredeemed, and the right of publication therefore rested with Murray. Moore now borrowed the money from Longmans and induced Murray to give up his claim. The money was paid, and, after a heated discussion with Byron's executors, the ms. was burnt. It was partly the pressure of the debt thus contracted, and partly the expressed wish of Byron, that induced Moore to undertake for Murray *The Letters and Journals of Lord Byron, with Notices of his Life* (1830).

In 1830 he undertook to write a *History of Ireland* which he left unfinished. After the death of his last child in 1845, Moore became a total wreck, but he lived until Feb. 25, 1852. He left sufficient provision for his wife in the *Diary* which he kept chiefly on her behalf.

His other works are, *A Letter to the Roman Catholics of Dublin* (1810); *A Melologue upon National Music* (1811); an operetta, *M.P. or The Blue Stocking* (1811); *A Set of Glees* (1827); *The Summer Fête* (1831); *Evenings in Greece* (1826–32); *Travels of an Irish Gentleman in Search of a Religion; Alciphron, a Poem* (1839).

See *Memoirs, Journal and Correspondence of Thomas Moore* (8 vols., 1853–56), ed. by Lord John Russell, which contains an immense quantity of biographical material; *Tom Moore's Diary* (1925); *The Poetical Works of Thomas Moore, Collected by Himself* (10 vols., 1840–42); also *Notes from the Letters of Thomas Moore to his Music Publisher, James Power* (1854); and *Prose and Verse, Humorous, Satirical and Sentimental by Thomas Moore, with suppressed passages from the memoirs of Lord Byron . . .* (1878), which includes Moore's contributions to the *Edinburgh Review* (1814–34). Among modern editions of Moore's *Poetical Works* may be mentioned that by Charles Kent (the Centenary ed., 1879), and that by W. M. Rossetti (1880). Memoirs of Moore are prefixed to these editions. There are many contemporary references to him, especially in the journals and letters of Byron. There is an excellent life, by Stephen Gwynn, *Thomas Moore* (1905), written for the "English Men of Letters Series."

MOORE, THOMAS STURGE (1870–), English poet, art critic and engraver, was born at Hastings, on March 4, 1870. Besides many collections of poetry he published studies of Altdorfer, Dürer, Correggio and others, and several volumes of essays.

His publications include: Poetry, *Vinedresser and other Poems* (1899), *Aphrodite against Artemis* (1901), *Absalom,* a play (1903), *The Little School* (1905, enlarged edition 1917), *Marianne* (1911), *The Sea is Kind* (1914), *Danaë* (1920), *Aforetime* (1920); Essays, *Art and Life* (1910), *Hark to these Three* (1915), *Some Soldier Poets* (1919), *Blind Thamyris,* a prose idyll (1920), *Judas* (1923).

MOORHEAD, a city of western Minnesota, U.S.A., on the Red River of the North, at an altitude of 907 ft., opposite Fargo (N.D.) and 250 m. N.W. of Minneapolis; the county seat of Clay county. It is on Federal highways 10N, 10S and 75 and the main lines of the Great Northern and the Northern Pacific railways. Pop. (1920) 5,720 (21% foreign-born white, largely from Norway, Sweden, Germany and Canada); 7,651 in 1930 by the Federal census. It is the seat of a State Teachers' college (established 1888) and of Concordia college (Norwegian Lutheran, 1891) which together increase the population by 1,000 students during 10 months of the year. Moorhead is a pleasant residential city, a general trading centre, and an important distribution point for potatoes, of which the county produced 4,000,000 bu. in 1926. There are several manufacturing industries, including a creamery which uses $3,000,000 worth of dairy and poultry products annually. Moorhead was founded in 1871 and was named after a member of the first board of directors of the Northern Pacific Railway. It was chartered as a city in 1881.

MOOR-HEN or Water-Hen, one of the *Rallidae* and a common bird throughout the Old World. One species, *Gallinula chloropus,* is about the size of a bantam hen, dark olive-brown above, iron-grey below, with white tail coverts which are conspicuous as it swims, and a scarlet frontlet in both sexes. It haunts rivers, streams, lakes and ponds, building a nest of flags, reeds, etc., on a clump of rushes, in or under a bush or on a tree, usually near the water, but occasionally some distance from it. The eggs, 7 to 11 in number, are dull buff with reddish spots. The bird swims well but in a jerky fashion, runs fast and, though taking wing with difficulty, is capable of prolonged and rapid flight. The American *G. galeata,* distinguishable by its larger frontal helm, is closely allied, and other species inhabit Africa, Asia and Australia. *G. nesiotis* of Tristan da Cunha has lost the power to fly. The purple water-hens or sultanas (*Porphyrio*) are an allied genus, species of which inhabit Europe, Africa, S. America and Australasia. The flightless *Notornis hochstetteri* of New Zealand and the purple gallinule or mud-hen (*Ionornis martinicus*) of S. and Central America and southern U.S.A. are other relatives.

MOORING MAST: *see* AERODROME.

MOORS (MAURES), a long-headed, fine-featured people of medium height with oval faces, hooked noses and slender, supple limbs, inhabiting Mauritania and the Northern Sudan, and descended from the Zenaga Berbers of southern Morocco who occupied Adrar and Tagant and later Hodh and Azaouad. In the 11th century they formed the Almoravide sect which conquered Morocco and Spain.

In the 16th century Kounta Arabs placed the southern tribes in subjection. Later, the Beni Hassan Arabs subjugated Tagant, Hodh and then the right bank of the Sénégal. Principal tribes in Mauritania are the Trarza, Brakna and Oulad Mbarck; in the Sudan, the Kounta, Berabich, Regeïbat, Mejdouf, Oulad Delim and Oulad Nassen. Fanatical Muslims, they obey Koranic law. Polygamy is rare, and divorce frequent; marriage is between members of the same caste. The following castes can be distinguished: (*a*) warriors or Hassane, descendants of the Arab invaders; (*b*) Marabout priests, commentators on the Koran, traders, doctors; (*c*) Zenaga, descendants of the early Berbers; (*d*) Harratine or liberated captives. They are nomads practising very little agriculture, and are held to be treacherous, thieves and redoubtable raiders.

See P. Marty, *L'Emirat des Trarzas* (1919); *Les Brakna* (1920); *Études sur l'Islam et les Tribus Maures* (1921).

MOOSE, the North American name of the elk (*q.v.*).

MOOSEJAW, a city and electoral division of Saskatchewan, Canada. Pop. (1931) 21,299. It is situated on a divisional point of the Canadian Pacific railway, about 400 miles W. of Winnipeg, and owes its importance chiefly to its railway connections. The principal industries include lumber and flour mills, iron works and the manufacture of agricultural implements. *See* SASKATCHEWAN.

MOOT, the common term for the assemblies of the hundred, borough, etc., in the history of early English institutions, and especially for the national assembly or council, the Witenagemot. The name survives in "moot hall," the term still applied to town-halls and council buildings in some English towns. From its meaning of assembly, the word was applied to a debate or discussion, in particular to the discussion of hypothetical cases by law students at the Inns of Court.

MOPLAH, a fanatical Mohammedan sect found in Malabar. They are believed to be descended from Arab immigrants who settled on the western coast of India and married local women, in the 9th century A.D. They are remarkable for the fanaticism displayed in attacks upon Hindus. The last rising was in 1925.

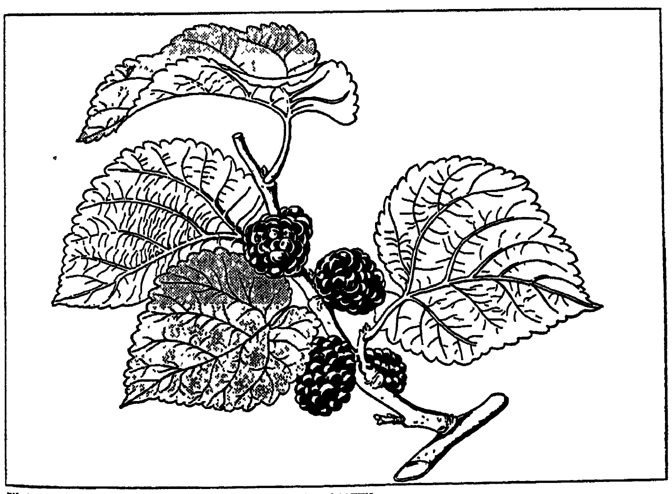
See *Tribes and Castes of Southern India* (1909).

MOPSUS, (1) Son of Ampyx (or Ampycus) and the nymph Chloris, a Lapith of Oechalia in Thessaly. He took part in the Calydonian boar hunt, and accompanied the Argonauts as their

prophet. He died from the bite of a serpent. He was afterwards worshipped as a hero and an oracle was consecrated to him. (2) Son of Rhacius (or Apollo) and Manto, daughter of Teiresias. Calchas is said to have died of chagrin because Mopsus outdid him in a contest of divination. Mopsus founded Mallus in Cilicia with the help of Amphilochus; he also is said to have built Colophon and his name is preserved in the place names Μόψου Ἑστία Μόψου Κρήνη. He was worshipped as a god by the Cilicians, and had two famous oracles at Colophon and Mallus.

MOQUEGUA, a maritime province of southern Peru, with the prerogatives of a department, bounded on north and east by the departments of Arequipa and Puno, south by Tacna Libre and west by the Pacific. Area 5,550 sq.m.; estimated population, (1920), 42,694. It includes the valley of the Moquegua river and the upper tributaries of the Tambo, the rest of the province consisting of barren *sierra* with great volcanic peaks and steep, narrow gorges, and the desert coast area. The vineyards and olive orchards of Moquegua, formerly famous, are giving way to cotton plantations. Other crops, maize, fruits and vegetables find local markets. Livestock is raised to a limited extent. Mineral resources are undeveloped. In fact, in spite of historical importance and great natural resources, the province is the most isolated and least developed of any on the coast. It possesses no system of roads except in the immediate vicinity of the capital, Moquegua. There is one railway which gives weekly service from Moquegua to its small though excellent port, Ilo, 63 m. distant, the most southerly of Peru. The capital, Moquegua, an Inca and colonial city (estimated pop. 5,680), in the valley of the Moquegua, 4,500 ft. above sea-level, a primitive town with excellent climate, has never recovered from its destruction by Chilean soldiers in 1881.

MORACEAE, in botany, a family of dicotyledons, belonging to the series *Urticales,* to which belongs also the nettle family (Urticaceae, *q.v.*). It contains about 55 genera with about 800 species, mostly trees or shrubs, widely distributed in the warmer parts of the earth. The largest genus, *Ficus* (the fig, *q.v.*), contains 800 species spread through tropical and sub-tropical regions, and includes the common fig of the Mediterranean region (*Ficus carica*), the banyan (*F. benghalensis*), and the india-rubber plant (*F. elastica*); many of the species are epiphytic, sometimes clinging so tightly round the host-plant with their roots as to strangle it.



BY COURTESY OF THE ROYAL HORTICULTURAL SOCIETY
BLACK MULBERRY (MORUS NIGRA), SHOWING BRANCH WITH FRUIT

Morus (mulberry, *q.v.*) contains ten species of trees or bushes in north temperate regions and in the mountains of the tropics. *Artocarpus,* including *A. incisa* (bread-fruit, *q.v.*), and *A. integrifolia* (jack-tree), has forty species, chiefly natives of the Indian Archipelago. The plants are rich in latex which may be very poisonous, as in *Antiaris toxicaria,* the Upas tree (*q.v.*) of Java, or sweet and nutritious as in *Brosimum Galactodendron,* the cow-tree (*q.v.*) of Venezuela. The latex often yields caoutchouc as in species of *Ficus* (*e.g., F. elastica*), *Cecropia* (*q.v.*), a tropical American genus with thirty to forty species, and others. In eastern United States the family is represented by *Morus* (mulberry) and one species of *Maclura* (osage orange), the latter being much planted for hedges. In the western United States (Rocky Mountain region) there are no native representatives of the family.

From the evidence of leaf-fossils, it is probable that the genus *Ficus* existed as far north as Greenland in the Cretaceous era and was generally distributed in North America and Europe in the Tertiary period up to Miocene times.

MORADABAD, a city and district of British India, in the Bareilly division of the United Provinces. The city (pop. 82,671 in 1921), on the right bank of the river Ramganga, was founded in 1625 by Rustam Khan, who built the fort which overhangs the river bank, and the fine Jama Masjid or great mosque (1631). The town has a special industry in ornamental brassware, sometimes plated with lac or tin, which is then engraved. Cotton weaving and printing is also carried on.

The DISTRICT OF MORADABAD lies east of the Ganges and west of the Rampur state. Area, 2,285 sq.m. It is traversed by the Ramganga and Sot. The eastern tract is submontane. The central portion consists of a level central plain descending at each end into the valleys of the Ramganga and Sot. The western section has a gentle slope towards the Ganges, with a rapid dip into the lowlands a few miles from the bank of the great river. In addition to Moradabad the principal towns are Amroha (*q.v.*), Sambhal (41,585) and Chaudausi (25,164).

For the early history of Moradabad *see* BAREILLY. It passed into the possession of the British in 1801. The population in 1921 was 1,198,653. Mohammedans are more numerous than in any other district of the province, forming more than one-third of the total population. Crops include wheat, rice, millet, pulse, sugar-cane and cotton.

MORAES, FRANCISCO DE (*c.* 1500–1572), Portuguese romance writer, was treasurer of the household to King John III., and he is first found in Paris in the suite of the Portuguese ambassador, D. Francisco de Noronha, who had gone there in 1540. He was a commander of the Order of Christ, and was called *O Palmeirim* on account of his authorship of the famous romance of chivalry, *Palmeirim de Inglaterra;* in 1572 he was assassinated at Evora. He appears to have written his book in France (perhaps in Paris) in 1544, dedicating it to the Infanta D. Maria, daughter of King Manoel, but the first extant Portuguese edition only came out in 1567. The *Palmeirim de Inglaterra* belongs to another branch of the same cycle as the *Amadis de Gaula;* the two romances are the best representatives of their class, and for their merits were spared from the *auto da fé* to which Cervantes condemned other romances of chivalry in *Don Quixote*. It has a well-marked plot, clearly drawn characters, and an admirable style, and has been reckoned a Portuguese classic from the time of its issue.

BIBLIOGRAPHY.—The *Palmerin of England,* by W. E. Purser (Dublin, 1904), contains an exhaustive study of the romance and the controversy concerning its authorship, with a sketch of the plot.

MORAINE, a term adopted from the French for the rocky material carried downwards by a glacier, and according to the position of the moraine on the glacier different names are applied to it. The *lateral* moraine occurs at the glacier side as a long mound, and when two glacial valleys converge into one valley two lateral moraines unite and form a *median* moraine in the resultant broader glacier. The material carried by the glacier is deposited where the glacier ends, and forms the *terminal* moraine, frequently in the form of a crescentic dam across the valley. The material pushed forward beneath the glacier is sometimes called the *ground* moraine. (*See* GLACIER.)

MORALE IN WAR: *see* ARMY, *Morale in War*.

MORALES, LUIS DE (*c.* 1509–1586), Spanish painter, called El Divino because of his emotional religious paintings, which appealed to the people. His favourite subjects, "Ecce Homo," "Pietà," "Christ at the Column," "Mater Dolorosa" were repeated many times and often copied. He was the first Spanish artist of pronounced national character, and one of the few Spanish painters who were summoned by Philip II. to help in the decoration of the Escorial; but his picture "Christ carrying the Cross" did not please the king, and was removed to the church of S. Jeronimo at Madrid. The story goes that the king

met the artist again at Badajoz in 1581, a few years before his death, and seeing that he was old and poor allowed him a pension. Morales' chief works are 20 panels with scenes from the life of Christ, painted for the church of Arrogo del Puerco (1563–68). One of his finest and most moving pictures is "Pietà" in the Academy at Madrid. The Hispanic Society in New York has three of his works. Others are at Dresden, London, Dublin, Paris.

MORALITY, PRIMITIVE. We know nothing of the beginnings of the moral life of man, nothing of the transition from animal behaviour to human conduct. In animal behaviour there is not a rudimentary morality but rather the material which, in human life, intelligence fashions into morality. The only source of knowledge available is the mind of the modern savage, with those relics of primitive ways of thought which survive in the folklore and superstitious practices of higher races. The basic needs which must be subserved if life is to endure are self-preservation and the preservation of the race. It is by food and the production and survival of offspring that these needs are satisfied, and round them the body of primitive morality is built up. Universally among primitive peoples there are tabus ("it is forbidden") in connection with food. As to the other great instinctive process, the preservation of the race, we find everywhere a close knit body of custom. Pregnancy, birth, puberty, menstruation, marriage, death, all are crises in which man comes into contact with the "sacred," all are bound up with the preservation of the race, so round them gathers a body of tabus and regulations.

Undoubtedly bravery is approved and cowardice condemned by primitive races; love is shown for spouse and children, and generosity is often considered a high social virtue. Again "oversexed" persons are regarded with a contempt which approaches moral reprobation, while in barter the whole system depends on the reliance to be placed on the good faith of both parties. But we find Society all-powerful, the individual wholly subordinate. Yet, in those early, hard days the assertion of man's individuality would only have procured his extinction. Life and the handing on of life were the vital interests of the individual as of society. "The individual, tended and cared for throughout his childhood, grows up accustomed to expect from others what he comes to find that they expect from him. So he comes to see himself as others see him when he is praised or blamed for acts that he has long been ready to approve or disapprove in them. In a word his self-consciousness becomes conscience: he seems to hear two voices within his breast, and one speaks with the authority of law: it is his 'tribal self'." (Ward, *Psychological Principles.*) If man is to live, he must so live that others may live also, thus he passes on himself moral judgment in the name of the community. But all the moral innovators down the ages have been those who, in some degree at least, have outgrown the "tribal self," primitive morality, and been inspired themselves and inspired others with an "Enthusiasm of humanity."

Bibliography.—R. H. Codrington, *The Melanesians* (1891); C. Lloyd Morgan, *Animal Behaviour* (1900); Sir W. B. Spencer and F. J. Gillen, *The Native Tribes of Central Australia* (1899), *The Northern Tribes of Central Australia* (1904), and *The Arunta* (1927); W. H. Rivers, *The Todas* (1906); A. Westermarck, *The Origin and Development of the Moral Ideas* (2 vols., 2nd ed. 1912–17); L. T. Hobhouse, *Morals in Evolution* (5th ed. 1925) and *Mind in Evolution* (3rd ed. 1926); A. F. Shand, *The Foundations of Character* (1920); B. Malinowski, *Sex and Repression in Savage Society* (1927); A. Junod, *Life of a South African Tribe,* 2nd ed. (1927). (E. A. S.)

MORAL SENSE: *see* Ethics, History of.

MORAN, EDWARD (1829–1901), American artist, was born at Bolton, Lancashire, on Aug. 19, 1829. He emigrated with his family to America at the age of 15 and settled in Philadelphia, where after having followed his father's trade of weaver he became a pupil of James Hamilton and Paul Weber. In 1862 he became a pupil of the Royal Academy in London; he established a studio in New York in 1872, and for many years after 1877 lived in Paris. He was a painter of marine subjects, and examples of his work are in many prominent collections. Among his canvases are 13 historical paintings, intended to illustrate the marine history of America from the time of Leif Ericsson to the return of Admiral Dewey's fleet from the Philippines in 1899. He died in New York city on June 9, 1901. His sons (Edward) Percy Moran (b. 1862) and Léon Moran (b. 1864), and his brothers Peter Moran (b. 1842) and Thomas Moran (*q.v.*) also became prominent American artists.

MORAN, PATRICK FRANCIS (1830–1911), cardinal archbishop of Sydney, was born at Leighlinbridge, Ireland, on Sept. 16, 1830. He was educated in Rome, from the age of 12, at the Irish college of St. Agatha, where he later became principal (1856–66). He was ordained a priest on March 19, 1853. From 1866 to 1872 he was secretary to his uncle, Cardinal Cullen, archbishop of Dublin. In 1873 he became bishop of Ossory, and in 1884 archbishop of Sydney. He was consecrated cardinal at Rome in August 1885. He paid many visits to Rome, and as primate of Australia presided over the plenary councils of 1885, 1895 and 1905. He died on Aug. 16, 1911, at Manby Palace, Sydney. His uncompromising attitude on religious questions provoked much controversy, but he did good work in the educational sphere, and arranged for the building of many schools, as well as churches and hospitals. He was active in Australian politics, and a supporter of Australian federation.

His most important works are the *History of the Catholic Archbishops of Dublin* (Dublin, 1864) and *Spicilegium Ossoriense* (3 series, Dublin, 1874–84).

MORAN, THOMAS (1837–1926), American artist, was born at Bolton, Lancashire, on Jan. 12, 1837, and emigrated with his parents to America in 1844, the family settling in Philadelphia. After having been apprenticed for some years to a wood-engraver he studied under his brother Edward and under James Hamilton in Philadelphia, and later studied in London, Paris and Italy. In 1871 he accompanied Prof. F. V. Hayden's exploring expedition to the Yellowstone, and in 1873 he went down the Colorado with Major J. W. Powell's famous exploring party; and on these two trips he made sketches for two large pictures, "The Grand Cañon of the Yellowstone" and "Chasm of the Colorado River," both of which were bought by the U.S. Government and are now in the Capitol at Washington. He became a member of the National Academy of Design in 1884 and of the American Water Color Society. He died at Santa Barbara, Calif., on Aug. 26, 1926.

MORAND, PAUL (1888–), French novelist, was born on March 13, 1888. He studied law and political science, and joined the diplomatic service, serving as attaché in London, Rome and Paris. He was then appointed chief of section of the *service des oeuvres françaises a l'étranger.* Morand made a European reputation by a series of arresting stories of life in different parts of post-war Europe.

His best-known books are *Tendres stocks* (2nd ed. 1921); *Ouvert la Nuit* (26th ed. 1922); *Fermé la Nuit* (1923); *Lewis et Irène* (1924); *L'Europe Galante* (1925).

MORANT, SIR ROBERT LAURIE (1863–1920), British civil servant, was born at Hampstead on April 7, 1863. He was educated at Winchester and at New college, Oxford, and on leaving the university was for a few years a schoolmaster. Later he went to Siam as educational adviser, and was entrusted by King Chulalongkorn with preparing a scheme of education for the whole country. In a few years he returned to England, and after some experience of social work in the east end of London, was appointed in 1895 to assist in the direction of the office of special inquiries and reports in the board of education. He became private secretary to successive ministers, and on him devolved a great deal of the preparation of Balfour's Education Act of 1902. In 1903 he was appointed permanent secretary of the Board of Education. In this capacity he proved himself a most efficient administrator, and in 1907 he was created K.C.B. In 1912, on the introduction of the National Insurance bill, Morant was appointed chairman of the Insurance Commission, a position which led naturally to his appointment as secretary to the Ministry of Health on its formation in 1919. He died in London, after a few days' illness, on March 13, 1920, leaving a name in the civil service as one of the greatest administrative officials of his time.

MORAT (Ger. *Murten*), a small town on the east shore of the Lake of Morat, in the Swiss canton of Fribourg, and 14 m. N. of Fribourg or 18¼ m. W. of Bern by rail. Morat is also connected

by rail to Solothurn, Neuchâtel, Yverdon and Lausanne. In 1920 its population was 2,175, of whom 1,812 were German-speaking and 1,889 were Protestants. In 1264 it exchanged its position as a free imperial city (enjoyed since 1218) for the rule of the count of Savoy. In 1475 it was taken by the Swiss at the commencement of their war with Charles the Bold, duke of Burgundy, whose ally was the duchess of Savoy; in 1476 it was besieged by Charles (*see* SWISS WARS). Morat was ruled in common from 1475 to 1798 by Bern and Fribourg, being finally annexed to Fribourg in 1814. The Lake of Morat has an area of 10½ sq.m., and is connected with that of Neuchâtel by way of the Broye canal. On its shores many lake dwellings have been found. It is overlooked by the 13th century castle and the tower of the *Rathhaus,* while it is still surrounded by its 15th century walls that are studded at intervals with watch towers.

MORATA, OLYMPIA FULVIA (1526–1555), Italian classical scholar, was born at Ferrara. Her father knew all the learned men of the day, and she grew up in the atmosphere of classical learning. She was summoned to teach Anne, daughter of the duchess of Ferrara, when she was not much more than 12 years old, but had to leave owing to her father's conversion to Protestantism, which was later followed by her own. About the end of 1550 she married Andrew Grunthler, of Schweinfurt, Bavaria, and went to Schweinfurt with him. They were besieged by the Protestants when Albert of Brandenburg occupied the place, and finally escaped to Heidelberg in 1554. Here she died on Oct. 25, 1555.

BIBLIOGRAPHY.—The scanty remains of her works—letters, dialogues, Greek verses—were collected and published by Celio Secundo Curione (1558). Monographs by Caroline Bowles, wife of Robert Southey the poet (1834), J. Bonnet (1850; Eng. trans., Edinburgh, 1854), and R. Turnbull (Boston, 1846); *see* also Caroline Gearey, *Daughters of Italy* (1886).

MORATÍN, LEANDRO FERNÁNDEZ DE (1760–1828), Spanish dramatist and poet, the son of N. F. de Moratín. Appointed secretary to Cabarrús on a special mission to France in 1787, he was ordained on his return to Spain in 1789, and presented with a sinecure benefice and a pension, which was continued until 1816. He then adopted a literary career and succeeded Samaniego as official translator to the foreign office—a post for which his travels in England, the Low Countries, Germany and Italy eminently fitted him. An ardent admirer of Molière, he preserved, notwithstanding, his own originality, and in such plays as *El viejo y la niña* (1786), *La comedia nueva* (1792), *La Mogigata* (1804) reveals himself a subtle satirist, a delicate versifier and a master of concise dialogue. His crowning triumph in original comedy was *El Sí de las Niñas* (1806), which was performed night after night to crowded houses, ran through several Spanish editions in a year and was soon translated into a number of foreign languages. Involved in the fall of Godoy, Moratín accepted (1811) the office of royal librarian under Joseph Bonaparte—a false step, which alienated from him all sympathy and compelled him to spend his last years in exile.

MORATORIUM, a term used to express a legal authorization postponing for a specified time the payment of debts or obligations. The term is also sometimes used to mean the period over which the indulgence or period of grace stretches, the authorization itself being called a moratory law.

MORAVIA, a province of Czechoslovakia, covers an area of 8,616 sq.m. In physical structure it is a large basin, drained mainly by the Morava and its tributaries but in part by the upper Oder. North and west of a line from Znojmo through Brno to the source of the Oder it is part of the mountainous plateau which slopes southward from the Vrchovina Českomoravská, and beyond the Olomouc bay of the Morava, of the Jeseník heights (Praděd, 4,887 ft.). Both these plateaux consist of old crystalline rocks and pre-Permian, notably Devonian limestones and Carboniferous strata. South and east of the line mentioned above Tertiary and Recent deposits, *e.g.,* loess, form a fertile, undulating territory with isolated hills, rising beyond the Morava to the outer ranges of the Bílé Karpaty and the West Beskids. The most important ranges of this downland run parallel to the Carpathians and include the Chřiby (1,915 ft.) west of the Morava and its continuations the Hory Vizovské and spurs of the West Beskids, east of the river. The bay of Olomouc projects a tongue of Recent deposits and their typical human responses into the eruptive zone, where small outcrops of Cretaceous strata reproduce conditions found in the neighbouring basin of the Elbe.

The accidented relief of Moravia gives rise to great varieties of climate which in association with the different geological formations diversify its agriculture. Thus on the high western plateau the cultivated crops grade from hardy cereals, flax and potatoes through wheat and rye to maize, sugar-beet and vine in the lower sheltered valleys where conditions resemble those of the Bohemian plain. Beyond the Morava the passage is from the last-named group through cereals to fodder crops and pasture on the pervious *flysch* and limestones of the Carpathian flanks. The province contains some 16% of the acreage under wheat in Czechoslovakia, and 30% of that devoted to sugar-beet. Other crops of importance are hops (Tršice), hemp in the warm lowlands, vegetables (Znojmo and Olomouc), chicory, fruit and tobacco. Forestry is well-developed and the raising of stock includes an esteemed breed of horses from the plain of the Hana, excellent sheep in the Carpathians and fine cattle along the north-eastern border. The mineral wealth, consisting chiefly of coal and iron, is considerable. The former is mined principally in the district of Moravská Ostrava, part of the Silesian field, but smaller quantities are obtained from the Rosice-Oslavany region, west of Brno; lignite is mined at Hodonín. Iron-ores are extracted in the Moravian-Silesian borderlands, Blanskó and Rosice. Other mineral products of lesser importance are graphite (Mohelnice and Staré Město), clay and slates.

Industrially Moravia is advanced. It shares the important iron and steel working of Silesia, possessing foundries at Vitkovice and has smaller works at Rosice. Machinery is manufactured at Brno and Blanskó; much of this is for domestic use in agriculture, agricultural industries and textile manufacture. The hops and barley of Olomouc supply large breweries with a flourishing export trade, while other distributed and thriving industries arising from local agriculture are distilling and sugar-refining, and along the mountain borderland of the west starch and glucose are prepared. The cloth industry dates from the 14th century and has its powerful centre at Brno, silks are manufactured in northern Moravia, hats at Prostejov and Novy Jičín and leather goods at Brno, Prostejov and Jihlava. Other activities include saw-milling, the manufacture of furniture (Brno and Třebič) and clay products (Znojmo).

The population of Moravia in 1921 numbered 2,662,884, 78·2% being Czechoslovaks, 21% Germans and 0·6% Jews. The German element is strongest at the northern and southern ends, for Moravia has always been a great thoroughfare for movements between Vienna and south-eastern Germany, and in several of the larger towns the proportion of Germans is fairly high. By religion its people are 91% Roman Catholic, 3·2% Protestant, 2·3% Czechoslovak church and 1·8% without any confession. Educationally the standard is high and reflects both the prosperity of the province and the cultural influence of its German contacts during a long association with Austria. For administrative purposes the province is included with Silesia and the two are divided into six electoral areas for representation in the Chamber of Deputies and three for the Senate. A large measure of provincial autonomy is granted, the provincial capital being Brno.

See under CZECHOSLOVAKIA and H. Hassinger, *Die mährische Pforte und ihre benachbarten Landschaften.,* Abhand. geog. Gesellsch., XI. 2 (Vienna, 1914); E. Schindler, *Klimatographie von Mähren und Schlesien* (Vienna, 1918) and B. Bretholz, *Geschichte Böhmens und Mährens* (Lieberec, 1921).

History.—The earliest recorded inhabitants of Moravia were the Celtic Boii, who have perpetuated their name in Bohemia, and Cotini. These were succeeded about 15–10 B.C. by the Germanic Quadi, a Suabian tribe. The Germanic races were pushed back from the Middle Danube with the coming of the Avars (*q.v.*) in A.D. 567. The exact date of the arrival of the Slavs in Moravia, as in Bohemia, is uncertain; but by the late 8th century Moravia was filled with Slavonic settlers, who acknowledged no particular tribe but took the general name of Moravians (Ger. Mehranen

or Mähren) from the river Morava. When Charlemagne destroyed the Avar empire (*c.* 796), Moravia became tributary to the German empire; but its princes enjoyed much independence, repeatedly making war on the empire. It was probably for political reasons that Duke Rastislaus of Moravia invited two missionaries from the coast of Constantinople, SS. Cyril (Constantine) and Methodius, to teach Moravia Christianity (863); but in 864 Rastislaus was defeated by King Louis, and Moravia came under the Church of Rome. Having rebelled in 869, Rastislaus was defeated, blinded and banished to a monastery; but his nephew and successor Sviatopluk regained his independence (874) and founded an extensive kingdom of "Great Moravia" reaching to the Oder and Vistula and including Bohemia. After a savage war against the empire, which allied itself with the Magyars, Sviatopluk was killed (894), and Moravia "wholly destroyed" by the Magyars in 907–8. After long being disputed between Poland, Hungary and Bohemia, Moravia was incorporated in Bohemia, in 1029, thus becoming part of the German empire. In 1182 it was made a separate margravate, but was still treated in practice as a fief and secondogeniture of the king of Bohemia, who was nearly always invested with it. In 1526 Moravia, like Bohemia and Silesia, came under Habsburg rule, which its diet, unlike that of Bohemia, accepted readily. Thereafter it shared the fortunes of Bohemia (*q.v.*) with the difference that the Czech national movement was usually more moderate, partly owing to the higher proportion of German settlers, introduced at various periods. In 1849 Moravia was made a separate Austrian crownland. In Nov. 1918 it became part of Czechoslovakia (*q.v.*), being created a federated province of that State under the law of 1927.

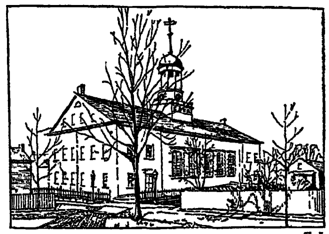
Bibliography.—For general development *see* under Bohemia; *see* also *Die Länder Oesterreich-Ungarns in Wort und Bild* (Vienna, 1881–89), vol. 9; *Die Oesterreichisch-Ungarische Monarchie in Wort und Bild* (Vienna, 1886–1902), vol. 17.

MORAVIAN BRETHREN or Moravian Church, a Christian communion founded in the east of Bohemia. For some years after the death of John Huss (1415), the majority of his followers were split into two contending factions. Some were pacified by concessions, and were recognized by the pope as the national Church of Bohemia (1433); but with this result some of Huss's followers, who wished to preserve his spiritual teaching, were not content. They laid great stress on purity of morals; and convinced that the official Church was morally corrupt, they founded a number of independent societies in Moravia and Bohemia. At this crisis Peter of Chelcic became the leader of the advanced reforming party. In ethics he anticipated much of the teaching of Tolstoy; in doctrine he often appealed to the authority of Wycliffe; and in some of his views it is possible to trace the influence of the Waldenses. He interpreted the Sermon on the Mount literally, denounced war and oaths, opposed the union of Church and State, and declared that the duty of all true Christians was to break away from the national Church and return to the simple teaching of Christ and His apostles. His followers were known as the Brethren of Chelcic, and wore a distinctive dress. His most famous supporter was John Rockycana, archbishop-elect of Prague, under whose influence the new community was founded and settled in the deserted village of Kunwald. Fresh recruits came streaming in, not only from the little societies already assisting, but also from the Waldenses, the national Church at Königgratz, and the university of Prague. They called themselves Jednota Bratrska, *i.e.*, the Church or Communion of Brethren; and this is really the correct translation of their later term, *Unitas fratrum.* At the Synod of Lhota (1467), they broke away entirely from the papacy, elected ministers of their own, and had Michael Bradacius consecrated a bishop by Stephan, a bishop of the Waldenses. At the synod of Reichenau (1495), they rejected the authority of Peter of Chelcic, and accepted the Bible as their only standard of faith and practice. In doctrine they were generally broad and radical. They taught the Apostles' Creed, rejected Purgatory, the worship of saints and the authority of the Catholic Church, practised infant baptism and confirmation, held a view on the Sacrament similar to that of Zwingli, and, differing somewhat from Luther in their doctrine of justification by faith, declared that true faith was "to know God, to love Him, to do His commandments, and to submit to His will." With the Brethren, however, the chief stress was laid, not on doctrine, but on conduct. For this purpose they instituted a severe system of discipline, divided their members into three classes—the Perfect, the Proficient, and the Beginners. They made great use of the press. In 1501 Bishop Luke of Prague edited the first Protestant hymn-book; in 1502 he issued a catechism, which circulated in Switzerland and Germany and fired the catechetical zeal of Luther; in 1565 John Blahoslaw translated the New Testament into Bohemian; in 1579–1593 the Old Testament was added; and the whole, known as the Kralitz Bible, is still in use. The constitution was practically Presbyterian. The growth of the Brethren was rapid; and by 1609, when Rudolph II. granted the *Letter of Majesty,* they were half the Protestants in Bohemia and more than half in Moravia.

At the very height of their power, however, they were almost crushed out of existence. The cause was the outbreak of the Thirty Years' War (1618). At the battle of the White Hill (1620) the Bohemian Protestants were routed; and for a hundred years the Brethren were almost extinct. But their bishop, John Amos Comenius (1592–1672), held them together. With an eye to the future, he published their *Ratio disciplinae,* and collected money for the "Hidden Seed" still worshipping in secret in Moravia. Of the "Hidden Seed" the greater number were Germans; they were probably descended from a colony of German Waldenses, who had come to Moravia in 1480 and joined the Church of the Brethren; and, therefore, when persecution broke out afresh they naturally fled to the nearest German refuge. With Christian David, a carpenter, at their head, they crossed the border into Saxony, settled down near Count Zinzendorf's estate at Berthelsdorf, and, with his permission, built the town of Herrnhut (1722–1727). But under Zinzendorf the history of the Moravians took an entirely new turn. He was a fervent Lutheran of the Pietist type, and a follower of Spener; and now he tried to apply these ideas to the Moravian refugees. For some years he had a measure of success. Instead of reviving Moravian orders at once, the settlers attended the Berthelsdorf parish church, regarded themselves as Lutherans, agreed to a code of "statutes" drawn up by the count, accepted the Augsburg Confession as their standard of faith, and, joining with some Lutheran settlers in a special Communion service in Berthelsdorf (Aug. 13, 1727), had such a powerful unifying experience that modern Moravians regard that day as the birthday of the renewed Moravian Church. They desired the re-establishment of their ancient church. In form the Moravian Church was soon restored. Before long persecution broke out against Herrnhut; the count sent a band of emigrants to Georgia; and as these emigrants would require their own ministers, he had David Nitschmann consecrated a bishop by David Ernest Jablonsky, grandson of Comenius (1735). In this way the Moravian orders were maintained; and yet, on the other hand, Zinzendorf's type of Lutheranism hampered the Brethren's progress in Germany. Instead of aiming at Church extension, they built settlements on the estates of friendly noblemen, erected Brethren's and Sisters' houses, and cultivated a quiet type of spiritual life. It is true that they evangelized all over Germany; but this part of their work was known as the Diaspora (1 Pet. i. 1); and the idea underlying this word is that the Brethren minister to the "scattered" in other Churches without drawing them into the Moravian Church. In Germany, therefore, the importance of the Moravians must be measured, not by their numbers, but by their influence upon other Christian bodies. It was from the Moravians that Schleiermacher learnt his religion, and they even made a passing impression on Goethe; but both these men were repelled by their doctrine of the substitutionary sufferings of Christ.

In reply to the very natural question why the Moravians began their work in England, the answer given by history is that John Wesley, on his voyage to Georgia (1735) met some Moravian emigrants; that on his return he met Peter Boehler, who was on his way to North Carolina; that through Boehler's influence both John and Charles Wesley were "converted" (1738). For a few years they took an active share in the Evangelical Revival (1738–

1755); but Zinzendorf's "ecclesiola" policy prevented their growth, and not till 1853 did the English Moravians resolve to aim at "the extension of the Brethren's Church." In 1749 the British Parliament recognized them as "an ancient protestant episcopal church." In foreign missions the distinctive feature about the Moravians is, not that they were so early in the field (1732), but that they were the first Protestants to declare that the evangelization of the heathen was the duty of the Church as such. Hitherto it had been a part of colonial policy. It was this that made their missions so influential.



BY COURTESY OF THE BETHLEHEM CHAMBER OF COMMERCE
MORAVIAN CHURCH BUILT AT BETHLEHEM, PA., IN 1803

Present Condition.—I. *Enterprises:* (1) Foreign missions in Labrador, Alaska, Canada, California, West Indies, Nicaragua, Demerara, Surinam, Cape Colony, Kaffraria, German East Africa, North Queensland, West Himalaya. (2) Leper Home near Jerusalem (1867). (3) Diaspora in Germany, Switzerland, France, Denmark, Norway, Russia, Poland. (4) Church extension in Germany, Great Britain, North America. (5) Boarding Schools: German province, 14; British, 7; American, 5. (6) Church Revival in Bohemia and Moravia, begun in 1869, and sanctioned by the Austrian government (1880). In Germany the official title of the Church is *Evangelische Brüder-Unität;* in Austria, *Evangelische Brüder-Kirche;* in England and America, *Moravian Church.*

II. *Doctrine.*—At the General Synod of 1909 they reaffirmed their old fundamental principle that "the Holy Scriptures are our only rule of faith and practice"; but at the same time they declared that their interpretation of Scripture agreed substantially with the Nicene Creed, the Westminster and Augsburg Confessions, and the Thirty-nine Articles. Since 1879 their leading doctrines have been formulated as follows: (1) the total depravity of man; (2) the real Godhead and real humanity of Christ; (3) justification and redemption through the sacrifice of Christ; (4) work of the Holy Spirit; (5) good works as fruits of the Spirit; (6) fellowship of believers; (7) second coming of Christ; (8) resurrection of the dead to life or judgment.

III. *Ceremonies.*—At morning worship the service consists of a litany, scripture lessons, sermon, singing, extempore prayer. At the evening service a litany is rarely used. The Communion is celebrated once a month. Infant Baptism is practised. There are three modes of admission to membership: in the case of the unbaptized, adult baptism (not immersion); in other cases confirmation or reception.

IV. *Church Policy.*—It is now held by some Moravians that their Church offers a *via media* between Anglicanism and Dissent. At the meeting of the Lambeth Conference in 1907 some overtures, on certain conditions, were made for (*a*) joint consecration of bishops, (*b*) joint ordination of ministers, (*c*) interchange of pulpits. In response the Moravians, at the General Synod (1909), welcomed the offer, but also declared their wish (*a*) to preserve their independence as a "Protestant Episcopal Church"; (*b*) to co-operate freely as heretofore with other Evangelical Churches.

General Statistics (Communicants), 1928

British Province (42 Congregations, including Home Missions)	3,520
Continental Province (24 Congregations)	7,723
America—Northern Prov. (98 Cong.)	18,029
America—Southern Prov. (38 Cong.)	7,791
Czecho-Slovakia (7 Cong.)	1,503
Missions (390 Stations and Out-stations)	39,902
Missionaries (European and American)	260
Missionaries (European [Native])	2,127
Total	80,855

BIBLIOGRAPHY.—For full information *see* the *Moravian Almanac; Annual Reports of the British Province; Results of the General Synod,* 1914; *The Moravian Church Book.* On the ancient church: Gindely, *Geschichte der Böhmischen Brüder* (1858); Goll, *Quellen u. Untersuchungen zur Gesch. d. Böhm. Brüder* (1882); E. de Schweinitz, *History of the Unitas Fratrum* (1885); Müller, *Die deutschen Katechismen d. Böhm. Brüder* (1887). On the renewed Church: Hamilton, *History of the Moravian Church during the 18th and 19th centuries* (1900); Hutton, *History of the Moravian Church* (1909); articles *"Böhmische Brüder"* and *"Zinzendorf"* in Herzog-Hauck, *Realencyklopädie,* and art. "Moravians" by E. R. Hasse in Hastings', *Encyclopaedia of Religion and Ethics.* (X.)

The United States.—The *Unitas Fratrum,* Brethren's Unity, known better in America as the Moravian Church, occupies a unique position among the churches coming to or arising in the United States, in these respects: it was the first to form an act upon the idea of converting heathen peoples, beginning at once among the Eskimos of the Arctic shores and the Indians of North America. It has gained more members among the heathen than it has had in its home churches. It has preserved its unity from a single division. It is the only Protestant Church to be under a single general supervision in its German, English and American territories, and the only one that has had from the first an unquestioned apostolic succession for its episcopate.

The Moravians began to arrive in Georgia and in Pennsylvania in the first half of the 18th century. The company that came to Georgia in 1735 removed to Pennsylvania, where other companies from abroad joined them, including Count Zinzendorf, who won the confidence of neighbouring Indians, the Six Nations, including permission to sojourn at will among the Iroquois. He also organized a church of six members at Skeksmeter, N.Y., among the Mohicans. In an attempt to unite German immigrants of the Lutheran and Reformed faiths, who had scarcely been able to organize themselves, he was less successful, though many conferences or synods were held; but meantime he brought about the organization of Moravian churches in Bethlehem, Nazareth and elsewhere and saw economical community settlements, like that of his own Herrnhut in Germany, begin at Bethlehem and Nazareth. These communities ceased to exist in 1856. The Moravian church did not develop rapidly in the United States, following in this respect the history of the denomination in Germany and Great Britain, perhaps because it was so greatly absorbed in developing its work among the heathen, Indians and Orientals. It sent, it may be, too many of its ministers and bishops to the pagans. Since the World War the missionary management has been divided and the foreign missions apportioned among the American and other provinces. The Church in America has for many years been organized into two provinces, the northern with its headquarters at Bethlehem, Pa., and the southern centring at Salem, N.C. At Bethlehem are the Missions Board and a Publication Society, with Church Extension and Sustentation societies. In 1927 the church in the United States had 150 ministers, 134 churches and 26,241 communicants. (H. K. C.)

See J. Taylor Hamilton, *The Moravian Church* (1895).

MORAVSKÁ OSTRAVA, the third city in Czechoslovakia, pop. (1921) 113,709, has valuable coal deposits. On the opposite bank of the Ostrawitsa is Ostrava Slezská, pop. (1921) 22,890.

MORAY,[1] THOMAS RANDOLPH, 1ST EARL OF (d. 1332), Scottish warrior and statesman, was the only son of Thomas Randolph of Nithsdale, who had been chamberlain of Scotland, and through his mother Lady Isabel Bruce was nephew to King Robert the Bruce. In June 1306, he was captured at Methven, and saved his life by becoming Edward's man. In 1308, however, he was taken by Sir James Douglas and imprisoned. Having made his submission, in 1312 or 1314 he was created earl of Moray and lord of Man and Annandale by the Scottish king. By a brilliant feat of arms he destroyed Edinburgh Castle early in 1314, and drove back the English at Bannockburn. He shared in Edward Bruce's expedition to Ireland in 1315, and returned to Scotland in 1317 with Robert Bruce. With Sir James Douglas, Randolph was closely allied; in 1318 they seized Berwick and in 1319 they raided the northern English counties, laying waste the country as far as York, and securing a two years' truce with Edward II.

In 1322 Moray shared in Douglas's exploit at Byland Abbey. In the next year he was one of the Scottish ambassadors charged

[1]In general, for "Moray" *see* MURRAY, the spelling having been constantly interchangeable. The present earls keep the spelling Moray.

to conclude a truce with England, and was sent to Avignon to persuade the pope to acknowledge Bruce's claims. In 1326 he concluded an offensive and defensive alliance between France and Scotland. The death of Bruce in 1329 made Moray regent of Scotland and guardian of the young king David II. He died at Musselburgh on July 20, 1332.

MORAY or **ELGINSHIRE** (Gaelic "among the sea-board men"), northern county, Scotland, bounded north by the Moray firth, east and south-east by Banffshire, south and south-west by Inverness and west by Nairnshire. It comprises only the eastern portion of the ancient province of Moray, which extended from the Spey to the Beauly and from the Grampians to the sea, embracing an area of about 3,900 sq. miles. The area of the county excluding water, is 477 sq.m. (305,931 acres). The county is divided between lowland and hill country. The lowland of the coast and its hinterland is the Laigh of Moray, a fertile tract 30 m. long and 5 to 12 m. broad, of old red sandstone and Triassic strata, with a wide distribution of glacial deposits, which were carried from the heights in an easterly and south-easterly direction along the present Moray firth. The sandstones at and near Quarry Wood are of special geological interest on account of their remarkable series of reptilian remains, which date them, at least in part, as Triassic, and possibly, in the lowest portion as Permian. The hilly south-central division of the county reaches a greatest height of 2,329 ft. in the Cromdale hills on the Banffshire border. This division belongs to the area of the crystalline schists of the central highlands, with granite between Lochindorb and Grantown. The two most important rivers, the Spey (*q.v.*) and the Findhorn, have their sources in Inverness-shire. About 50 m. of the course of the Spey are in Moray, to which it may be roughly said to serve as the boundary line on the south-east and east. The Findhorn rises in the Monadliadh mountains which form the watershed for several miles between it and the Spey. Of its total course of nearly 70 m. only the last 12 are in the county, before it enters the Moray firth in a bay on the north-eastern shore to which it has given its name. The Lossie rises in the small lakes on the flanks of Carn Kitty and pursues a winding course of 34 m. to the Moray firth. The Spey and Findhorn are famous for salmon, and some of the smaller streams afford good sport.

Lochindorb, 6 m. north-north-west of Grantown, is now the largest lake. In the upper end, on an island believed to be artificial, stand the ruins of Lochindorb castle, in the 14th century the stronghold of the Wolf of Badenoch, and afterwards successively the property of the earl of Moray, the Campbells of Cawdor and the earl of Seafield. In the southern half of the county are several fine glens, including Rothes, Lossie, Gheallaidh, Tulchan and Beag. Strathspey is a broader and beautiful valley.

Agriculture.—Considering its latitude and the extent of its arable land the standard of farming in Moray is high. The rich soil of the lowlands is well adapted for oats and barley. The breeding of live-stock is profitable, and some of the finest specimens of shorthorned and polled cattle and of crosses between the two are bred. On the larger farms in the Laigh Leicester sheep are kept all the year round, but in the uplands the Black-faced take their place. Horses and pigs are also raised.

Other Industries.—Whisky is the chief product. There are woollen mills, distilleries, sawmills and iron foundries at Elgin; woollen mills, distilleries and chemical works at Forres; and distilleries at Rothes. Owing to the absence of coal, what little mineral wealth there is (iron and lead) cannot be remuneratively worked. The sandstone quarries, yielding a building-stone of superior quality, are practically inexhaustible. The plantations mainly consist of larch and fir and, to a smaller extent, of oak. The Firth fisheries, comprising haddock, cod, herring, etc., are of considerable value.

Population and Government.—The population was 40,805 in 1931, when 532 persons spoke both Gaelic and English. The chief towns are Elgin (pop. in 1931, 8,810), Forres (4,169) and Lossiemouth (3,914), to which may be added Rothes (1,292), Grantown-on-Spey (1,577) and Burghead (1,255). In conjunction with Nairnshire the county returns one member to parliament. Elgin and Forres are royal burghs; the municipal and police burghs include Burghead, Elgin, Forres, Grantown-on-Spey, Lossiemouth, and Rothes. Moray is included in one sheriffdom with Inverness and Nairn, and there is a resident sheriff-substitute at Elgin. The county is under school-board jurisdiction, several of the schools earning grants for higher education. There are an academy, a school of science and art and a technical school at Elgin.

History.—The stone circle at Viewfield is an interesting prehistoric monument. Christianity, introduced under the auspices of Columba (from whose time the site of Burghead church has probably been so occupied), flourished for a period until the Columban church was expelled in 717 by King Nectan. Thereafter the district was given over to internecine strife between the northern and southern Picts, which was ended by the crushing victory of Kenneth MacAlpine in 831, as one result of which the kingdom of Pictavia was superseded by the principality of Moravia. Later the Norsemen raided the country first under Thorstein and then under two Sigurds. It was in the time of the second Sigurd that the Firth was fixed as the northern boundary of Moray. In spite of such interruptions as the battle of Torfness (Burghead) in 1040, in which Thorfinn, earl of Orkney and Shetland, overthrew the Scots under King Duncan, the consolidation of the kingdom was being gradually accomplished. After Macbeth ascended the throne the Scandinavians held their hands. Though Macbeth and his *fainéant* successor, "daft" Lulach, were the only kings whom Moray gave to Scotland, the province continued under the rule of its own marmaer, or great steward until the dawn of the 12th century, when as an entity it ceased to exist. With a view to breaking up the power of the marmaers, David I. and his successors colonized the seaboard with settlers from other parts of the kingdom, but from time to time the clansmen and their chiefs descended from their fastnesses and plundered the Laigh. Meanwhile, the Church had become a civilizing force. In 1107 Alexander had founded the see of Moray and the churches of Birnie, Kinneddar and Spynie were in turn the cathedral of the early bishops, until in 1224 under the episcopate of Andrew of Moray (de Moravia), the church of the Holy Trinity in Elgin was chosen for the cathedral. Another unifying factor was the struggle for independence.

In his effort to stamp out Scottish nationality Edward I. came as far north as Elgin in 1296. Wallace, however, was well supported by Sir Andrew Moray of Bothwell, and Bruce recognized the assistance he had received from the men of the north by erecting Moray into an earldom on the morrow of Bannockburn and bestowing it upon Thomas Randolph. (*See* MORAY, THOMAS RANDOLPH, EARL OF.) Henceforward the history of the county resolved itself in the main into matters affecting the power of the Church and the ambitions of the Moray dynasties. There was strife between Covenanters and the adherents of Episcopacy until, prelacy itself being abolished in 1689, the bishopric of Moray came to an end after an existence of 581 years. (For the subsequent history of the earldom *see* MURRAY or MORAY, EARLS OF.) Other celebrated Moray families who played a part in local politics were the Gordons, the Grants and the Duffs. Still, national affairs occasionally evoked interest in Moray. In the civil war Montrose ravaged the villages which stood for the Covenanters, but most of the great lairds shifted in their allegiance, and the mass of the people were quite indifferent to the declining fortunes of the Stewarts. Charles II. landed at Garmouth on July 3, 1650, on his return from his first exile in Holland. The fight at Cromdale (May day, 1690) shattered the Jacobite cause, for the efforts in 1715 and 1745 were too spasmodic and half-hearted to affect the loyalty of the district to Hanoverian rule. A few weeks before Culloden Prince Charles Edward stayed in Elgin for some days, and a month afterwards the duke of Cumberland passed through and administered the *coup de grâce* to the Young Pretender on Drummossie moor.

Elginshire has twice been the scene of terrible catastrophes. In 1694 the barony of Culbin—a fine estate, comprising 3,600 ac. of land, so fertile that it was called the Granary of Moray, a mansion, a church and several houses—was buried under a mass of sand in a severe storm. This sandy waste, north-west of

Forres, measures 3 m. in length and 2 in breadth. The other calamity was the Moray floods of Aug. 2 and 3, 1829. The Findhorn inundated an area of 20 sq.m.; the Divie rose 40 ft., and the Lossie flooded all the low ground around Elgin.

MORBIHAN, a department of western France on the Atlantic seaboard, formed of part of Lower Brittany, and bounded S.E. by the department of Loire-Inférieure, E. by that of Ille-et-Vilaine, N. by Côtes-du-Nord, and W. by Finistère. Area, 2,738 sq. miles. Pop. (1926) 543,175. The department is formed of the denuded folds of the Armorican system, which have axes of granitic rocks running for the most part E.S.E. to W.N.W. The most northerly of these stretches into the department from the Montagnes Noires of S. Finistère, and in Morbihan reaches a height of 974 ft. The next ridge to the south runs across the centre of the department and dies down on its east and west borders; it forms the barren Landes de Lanvaux, about 1 to 3 m. wide and 31 m. long. Parallel lines of granite and Archaean rock also form most of the coast. The Blavet river on the west runs across the structural lines and has some pretty valley sections where it cuts across the harder axes. The Oust is a tributary of the Vilaine, which it joins at the east end of the Landes. The great feature of the department is its coastline, with a number of picturesque estuaries, formed through invasion of river valleys by the sea, and the Morbihan, or "little sea," studded with islands, which are classic ground for the student of prehistoric archaeology. The Morbihan is separated from the sea outside, the Mor Braz, by the peninsula of Ruis, save for a tide-race at the end of the peninsula. To the west is the peninsula of Quiberon, which is joined to the mainland by a long sandspit. Off the coast lie the islands of Groix, Belle-Île (*q.v.*), Houat and Hoedik.

The climate of Morbihan is moist and mild. Unproductive heath occupies more than a quarter of the department, about a third of which is arable land. The shores of the estuaries are rich in southern plants, figs, rose-laurels, aloes, etc. Rye, buckwheat, wheat and oats, potatoes and mangels are the chief crops; hemp and flax are also grown. Horned cattle are the chief livestock and bee-keeping is important. Seaweed is used for manure. Lorient (*q.v.*) is a shipbuilding centre, while the sardine, oyster (Auray, St. Armel, etc.), anchovy and lobster fisheries are important, as is fish-preserving. Hennebont makes sheet-tin for sardine-boxes. There are several slate-quarries, and a number of minor industries, including lace-making by hand.

The department is served by the Orléans railway and the canal from Nantes to Brest uses the Oust; the Blavet is also canalised. It is divided into three arrondissements, namely: Vannes, Lorient, and Pontivy—with 38 cantons and 260 communes. The capital Vannes is the seat of a bishopric of the province of Rennes. The department belongs to the region of the XIth army corps (Nantes) and to the académie (educational division) of Rennes, where also is its court of appeal. The principal places are Vannes, Lorient, Ploërmel, Pontivy, Auray, Hennebont, Carnac and Locmariaquer, the last two famous for megalithic monuments, as are Erdeven and Plouharnel; Elven, with two towers of the 15th century, remains of an old stronghold; Josselin which has the fine château of the Rohan family and a church containing the tomb (15th century) of Olivier de Clisson and his wife; Guern with a chapel of the 15th and 16th centuries and Le Faouët with a chapel of the 15th century; Quiberon, associated with the disaster of the French *émigrés* in 1795; Sarzeau, near which is the fortress of Sucinio (13th and 15th centuries); Ste. Barbe with a chapel, dating from about the end of the 15th century, finely situated, overlooking the Ellé; St. Gildas-de-Ruis, with a Romanesque church and other remains of a Benedictine abbey of which Abelard was for a time abbot. The principal *pardons* (religious festivals) are those of Ste. Anne-d'Auray and St. Nicolas-des-Eaux.

MORCAR or **MORKERE, EARL** (*fl.* 1066), earl of the Northumbrians, son of Earl Aelfgar, brother of Edwin, earl of the Mercians. He assisted the Northumbrians to expel Tostig, of the house of Godwin, in 1065 and was chosen earl by the rebels, an election which Tostig's brother, Harold, later accepted. In spite of the help which Harold afterwards gave them against Tostig and Harold Hardrada, the two brothers left him to fight alone at Hastings. After trying to secure the crown for their own house, they submitted to William, but lost their earldoms. They attempted unsuccessfully to raise the North in 1068. They were pardoned, but Morcar afterwards joined Hereward in the Isle of Ely (1071), and later died in prison.

See E. A. Freeman, *Norman Conquest* vols. 2–4 and *William Rufus*, vol. i.

MORDVINIANS, otherwise called MORDVA, MORDVS, or MORDVINS, a people numbering about one million, speaking a Finno-Ugrian language, who inhabit the middle Volga provinces of Russia and spread in small detached communities to the south and east of these. Their settlement in the basin of the Volga is of high antiquity. There are two dialects Erza and Moksha. The southern branch, or the Moksha, have a darker skin and darker eyes and hair than the northern. A third branch, the Karatays, found in Kazan, appears to be mixed with Tatars. The Mordvins have maintained a good deal of their old national dress, especially the women, whose profusely embroidered skirts, original hair-dress, large ear-rings which sometimes are merely hare-tails, and numerous necklaces covering all the chest and consisting of all possible ornaments, easily distinguish them from Russian women. They have mostly dark hair, blue eyes, generally small and rather narrow. They are generally roundish headed, finely built, rather tall and strong, and broad-chested. Their chief occupation is agriculture. They now manufacture wooden ware of various sorts. They are also masters of apiculture. They have a considerable literature of popular songs and legends, some of them recounting the doings of a king Tushtyan who lived in the time of Ivan the Terrible. Nearly all are Christians; they received baptism in the reign of Elizabeth, and the Nonconformists have made many proselytes among them. But they still preserve much of their own mythology, which they have adapted to the Christian religion. According to some authorities, they have preserved also, especially the less russified Moksha, the practice of kidnapping brides, with the usual battles between the party of the bridegroom and that of the family of the bride. The worship of trees, water (especially the water-divinity which favours marriage), the sun or Shkay, who is the chief divinity, the moon, the thunder and the frost, and of the home-divinity Kardazserko still exists among them; and a small stone altar or flat stone covering a small pit to receive the blood of slaughtered animals can be found in many houses. Their burial customs seem founded on ancestor-worship. On the fortieth day after death the dead person is supposed to return home. One of his household represents him, and, coming from the grave, speaks in his name.

The language is treated of in Ahlquist's *Versuch einer Mokscha-mordwinischen Grammatik nebst Texten und Wörter-Verzeichniss* (St. Petersburg, 1861), and their history, customs and religion by Smirnov (trans. by Boyer), "Les Populations finnoises de la Volga" (in *Publications de l'école des langues orientales, vivantes*, 1898). Much valuable information respecting customs, religion, language and folk-lore will be found in papers by Paasonen, Heikel, Ahlquist, Mainof and others printed in the *Journal de la Société Finno-Ougrienne* and the *Finnisch-ugrische Forschungen.*

MORE, HANNAH (1745–1833), English religious writer, was born at Stapleton, near Bristol, on Feb. 2, 1745. She may be said to have made three reputations in the course of her long life: first, as a clever verse-writer and witty talker in the circle of Johnson, Reynolds and Garrick; next, as a writer on moral and religious subjects on the Puritanic side; and lastly, as a practical philanthropist. She was the youngest but one of the five daughters of Jacob More, who, though a member of a Presbyterian family in Norfolk, had become a member of the English Church and a strong Tory. He taught a school at Stapleton in Gloucestershire. The elder sisters established a boarding-school at Bristol, and Hannah became one of their pupils when she was 12 years old. Her first literary efforts were pastoral plays, the first being written in 1762 under the title of *A Search after Happiness* (2nd ed. 1773). Metastasio was one of her literary models; on his opera of *Attilio regulo* she based a drama, *The Inflexible Captive,* published in 1774. She gave up her share in the school on contracting an engagement of marriage with a Mr. Turner. The wedding never took place, and Hannah More

accepted from Turner an annuity which had been settled on her without her knowledge. This set her free for literary pursuits, and in 1772 or 1773 she went to London. Some verses on Garrick's *Lear* led to an acquaintance with the actor-playwright; Miss More was taken up by Elizabeth Montague; and her unaffected enthusiasm, simplicity, vivacity, and wit won the hearts of the whole Johnson set, the lexicographer himself included, although he is said to have told her that she should "consider what her flattery was worth before she choked him with it." Garrick wrote the prologue and epilogue for her tragedy *Percy,* acted at Covent Garden in Dec. 1777. Another drama, *The Fatal Falsehood,* produced in 1779 after Garrick's death, was less successful. The Garricks had induced her to live with them; and after Garrick's death she remained with his wife. In 1781 she met Horace Walpole, and corresponded with him from that time.

Hannah More published *Sacred Dramas* in 1782, and it rapidly ran through 19 editions. These and the poems *Bas-Bleu* and *Florio* (1786) mark her gradual transition to more serious views of life, which were fully expressed in prose in her *Thoughts on the Importance of the Manners of the Great to General Society* (1788), and *An Estimate of the Religion of the Fashionable World* (1790). She was intimate with Wilberforce and Zachary Macaulay, with whose evangelical views she was in entire sympathy. She published a poem on *Slavery* in 1788. In 1785 she bought a house, at Cowslip Green, near Wrington, near Bristol, where she settled down to country life with her sister Martha, and wrote many ethical books and tracts: *Strictures on Female Education* (1799), *Hints towards forming the Character of a Young Princess* (1805), *Coelebs in Search of a Wife* (only nominally a story, 1809), *Practical Piety* (1811), *Christian Morals* (1813), *Character of St. Paul* (1815), *Moral Sketches* (1819). The tone is uniformly animated; the writing fresh and vivacious; and there was an originality and force in her way of putting commonplace sober sense and piety that accounts for her popularity.

The most famous of her books was *Coelebs in Search of a Wife,* which had an enormous circulation. The model Stanley children were said to have been drawn from T. B. Macaulay and his sister. She also wrote many spirited rhymes and prose tales, the earliest of which was *Village Politics* (1792), by "Will Chip," to counteract the doctrines of Tom Paine and the influence of the French Revolution. The success of *Village Politics* induced her to begin the series of "Cheap Repository Tracts," which were for three years produced by Hannah and her sisters at the rate of three a month. Perhaps the most famous of these is *The Shepherd of Salisbury Plain,* describing a family of phenomenal frugality and contentment. This was translated into several languages. Two million copies of these rapid and telling sketches were circulated in one year, teaching the poor in rhetoric of most ingenious homeliness to rely upon the virtues of content, sobriety, humility, industry, reverence for the British Constitution, hatred of the French, trust in God and in the kindness of the gentry.

Perhaps the best proof of Hannah More's sterling worth was her indefatigable philanthropic work for the children in the mining districts of the Mendip hills. The More sisters met with a good deal of opposition. The farmers thought that education, even to the limited extent of learning to read, would be fatal to agriculture, and the clergy, whose neglect she was making good, accused her of Methodist tendencies. In her old age, philanthropists from all parts made pilgrimages to see the bright and amiable old lady, and she retained all her faculties till within two years of her death, dying at Clifton, where the last five years of her long and, for the most part, singularly happy life were spent, on Sept. 7, 1833.

See H. Thompson *The Life of Hannah More, with Notices of Her Sisters* (1838). The article in the *Dict. Nat. Biog.* is by Sir Leslie Stephen. Some letters of Hannah More, with a very slight connecting narrative were published in 1872 by William Roberts as *The Life of Hannah More. See* also *Hannah More* (1888), by Charlotte M. Yonge, in the "Eminent Women" series, and other lives by "Marion Harland," (1900) and Miss Meakin (1911). *Letters of Hannah More to Zachary Macaulay* were edited (1860) by Arthur Roberts. The contemporary opposition to her may be seen in an abusive *Life of Hannah More, with a Critical Review of Her Writings* (1802), by the "Rev. Archibald Macsarcasm" (William Shaw, rector of Chelvey, Somerset).

MORE, HENRY (1614–1687), English philosopher of the Cambridge Platonist school, was born at Grantham in 1614. Both his father and his mother, he tells us, were "earnest followers of Calvin," but he himself "could never swallow that hard doctrine." In 1631 he was admitted at Christ's college, Cambridge, about the time Milton was leaving it. He immersed himself "over head and ears in the study of philosophy," and fell for a time into a scepticism, from which he was delivered by a study of the "Platonic writers." He was fascinated especially by Neoplatonism, and this fascination never left him. The *Theologia germanica* also exerted a permanent influence over him. He took his bachelor's degree in 1635, his master's degree in 1639, and immediately afterwards was chosen fellow of his college. Fifteen years after the Restoration he accepted a prebend in Gloucester cathedral, but only to resign it in favour of his friend Dr. Edward Fowler, afterwards bishop of Gloucester. He would not accept the mastership of his college, to which, it is understood, he would have been preferred in 1654, when Cudworth was appointed. He drew around him many young men of a refined and thoughtful turn of mind, but among all his pupils the most interesting was Lady Conway, at whose country seat at Ragley, Warwickshire, More continued at intervals to spend "a considerable part of his time." Amidst the woods of this retreat he composed several of his books. The spiritual enthusiasm of Lady Conway was a considerable factor in some of More's speculations, none the less that she at length joined the Quakers. She became the friend not only of More and Penn, but of Baron van Helmont and Valentine Greatrakes, mystical thaumaturgists of the 17th century. Ragley became a centre not only of devotion but of wonder-working spiritualism (*cf.* the account in the novel *John Inglesant* ch. xv.). From this, his genius suffered, and the rationality which distinguishes his earlier is much less conspicuous in his later works. He was a voluminous writer both in verse and in prose. His most notable work, the *Divine Dialogues* (1688), summarizes his general view of philosophy and religion.

Henry More represents the mystical and theosophic side of the Cambridge movement. The Neoplatonic extravagances which lay hidden in the school from the first came in his writings to a head, and merged in pure phantasy. Mystical elevation was the chief feature of his character, a certain radiancy of thought which carried him beyond the common life without raising him to any artificial light, for his humility and charity were not less conspicuous than his piety. He died on Sept. 1, 1687, and was buried in the chapel of the college he loved.

Before his death More issued complete editions of his works, his *Opera theologica* in 1675, and his *Opera philosophica* in 1678. The chief authorities for his life are Richard Ward's *Life* (1710); the prefatio generalissima prefixed to his *Opera omnia* (1679); and also a general account of the manner and scope of his writings in an *Apology* published in 1664. The collection of his *Philosophical Poems* (1647), in which he has "compared his chief speculations and experiences," should also be consulted. An elaborate analysis of his life and works is given in Tulloch's *Rational Theology,* vol. ii. (1874); *see* also R. Zimmermann, *Henry More und die vierte Dimension des Raums* (Vienna, 1881). *See* ETHICS.

MORE, PAUL ELMER (1864–), American author, was born in St. Louis (Mo.), Dec. 12, 1864. He was educated at Washington university and Harvard, and he was assistant in Sanskrit at Harvard, 1894–95, and associate in Sanskrit and classical literature at Bryn Mawr college, 1895–97. He was literary editor of the *Independent,* 1901–3, and of the New York *Evening Post,* 1903–9, and editor of the *Nation,* 1909–14, in these capacities doing much to develop taste and maintain high critical standards in America.

He is the author, among other works, of *Shelburne Essays* (11 vols., 1904–21); *Life of Benjamin Franklin* (1900); *Nietzsche* (1912); *The Religion of Plato* (1921); *Hellenistic Philosophies* (1923); and *The Christ of the New Testament* (1924).

MORE, SIR THOMAS (1478–1535), English lord chancellor, and author of *Utopia,* was born in Milk street in the City of London, on Feb. 7, 1478. He attended St. Anthony's School in Threadneedle street, at that time under Nicolas Holt, and at thirteen was early placed in the household of Cardinal Morton, archbishop of Canterbury. Young Thomas More obtained this

privilege through the influence of his father, Sir Thomas, then a rising barrister and afterwards a justice of the court of king's bench. About 1492 young More was sent to Canterbury Hall, Oxford, afterwards absorbed in Christ Church, where he is said vaguely to have had Colet, Grocyn and Linacre for his tutors. All More himself says is that he had Linacre for his master in Greek. More's father, who intended his son to make law his career, feared the influence of the "new learning," and removed him from the university about 1494, and entered him at New Inn. In February 1496 More was admitted at Lincoln's inn. In his professional studies More early distinguished himself and was appointed reader-in-law in Furnival's inn; but he would not relinquish the studies which had attracted him in Oxford. Erasmus says that he tried his hand at "little comedies," and he studied Pico della Mirandola. Among his friends were Lily and Colet, the latter of whom became his confessor and exercised great influence over him. The balance of his faculties seemed to be restored by a revival of the antagonistic sentiment of humanism which he had imbibed from the Oxford circle of friends, and from Erasmus. More's acquaintance with Erasmus might have begun during Erasmus's first visit to England in 1497. Tradition has dramatized their first meeting into the story given by Cresacre More—that the two happened to sit opposite each other at the lord mayor's table, that they got into an argument during dinner, and that, in mutual astonishment at each other's wit and readiness, Erasmus exclaimed, "Aut tu es Morus, aut nullus," and the other replied, "Aut tu es Erasmus, aut diabolus!" The acquaintance rapidly ripened into warm attachment. This contact with the prince of letters revived in More the spirit of the "new learning," and he returned with ardour to the study of Greek. He acquired facility in the Greek language, from which he made and published some translations. His Latin style, though wanting the inimitable ease of Erasmus, is yet in copiousness and propriety much above the ordinary Latin of the English scholars of his time.

At about this time More desired to give himself over to an ascetic life. He took a lodging near the Charterhouse, and subjected himself to the discipline of a Carthusian monk. He wore a sharp shirt of hair next his skin, scourged himself every Friday and other fasting days, lay upon the bare ground with a log under his head, and allowed himself but four or five hours' sleep. This phase lasted for some four years 1499 to 1503. He then abandoned all idea of leaving the world, but to the end of his life he was scrupulous in the observance of his religious duties.

More sat in the parliament of 1504, when he contested Dudley's demand on behalf of the king for an "aid" in money on the marriage of Princess Margaret. More's speech is said to have moved the house to reduce the subsidy of three-fifteenths which the Government had demanded to £30,000. Henry VII. revenged himself upon More's father, who was sent to the Tower, and only released on payment of a fine of £100. Thomas More found it advisable to withdraw from public life for a time. During this period of retirement the old dilemma recurred. One while he devoted himself to the sciences, "perfecting himself in music, arithmetic, geometry and astronomy, learning the French tongue, and recreating his tired spirits on the viol," or translating Greek epigrams; another while resolved to take priest's orders.

But at this time he made acquaintance with the family of John Cult of New Hall, in Essex. The "honest and sweet conversation" of the three daughters attracted him, and though his inclination led him to prefer the second he married the eldest, Jane, in 1505, not liking to put the affront upon her of passing her over in favour of her younger sister. The newly-married pair settled in Bucklersbury, and lived a life of unbroken domestic felicity. At Bucklersbury he was visited by Erasmus, and on a second visit in 1508 the great scholar wrote the *Moriae Encomium*, dedicated to his friend and host. His wife died in 1511, and he married, within a month, Alice Middleton, a widow with one daughter. They moved to Crosby place, Bishopsgate.

The death of the old king in 1509 restored More to the public career for which his abilities specially fitted him. From this time there was scarce a cause of importance in which he was not engaged. His professional income amounted to £400 a year, equal to £4,000 in present money, and, "considering the relative profits of the law and the value of money, probably indicated as high a station as £10,000 at the present day" (Campbell). In 1509 he was elected a bencher of Lincoln's inn, and in 1510 was appointed under-sheriff of London. He soon attracted the attention of the young king and of Wolsey. It was during a residence in Antwerp that he met Peter Giles (Aegidius), a friend of Erasmus, and sketched out the idea of *Utopia*. He was repeatedly employed on embassies to the Low Countries, and was for a long time stationed at Calais as agent in the shifty negotiations carried on by Wolsey with the court of France. The spirit with which he pleaded before the Star Chamber in a case of *The Crown* v. *The Pope* marked him out for employment. More obtained in this case judgment against the Crown. Henry, who was present in person at the trial, had the good sense not to resent the defeat, but took the counsel to whose advocacy it was due into his service. In 1518 More was made master of requests, and sworn a member of the privy council. He was now compelled to resign his post of under-sheriff to the city and his private practice at the bar. In 1521 he was knighted and appointed sub-treasurer to the king, and was again sent on mission to Calais and the Low Countries. In the parliament of 1523 he was elected Speaker on Wolsey's nomination. The choice of this officer rested nominally with the house itself, but in practice was always dictated by the court. Many apocryphal stories have grown round More's speakership. In fact the records of the House do not justify Roper's account of his independent attitude.

In 1525 More was appointed chancellor of the duchy of Lancaster, and no pains were spared to attach him to the court. The king frequently sent for him into his closet, and discoursed with him on astronomy, geometry and points of divinity. This growing favour, by which many men would have been carried away, did not impose upon More, who understood the fickleness of royal favour. Then the king began to come himself to More's house at Chelsea (he had bought his house there in 1523) and would dine with him without previous notice. William Roper, husband of More's eldest daughter, mentions one of these visits, when the king after dinner walked in the garden by the space of an hour holding his arm round More's neck. Roper afterwards congratulated his father-in-law on the distinguished honour which had been shown him. "I thank our Lord," was the reply, "I find his grace my very good lord indeed; and I believe he doth as singularly favour me as any subject within this realm. Howbeit, son Roper, I may tell thee I have no cause to be proud thereof, for if my head would win him a castle in France it should not fail to go." As a last resource More tried the expedient of silence, dissembling his wit and affecting to be dull. This had the desired effect so far that he was less often sent for.

But it did not alter the royal policy, and in 1529, when a successor had to be found for Wolsey, More was raised to the chancellorship. He was the first layman to hold the office. The selection was justified by More's high reputation, but it was also significant of the modification which the policy of the court was then undergoing. It was a concession to the rising popular party, to which it was supposed that More's politics inclined him. The public favour with which his appointment had been received was justified by his conduct as judge in the court of chancery. Having heard causes in the forenoon between eight and eleven, after dinner he sat again to receive petitions. The meaner the suppliant was the more affably he would speak to him and the more speedily he would despatch his case. Business was despatched with unprecedented regularity. One morning being told by the officer that there was not another cause before the court, he ordered the fact to be entered on record, as it had never happened before. He usually, but not always, refused all the customary gifts, and did not permit his connections to interfere with the course of justice. One of his sons-in-law, Heron, having a suit in the chancellor's court, and refusing to agree to any reasonable accommodation, because the judge "was the most affectionate father to his children that ever was in the world," More thereupon made a decree against him. On the other hand he appears to have been merciless in his treatment of heretics. In the epitaph

which he wrote, he described himself as *hereticis molestus,* and, although the accusations of Protestants may be discounted, his own words and unimpeachable documents bespeak his severity.

But in raising More to the chancellorship, the king had counted upon his support in his desired divorce from Queen Catherine and in the church policy to which he was driven by that desire. More signed the articles of Wolsey's impeachment, but he had no share in the proclamation which ordered the clergy (Feb. 11, 1531) to acknowledge Henry as the supreme head of the church, "so far as the law of Christ will allow." As Henry's policy developed further, More found himself increasingly at variance with it. The divorce was a point upon which he would not yield. And, as he saw that the marriage with Anne Boleyn was determined upon, he petitioned the king to be allowed to resign the Great Seal, alleging failing health. The resignation was accepted, on May 10, 1532. More left office, as he had entered it, a poor man. His necessitous condition was so notorious that the clergy in convocation voted him a present of £5,000. This he peremptorily refused, either for himself or for his family, declaring that he "had rather see it all cast into the Thames." Yet the whole of his income after resigning office did not exceed £100 a year.

But although More strictly abstained from public activities Henry resented his absence from court and his silence. More refused to attend the coronation of Anne Boleyn, and from that moment was marked out for vengeance. A first attempt made to bring him within the meshes of the law failed. He was summoned before the privy council to answer to a charge of receiving bribes in the administration of justice. The charge was easily refuted. A bill was brought into parliament (Feb. 21, 1534) to attaint the friends of Elizabeth Barton (*q.v.*), the "Holy Maid of Kent." Barton turned out to have been an impostor, but she had duped More, and he had given his countenance to her supernatural pretensions. His name, with that of Fisher, was accordingly included in the bill as an accomplice. When he came before the council it was at once apparent that the charge of treason could not be sustained, but he was asked why he had not expressed his approval of the king's attitude towards the papal see. He replied by repeating the substance of conversations with the king on the subject. The revelation was disconcerting, and unlikely to help More's cause in the end. But the charge of treason being too ridiculous to be proceeded with, More's name was struck out of the bill. When his daughter brought him the news, More is reported to have said, "I' faith, Meg, quod differtur, non aufertur: that which is postponed is not dropt."

In March 1534 the bill vesting the crown in Anne Boleyn's issue, and imposing an oath abjuring any foreign potentate and, in the case of clergy, the authority of the pope, was passed and the oath ordered to be tendered. More was sent for to Lambeth, where he offered to swear to the succession, but steadily refused the oath of supremacy as against his conscience. Thereupon he was given in charge to the abbot of Westminster, and, persisting in his refusal, was four days (April 17) afterwards committed to the Tower. More was well treated by his gaolers, and, though he suffered in health from his confinement, he was witty and gay when his family were allowed to visit him, and he wrote cheerfully to his friends. In June 1535 he was found to be in communication with his fellow-prisoner, Fisher. He was then rigorously isolated, and was denied the use of pen and ink. He was brought to trial before a special commission and a picked jury at Westminster Hall on July 1. Rich, the solicitor-general, quitted the bar and presented himself as a witness for the Crown. Being sworn, he detailed a confidential conversation he had had with the prisoner in the Tower. He affirmed that, having himself admitted in the course of this conversation "that there were things which no parliament could do—*e.g.,* no parliament could make a law that God should not be God," More had replied, "No more could the parliament make the king supreme head of the Church." By this act of perjury a verdict of "guilty" was procured.

The execution of the sentence followed within the week, on July 7, 1535. The head was fixed upon London Bridge. Tradition says that it was eventually rescued by his daughter, and that it was buried with her at St. Dunstan's, Canterbury. The vengeance of Henry was not satisfied by this judicial murder of his friend and servant; he enforced the confiscation of what small property More had left, expelled Lady More from the house at Chelsea, and even set aside assignments which had been legally executed by More, who foresaw what would happen before the commission of the alleged treason. More's property was settled on Princess Elizabeth, later queen, who held it till her death.

Sir Thomas More was twice married, but had children only by his first wife, who died about 1511. His only son, John, married an heiress, Ann Cresacre, and was the grandfather of Cresacre More, Sir Thomas More's biographer. His eldest daughter, Margaret (1505–1544), married to William Roper (1496–1578), was a woman of high intelligence, whose devotion to her father has become a legend.

More was lawyer, wit, scholar and a great amateur of the arts. He was an intimate friend of Holbein, whose first introduction to England was as a visitor to More in his house at Chelsea, where the painter is said to have remained for three years and probably first met Henry VIII. Holbein painted portraits of Sir Thomas and his family. More was beatified by Leo XIII. in 1886.

The *Epistola ad Dorpium* exhibits More emphatically on the side of the new learning. It contains a vindication of the study of Greek, and of the desirability of printing the text of the Greek Testament—views which were condemned by the party to which More afterwards attached himself.

In the *Utopia,* published in Latin in 1516 (1st English translation, 1551), More wrote a delightful satire on government and society. In it he relates the conversation of himself and Peter Giles with a fictitious mariner Ralph Hythlodaye, who has sailed with Amerigo Vespucci. Hythlodaye had visited England, and has much to say of the evils of poverty and the luxury of the rich. This description is compared with that of the island of Utopia where community of goods, a national system of education, the rule of work for all, and a philosophy under which the good of the individual is sacrificed to the common good, makes an ideal state. Slavery and monarchy, however, have their place in Utopia. The book derives from Plato, and has had numerous successors, but none more witty and satirical.

For a bibliography of More's numerous works *see* the article in the *Dict. Nat. Biog.* and the Catalogue of the Alfred Cock collection of books and portraits of or relating to Sir Thomas More which is preserved in the Guildhall Library, London. The more important of his works and their editions are here given. *Luciani dialogi . . . complura opuscula ab Erasmo Roterodamo et Thoma Moro . . . traducta* (Paris, 1506 and 1514; Venice, Aldus, 1516, etc.) was accomplished by Erasmus and More in 1505. *The Lyfe of John Picus, earle of Mirandula . . .* printed by Wynkyn de Worde in 1510, translated by More from the Venice ed. of 1498, was edited by J. M. Rigg for the Tudor Library in 1890. *Historie of the pittiful Life and unfortunate Death of Edward the Fifth and the then Duke of York with . . . Richard the Third* was written, according to Rastell, in 1513, and first printed in a corrupt version in Grafton's continuation of Harding in 1543; it is included by Rastell in his 1557 edition of More's *Workes,* but it has been suggested that the Latin original was by Cardinal Morton; as the *History of King Richard III.* it was edited by J. R. Lumby for the Pitt Press in 1883. The *Libellus vere aureus . . .* better known as *Utopia,* was printed at Louvain in 1516, under the superintendence of Erasmus, and appeared in many subsequent editions, the finest being the Basel edition of 1518 produced by the Froben press under the eye of Erasmus and adorned with illustrations by Holbein. It was translated into the chief languages of Europe, and into English by Ralph Robinson as *A fruteful and Pleasaunt Worke of the best State of a Publyque Weale, and of the newe Yle called Utopia* (Abraham Nell, 1551); many modern editions of which the most famous is that produced by William Morris at the Kelmscott Press (1893). Other translations of *Utopia* are by Gilbert Burnet (1684) and by A. Cayley (*Memoirs of More,* 2 vols., 1808). Against Luther and Tyndale Sir T. More wrote *A Dyaloge of Syr Thomas More, Knt.,* written in 1528 and printed by John Rastell in 1529; *Sir Thomas More's Answere to the fyrste parte of the Poyson'd book . . . The Souper of the Lorde* (William Rastell, 1532) with a "Second Parte" in 1533. The *Apologye of Syr Thomas More,* written in 1533, is a defence of his own polemical style and of the treatment of heretics by the clergy. *A Dyaloge of Comfort against Tribulacion,* printed by Rastell in 1533, was destined primarily for More's family.

More's English works were collected by William Rastell and published as *The Worke of Sir Thomas More Knyght* by Cawood, Waly and Tottel in 1557; his Latin works *Thomae Mori . . . Lucubrationes* were partially collected at Basle 1563 and in 1566 (*omnia opera*) at

Louvain; a fuller edition drawn chiefly from these two appeared at Frankfort and Leipzig in 1689. His correspondence with Erasmus is partly included in the editions of the Letters of Erasmus, and much of his correspondence is calendared in Gairdner's *Letters and Papers of Henry VIII.*, the letters written to his family in his last days being found in vol. viii.

The Mirror of Vertue in Worldly Greatness; or, the Life of Syr Thomas More was written by his son-in-law William Roper about the end of Mary's reign. It was preserved in ms. during the reign of Elizabeth, and handed down in copies, many of which were carelessly made. It was not given to the press till 1626, with the date of Paris. Reprints were made by Hearne (Oxford, 1716), by Lewis (1729, 1731), who added an appendix of documents, and by Singer (1817, 1822) and for the King's Library (1902). Roper's *Life* is the source of all the many subsequent biographies. More's *Life* in ms. (Harleian 6253 and elsewhere), anonymous, but by Nicolas Harpsfield, was also written in Mary's reign. All that is material in this ms. is taken from Roper. The preface is signed Ro. Ba. (Robert Barnstaple?). William Rastell's *Life of More*, of which fragments are preserved in the Arundel Coll. (Brit. Mus.), is unhappily, lost. Thomas Stapleton *Tres Thomae, s. res gestae S. Thomae apostoli, S. Thomae archiepiscopi Cantuariensis, Thomae Mori* (Douay, 1588; Cologne, 1612) and the *Vita Thomae Mori* (separately) (Gratz, 1689) translates Roper, interweaving what material he could find scattered through More's works and letters and the notices of him in the writings of his contemporaries. Cresacre More, great-grandson of Sir Thomas, compiled a new life about the year 1627. It was printed at Paris without date, but, according to the editor, J. Hunter, in 1631. The title of this edition is: *The Life and Death of Sir Thos. More, Lord High Chancellour of England*, and with new title-page 1642, 1726, 1828. The later lives of Sir Thomas More have been numerous the best being those by G. T. Rudhart *Thomas Morus, aus den Quellen bearbeitet* (Nuremberg, 1829); by Father T. E. Bridgett, *Life and Writings of Sir Thomas More* (1891); and by W. H. Hutton, *Life and Writings of Sir Thomas More* (1891). Anne Manning's *The Household of Sir Thomas More* (1851, reprinted in King's Novels, 1905) is an attractive reconstruction. The tragedy of *Sir Thomas More*, edited by A. Dyce for the Shakespeare Society in 1844, and connected by some commentators with Shakespeare, was written about 1590, and therefore gives a nearly contemporary view of More. A later playwright, James Hurdis, made More's career the subject of a play in 1792.

MORÉAS, JEAN (1856–1910), French poet, born at Athens, was the grandson of Papadiomontopoulos, one of the heroes of Missolonghi. He was one of the leaders of the symbolist movement in French poetry, but his early volumes of poems, *Les Syrtes* (1884), *Les Cantilènes* (1886), and *Le Pèlerin passionné* (1891) won recognition beyond the limits of this school. In the *XIXe siècle* (Aug. 11, 1885) he formulated the principles of the symbolists, defending them from the appellation of "decadent," and in the literary supplement of the *Figaro* (Sept. 18, 1886) he published a manifesto justifying the innovations of the new school as the natural development of the prosody of Baudelaire, Mallarmé and Verlaine. As time went on he repudiated the licence claimed by the symbolists, and became the leader of an offshoot from the main body known as the *école romane*, the chief members of which were Raymond de la Tailhède, Maurice du Plessys, Ernest Raynaud, and Charles Maurras. Moréas and his new followers returned to the traditional severity of French versification, and to the classical and antique tradition. His later volumes are *Poésies, 1886–1896* (1898), *Stances* (6 vols., complete ed. 1905), indispensable for the student of his work, *Histoire de Jean de Paris, roi de France* (1902), *Voyage en Grèce en 1897* (1902), *Contes de la vieille France* (1903), and a classic drama in verse, *Iphigénie à Aulis* (1904), in close imitation of Euripides, which was presented, Aug. 24, 1903, in the ancient theatre of Orange, and subsequently at the Odéon in Paris. He died March 31, 1910.

See Anatole France, *La Vie littéraire* (4th ser., 1892); A. van Bever and P. Léautaud, *Poètes d'aujourd'hui, 1880–1900* (11th ed., 1905); P. Berthelot, art. "Symbolisme" in *La Grande encyclopédie;* and J. de Gourmont, *Jean Moréas, biographie critique* (1905).

MOREAU, GUSTAVE (1826–1898), French painter, was born in Paris on April 6, 1826. His father was an architect. The only influence which really affected Moreau's development was that of the painter Chassériau (1819–1857). Moreau's first picture was a "Pietà" (1852), now in the cathedral at Angoulême. In the Salon of 1853 he exhibited a "Scene from the Song of Songs" (now in the Dijon Museum) and the "Death of Darius" (in the Moreau Gallery, Paris), both conspicuously under the influence of Chassériau. From that time he exhibited regularly, with an interval in 1869 to 1876. His colour is luminous, like enamel; and his subjects strange and mysterious. Moreau exhibited for the last time at the Salon of 1880, when he contributed "Helen" and "Galatea"; to the Great Exhibition of 1889 he again sent the "Galatea" and "The Young Man and Death." Moreau received many honours and prizes. He succeeded Delaunay as professor at the École des Beaux Arts, and his teaching was highly popular. He died on April 18, 1898, leaving to the state his house, containing about 8,000 pictures, water-colours, cartoons and drawings, which form the Moreau Gallery.

See Ary Renan, *Moreau* (Paris, 1900); Paul Flat, *Le Musée Gustav Moreau* (Paris, 1900); for an appreciation of his art *see* J. K. Huysman's *Certains* (1908).

MOREAU, HEGESIPPE (1810–1838), French lyric poet, was born in Paris. He was habitually homeless, and exposed himself to the dangers of a cholera hospital in the great epidemic of 1832 simply to obtain shelter and food. It was only just before his death that he succeeded in getting his collected poems published, selling the copyright for £4 sterling and 80 copies of the book. This volume, *Myosotis*, was received not unfavourably, but the author's death on Dec. 20, 1838, in a refuge of the destitute, created an excessive interest in it. Moreau's work has a strong note of imitation, especially in his earlier songs, distinguished from those of his model, Béranger, chiefly by their elegiac note.

MOREAU, JEAN VICTOR MARIE (1763–1813), French general, was born at Morlaix in Brittany on Feb. 14, 1763. As a law student at Rennes he formed his fellow-students into an armed band, which took part in daily affrays between the young *noblesse* and populace of the town. He served under Dumouriez with the volunteers of Ille-et-Vilaine, and in 1793 his merits secured his promotion as general of brigade. Carnot promoted him to be general of division early in 1794, and gave him command of the right wing of the army under Pichegru, in Flanders. The battle of Tourcoing established his military fame, and in 1795 he was given the command of the Army of the Rhine-and-Moselle, with which he advanced into Germany. He won several victories and penetrated to the Isar (*see* French Revolutionary Wars), but at last had to retreat before the archduke Charles. The skill he displayed in conducting the retreat greatly enhanced his own reputation; he brought back with him more than 5,000 prisoners. In 1797 after difficulties caused by want of funds and material he again crossed the Rhine, but was checked by the conclusion of the preliminaries of Leoben between Bonaparte and the Austrians. At this time he discovered the correspondence between his old comrade and commander Pichegru and the émigré prince de Condé. Too late to clear himself, he sent the correspondence to Paris and issued a proclamation to the army denouncing Pichegru as a traitor. He was dismissed, and was only re-employed in 1799 when the advance of Suvárov made it necessary. He commanded the Army of Italy for a short time before being appointed to the Army of the Rhine, and remained with Joubert, his successor till the defeat of Novi. Joubert fell in the battle, and Moreau then conducted the retreat of the army to Genoa, where he handed over the command to Championnet. When Bonaparte returned from Egypt he found Moreau at Paris, greatly dissatisfied with the Directory, and obtained his assistance in the *coup d'état* of 18 Brumaire. The First Consul again gave him command of the Army of the Rhine, with which he forced back the Austrians from the Rhine to the Isar. On his return to Paris he married Mlle. Hullot, a creole of Josephine's circle, an ambitious woman who gained a complete ascendancy over him, and after winning the victory of Hohenlinden (Dec. 3, 1800) he settled down to enjoy the fortune he had acquired during his campaigns. His wife collected around her all who were discontented with the aggrandisement of Napoleon. This "club Moreau" annoyed Napoleon, and encouraged the Royalists, but Moreau, though not unwilling to become a military dictator to restore the republic, would be no party to an intrigue for the restoration of Louis XVIII. This was well known to Napoleon, who seized the conspirators. Bonaparte procured Moreau's condemnation with great difficulty, and then treated him with a pretence of leniency, commuting a sentence of

imprisonment to one of banishment. Moreau lived in obscurity for some years at Morrisville, New Jersey, until the destruction of the *grande armée* in Russia. Then, probably at the instigation of his wife, he committed the last and least excusable of his political errors. Negotiations were set on foot with Bernadotte, who, being now crown prince of Sweden and at the head of an army opposing Napoleon, introduced Moreau to the tsar Alexander. In the hope of re-establishing popular government in France, Moreau advised the allied sovereigns on the conduct of the war. He was mortally wounded while talking to the tsar at the battle of Dresden on Aug. 27, 1813, and died on Sept. 2. He was buried at St. Petersburg.

Moreau's fame as a general stands very high; his combinations were skilful and elaborate, his temper always unruffled. He was a sincere republican, though his father was guillotined in the Terror.

See C. Jochmus, *General Moreau—Abriss einer Geschichte seines Lebens und seiner Feldzüge* (1814), a standard work; A. de Beauchamp, *Vie politique, militaire, et privée du Général Moreau* (tr. by Philippart, 1814); Picard, *Bonaparte et Moreau* (1905); and Daudet, *L'exil et la mort du général Moreau* (1909).

MOREAU DE SAINT MÉRY, MEDÉRIC LOUIS ÉLIE (1750–1819), French politician, was born at Fort de France, in the island of Martinique, on Jan. 28, 1750. He came to Paris at the age of 19, and became an *avocat* at the parlement of Paris. He returned to Martinique to practise law, and in 1780 was appointed member of the colonial council of San Domingo. Returning to Paris in 1784, he was commissioned to study the legislation of the French colonies. In 1789 he was president of the assembly of the electors of Paris and represented Martinique in the Constituent Assembly. His moderate ideas caused his arrest after Aug. 10, 1792, but he escaped to the United States, and opened a bookseller's shop at Philadelphia. Returning to France in 1799, he became historiographer to the navy and councillor of state, and drafted in part the colonial and maritime code. In 1802 he was appointed by the first council administrator of the duchies of Parma, Piacenza, and Guastalla, but was dismissed in 1806 and lived until his death on a pension paid him by the Empress Josephine, a kinswoman of his.

He published *Lois et constitutions des colonies françaises de l'Amerique sous le Vent de 1550 à 1785* and *Déscription topographique et politique de la partie espagnole et de la partie française de l'Ile de Saint-Domingue* (1796–98).

See Fournier-Tescay, *Discours prononcé aux obsèques de Moreau le 30 Janvier 1819;* Silvestre, *Notice sur Moreau* (1819).

MORECAMBE, municipal borough, watering place and minor seaport, Lancaster parliamentary division, England, on Morecambe bay, 236 m. N.W. from London by the L.M.S. railway. Pop. (1931) 24,586. A promenade extends along the shore; there are a quay, a pier, and a winter garden. The L.M.S. railway is the harbour authority. The town was incorporated in 1902. The former alternative name was Poulton-le-Sands.

MOREL, the surname of several French classical scholars and printers in the 16th and 17th centuries, known for their editions of classical authors and the Fathers. (1) GUILLAUME MOREL (1505–1564) was born at Tilleul in Normandy. He became king's printer in 1555. His most important work was *Thesaurus vocum omnium latinarum,* containing quotations from Greek authors, taken from hitherto unpublished mss. in the Paris library. (2) FÉDÉRIC MOREL, surnamed the Elder (1523–1583), was born in Champagne. About 1550 he married the daughter of the famous printer, Michel de Vascosan, in 1557 set up in business in the rue Saint Jean de Beauvais, and in 1571 was appointed printer to the king. His chief publications were the *Declamationes* of Quintilian and *L'Architecture de Philibert Delorme.* (3) FÉDÉRIC MOREL, son of the preceding, surnamed the Younger (1558–1630), was one of the greatest Greek scholars of his time. He succeeded to his father's business, and was also professor of eloquence at the Collège de France. Special mention may be made of his revised edition of Amyot's translation of *Plutarch* and his Latin translations of some of the dissertations of Maximus of Tyre, of Libanius, Hierocles and Theodoret. (4) CLAUDE MOREL (1574–1626), brother of the preceding, also published editions of many of the Fathers and other authors. (5) CHARLES MOREL (1602–40) was printer and secretary to the king. He issued the works of Clement of Alexandria, Gregory of Nazianzus, Cyril, Synesius and Chrysostom, and the *Concilia generalia et provincialia* of Severin Bini. (6) GILLES MOREL, brother of the preceding (dates unknown). His chief publication is the *Grande bibliothèque des pères* (17 vols., 1643).

See M. Maittaire, *Historia typographorum aliquot parisiensium* (1717), for all the above; Fédéric Morel the elder is the subject of a monograph by J. Dumoulin (1901).

MOREL (*Morchella esculenta*), an edible fungus of North America and central and southern Europe. The wrinkled pileus (cap), the edible portion, is yellowish-brown and about an inch long. It is chiefly used in gravies and sauces. By many the flavour is considered superior to that of most mushrooms. The morel is an Ascomycete. (*See* FUNGI.)

MORELIA (formerly Valladolid), a city of Mexico and capital of the State of Michoacán, 125 m. direct and 234 m. by rail W. by N. of the city of Mexico, near the southern margin of the great Mexican plateau, 6,398 ft. above sea-level, in lat. 19° 42′ N., long. 100° 54′ W. Pop. (1924) 40,000, partly Indians and mestizos. Morelia is served by a branch of the Mexican National railway; its station is outside the city, with which it is connected by a small tramway line. The city is built on a rocky hill rising from the Guayángareo valley, which gives to it a strikingly picturesque appearance. It has the usual rectangular plan, with several pretty squares and straight, clean, well-paved streets. Facing the *plaza mayor,* now called the Plaza de los Mártires because of the execution there of the patriot Matamoros in 1814, is the cathedral, one of the finest specimens of the old Spanish Renaissance church architecture in Mexico.

Opposite the cathedral is the Government palace, which also contains the public library. The municipal government is housed in an ancient tobacco factory converted to public uses, and a fine old Capuchin convent now serves as a public hospital. The Paseo, or public park, is distinguished for its fine trees and flowers. The Morelianos are noted for their love of music, and musical competitions are held each year, the best band being sent to the city of Mexico to compete with similar organizations from other States. The public water-supply is brought into the city over a fine old aqueduct (3 m. in length, carried on arches), which was built in 1785 by the bishop of the diocese as a famine relief work. Like the rest of Michoacán, Morelia is a stronghold of clericalism and conservatism. Its manufactures include cotton, woollen and silk textiles, cigars and cigarettes, and *dulces,* or sweetmeats, notably a variety called *Guayabate.*

Morelia, first known as Valladolid, was founded in 1541 by Viceroy Mendoza. In 1582 Valladolid replaced Patzcuaro as the capital of Michoacán. It was the birthplace of both Morelos and Itúrbide, and was captured by Hidalgo at the beginning of the revolutionary outbreak of 1810–11, and by Itúrbide in 1821 when on his march to Mexico City. Its name was changed in 1828, in honour of the revolutionary leader José Maria Morelos y Pavón, and in 1863 it was made the see of an archbishop.

MOREL-LADEUIL, LÉONARD (1820–1888), French goldsmith and sculptor, was born at Clermont-Ferrand in 1820, and died at Boulogne on March 15, 1888. He was apprenticed first to Morel, a manufacturer of bronzes, under whom he became one of the most expert chasers, or *ciseleurs,* in France, and then to Antoine Vechte, to acquire the art of *repoussé* (*q.v.*)—the art in which he was to excel. He studied further under J. J. Feuchère and was commissioned by the French Government to produce the "Empire Shield." The trade, annoyed that a craftsman should obtain commissions direct, thenceforward boycotted the young artist. He was encouraged nevertheless by a foreign dealer in Paris, Marchi, who employed him on statuettes, until 1859, when Messrs. Elkington engaged him to work in Birmingham in *repoussé,* assuring him a free hand. His beautiful plateau called "Dreams," was subscribed for by Birmingham as the town wedding-gift to the prince and princess of Wales. Morel-Ladeuil remained with the firm for twenty-three years, the first result being his masterpiece the "Milton Shield: Paradise Lost" (in *repoussé* steel and silver), which was bought by the English Government

for £3,000. His "Helicon Vase," in steel, silver and gold, priced at £6,000, was presented by the ladies and gentlemen of the royal house to Queen Victoria on her first jubilee. His total work, apart from the productions of his youth, numbers 35 pieces.

See *L'Oeuvre de Morel-Ladeuil, sculpteur-ciseleur,* by L. Morel (Paris, 1904).

MORELLET, ANDRE (1727–1819), French economist, miscellaneous writer and academician (1785), was born at Lyons. He was educated by the Jesuits in his native town, and at the Sorbonne; he then took holy orders, but his designation of abbé was the chief thing clerical about him. He had a ready and biting wit, and Voltaire called him "L'Abbé Mord-les." A year before his death in Paris (Jan. 12, 1819) he brought out four volumes of *Mélanges de littérature et de philosophie du XVIIIe siècle,* composed chiefly of selections from his former publications. His valuable *Mémoires sur le XVIIIe siècle et la Révolution* (2 vols., 1821), appeared posthumously.

A bibliography of his numerous works is given in Quérard's *La France littéraire,* vol. vi.; *see* also Sainte-Beuve, *Causeries du lundi,* vol. i.

MORELLI, GIOVANNI (1816–1891), Italian patriot and art critic, born at Verona on Feb. 16, 1816, was educated first at Bergamo and then at Aarau in Switzerland. At 18 he commenced his university career at Munich, being debarred as a Protestant from entering any Italian college, and became the pupil of Ignatius Döllinger, the celebrated professor of anatomy and physiology. He specially devoted himself to natural philosophy and medicine but was also keenly interested in all scientific and literary pursuits. His brilliant gifts and independence of thought and judgment attracted the attention of the most distinguished men of the day. In Paris his intimacy with Otto Mündler was not without its effect in determining the direction of his future studies; and while in Switzerland, he formed a friendship with Louis Agassiz, whose teaching made a lasting impression upon him. On his return to Italy in 1840 he became associated in Florence with the patriots who were working for the deliverance of their country from Austrian rule. He took part in the war of 1848, and was chosen by the provisional Lombard government to plead the cause of Italian unity before the German parliament.

In 1860 Victor Emmanuel named Morelli a citizen of the Sardinian kingdom, and in the next year he was elected deputy for Bergamo to the first free Italian parliament. He was a staunch supporter of Cavour, and exercised a considerable influence over the most prominent statesmen of the Right, who valued his sound judgment, integrity, moderation and foresight. After his election he drew the attention of parliament to the urgent need of reform in the administration of matters relating to the fine arts and a commission was appointed to bring under government control all works of art which could be considered public property. The commission, of which Morelli was president, began its work in Umbria and the Marches, and he appointed as his secretary G. B. Cavalcaselle, who was then engaged in collecting materials for a work on Italian art. Much that Cavalcaselle then learned from his chief was embodied in the well-known *History of Painting,* published in 1864 in conjunction with Sir Joseph Crowe.

The immediate result of Morelli's first labours in the Marches was an enactment, which bears his name, prohibiting the sale of works of art from public and religious institutions. In 1873 he became a senator of the kingdom of Italy, having voluntarily resigned his seat in the Lower House owing to the increasingly democratic tendencies of the Chamber. In Milan, his home, he published some of his researches into the history of Italian art. In order to be free to speak his mind unreservedly, he adopted a pseudonym and wrote in German. His first contributions, a series of articles on the Borghese gallery, were published in Lützow's *Zeitschrift für bildende Kunst* (1874–76). Posing as an art-loving Russian, he adopted the pseudonym of Ivan Lermolieff—an anagram of his own name with a Russian termination—and described his essays as *Ein kritischer Versuch,* translated from the Russian by Johannes Schwarze—a Germanized form of Morelli.

In 1880 Morelli published under the same pseudonym, *Die Werke italienischer Meister in den Galerien von München, Dresden und Berlin,* which inaugurated a new and more scientific method of criticism, and marks an epoch in the art studies of the 19th century. The book was translated into English in 1883, with Morelli's own name upon the title-page, a few years later into Italian. A volume of *Critical Studies,* first of a series of three which, under the title of *Kunstkritische Studien,* was to contain all Morelli's contributions to art literature, was published in 1890. The first part, cast in dialogue form, contains a detailed exposition of his method. Then follow *The Borghese Gallery,* a reissue of his former articles with many important additions, and *The Doria Gallery,* an entirely new contribution. The second volume deals with the galleries of Munich and Dresden, and is a revised edition of the first two parts of the original book of 1880; but here again copious additions rendered it practically a new book. The third volume was to treat of the Berlin gallery, and was also to contain an exhaustive account of the drawings of Italian masters, but it was not carried out. Morelli was taken seriously ill in Feb. 1891 and died at Milan on Feb. 28.

MORELLI'S METHODS

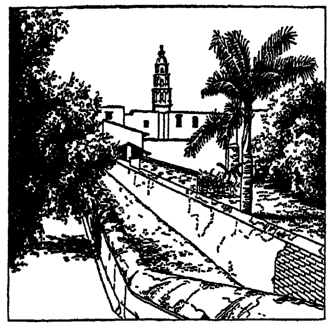
Morelli found art criticism uninspired, unscientific and practically worthless. To be of any real value he held that historical, documentary and traditional knowledge respecting works of art was only of secondary importance as compared with the evidence to be derived from the study of the pictures themselves. He contended that art criticism must be conducted on scientific principles and follow a strict course of inductive reasoning. A painting should be subjected to a searching analysis, and each of its component parts and minutest details to methodical investigation.

Studying one day in the Uffizi, it suddenly struck him that in a picture by Botticelli containing several figures the drawing of the hands was remarkably similar in all; that the same characteristic but plebeian type, with bony fingers, broad square nails, and dark outlines, was repeated in every figure. Turning to the ears, he observed that they also were drawn in an individual manner. Then he examined other works by this painter, and found that the same forms were exactly repeated, together with other individual traits which seemed distinctive of the master: the characteristic type of head and expression, the drawing of the nostrils, the vitality of movement, the disposition of drapery, harmony of colour (where it had not been tampered with by the restorer), and quality of landscape.

In all Botticelli's true works the presence of these and other characteristics proclaimed their genuineness. In paintings where the forms and types were those of the painter, but where vitality, movement, and all deeper qualities were absent, Morelli recognized works executed from the master's cartoons; while in pictures where neither types nor forms responded to the test, and where only a general family likeness connected them with Botticelli, he discerned the productions of pupils and imitators. After applying his method to the works of Botticelli, he examined those of other Florentine masters, and afterwards of painters of other Italian schools, everywhere meeting with results to him not less convincing. If the drawing of the hand and ear were not always conspicuous, there were other peculiarities of this language of form to aid in the identification of a master: the treatment of the hair, as in Piero dei Franceschi; the indication of the sinews, as in Foppa; the drawing of the eye, as in Liberale da Verona; the modelling of the eyelid and upper lip, as in Ambrogio de Predis; the form of the feet, as in Luini. In short, all apparently insignificant details were of importance in his plan of study, for to him they were like the signature of the master. (C. J. Ff.; X.)

MORELOS, an inland State of Mexico on the southern slope of the great Mexican plateau, lying south of the Federal District, with the States of Puebla on the east and south-east, Guerrero on the south, and Mexico on the west, north and north-east. Pop. (1921) 103,440, including a large percentage of Indians and mixed bloods. Area 2,773 sq. miles. Its surface is roughly broken by mountain ranges extending southward from the Sierra de Ajusco, forming many valleys opening southward. It is drained by the Amacusac river, a northern tributary of the Mescala, or Balsas. There is a wide variation of climate for so small a territory, the

higher elevations of the Sierra de Ajusco being cold and humid (the Mexican Central crosses the range at an elevation of 9,974 ft.); the lower spurs mild, temperate and healthy, the lower valleys sub-tropical, hot and unhealthy. The rainfall is light in the lower regions and irrigation is generally employed. Morelos is one of the most flourishing agricultural States of Mexico, producing sugar, rice, Indian corn, coffee, wheat, fruit and vegetables. Although the State is supposed to have several of the minerals found in this part of Mexico (silver, cinnabar, iron, lead, gold, petroleum and coal), its mining industries continue undeveloped and neglected.



BY COURTESY OF THOMAS F. LEE

A WHITE-WALLED STREET IN THE CITY OF CUERNAVACA, CAPITAL OF MORELOS

After the capital, Cuernavaca, the largest city in the State is Cuautla Morelos, or Ciudad Morelos (pop. 4,462 in 1921), 27 m. east by south of Cuernavaca, on the Interoceanic railway, and in a rich sugar-producing district; it has large, modern sugar mills. There are hot sulphur springs here. The town is celebrated in Mexican history for the intrepid defence of the place by José Maria Morelos (1765–1815), the patriot leader, against a greatly superior royalist force, from Feb. 19, to May 2, 1812, when he cut his way through the attacking army and escaped. Other important towns are Yautepec (2,537 in 1921), 16 m. east of Cuernavaca, on the Interoceanic line; Tetecala, 13 m. south-west of the capital, a characteristic Indian town near the pyramid of Xochicalco, and Jojutla, 21 m. south of the capital, on the Interoceanic railway near the southern boundary of the State. Lake Tequesquiten was formed by the subsidence of a large area about the middle of the 19th century, carrying with it an old town. The spire of the old church is still seen in the middle of the lake.

MOREPORK, the name given to two birds, from a fancied resemblance of their calls to these words. One is the Australian species of frogmouth (*q.v.*), related to the goatsuckers and nighthawks. The other is a small brown owl of New Zealand (*Spiloglaux novae-zealandiae*), still fairly common, which haunts the clumps of Maori bush and calls in the twilight. Maori names for this owl are *ruru* and *koukou,* both being attempts to turn his cry into words; he plays a lively part in Maori bird lore.

MORESNET, a small area of Belgium on the German border, 4 m. S.W. of Aix-la-Chapelle. *See* EUPEN and MALMÉDY.

MORETON BAY CHESTNUT or **AUSTRALIAN CHESTNUT,** a tall tree known botanically as *Castanospermum australe* (family Leguminosae), native of Queensland and New South Wales. The pods are almost cylindrical, about 9 in. long and 2 in. broad, and are divided interiorly by a spongy substance into three to five cells, each of which contains a large chestnut-like seed. The seeds are roasted and eaten by the natives; the timber, which somewhat resembles walnut, is soft, fine-grained, and takes a good polish, but is not durable.

MORETO Y CAVAÑA, AGUSTIN (1618–1669), Spanish dramatist and brilliant plagiarist. His adaptations are remarkable for their charm and skill; the most celebrated is *El Desdén con el Desdén,* whose episodes are taken from four separate plays of Lope de Vega.

MORETTO, IL (1494–1554), Italian painter of the Brescian school. His real name was Alessandro Bonvicino. He was probably born at Brescia, and was a pupil of Fiorante Ferramola, a Brescian follower of Foppa. It has been said that Moretto's works display the influence of Titian, of Raphael, and of other contemporary masters. He was, however, a strong individuality with a distinctive style of his own. His conception of form was strong and elegant; his sense for colour harmonious and decorative. His compositions are bathed in a cool, silvery tone, his figures are modelled by a fine play of light and shade. As a portraitist he went beyond the rendering of external form, penetrating into the character and disposition of his sitters. He worked chiefly in Brescia, where his paintings can best be studied. In 1529 he was in Bergamo; in 1540–41 in Milan and Verona. He died at Brescia on Dec. 29, 1554.

His earliest picture, dated 1518, is the "Christ bearing the Cross," at the Town gallery of Bergamo; the frescoes in the Corpus Domini chapel of San Giovanni Evangelista at Brescia are dated 1521. In the decoration of this chapel he collaborated with Romanino, another leading painter of Brescia. Among his first paintings are the ceiling fresco representing the "Vision of Moses," and other paintings in the Galleria Martenengo at Brescia. The churches of Brescia possess many altar pieces by him, among which the "Coronation of the Virgin," in San Nazzaro e Celso, is perhaps the most notable. In the church of Paitone, near Brescia, is "The Virgin appearing to a Shepherd Boy." There is a large, well-composed picture representing "Christ in the house of Levi" in the nuns' gallery of Santa Maria della Pieta in Venice, dated 1544. The Vienna gallery has a "St. Justina," perhaps his finest work. The National Gallery, London, has three fine portraits and several other works, the Johnson collection in Philadelphia a "Madonna and Donors"; the Metropolitan Museum of Art at New York a "Christ in the Desert," a charming early work, and an "Entombment," dated 1554, which is his latest known work. His foremost pupil was the famous portrait painter Giambattista Moroni.

See Crowe and Cavalcaselle, *History of Painting in North Italy* (2nd ed. 1912); G. Morelli, *Italian Masters in German Galleries* (1883); S. Fenaroli, *Alessandro Bonvicino* (1875). (I. A. R.)

MORET Y PRENDERGAST, SEGISMUNDO (1838–1913), Spanish politician, was born at Cadiz on June 2, 1838. He was educated at the Central University, Madrid, and became professor of political economy there. In 1863 he entered the Cortes as a Liberal, took part in the revolution of 1868 and in the constituent assembly of 1869. Colonial secretary in 1870 under General Prim, and later finance minister, he was for a few months in 1872 Spanish ambassador to Great Britain, and after resigning this post accepted the directorship of a large London bank. A year later he returned to Spain. He re-entered Parliament in 1879, and helped to found the Democratic dynastic party. He was minister for foreign affairs under Sagasta in 1885 and again in 1893–4, minister of the interior 1885–8, and minister of colonies 1897. In this capacity he advocated the grant of autonomy to Cuba and Porto Rico, and was opposed to the war with America of 1898. He was Prime Minister in 1905–6 and again in 1909, and at the time of his death in Madrid on Jan. 28, 1913, was president of the Chamber.

MORGAGNI, GIOVANNI BATTISTA (1682–1771), Italian anatomist, was born on Feb. 25, 1682 at Forlì. After graduating in 1701 at Bologna in philosophy and medicine, he acted as prosector to A. M. Valsalva (one of the distinguished pupils of Malpighi), whom he assisted in preparing his celebrated *Anatomy and Diseases of the Ear* (1704). When Valsalva was transferred to Parma, Morgagni succeeded to his anatomical demonstratorship, but after a time gave up his post and spent two or three years at Padua, where in 1710 he succeeded his friend, Domenico Guglielmini, as professor of medicine. In 1715 he was promoted to the chair of anatomy in which he enjoyed a stipend that was increased from time to time by vote of the senate until it reached 1,200 gold ducats. He was honoured by various academies, by cardinals and popes, and was elected patron of the German students of the university. Morgagni died at Padua on Dec. 6, 1771.

Although his *Adversaria anatomica* (1706–19) had established his reputation as an accurate anatomist, it was not until 1761, when he was in his eightieth year, that he brought out the great work which made pathological anatomy a science, and diverted the course of medicine into new channels of exactness—the *De Sedibus et causis morborum per anatomem indagatis* (often reprinted, Eng. trs. 1769). It treats of the morbid conditions of the body *a capite ad calcem,* and contains records of some 640 dissections, the symptoms during the course of the malady and other antecedent circumstances being always prefixed with more or less fullness. Although he was the first to demonstrate the absolute necessity of basing diagnosis, prognosis and treatment on a

comprehensive knowledge of anatomical conditions, he made no attempt to exalt pathological anatomy into a science disconnected from clinical medicine and remote from practical needs.

BIBLIOGRAPHY.—Morgagni's collected works were published at Venice in 5 vols. in 1765. His biography was published by Mosca at Naples in 1768. *See* also prefix to Tissot's 1779 edition of the *De Sensibus.*

MORGAN, ARTHUR ERNEST (1878–), American engineer and college president, was born at Cincinnati (O.), on June 20, 1878. He received his early education in the high school at St. Cloud (Minn.), and then spent three years in Colorado in various occupations, including a short term at the University of Colorado. Returning to Minnesota, he worked for his father, a land surveyor, and studied engineering at night. In 1902 he commenced to practise for himself at St. Cloud, making a special study of floods and flood control. In 1907 he became supervising engineer of U. S. Government drainage investigations, but in 1909 founded the Morgan Engineering Company, of which he became president. His firm undertook many reclamation projects in the southern States. In 1921 he was appointed president of Antioch college, Yellow Springs (O.), which was reorganized under his inspiration. (*See* ANTIOCH COLLEGE.) He was the author, among other works, chiefly technical, of *The Miami Valley and the 1913 Flood* (1917) and of *My World* (1927), an expansion of a syllabus used for some years in classes at Antioch college.

MORGAN, DANIEL (1736–1802), American soldier, was born in Hunterdon county, N.J., in 1736, of Welsh ancestry. In 1753 he removed to Virginia. In June, 1775, soon after the outbreak of the War of Independence, he was commissioned a captain of Virginia riflemen. In the winter of 1775 he accompanied Gen. Benedict Arnold to Canada, and in the assault on Quebec (Dec. 31) he and his riflemen penetrated well into the city, where he was hemmed in and was forced to surrender. Late in 1776 he was released, and soon after commissioned colonel. In Sept. 1777 he joined Gen. Horatio Gates, then engaged in the campaign against Gen. Burgoyne, and took part in both battles of Saratoga. In July, 1779, he resigned from the army and retired to Virginia. After the battle of Camden, however, he joined Gates at Hillsborough, N.C., took command of a corps, and was made brigadier general. In Jan., 1781 Cornwallis and Tarleton attempted to entrap him, but at Cowpens (Jan. 17) he defeated Tarleton and then escaped from Cornwallis into North Carolina. In Nov. 1794 he commanded troops sent to suppress the Whisky Insurrection in western Pennsylvania. He was a Federalist representative in Congress in 1797–99, and died in Winchester, Va., July 6, 1802.

See James Graham, *The Life of General Daniel Morgan of the Virginia Line* (1856); and Rebecca McConkey, *The Hero of Cowpens* (New York, 1885).

MORGAN, SIR HENRY (*c.* 1635–1688), Welsh buccaneer, and lieutenant-governor of Jamaica, is said to have been kidnapped as a boy at Bristol and sold as a slave at Barbadoes, thence making his way to Jamaica, and is possibly to be identified with the Captain Morgan who accompanied the expedition of John Morris and Jackman when Vildemos, Trujillo and Granada were taken. In 1666 he commanded a ship in Edward Mansfield's expedition which seized the island of Providence or Santa Catalina, and shortly afterwards was chosen by the buccaneers as their "admiral." In 1668 he was commissioned by Sir Thomas Modyford, the governor of Jamaica, to capture some Spanish prisoners, in order to discover details of the threatened attack on Jamaica. He took Puerto Principe, Porto Bello on the mainland, and collected a large sum from the governor of Panama. Entrusted with another expedition by Modyford against the Spaniards, he ravaged the coast of Cuba, and in 1669 sacked Maracaibo, and afterwards Gibraltar. Returning to Maracaibo, he found three Spanish ships waiting to intercept him; but these he destroyed or captured, recovered a considerable amount of treasure from one which had sunk, and exacted a heavy ransom for evacuating the place.

On his return to Jamaica a new commission was given to Morgan, as commander-in-chief of all the ships of war in Jamaica, to levy war on the Spaniards. He recaptured the island of Santa Catalina in Dec. 1670, and in 1671 took Panama. Meanwhile on July 8, 1670, a treaty had been signed between Spain and England, and both Modyford and Morgan were ordered home under arrest to answer for their conduct. Morgan, however, soon gained the king's favour, and in 1674 was appointed lieutenant-governor of Jamaica and was knighted, leaving England in December. He was charged by Lord Vaughan, afterwards earl of Carbery, the governor, soon after his appointment, of encouraging privateering; he intrigued against his colleagues and successive governors of Jamaica, and participated in various drunken orgies. Finally, on Oct. 12, 1683, he was suspended in Jamaica from all his employments. He died in Aug. 1688.

See A. O. Exquemelin (one of Morgan's buccaneers), *Buccaneers of America* (1684, reprinted 1891); A. Morgan, *History of the Family of Morgan* (1901); J. L. Phillips, *Sir Henry Morgan* (1912).

MORGAN, JOHN HUNT (1825–1864), American Confederate soldier, was born in Huntsville, Ala., on June 1, 1825, and was brought up near Lexington, Ky. In the Mexican War he was a first lieutenant of a cavalry regiment. On the outbreak of the Civil War he joined the Confederate army and, being an able scout, was made commander of a cavalry squadron. He was commissioned a colonel after the battle of Shiloh, and in July 1862 made the first of his famous raids, threatening Louisville and Cincinnati. In August and September he took part in General Braxton Bragg's invasion of Kentucky, and again threatened Ohio. In December he defeated the Union garrison at Hartsville, Tenn., was commissioned brig.-general for this success, and soon afterward again raided Kentucky. To cover Bragg's movement from Tullahoma to Chattanooga Morgan made, in July 1863, his raid into Indiana and through Ohio, though Bragg had instructed him to confine himself to Kentucky. With 2,460 men he crossed the Cumberland, near Burkesville, Ky., on July 2; on the 5th he captured a garrison at Lebanon, and on the 13th entered Ohio near Harrison. The regular cavalry was now close behind him. He marched through the suburbs of Cincinnati on the night of the 13th and on the 18th reached Portland, near Buffington island, where in a sharp battle he lost 600 or more men, and as many more surrendered. On the 26th he surrendered to General Shackelford at New Lisbon. He was imprisoned in the penitentiary at Columbus, from which on the night of Nov. 27 he escaped. In the spring of 1864 he was put in virtual command of the department of south-western Virginia, and late in August he took command at Jonesboro, Ga. On Sept. 4 he was shot in a garden in Greenville, Tenn., having been betrayed, it appears, to the Federals.

See Basil W. Duke, *History of Morgan's Cavalry* (1867).

MORGAN, JOHN PIERPONT (1837–1913), American financier and banker, was born in Hartford, Conn., on April 17, 1837, a son of Junius Spencer Morgan (1813–90), who was a partner of George Peabody and the founder of the house of J. S. Morgan and Co. in London. He was educated at the English High school in Boston and at the University of Göttingen. In 1857–60 he worked in the New York banking house of Duncan, Sherman and Co.; from 1860 to 1864 was agent and attorney in New York for George Peabody and Co. of London, and afterwards for its successor, J. S. Morgan and Co., of which he became head; in 1864–71 was a member of the firm of Dabney, Morgan and Co., and in 1871 he entered the firm of Drexel, Morgan and Co., which, in 1895, became the firm of J. P. Morgan and Company.

This firm, which was closely associated with Drexel and Co. of Philadelphia, Morgan, Harjes and Co. (successors to Drexel, Harjes and Co.) of Paris, and Morgan, Grenfell and Co. (before 1910 J. S. Morgan and Co.) of London, became, largely through Morgan's ability, one of the most powerful banking houses in the world. It carried through the formation of the United States Steel Corporation, harmonized the coal and railway interests of Pennsylvania, and purchased the Leyland line of Atlantic steamships and other British lines in 1902, thus effecting an Atlantic shipping "combine" (*see* STEAMSHIP LINES); and it, or the banking houses which it succeeded, reorganized numerous railways including the Chesapeake and Ohio; the Erie and the Reading; the Northern Pacific; and the Baltimore and Ohio. In 1895 the banking house of J. P. Morgan and Company supplied

the United States Government with $62,000,000 in gold to restore the Treasury gold reserve to $100,000,000. Morgan was an enthusiastic yachtsman, whose "Columbia" defeated the "Shamrock" in 1899 and 1901 for the "America's" cup; a notable collector of books, pictures and other art objects, many of which he gave to the Metropolitan Museum of Art (of which he was president); and a generous benefactor of the American Museum of Natural History, the Metropolitan Museum of Art, Harvard university (especially its medical school), the Lying-in hospital of the city of New York and the New York trade schools. He died in Rome March 31, 1913.

His will provided that after the distribution of enumerated bequests amounting to about $17,000,000, chiefly to his family, the residue of his estate should pass to his son, John Pierpont Morgan. In 1916 the estate was finally appraised at $69,449,732. He left only some $700,000 to charities; but while living he had been a generous giver, and in his will suggested that his son continue certain accustomed annual contributions. His works of art and books were left to his son without restrictions, although in his will he said: "It has been my desire and intention to make some suitable disposition of them or of such portion of them as I might determine, which would render them permanently available for the instruction and pleasure of the American people." In the summer of 1913 most of the art collection was placed as a loan exhibit in the Metropolitan Museum of Art, New York city. Later, some items, mostly replaceable, were sold. The remainder, consisting of over 3,000 pieces, was presented to the museum by the son in Dec. 1917, and a new wing was added to the building to house them permanently. This was opened in June 1918. This collection covered all periods and included matchless bronzes, enamels, porcelains and tapestries. The library (dedicated by the son by public charter in 1923 as an institution of research for scholars and provided with liberal endowment, in memory of his father) was appraised at $7,500,000, and consisted of about 25,000 vol. of illuminated manuscripts, early printed books, examples from famous presses and association copies.

MORGAN, JOHN PIERPONT, JR. (1867–), son of John Pierpont Morgan (1837–1913), succeeded his father and continued as active head of J. P. Morgan and Company, and of its associated banking-houses in Philadelphia, London and Paris. He was born at Irvington, N.Y., on Sept. 7, 1867, prepared for college at St. Paul's school and graduated from Harvard in 1889. He received the honorary degree of LL.D. from Cambridge university in 1919 and from Harvard in 1923. In 1891 he became a member of the firm of which his father was the head, and later spent eight years with the London house of J. S. Morgan and Company, now Morgan, Grenfell and Company. Within 16 months after Morgan succeeded his father in 1913 as head of the house, the World War began. Almost immediately the finance department of the City of New York became confronted with a grave situation. Owing to the dislocation of the foreign exchanges, the City of New York found itself unable to meet its obligations maturing in London and Paris, aggregating upwards of $80,000,000. Thereupon Morgan organized a successful bankers' syndicate for $100,000,000 gold, through the operation of which the city's credit was maintained intact.

Within a year the British Government, followed by the French Government, enlisted the services of Morgan and his partners to undertake the work of co-ordinating and finally purchasing in the United States their all-important supplies of foodstuffs and munitions. The purchases which the firm made for the British and French Governments aggregated several billion dollars, and the work which the Morgan firm accomplished in organizing sources of industrial supply in America proved of great service to the U.S. Government when, two years later, in 1917, it undertook to secure its supplies upon a huge scale for the prosecution of its part in the war. Before America's entry into the war, Morgan undertook the work of financing a great part of the Allies' requirements for credits in the United States, and prior to April 1917 had arranged total loan issues to the British and French Governments of $1,550,000,000. During the period of world reconstruction following the war, Morgan continued active; the loans to Great Britain, France, Belgium, Italy, Austria, Switzerland, Japan, Argentina, Australia, Cuba, Canada and to Germany under the Dawes Plan, issued by the firm of J. P. Morgan and Company, aggregated between April 1917 and April 1926 approximately $1,700,000,000. During America's participation in the war Morgan served as a member of the Liberty Loan and other important committees. For five years he was a member of the advisory council of the Federal Reserve Board. In 1922, at the request of the reparations committee, he served at Paris upon a committee of bankers whose report, laying down the essentials of the German reparations problem, was an important preliminary to the work of the Dawes committee two years later. In 1929 he served as an unofficial American delegate at the conference of experts which opened in Paris on Feb. 9 with the hope of making a final and definite settlement of the reparations problem.

In 1920 Morgan presented his residence at Prince's Gate, in London, to the U.S. Government for an embassy. In 1923, by public charter, he dedicated his father's library (to which he had made important additions) as an institution of research for scholars, at the same time providing liberal endowment for it.

MORGAN, LEWIS HENRY (1818–1881), American ethnologist, was born near Aurora (N.Y.) on Nov. 21, 1818. He graduated in 1840 from Union college, and was admitted to the bar and practised at Rochester (N.Y.). His interest in the Iroquois tribe led him to live among them, studying their social organization. In Oct. 1847 he was formally adopted into the Hawk clan of the Seneca tribe, and received the name "Ta-ya-da-o-wub-Rub." The fruit of his researches was *The League of the Iroquois* (1851; new ed. 1904 and 1922). The success of the book encouraged him to further research, resulting in his *Systems of Consanguinity and Affinity of the Human Family* (1869). In 1877 he added to his reputation by publishing *Ancient Society, or Researches in the Lines of Human Progress from Savagery, through Barbarism, to Civilization.* Morgan was a member of the New York assembly in 1861 and of the New York senate in 1868–69. In 1880 he was president of the American Association for the Advancement of Science. He died in Rochester (N.Y.) on Dec. 17, 1881. In addition to the works above mentioned, he published *The American Beaver and his Works* (1868), and *Houses and House-life of the American Aborigines* (1881).

See W. H. Holmes' *Biographical Memoir of L. H. Morgan* (1908).

MORGAN (SYDNEY) LADY (*c.* 1783–1859), Irish novelist, daughter of Robert Owenson, an actor, was born in 1783, in Dublin. She was one of the most vivid and hotly discussed literary figures of her generation. She began her career with a precocious volume of poems. Her *St. Clair* (1804), a novel of ill-judged marriage, ill-starred love, and impassioned nature-worship, in which the influence of Goethe and Rousseau was apparent, at once attracted attention. But the book which made her reputation was *The Wild Irish Girl* (1806), in which she appeared as the ardent champion of her native country, a politician rather than a novelist, extolling the beauty of Irish scenery, the richness of the natural wealth of Ireland, and the noble traditions of its early history. She was known in Catholic and Liberal circles by the name of her heroine "Glorvina." Sydney Owenson entered the household of the marquess of Abercorn, and in 1812, persuaded by Lady Abercorn, she married the surgeon to the household, Thomas Charles Morgan, afterwards knighted, but books still continued to flow from her facile pen. In 1814 she produced her best novel, *O'Donnell.* She was at her best in her descriptions of the poorer classes, of whom she had a thorough knowledge. Her elaborate study (1817) of *France* under the Bourbon restoration was attacked with outrageous fury in the *Quarterly,* the authoress being accused of Jacobinism, falsehood, licentiousness and impiety. She took her revenge indirectly in the novel of *Florence Macarthy* (1818), in which a *Quarterly* reviewer, Con Crawley, is insulted with supreme feminine ingenuity.

Of her many other works may be mentioned *Passages from my Autobiography* (1859). She died on April 14, 1859.

Her autobiography and many interesting letters were edited with a memoir by W. Hepworth Dixon in 1862.

MORGAN, THOMAS HUNT (1866–), American biologist, was born at Lexington, Ky., on Sept. 25, 1866, and educated at the State college of Kentucky and Johns Hopkins university (Ph.D., 1890). In 1891 he became associate professor and in 1894 professor of biology at Bryn Mawr college. In 1904 he was appointed professor of experimental zoology at Columbia university. There, in co-operation with his pupils, he carried on a long series of experimental studies in the laws and mechanism of heredity which resulted in theoretical contributions of first importance to the subject. His observations formed the basis for a complicated theory of paired elements, "factors" or "genes," within the chromosome which are responsible for hereditary unit characters of the individual. The nature of these genes, their arrangement within the chromosome, their relations with each other, and their behaviour in normal inheritance as well as in mutation cases constitute the chief subjects of his research. His observations and conclusions are published in various scientific journals and in his books, which include: *Development of the Frog's Egg* (1887); *Regeneration* (1901); *Evolution and Adaptation* (1903); *Experimental Zoology* (1907); *Heredity and Sex* (1913); *Mechanism of Mendelian Heredity* (1915); *The Physical Basis of Heredity* (1919); *Evolution and Genetics* (1925); *The Theory of the Gene* (1926); *Experimental Embryology* (1927).

MORGANATIC MARRIAGE, a form of marriage in which the contracting parties are not by birth of equal status or rank, and under which the wife, if not of equal rank, does not take the rank of her husband, and the children, whether it be the wife or husband that is of lower rank, have no right of succession to the dignities, fiefs or entailed property of the parent of higher rank. Marriage in this form was properly peculiar to the German peoples, from whom it was adopted by the royal families of other countries. Equality by birth (*Ebenbürtigkeit*) was formerly throughout Germany the necessary condition to a complete and perfect marriage, but in more recent times it was applicable only to members of reigning or "mediatized" houses. In the constitution of the various states, and in the "house laws" (*Hausgesetze*) of the reigning families, the rules were laid down as to what constituted *Ebenbürtigkeit*. In Great Britain the regulations as to the marriages of members of the royal family are contained in the Royal Marriage act 1772 (*see* Marriage). The term "morganatic marriage" is applied generally to any marriage of a person of royal blood with one of inferior rank. Such marriages are recognized as fully binding by the church, the children are legitimate, and no other marriage can take place during the lifetime of the contracting parties.

MORGAN CITY, a city of St. Mary parish, Louisiana, U.S.A., 80 m. W.S.W. of New Orleans, on the Atchafalaya river, Federal highway 90, and the Southern Pacific railway. Pop. 5,429 in 1920; 5,985, 1930. It is the centre of the muskrat-raising district of the state, and has a large fish and oyster industry, a stone crusher making railroad ballast, box factories, saw and planing mills and other manufacturing plants. Its water-borne commerce (all domestic) amounted in 1925 to 777,211 tons, valued at $2,638,568. The city was founded in 1856 and incorporated in 1860 as Brashear City, adopting its present name in 1878.

MORGANTOWN, a city of West Virginia, U.S.A., the county seat of Monongalia county; on the Monongahela river and Federal highways 19 and 119, at an altitude of 825 ft., 100 m. S. of Pittsburgh. It is served by the Baltimore and Ohio and the Monongahela railways and river steamers. The population was 12,127 in 1920 (90% native white) and was 16,186 in 1930 by the Federal census. It is the seat of West Virginia university (established 1867), which has a 50 ac. campus on the river, farms of 700 ac. a mile distant, and an enrollment in 1926–27 of 3,849 students at Morgantown, with 1,205 more in extension courses given in various mining towns and industrial communities throughout the state. Morgantown is a coal-mining centre and has various manufactures (especially cut glass, wire glass, window glass and watch crystals), with an output in 1925 valued at $3,739,916. The city was founded in 1768 by David and Zackwill Morgan. It was incorporated as a town in 1785, and chartered as a city in 1905, after the annexation of Greenmont, Seneca and South Morgantown.

MORGARTEN, the name of the pasture slopes that descend westwards to the south end of the lake Aegeri in the Swiss canton of Zug, about 2m. by road from the Sattel station on the railway line from Schwyz to Zürich. It was at the foot of these slopes and on the shore of the lake that the small Swiss force defeated the large Austrian army, advancing from Zug on Schwyz, on Nov. 15, 1315, and so laid the foundations of Swiss liberty. For an account of the battle and its military significance *see* Swiss Wars. As the lake has shrunk, the exact site of the battle has been disputed.

The original accounts of the battle are collected in part iii. (1884) of the *Mitteilungen* of the Historical Society of Schwyz. *See* also the careful study in K. Bürkli's *Ein Denkmal am Morgarten; wo ist sein Platz?* (Zug, 1895).

MORGEN, a unit of measurement of land in Holland and the Dutch colonies, and hence still current in South Africa, equivalent to about 2 acres. It is also used in Prussia, Norway and Denmark, where it equals about two-thirds of an acre. The word is usually taken to be the same as the German and Dutch word for "morning," the area of a "morgen" being equal to that covered by a morning's ploughing.

MORGHEN, RAFFAELLO SANZIO (1758–1833), Italian engraver, was born at Naples on June 19, 1758. He studied first under his father, and then under the celebrated Volpato. He assisted this master in engraving the famous pictures of Raphael in the Vatican, and the print which represents the miracle of Bolsena is inscribed with his name. He married Volpato's daughter, and removed to Florence to engrave the masterpieces of the Florentine gallery. The grand duke commissioned him to engrave the "Last Supper" of Leonardo da Vinci. In 1812 Napoleon invited him to Paris and paid him the most flattering attentions. He died at Florence on April 8, 1833.

MORIAH, a place-name of ancient Palestine with two distinct connotations. (1) A land entirely unknown, on a mountain in which Abraham offered Isaac (Gen. xxii. 2). Traditionally, "the land of Moriah" is identified with the site of the Temple at Jerusalem, except by the Samaritans and a few western scholars (such as Dean Stanley) who accept their belief that the mountain was Gerizim. (2) The upper part of the hill of Ophel, the threshing floor of Araunah, upon which Solomon erected the Temple, was once called Mount Moriah (2 Chron. iii. 1). Whether this name be derived from the corruption in Genesis or not cannot be definitely decided; the testimony of Josephus, who often names the temple hill "Moriah," is of course not original.

MORIER, JAMES (1780–1849), English traveller and author, was born in 1780. Through the influence of his uncle, Admiral William Waldegrave, Baron Radstock, he entered the diplomatic service, and as secretary to Lord Elgin followed the grand vizier in the Egyptian campaign. From 1810 to 1816 he was the British representative at the court of Persia. His enduring fame rests on *The Adventures of Hajji Baba of Ispahan* (1824) and *The Adventures of Hajji Baba of Ispahan in England* (1828), one of the most entertaining books on the East ever written, and a most amusing satire on western civilization. *Hajji Baba* has been frequently reprinted. Morier died at Brighton on March 23, 1849. He also wrote books about his Eastern experiences.

MORIER, SIR ROBERT BURNETT DAVID (1826–1893), British diplomatist, was born at Paris on March 31, 1826. On leaving Balliol College, Oxford, where his life-long friendship with Jowett had begun, he obtained an appointment in the Education Department, but resigned in 1852, and in the following year became attaché at Vienna. In the succeeding years he was attached to almost every court in Germany. While secretary of legation at Darmstadt in 1866–71, he became a trusted adviser of the crown princess, and through her acquired an intimate friendship with the crown prince (afterwards the emperor Frederick III.). Bismarck, already jealous of British influence at court, honoured Morier with a hatred not lessened by the fact that Morier's knowledge of German politics was unrivalled outside Germany. On leaving Darmstadt, Morier became chargé d'affaires, first at Stuttgart and then at Munich, and in 1876 was

appointed minister at Lisbon. He was minister at Madrid from 1881 to 1884 when he became ambassador at St. Petersburg. Bismarck now took alarm at the lessening influence of Germany over Russia, and tried to procure Morier's downfall. The *Kölnische Zeitung* declared in Dec. 1888 that Morier had used his position at Darmstadt during the Franco-German War to betray the movements of the German troops to Marshal Bazaine. The authority for this charge was an alleged declaration made by Bazaine to the German military attaché at Madrid. Bazaine had died in September, but Morier had previously procured from him a written denial, which he now published in *The Times.* Morier was appointed Lord Dufferin's successor at Rome in 1891; but before he could take up office, he died at Montreux on Nov. 16, 1893.

See *Memoirs and the Letters of the Rt. Hon. Sir Robert Morier from 1826 to 1876* by his daughter, Mrs. Rosslyn Wemyss (2 vols., 1911) and I. Neumann's *Die Gesch. der deutschen Reichsgründung nach den Memoiren von Sir Robert Morier* (1919).

MÖRIKE, EDUARD FRIEDRICH (1804–1875), German poet, born at Ludwigsburg on Sept. 8, 1804, was lecturer in literature at the Katharinenstift in Stuttgart from 1851 to 1866. He died at Stuttgart on June 4, 1875. Mörike is the most lyrically gifted of all the poets belonging to the so-called Swabian school which gathered round Uhland. His works include *Gedichte* (1838; 22nd ed., 1905); *Idylle vom Bodensee, oder Fischer Martin und die Glockendiebe* (1846; 2nd ed., 1856); *Klassische Blumenlese* (1840) and several novels, among them the subjective and romantic *Maler Nolten* (1832; 6th ed., 1901).

See Mörike's *Gesammelte Schriften* (4 vols., 1878), and the *Volksausgabe* (4 vols., 1905). Selections from his literary remains were published by R. Krauss in *Eduard Mörike als Gelegenheitsdichter* (1895), and his correspondence with Hermann Kurz, Moritz von Schwind and Theodor Storm, by J. Bächtold (1885–91); an edition of Mörike's *Ausgewählte Briefe,* in 2 vols., appeared 1903–04. *See* H. Maync, *E. Mörike, sein Leben und Dichten* (1902; 4th rev. ed. 1927); K. Fischer, *Mörikes künstlerisches Schaffen und dichterische Schöpfungen* (1903).

MORIN, JEAN (latinized JOANNES MORINUS) (1591–1659), French theologian, was born in 1591 at Blois, of Protestant parents. He learned Latin and Greek at Rochelle, and continued his studies at Leiden, subsequently removing to Paris. His conversion to the Roman Church is ascribed to Cardinal du Perron. In 1618 he joined the congregation of the Oratory, and in due course took priest's orders. In 1625 he visited England in the train of Henrietta Maria; in 1640 he was at Rome, on the invitation of Cardinal Barberini, and was received with special favour by Pope Urban VIII. He was, however, soon recalled to Paris by Richelieu, and the rest of his life was spent in incessant literary labour. The *Histoire de la délivrance de l'église chrétienne par l'emp. Constantin* (1630), gave great offence at Rome, and a *Déclaration* (1654), directed against faults in the administration of the Oratory, was strictly suppressed. So, too, his great work on penance gave equal offence to the Jesuits and to Port-Royal, and even after his death, in 1659, the polemical vehemence of his *Exercitationes biblicae* long led Protestants to neglect his work in which he destroyed the current theory of the integrity of the Hebrew text of the Scriptures.

Morin's fame rests on his *editio princeps* of the Samaritan Pentateuch and Targum, in the Paris Polyglott, which gave the first impulse in Europe to the study of this dialect, which he acquired without a teacher (framing a grammar for himself) by the study of mss. then newly brought to Europe.

MORION, a light round-shaped head-piece or helmet (*q.v.*).

MORIORI. The Moriori, the almost extinct inhabitants of the Chatham islands, are a Polynesian people of culture allied to that of the Maori of the South Island. But having to contend with a more unfavourable environment, their arts and crafts were of a ruder kind. They had no cultivated foods, but lived on fern-root, eels, fish, *karaka* berries and birds. Albatrosses were obtained by perilous expeditions to the outlying rocks where they nested. The clothing of the Moriori was of sealskin and rudely woven flax. Their social organization was similar to that of the Maori but they were a peaceful people, quarrels being settled by a duel with a kind of single-stick. Hence they were easily conquered and enslaved by a warlike party of Maori in 1835.

BIBLIOGRAPHY.—A. Shand, *The Moriori People* Mem. Polynesian Soc. II., 1911; H. W. Williams, "Language of the Chatham islands," *Transactions N.Z. Institute* 51, 1918; and the excellent monograph of H. D. Skinner, *Moriori Material Culture,* Mem. Bishop Museum, vol. ix., No. 1, 1923.

MORISCOS (*i.e.,* "little Moors"), the name given to the Spanish Mohammedans who accepted baptism and their descendants. Many, if not most, of them were in reality of the same race as the Christians, and were descended from converts to Islam. By the terms of the capitulation of Granada in 1492 freedom of worship was secured to the Mohammedans. But at the end of 1499 Cardinal Jimenez insisted on adopting coercive measures. A rebellion ensued, and the Mohammedans were suppressed. Want of power, or other obstacles, delayed the final extinction of tolerated Mohammedanism in all parts of Spain, but by 1525 it was everywhere suppressed. As they were dependent on the protection of the landlords, the Mohammedans were docile tenants, and their competition weighed heavily on the Christians. The same quality of industry remained to the Moriscos, and excited the envy of their Christian fellow-countrymen. In 1568 the government of Philip II. issued an edict, which ordered them to renounce all their Moorish ways of life and to give up their children to be educated by Christian priests. The result was a rebellion in Granada, which was put down with great difficulty, the Moriscos being finally expelled from the city and scattered over other parts of Spain. The expulsion of the whole body of Moriscos from all Spain was decided on in 1608. The edict was published on Sept. 22 1609, and the expulsion was carried out with great cruelty. The number driven out has been variously estimated at 120,000 or at 3,000,000.

See H. C. Lea, *The Moriscos of Spain: Their Conversion and Expulsion* (1901).

MORITZ, KARL PHILIPP (1757–1793), German author, was born at Hameln on the Weser on Sept. 15, 1757, of humble parentage. He was apprenticed to a hat-maker, but later on studied philosophy at Erfurt and Wittenberg in 1777. While on a tour through Italy in 1786 he became acquainted with Goethe, who interested himself in him. On his return, he became professor of archaeology and aesthetics, at the Berlin academy. He died on June 26, 1793. Of Moritz's writings on aesthetic, archaeological and philosophical subjects, the little treatise *Über die bildende Nachahmung des Schönen* (1788; repr. 1888) and *Die Götterlehre* (1791; 10th ed., 1855, a reprint in Reclam's *Universalbibliothek,* 1878) are important; interesting, too, are the accounts of his travels, *Reisen eines Deutschen in England* (1788; repr. 1903; also trans. into Eng.) and *Reisen eines Deutschen in Italien* (3 vols., 1792–1793). But he is best known by his two novels, *Anton Reiser* (1785–1790; new ed. by L. Geiger, 1886) and *Andreas Hartknopf* (1786), which are mainly autobiographical, and give an admirable idea of the intellectual life of the *Sturm und Drang* period of German letters.

See K. F. Klischnig, *Erinnerungen aus den zehn letzten Lebensjahren meines Freundes Anton Reiser* (1794); Varnhagen von Ense, *Denkwürdigkeiten,* vol. iv. (1838); and M. Dessoir, *Karl Philipp Moritz als Aesthetiker* (1889).

MORLAIX, a town of western France, capital of an *arrondissement* in the department of Finistère, 37 m. E.N.E. of Brest on the railway to Rennes. Pop. (1926) 11,483. Coin finds suggest that Morlaix was probably occupied in the time of the Romans. The counts of Leon held the lordship in the 12th century, but the dukes of Brittany disputed possession with them, and in 1187 Henry II. of England, guardian of Arthur of Brittany, besieged and took the town. During the Hundred Years' War Morlaix was held by French and English in turn, and was pillaged by the latter in 1522. Mary Queen of Scots, on her way to be married to the dauphin, made solemn entry into Morlaix in 1548. The town having joined the League, the castle was taken by storm in the name of Henry IV. in 1594. Morlaix lies 5 m. from the English Channel in a narrow valley. Below the town the river Dossen widens into an estuary, the mouth of which is commanded by the Château du Taureau, built in 1542 for defence against the English. The railway from Paris to Brest crosses

the valley on a two-storeyed viaduct 200 ft. above the quays. Morlaix contains several wooden houses of the 15th, 16th and 17th centuries. These have large covered courts, with huge open fireplaces and carved wooden staircases, supported on pillars, leading from the court to the upper storeys.

The town of Morlaix has a sub-prefecture, besides a tribunal of commerce and a chamber of commerce. The industries include the manufacture of tobacco, tanning, brewing and the manufacture of casks, wooden shoes and candles; there is an active trade in grain, agricultural produce, oil-seeds, leather, wax, honey and in horses and other livestock. Fruit and vegetables are exported to Great Britain and the Channel islands. The port, consisting of an outer tidal harbour and an inner basin, admits vessels drawing 16 ft. at spring tides and 11 ft. at neap tides.

MORLAND, GEORGE (1763–1804), English painter of animals and rustic scenes, was born in London on June 26, 1763. His father and grandfather were both artists, and his mother is usually identified with a Maria Morland, who exhibited at the Academy in 1785 and 1786. Morland exhibited sketches at the Royal Academy in 1773 when he was only ten years old; he exhibited at the Free Society in 1775 and 1776, at the Society of Artists in 1777, and at the Royal Academy in 1778, 1779 and 1780. He studied for a short time at the Royal Academy, but from the age of 14 was apprenticed to his father, who was artist, engraver and picture-restorer. Before his apprenticeship came to an end Romney offered to take Morland into his studio for three years, with a salary of £300 a year, but the offer was rejected. As soon as Morland was free from his dull, respectable home, he began a career of reckless prodigality. In 1785 he was in France, and in 1786 he married Anne, the sister of William Ward, the engraver.

At this time Morland painted the six pictures known as the Laetitia series, engraved by J. R. Smith, and four other didactic works, "The Idle and the Industrious Mechanic" and "The Idle Laundress and the Industrious Cottager," engraved by Blake. When he moved from Pleasant Passage, Hampstead road, where he lived after his marriage, to Warren place, he began the extravagant course which ruined him. In 1799 he was sent to King's Bench prison, where he lived "within the rules," occupying a small furnished house in St. George's Fields with his wife and his brother Henry, but keeping his exact residence a secret. From this time onward he worked chiefly for his brother, who, like his friends, regarded him as a gold mine and exploited him shamelessly. Henry Morland found it advantageous to employ him at a daily fee of from two to ten guineas. In 1802 he was set free, but in 1803 had to place himself in the custody of the Marshalsea to avoid his creditors. Dissipation had already ruined his health. His left hand was paralyzed, apoplectic fits became frequent and his nerves were completely shattered. He now lived for long periods with his brother, to whom he always returned after a fierce quarrel had caused temporary absence. On Oct. 19, 1804, during one of these absences, he was arrested for a small debt and taken to a sponging-house. There he stayed, refusing all offers of help. While trying to make a drawing which could be sold in discharge of the debt he was seized with a fit. This led to an attack of brain fever of which he died on Oct. 29.

Morland's career is represented as one long record of imprisonments for debt, but his capacity for work was astounding, and when he was not painting he was usually recording impressions. According to one biographer, Dawe, he painted 492 pictures for his brother alone between 1796 and his death.

The finest of his pictures were executed between 1790 and 1794, and amongst them his "Inside of a Stable," in the National Gallery, may be reckoned as a masterpiece. His scenes in rustic and homely life show much instinctive feeling for nature. His colouring is mellow, rich in tone, and vibrant in quality, but, with all their charm, his works reveal often signs of the haste with which they were painted and the carelessness with which they were drawn. As a painter of English scenes he takes the very highest position. Many of his best works have been well rendered in mezzo-tint by J. R. Smith, W. Ward, his brother-in-law, P. Dawe, G. Keating, S. W. Reynolds and other engravers. He exhibited regularly at the Royal Academy from 1784 to 1804, but few of his Academy pictures can be identified owing to the inadequate description of them afforded by their titles. Both the originals and the mezzo-tint engravings still sell for high prices: the Laetitia series were sold for £5,600 in 1904 and "Dancing Dogs" fetched 4,000 guineas in 1905.

Four biographies of him appeared shortly after his death, written by W. Collins (1805), F. W. Blagdon (1806), J. Hassell (1806) and George Dawe (1807). Later biographies are those by Ralph Richardson (1895), J. T. Nettleship (1898), G. C. Williamson (1904 and 1907), Sir Walter Gilbey and E. D. Cumming (1907).

MORLEY, HENRY (1822–1894), British man of letters, was born in London on Sept. 15, 1822. He was sent to the Moravian school at Neuwied, whose system strongly influenced his subsequent theories of education. After an experiment in medical practice, which failed through the dishonesty of his partner, he set up a small school for young children at Liscard, near Liverpool. His principle was to abolish all punishment, to make his pupils regard their work as interesting instead of repellent, and to form their character by appealing exclusively to higher motives. The scheme proved a complete success. In 1851 he settled in London, on the invitation of Charles Dickens, as a regular contributor to *Household Words.* He was also on the staff of the *Examiner,* which he edited from 1861 to 1867. Meanwhile he wrote admirable monographs on *Palissy the Potter* (1852), *Jerome Cardan* (1854), *Cornelius Agrippa* (1856), *and Clément Marot* (1870). His dramatic criticisms were reprinted in 1866 under the title of *The Journal of a London Playgoer, 1851–1866.* In 1857 he was appointed evening lecturer in English literature at King's College, and in 1865 succeeded David Masson as professor of English literature at University college, London. He published in 1864 the first volume of a monumental history of English literature entitled *English Writers,* which he eventually carried in eleven volumes down to the death of Shakespeare. He was indefatigable as a popularizer of good literature. After editing a standard text of Addison's *Spectator,* he brought out a vast number of classics at low prices in Morley's Universal Library, Cassell's National Library and the Carisbrooke Library. In 1882 he became principal of University Hall, which was a place of residence for students of University college and the home of Manchester New college. Morley was an untiring advocate of a teaching university for London. In 1889 he resigned his offices and retired to Carisbrooke, Isle of Wight, intending to devote his leisure to the completion of his *English Writers.* But with his work only half achieved he died on May 14, 1894.

MORLEY [of Blackburn], **JOHN MORLEY,** Viscount (1838–1923), English statesman and author, was born at Blackburn on Dec. 24, 1838, the son of Jonathan Morley, surgeon. He matriculated at Lincoln college, Oxford, in 1856, and in 1859 came up to London to pursue a literary career. He became editor of the moribund *Literary Gazette,* which not all his ability could preserve from extinction. Gradually, however, he became known as a philosopher and a radical, and as one of the ablest and most incisive contributors to the literary and political press of the day. His sympathies as a thinker seem to have been at this time chiefly with positivism, and he acquired a reputation as an agnostic, which became confirmed in the popular mind when he somewhat aggressively spelt God in one of his essays with a small "g." From 1868 to 1870 he was editor of the daily *Morning Star.* In 1867 he succeeded G. H. Lewes in the editorship of the *Fortnightly Review,* which he conducted with brilliant success until 1883, when he was elected to parliament; he then assumed in exchange, but not for long, the editorship of *Macmillan's Magazine.* He had been connected with Messrs. Macmillan since the commencement under his editorship, in 1878, of the "English Men of Letters" series, in which nothing is better than the editor's own contribution, *Life of Edmund Burke,* an extension of his article in the 9th edition of this encyclopædia (1876). Since 1880 he had also been editor of the *Pall Mall Gazette,* which had been turned into a Liberal paper. (*See* Newspapers.)

In 1883 Morley, who had twice unsuccessfully attempted to enter parliament, was returned for Newcastle-upon-Tyne at a by-election. The prestige thus acquired led to his presiding over a

great Liberal congress at Leeds in the same year; and, although the platform never seemed his natural element, the literary finish of his style and the transparent honesty of his reasoning rapidly gained him a prominent position in the House of Commons. When, in February 1886, Gladstone returned to office as a home ruler, Morley, who had never before held any public appointment, filled one of the most important posts in the cabinet as secretary for Ireland. He had always expressed his sympathy with the Irish Nationalist movement. He had no opinions to recant, no pledges to explain away. He is credited with an especial influence over Gladstone in the matter of home rule, and in particular with having kept him steady in the Bill of 1886 to his original purpose of entirely separating the Irish from the British legislature, a provision which pressure from their own party afterwards compelled both of them to abandon. After the severe defeat of the Gladstonian party at the general election of 1886, Morley led a life divided between politics and letters until Gladstone's return to power in 1892, when he resumed his former office. There was a strong current of disapproval in his own constituency of his attitude to the Eight Hours' Labour Bill, which he regarded as an interference with personal liberty, and to a less degree of his anti-Imperialist views. The result was that at the election of 1895 he lost his seat, but soon found another in Scotland, for the Montrose Burghs. He had during the interval taken a leading part in parliament, but his tenure of the chief secretaryship of Ireland was hardly a success. The Irish gentry, of course, made things as difficult for him as possible, and the path of an avowed home ruler installed in office at Dublin Castle was beset with pitfalls. In the intestine disputes which agitated the Liberal party during Rosebery's administration, and afterwards, Morley sided with Sir William Harcourt, and was the recipient and practically co-signatory of his letter resigning the Liberal leadership in December 1898.

Morley's activities were now again turned to literature, the political views most characteristic of him, on the Boer war in particular, being practically swamped by the overwhelming predominance of unionism and imperialism. As a man of letters his work was practically concluded at this period, and may briefly be characterized. His position as a leading English writer had early been determined by his monographs on *Voltaire* (1872), *Rousseau* (1873), *Diderot and the Encyclopaedists* (1878), *Burke* (1879), and *Walpole* (1889). His *Life of Oliver Cromwell* (1900) revises Gardiner as Gardiner revised Carlyle. The *Life of Cobden* (1881) is an able defence of that statesman's views rather than a critical biography or a real picture of the period. He had the true admiration of the philosopher for the man of action, Walpole and Cromwell fascinated him for this reason, and Stafford perhaps more than they. At the same time his political experience gave him a wider view of the necessities of practical statesmanship than, for instance, Acton. Morley's contributions to political journalism and to literary, ethical and philosophical criticism were numerous and valuable. They show great individuality of character, and recall the personality of John Stuart Mill, with whose mode of thought he had many affinities. As in letters, so in politics. A philosophical radical of a somewhat mid-19th-century type, and highly suspicious of the later opportunistic reaction (in all its forms) against Cobdenite principles, he yet retained the respect of the majority whom it was his usual fate to find against him in English politics by the indomitable consistency of his principles and by sheer force of character and honesty of conviction and utterance.

After the death of Gladstone Morley was principally engaged upon his biography. Representing as it does so competent a writer's sifting of a mass of material, the *Life of Gladstone* (1903), was a masterly account of the career of the great Liberal statesman; traces of liberal bias were inevitable but are rarely manifest; and in spite of the *a priori* unlikelihood of a full appreciation of Gladstone's powerful religious interests from such a quarter, the whole treatment is characterized by sympathy and judgment. In 1902 he received the new Order of Merit.

When Campbell-Bannerman formed his cabinet at the end of 1905 Morley became secretary of state for India. In this position he was conspicuous in May 1907 and afterwards for his firmness in sanctioning extreme measures for dealing with the outbreak in India of alarming symptoms of sedition, in which he was bitterly attacked by some of the more extreme members of the Radical party. At the same time he showed his popular sympathies by appointing two distinguished native Indians to the council, and taking steps for a decentralization of the administrative government. When Campbell-Bannerman resigned in 1908 and Asquith became prime minister, Morley retained his post in the new cabinet; but was transferred to the upper house, with the title of Viscount Morley of Blackburn. His subsequent career at the India Office will always be associated with his extensive remodelling (1908–1909) of the system of government in India so as to introduce more fully the representative element. (*See* INDIA.) In his tenure of this office he showed again something of the philosopher's leaning to despotism. He admittedly kept his private conclusions out of his public actions, to a certain extent. The author of the essay *On Compromise*, the very Gospel of dissent, was in practice convinced that "the first duty of a government is to govern," and there was never a secretary of state who treated his viceroy more despotically. (*See* MINTO, EARL OF.) Similarly by communicating privately with the viceroy he tended to deprive the Council of State of information and influence on foreign policy. And though primarily responsible for the first great step towards Indian self-government, he disowned the Montagu-Chelmsford reforms as premature.

Lord Morley held the seals of the India Office till Nov. 1910. One of his last official acts had been to resist the appointment of Kitchener to the vice-royalty, pressed strongly upon ministers by King Edward just before his death. Morley remained in the cabinet as lord president of the council, and was one of the four counsellors of state to administer the kingdom during King George's visit to India in 1911–12.

In the critical period of domestic politics which began with the budget of 1909 he played a somewhat prominent part. He defended that budget in the great debate of November 1909 and, while admitting that the Lords had the legal right of rejection, said that to assert it was a "gambler's throw." Morley led the House of Lords during most of the session in which the Parliament bill, which he warmly supported, was passed; and it was he who read out to the House on the last night of debate that definite assurance from King George of his assent to a creation of peers which finally secured the exiguous but adequate majority of 17.

The entrance of Great Britain into the World War brought Morley's official career to an abrupt termination. He felt that his pacifist outlook was sufficiently well-known to make it unnecessary for him to give reasons for resigning; and he retired to Wimbledon, where he wrote his *Recollections* (2 vols. 1917). In 1921 his publishers brought out a complete edition of his works; and he was generally regarded, during his last years, as sharing with Mr. Hardy the position of *doyen* of English men of letters. He died at Wimbledon on Sept. 23, 1923.

See, in addition to the *Recollections*, Sardār 'Ali Khan, *Life of Lord Morley* (1923); J. H. Morgan, *John, Viscount Morley* (1924); F. W. Hirst, *Early Life and Letters of John Morley* (1927). Morley's *Memorandum on Resignation*, 1917, was posthumously published in 1928.

MORLEY, SAMUEL (1809–1886), English manufacturer and politician, was born on Oct. 15, 1809 at Homerton, the youngest son of a Nottingham hosier. In 1825 he entered his father's London warehouse, and when his father retired in 1840 became practical head of the London concern, and when his brothers retired in 1855 sole owner. In 1860 he was sole owner also of the Nottingham business, which grew rapidly, with huge mills at Nottingham and in Leicestershire and Derbyshire employing thousands of hands. In 1865 Morley was elected Liberal M.P. for Nottingham, and from 1868–85 sat for a Bristol division. He was one of the principal proprietors of the London *Daily News*. Morley was a deeply religious man, interested in the temperance movement, unstinting in charity, and a model employer. He died on Sept. 5, 1886.

See E. Hodder, *Life of Samuel Morley* (1887); F. M. Thomas, *I. and R. Morley: a Record of a Hundred Years* (1900).

MORLEY, THOMAS (1557–1603), English musical composer, was a pupil of William Byrd, but nothing is known as to his origin and very little as to the incidents of his career. He was admitted (July 5, 1588) Mus. Bac. at Oxford, and in 1596 entered the Chapel Royal, where he successively filled the offices of epistler and gospeller. On Sept. 11, 1598, Morley received a licence for twenty-one years to print ruled music-paper and songbooks in English, Latin, French or Italian. His rights under this grant were assigned to him by various publishers. On Oct. 7, 1602, his place in the Chapel Royal was filled up, and on Oct. 25, 1603, administration of his goods was granted to his widow. Morley was incontestably one of the greatest of the secular Elizabethan composers. His madrigals, canzonets and ballets are remarkable for their beauty and admirable workmanship, and his *Plaine and Easie Introductione to Practicall Musicke,* in spite of its frequent obscurity, is invaluable for the history of musical science in England.

His works are: (1) *Canzonets to Three Voices* (1593; 2nd ed., 1606; 3rd ed., 1631; Ger. trans.: Cassel, 1612, and Rostock, 1624); (2) *Madrigals to Four Voices* (1594; 2nd ed., 1600); (3) *First Book of Ballets to Five Voices* (1595; an Ital. ed. appeared in London in the same year; 2nd ed., 1600; Ger. ed., Nuremberg, 1609); (4) *First Book of Canzonets to Two Voices* (1595; 2nd ed., 1619); (5) *Canzonets or Short Little Songs to Four Voices, selected out of Italian Authors* (1597); (6) *Canzonets to Five and Six Voices* (1597); (7) *A Plaine and Easie Introduction to Practicall Musicke* (1597; 2nd ed., 1608; 3rd ed., 1771); (8) *Madrigals to Five Voices, selected out of Italian Authors* (1598); (9) *The First Book of Consort Lessons, made by divers authors, &c.* (1599; 2nd ed., 1611); (10) *The First Book of Airs to Sing and Play to the Lute with the Base Viol* (1600); (11) *The Triumphs of Oriana to Five and Six Voices, composed by divers several authors* (1601). Besides the above, services, anthems, motets and virginal pieces by Morley are to be found in various collections, both printed and manuscript.

MORLEY, a municipal borough in the West Riding of Yorkshire, England, 4 m. S.S.W. of Leeds, on the L.M.S. and L.N.E. railways. Pop. (1931), 23,397. The town is situated on a spur of the Pennines, at an altitude of about 450 feet. In the neighbourhood are the ruins of Hawley Hall, dating from 1590. Here, during the Civil War, the parliamentary army sustained a heavy siege from the Royalists. The chief industries are connected with woollen cloth, but coal mining and stone quarrying are carried on, and machinery is manufactured. The borough, which was incorporated in 1885, has a mayor, 7 aldermen, and 21 councillors.

MORMAOR or MORMAER, a title used to designate the rulers of the seven provinces into which Celtic Scotland, *i.e.*, the part of the country north of the Forth and the Clyde, was divided (Gael. *mor*, great, and *maor*, steward or bailiff). These seven mormaorships, or original "earldoms" of Scotland, as they were afterwards called, were: Angus, Athole with Gowry, Caithness with Sutherland, Fife, Mar with Buchan, Moray with Ross, and Stratherne with Menteith.

MORMONISM does not claim to be a new religion, but regards itself as a new dispensation of the one and only Gospel of the Lord Jesus Christ; God's plan of "Eternal Life, which God, that cannot lie, promised before the world began." (Titus 1:2.) But while there is but one gospel, there have been many dispensations of it, by reason of men from time to time "falling away" from the order of things God has revealed to them. Ultimately, however, according to Mormon beliefs, and their interpretations of the Jewish and Christian documents, there is to be a final or last dispensation of this one and only "everlasting Gospel," known as the "dispensation of the fullness of times," in which all things pertaining to the redemption of the earth and the salvation of man will be gathered together in one, both in heaven and in earth. (Eph. 1:9–10.) The appearing of God the Father and his Son Jesus Christ to Joseph Smith, the bringing forth of the Book of Mormon, the alleged American volume of scripture, and the organization of the Church of Jesus Christ of Latter-Day Saints, was the beginning of this promised dispensation of the fullness of times.

Authoritative Sources of Doctrine.—The Church of Jesus Christ of Latter-Day Saints recognizes two sources of doctrine; (1) the written word of God—the scriptures; and (2) direct revelation from God. The books accepted as scripture are: (1) the Bible, the Old and the New Testament, as far as they are correctly translated from the original documents; (2) The Book of Mormon, an alleged ancient American record, said to have been translated by Joseph Smith, "by the gift and power of God"; (3) The Doctrine and Covenants, a collection of revelations given in the present day, chiefly through Joseph Smith; (4) The Pearl of Great Price, a collection of fragments from writings of Moses and Abraham, not found in the Bible, but purported to have been revealed to Joseph Smith; also some historical and doctrinal writings of Joseph Smith's. These four books have been officially accepted as scripture by vote of the Church. All other writings and discourses are of secondary character and of value in proportion to their strict conformity to the above named books of scripture.

The Church believes in present day and continuous revelation: by direct word of mouth and visible presence of God; by voice communication without visible presence; by visitation of angels and deliverance of messages; also by impressions upon the mind of man by the Spirit of God. Revelation in any of these manners is the supreme source of knowledge, and the final arbiter of doctrine for the Church, even superior to the written word.

It is the doctrine of the Church that its members have the right to divine guidance through revelation for their individual lives; as also all officers of the Church in their respective callings and stations, but not for the guidance of the Church or the domination of others. There is but one man on the earth at a time, when the Church is established, who may receive revelation for the guidance of the Church, and he is the President of the Church, God's Prophet, Seer and Revelator and mouth-piece. His official word, when speaking in the name of the Lord, the Church is to receive as from God's own mouth. No revelation is of binding force as law upon the Church, however, until officially accepted by vote of the Church in general conference assembled.

Of Existences.—Mormon theology and philosophy take note of existences, of time, space, matter, the extent and nature of the universe. Duration is without beginning or end; space is limitless; matter, in its elemental status, eternal; and while subject to infinite mutations may neither be created nor annihilated. Mind—identical with intelligence—is equally eternal (Doc. and Cov, Sec. 93). Mind is that which directs action, matter that which is acted upon (Book of Mormon, II. Nephi, Ch. 2). From this action of mind or spirit upon matter, proceed all changes and accomplishments brought to pass in an eternal universe, where eternal cause is ceaselessly active under a universal reign of law. "There are many kingdoms (meaning worlds and world systems) for there is no space where there is no kingdom; and there is no kingdom in which there is no space, either a greater or a lesser kingdom. And to every kingdom is given a law; and to every law there are certain bounds also and conditions." These "kingdoms" or worlds and world systems, are inhabited by intelligences in varied states of development. Some are spirits who have passed through a mortal life and are awaiting resurrections; others are unbodied spirits, awaiting opportunity for birth into mortal life, that they may be put in the way of eternal progression. Also in some of these many kingdoms is an order of translated beings, men who have been brought into mortal life and then translated from that life—*i.e.*, death suspended as in the case of Enoch and his people, and Elijah (Gen. 5:21–24; Heb. 11:5; Pearl of Great Price, Book of Moses 7:67–69). Others have passed through mortal life to a resurrection which has brought them into immortal life where spirit and element are inseparably connected.

Of God.—In its doctrine of God, "Mormonism" is Christ-Theistic. It accepts Jesus Christ as the incarnation of Deity. He is God manifested in the flesh (I Tim. 3:16); a complete revelation of Deity in personality and in form; in intellectual and spiritual powers, having all the attributes of the Father, and possessing all power in heaven and in earth. (Heb. 1:1–3, Matt. 28:18.) There is but one God-nature, or essence, but many may be partakers of that one nature (II Peter 1:4); may be, in fact, incarnations of the God nature. "I and my Father are one,"

said Jesus (St. John 19:30; also St. John 14:17). The Trinity of Father, Son and Holy Ghost is accepted as illustrating this principle of one divine nature and a plurality of persons participating therein.

Proceeding from the presence of these divine personages is a "spirit" which "fills the immensity of space." "The light which is in all things, which giveth life to all things, which is the law by which all things are governed, even the power of God." (Doc. and Cov., Sec. 88:6–7.) This "the True Light, which lighteth every man that cometh into the world" (St. John 1:9); also is called the "Light which is the life of men" (St. John 1:4; *id.* 8:13). This Spirit is God immanent in the world (Doc. and Cov., 88:7–13); is everywhere consciousness, all seeing, all knowing; is an all-pervading and active Will; is possessed of all the qualities and attributes of God, save only form; and is in all who attain unto like perfect participation and fullness of the divine nature.

Of Man.—It is the declared purpose of God to bring to pass the immortality and eternal life of man. Essential to this is the inseparable union of spirit and element, the spirit and its bodily garment, constituting the perfect soul. (Doc. and Cov., sec. 88:15–16; *id.*, sec. 93.) Hence man's earth-life and his experience in the midst of broken harmonies; his death and his resurrection to immortality; all of which is necessary to his progress, that he may acquire the knowledge and have the wisdom which such experiences alone can teach. Man finds himself, and proves himself worthy of that eternal weight of glory, which it is God's purpose to grant to him; or by his failure to react to God's intent, he learns that he must abide in lesser degrees of glory on planes of existence in keeping with his limited capacity, or his unwillingness to make progress. In the Father's house are many mansions, of infinite degrees of glory, of which sun, moon and stars in all their infinitude of brightness are spoken of as being typical (I Cor. 15; Doc. and Cov., sec. 76).

The Gospel.—The means of attaining unto all that God has designed for man in his earth life are acceptance of and obedience to the gospel, of which Jesus Christ is the centre and circumference. He is the Redeemer and Savior of men, the resurrection and the life. By Him is brought to pass the forgiveness of sin, the resurrection to physical immortality, and the spirit birth into union with God.

Organization and Government.—The Mormon Church organization and government arise out of the priesthood. Priesthood is regarded as power delegated from God to man by which man is authorized to act in the name or the authority of God. The Aaronic priesthood has to do mainly with temporal affairs, the collection of tithes, the distribution of charities, the general care of its properties and the administration of the outward ordinances of the gospel, water baptism and the administration of the Lord's supper. The officers of this priesthood are bishops, priests, teachers and deacons. There is a general presidency over this priesthood known as the presiding bishopric of the Church, consisting of three high priests of the Melchizedek order, one of whom is the bishop, the other two counsellors. This bishopric is designated by the first presidency, ordained by them, and accepted and sustained by the vote of the Church. The Melchizedek priesthood has mainly to do with spiritual affairs, the proclamation of the truth to the world, and bearing witness of it, and exercising in the higher phases of Church activities administrative, legislative and judicial functions, even including supervision of temporal affairs. The officers of this priesthood are apostles, prophets, seers, revelators, patriarchs, high priests, seventies and elders. The two great duties of the Church are to make proclamation of her truth, and perfect the lives of those who receive it.

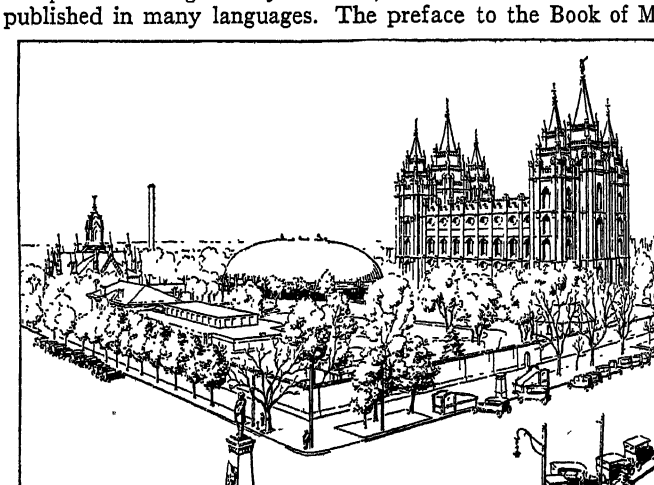
Territorially the Church holds a world-wide jurisdiction. It is the church universal—catholic in the widest sense. In America where the Church is intensively organized, a central place is recognized as Zion, located in Jackson County, Mo. Here a holy city is yet to be built by the Church, a New Jerusalem, into which will be gathered those of all nations. This will be the centre of administrative activities of the church universal, and the site of the chief temples. Other cities and settlements grouped conveniently for local administration purposes, outside of the central place, are to be, and now are, called "stakes of Zion."

To supplement the work of the priesthood there are The National Womans' Relief Society; the Sunday Schools; the Young Ladies' Mutual Improvement Associations; Primary Association, promoting mid-week child culture; and Religion Classes providing training side by side with secular education. The Church maintains a school system comprising high schools, seminaries and college grades, where, respectively, Mormon theology is made part of the Church school curriculum. (R. Sm.)

MORMONS or **LATTER-DAY SAINTS,** a religious society founded by Joseph Smith (*q.v.*) and associates at Fayette, Seneca County, New York, April 6, 1830. It was organized conformably to the laws of the State of New York, which required no fewer than six persons to constitute a religious society. Joseph Smith's associates were Oliver Cowdery, Hyrum Smith, Peter Whitmer, Jr., Samuel H. Smith and David Whitmer. In addition to these, a few others became members of the Church at the time of its organization.

Smith, when a boy between 14 and 15 years of age, claimed to have had, in answer to prayer, a vision in which two heavenly personages appeared to him and proclaimed the opening of a new Gospel dispensation. These personages, he said, were God the Father and his son, Jesus Christ. Afterwards, according to Joseph's account, a heavenly messenger appeared to him, giving his name as Moroni, and revealing the existence of a record engraved upon gold plates and hidden in a hill between Palmyra and Manchester, N. Y., not far from the Smith home; a record containing the fulness of Christ's Gospel, as made known by the risen Redeemer to the ancient inhabitants of America. Four years later, or on Sept. 22, 1827, the plates were delivered into Joseph's hands, and with them instruments called "interpreters" (Urim and Thummim), by which he translated the cryptic characters found upon the plates, and gave to the world the Book of Mormon—so called because its author and compiler was a prophet named Mormon, father to Moroni, who as a mortal had concealed the record in the hill.

The Book of Mormon was first published at Palmyra, N.Y., early in 1830, in an edition of five thousand copies. Since then it has passed through many editions, and has been translated and published in many languages. The preface to the Book of Mormon prints the testimony of three witnesses that they beheld the plates and the inscriptions from which the translation was made. Eight additional witnesses testified to the same. Following the publication of the book, came the organization of the Church of Jesus Christ of Latter-Day Saints, commonly called the Mormon Church, and its members Mormons, because of the *Book of Mormon,* believed by them to be of divine authenticity, and of equal authority with the Jewish Scriptures. At the organization of the Church, Smith and Oliver Cowdery were sustained respectively as its first and second Elders, and the former as Prophet, Seer and Revelator.



BY COURTESY OF THE CHICAGO BURLINGTON & QUINCY RAILROAD CO.

THE MORMON TABERNACLE AND TEMPLE AT SALT LAKE CITY

Mormonism drew its first proselytes from the rural districts of New England. In the autumn of 1830 it sent missionaries to the Indians living upon reservations in New York State and in newer States. These missionaries—Oliver Cowdery, Peter Whitmer, Jr., Parley P. Pratt and Ziba Peterson—proceeded westward and in Ohio converted a number of white people, including Sidney Rigdon and others who became prominent in the Latter-day Church. They continued onward to Western Missouri, which was then the frontier of the nation.

Ohio, the First "Stake of Zion."—About the same time, the infant Church, partly because of the opposition it encountered in New York, but mainly to be nearer the field of its future operations, moved to Kirtland, Ohio, where the first "Stake of Zion" was established, the first temple built, and the priesthood more thoroughly organized. A first presidency was created, Joseph Smith and two others being the incumbents. Twelve Apostles were chosen, with quorums of seventy to assist them. High priests, patriarchs, bishops and stake presidents were also among the offices instituted. The Church membership at that time was between 3,000 and 4,000.

In the summer of 1831 a Mormon colony settled in Jackson county, Mo., upon lands purchased from the Federal government, and consecrated by the Prophet as a site for the New Jerusalem. Most of these Mormons were from the North and East and were abolitionist in their tendencies, a very serious charge at that time when Missouri was a slaveholding State. Moreover they were poor and brought little property, yet they looked forward to their future possession of the country thereabouts as "The Land of Zion." This together with the religious and social differences, aroused the bitter opposition of the older settlers who, having no recourse to law, proceeded by violence and terrorizing to force the removal of the entire colony in the autumn of 1833 to Clay, Caldwell and Daviess counties in the same State.

The Mormons Leave Ohio.—Mormonism thrived despite this opposition, missions in Canada as well as in the States contributing many converts. The failure of the Kirtland Bank, an unchartered institution, in 1837, however, nearly wrecked the Church. Doubts of its soundness were present almost from the first. When Rigdon and Smith, respectively secretary and treasurer, were charged with violating the State law against unchartered banks, they appealed on the ground that it was not a bank but an association. The institution however suspended payment and closed its doors in November, 1837, as did many other banks throughout the country at this particular time. The failure created a bitter feeling against the Prophet on the part of many of his followers and a number of leading Elders fell away. Those who remained Smith's followers soon removed to Missouri, whither Smith and Rigdon had already gone, settling chiefly in Caldwell county where the Jackson county refugees had previously settled and where there were few inhabitants other than of Mormon faith. There they founded the City of Far West (now Kerr). They also projected a temple and laid out other towns.

Mormon missionary work in England helped to save the Church at this critical stage. Heber C. Kimball and Orson Hyde, two of the twelve Apostles, together with other elders, in 1837 began preaching in Lancashire and neighbouring parts of England and after about eight months had baptized nearly 2,000 persons. This was but the first of many missions in European countries, which countries were to furnish from their peasant classes a large proportion of the converts to Mormonism.

The Missouri Exodus.—Movements by Mormon settlers beyond Clay county into surrounding counties again led to clashes with the Missourians, who were now thoroughly aroused against the Mormons who were coming in such numbers as to seem to the gentiles a menace to the State. An election riot in Gallatin, where an attempt was made to prevent the Mormons from voting, was the spark that kindled a general conflagration. Armed bands of both parties were soon abroad in the country shedding blood and instituting a reign of lawlessness. Numbers were killed on both sides. Finally the governor ordered out the State militia against the Mormons. Their town of Far West was surrounded and their leaders captured. On their way to trial the leaders escaped and made their way to Illinois. The action of the State in support of the local Missourians gave the latter courage for further terrorization acts against the Mormons until they were forced to move.

The Illinois Period.—The mid-winter exodus of the Mormons from Missouri (1838–39) led to the founding of the city of Nauvoo on the east bank of the Mississippi, in Hancock county, Ill. In Missouri the Saints had numbered twelve to fifteen thousand; in Illinois this figure increased to about twenty thousand, most of them citizens of Nauvoo. There the Prophet resided and continued to direct the spiritual and temporal activities of the Church.

Under his direction Brigham Young, President of the Twelve Apostles, was sent with a majority of that council to England, to enlarge the work already begun there. The missionaries penetrating to all parts of the United Kingdom, converted 5,000 people, founded a periodical known as the *Millennial Star*, published a British edition of the *Book of Mormon*, printed and distributed thousands of tracts, and established a permanent shipping agency to carry forward the work of "gathering Israel to the Land of Zion." The first company migrating from Europe under these auspices, was a small group of 41, which sailed from Liverpool in June 1840, for Nauvoo via New York. Subsequently Mormon immigration from Europe passed up the Mississippi. The first half of the decade of the '40s witnessed the rapid growth of the Mormon community in Illinois and in Iowa. At Nauvoo a temple was built, a university projected, the city chartered and extended, and the Nauvoo Legion organized, under Legislative sanction, as a part of the State militia.

Difficulties and Dissension.—The Mormons had enemies in Illinois, however, and trouble was brewing. The Mormons at the time held the balance of political power in the State and were courted by both Whigs and Democrats. The Whigs had granted the Nauvoo charter, but their friendship was lost when Smith supported the Democrats in the gubernatorial campaign of 1842. Advising his people on other occasions to vote for the Whigs alienated the Democrats in turn. Political opposition was intensified when Smith in 1844 announced himself as a candidate for President of the United States. Meanwhile serious dissension occurred within the Church. Though not officially announced until 1852 it was in 1843 that Smith claimed to have received the revelation proclaiming the doctrine of plural marriages, which the Prophet acted upon by soon taking additional wives. The doctrine was also made known to some of the Elders who did likewise, though at first in secret. This practice led to the secession of William and Wilson Law, with others, from the church. They set up a paper called the *Nauvoo Expositor*. Smith as mayor of the city condemned the *Expositor* as a public nuisance and ordered its printing press and type to be destroyed. The order was carried out by the city marshal and police. The revelations of the *Expositor* and Smith's act in suppressing it aroused the entire country about Nauvoo to mob fury. Inflammatory speeches and exaggerated rumours of Mormon practices added fuel and gathered crowds. Smith proclaimed martial law in Nauvoo and allowed no one to enter the city. Governor Ford pacified the mob in Carthage by promising the Prophet should be made to answer the charges against him and at the same time he sent Smith notice to appear at Carthage. Smith hesitated to comply with the order, and even considered flight to the Rocky mountains, but was persuaded to surrender to the law. With his brother Hyrum and several other leaders he proceeded to Carthage, and, pending the trial, was placed with the others in the visitors' room of the Carthage jail, Governor Ford pledging the honour of the State for his protection. This pledge was violated by a mob of about 200 men who, with blackened faces, on the afternoon of June 27, assaulted the jail, and with the connivance of the guards shot to death Joseph and Hyrum Smith, and all but fatally wounded John Taylor; Willard Richards, their fellow prisoner, escaping unhurt.

When this crime was committed most of the Apostles were absent from Nauvoo. Upon hearing the tidings, they at once returned, and in August of that year (1844) succeeded to the leadership of the Church. Sidney Rigdon claimed the succession, by

virtue of having been Joseph Smith's counsellor in the first Presidency, the highest authority in the Church; the Twelve Apostles ranking next. But the Prophet's death had dissolved the First Presidency. Moreover, he had said: "Where I am not, there is no First Presidency over the Twelve." This ruling, overwhelmingly sustained by the people, disposed of Rigdon's claim and settled the question as to who should preside over the Church. A number of others parted company with the main body at that time, and founded the Reorganized Church of Jesus Christ of the Latter-Day Saints (*see* p. 811). The majority, however, followed Brigham Young and his fellow Apostles.

From Illinois to Utah.—Less than two years later came the enforced wintry exodus of the saints from Illinois, the first companies crossing the frozen Mississippi on the ice. Dragging their heavily loaded wagons across snow-covered, rain-soaked Iowa, tarrying on the way only long enough to found temporary settlements and sow crops to be reaped by those who followed them, the vanguard, in June 1846, reached the Missouri River, and by permission encamped temporarily on the Pottawatomie Indian lands. They were now on the nation's frontier.

It devolved upon Brigham Young (*q.v.*) to lead the migrating Mormons to their new home in the wilderness. During the troubles in Missouri he had given proof of his ability as an organizer and leader. His mission to Britain furnished additional evidence. He was the man of all men for the responsibility now resting upon him. At the head of a picked company numbering 143 men, three women and two children, Brigham Young, in April 1847, started to cross the great plains between the Missouri river and the Rocky mountains. (*See* UTAH: *History.*) In covered wagons, drawn by mules and oxen, they carried ploughs, implements, seed grain and a year's supply of provisions. Passing through the Indian country, over wide prairies and rugged mountains, these pioneers, on July 24th, entered the valley of the Great Salt lake, then uninhabited except by red men, and included in a region belonging to Mexico. At the close of the Mexican War the land was ceded to the United States.

Other companies of Mormon emigrants followed and, as soon as practicable, the settlers took steps to organize a civil government. In March 1849 they set up the Provisional State of Deseret, and petitioned Congress for admission into the Union. The prayer for Statehood failed, but the Territory of Utah was organized September 1850. Brigham Young was appointed Governor by President Fillmore, and at the expiration of a four year term, was reappointed by President Pierce.

Frontier Hardships.—Many hardships attended the colonization of the barren region in which these people made their home. Not only drouth, but crop-devouring crickets and grasshoppers, as well as blood-thirsty Indians, had to be dealt with and overcome. "It is better to feed the Indians than to fight them," said Brigham Young, and his wise policy prevailed, the warlike red men finally becoming friendly and peaceable. Drouth was conquered by irrigation, the Mormons being the pioneers in that art.

Political Relations with Federal Government.—There were also political difficulties between the Mormons and the U.S. officials sent to govern them and administer the law. Some of President Pierce's appointments were unfortunate in consideration of the delicate task which they faced, and the Mormons were justly aroused to anger by their deeds. On the other hand there was the evident determination of the Church to maintain its authority over civil affairs. Official after official returned to Washington, maintaining that his office was untenable, some of them reporting actual violence against them. It was rumoured that a crowd broke into the office of Judge George P. Stiles and seized the Federal court records along with the Judge's personal books and papers. The former were placed in a church safe, but the latter were burned. Stiles believed the court records were included in the bonfire and reported their destruction to Washington. Outrages against non-Mormons were continually reported and in the summer of 1857 occurred the famous Mountain Meadows massacre in which 120 men, women and children were killed by the Mormons and Indians. The Church has always disclaimed responsibility for this incident, but it, nevertheless, inflamed the people throughout the United States. President Buchanan soon after his inauguration decided to appoint a non-Mormon governor, and to back up his acts and those of other Federal officials with force if necessary, in order to restore U.S. authority. Alfred Cumming was appointed governor and Col. Albert Sidney Johnson was ordered to the territory with 1,500 troops in the autumn of 1857. He was shut out from Salt Lake Valley and compelled to winter east of the Wasatch mountains, the way being blocked by winter snows and the Territorial Militia acting under orders from Brigham Young. When spring came Gov. Cumming entered Salt Lake city and was received with every demonstration of good will. His reports were favourable to the Mormons and peace commissions sent by Buchanan were able to strike a compromise with the Mormon officials.

Brigham Young's Leadership.—The history of the Mormon Church during the thirty years that Brigham Young presided over it, is to a large extent the history of the settling up and development of the Inter-Mountain West during the same period of time. He and his people—many thousands of them emigrants from the Old World—spread their colonizing activities over Utah (*see* UTAH: *History*) and parts of Idaho (*q.v.*), Nevada (*q v.*), Colorado, Arizona and New Mexico. Young built temples, tabernacles, theatres, founded schools, and was at the head and front of every great mercantile, industrial, or educational movement in his vicinity. He also perpetuated the missionary system of the Church and extended it to most of the countries of the globe. After his death in 1877, he was succeeded by John Taylor, the senior Apostle in the Council of the Twelve.

Struggle over Polygamy.—President Taylor's administration was notable for the prosecution of plural marriage, commonly called polygamy, under the laws of Congress enacted against it. This form of marriage as practised by Joseph Smith and others in Illinois, had been perpetuated by the founders of Utah. Only a small percentage of the people ever engaged in it. As early as 1862, Congress had legislated against the institution, but the law proved inoperative, and was supplemented twenty years later by the Edmunds Law, still later by the Edmunds-Tucker Law. Under these statutes a vigorous crusade was carried on in Utah, Idaho and Arizona, wherever polygamists were found.

During the so-called "crusade" men and women were fined and imprisoned, certain Mormon leaders were driven into exile, and a great deal of suffering was inflicted before they could be induced to yield the point and "come within the law"—a law deemed by them unconstitutional, infringing upon religious liberty. In 1890, after the United States Supreme Court had affirmed the constitutionality of the anti-polygamy laws, President Wilford Woodruff, who was then at the head of the church, issued a Manifesto, announcing his intention to submit to the laws of the land in relation to plural marriage, and advising all other Latter-Day Saints to do the same. The General Conference in October sustained the Manifesto and thus withdrew sanction from the further solemnization of plural marriages in the Mormon Church.

A change of feeling ensued. Mormons and non-Mormons, in Utah and elsewhere, became more friendly with each other. Presidents Benjamin Harrison and Grover Cleveland, in successive proclamations, pardoned all polygamists, on condition of future obedience, the escheated Church property was returned, and in Jan. 1896, the Territory of Utah was admitted into the Union.

Later History and Status.—Since that time the Mormon Church has had three Presidents, all former members of the Council of the Twelve. Under President Lorenzo Snow, a natural financier, it was relieved of a heavy burden of debt, resulting partly from escheatment proceedings against Church property under the Edmunds-Tucker Law. Then came President Joseph F. Smith, son of the martyred Patriarch Hyrum Smith, and lastly President Heber J. Grant, the first Utah-born President.

The membership of the Mormon church was reported in 1924 as 535,659, an increase of about 200,000 since 1900. It was estimated that of all church members about 90% in Utah, 53% in Idaho, 24% in Nevada, 21% in Wyoming and 11% in Arizona were Mormons, these being the chief states in which the Church has gained a hold. Missionary work among the Mormons has al-

ways been and continues to be decidedly active. In 1924 the number of missionaries maintained in the United States was 1,092 and the number maintained in foreign lands was 779.

Bibliography.—No impartial and critical history of the Mormons yet exists. The *New York Public Library Bulletin,* Mar. 1909, contains a list of the Berrian collection at that library, which forms the most complete bibliography to be found. A typical Mormon textbook for school use is J. F. Smith (church historian), *Essentials in Church History* (1922). A larger work published by the church is *History of the Church of Jesus Christ of Latter-Day Saints* (1902–12). *See* also J. Q. Adams, *The Birth of Mormonism* (1916); W. E. La Rue, *The Foundations of Mormonism* (1919); Lucy Smith (mother of the Prophet), *Biographical Sketches of Joseph Smith* (1858); I. W. Riley, *The Founder of Mormonism* (1902); *William Clayton's Journal* (1921); H. H. Bancroft, *History of Utah* (1889); O. F. Whitney, *History of Utah* (1892–98); R. M. Werner, *Brigham Young* (1925); F. J. Cannon, *Under the Prophet in Utah* (1911); W. A. Linn, *The Story of the Mormons* (1902); J. H. McClintock, *Mormon Settlement in Arizona* (1921); E. E. Erickson, *Psychological and Ethical Aspects of Mormon Group Life* (1922); F. S. Harris and N. I. Butt, *The Fruits of Mormonism* (1925); J. H. Snowden, *The Truth About Mormonism* (1926). (R. Sm.)

Reorganized Church of Jesus Christ of Latter Day Saints.—This church claims to be the legal successor of the Church of Jesus Christ of Latter Day Saints founded by Joseph Smith. After Smith's death in 1844 a portion of the church rejected the leadership of Brigham Young. A reorganization was partially effected in 1852, and in 1860 Joseph Smith, son of the founder of the church, became its president, continuing till his death in 1914. He was succeeded by his son Frederick Madison Smith, who occupied that position in 1929.

The church rejects polygamy and certain other teachings introduced by Brigham Young and his associates, and adheres to the teachings of the original church as promulgated by its founder. It believes in God the Father, Christ his Son, and in the Holy Ghost, and holds that divine revelation, prophecy, healing, tongues and other spiritual gifts promised in the New Testament are to be enjoyed by the people of God today. It teaches faith, repentance, baptism, the laying on of hands, resurrection of the dead, and eternal judgment. It believes in a literal gathering to Zion, which by revelation is located in Missouri. In organization the church has a first presidency, twelve apostles, seventies, patriarchs or evangelists, bishops, elders, priests, teachers and deacons. It numbers (1929) more than 100,000 members with headquarters in Independence, Missouri.

MORMYR (*Mormyridae*), the name of a family of fishes restricted to the fresh-waters of Africa, soft rayed fishes with abdominal pelvic fins, a small mouth with few teeth, small eyes, restricted gill-openings and small scales. The brain is very large, with a great convoluted cerebellum, and enlargements in other regions that suggest that these fishes have the senses of taste and hearing particularly well developed. (V. Franz, *Zool. Jahrb. Anat. Abth.,* 1911.) A loosely attached bony plate on each side of the head covers a vesicle which communicates with the internal ear; paired electric organs are present in the tail. About 120 species are known, strange-looking fishes, exhibiting great diversity, some having the mouth at the end of a long snout which resembles the trunk of an elephant. Most feed on small prey, or on weeds or organic débris. The Nile species are represented in ancient Egyptian mural paintings and hieroglyphics.

MORNAY, PHILIPPE DE (1549–1623), seigneur du Plessis-Marly, usually known as Du-Plessis-Mornay or Mornay Du Plessis, French Protestant, was born at Buhy in Normandy on Nov. 5, 1549. His mother had leanings toward Protestantism, and, on his father's death in 1559, the family formally adopted the reformed faith. Mornay studied law and jurisprudence at Heidelberg in 1565 and the following year Hebrew and German at Padua. His career as Huguenot apologist began in 1571 with the work *Dissertation sur l'église visible,* and as diplomatist in 1572 when he undertook a confidential mission for Admiral de Coligny to William the Silent, prince of Orange. He escaped the St. Bartholomew massacre by the aid of a Catholic friend, and took refuge in England. Returning to France in 1573, he fought under Henry of Navarre. He was taken prisoner on Oct. 10, 1575, but not being recognized was ransomed for a small sum. Shortly afterwards he married Charlotte Arbaleste at Sedan. Mornay was gradually recognized as the right-hand man of the king of Navarre, whom he represented in England from 1577 to 1578 and again in 1580, and in the Low Countries 1581–82.

After the death of the prince of Condé in 1588 Mornay's influence became so great that he was popularly styled the Huguenot pope. He was present at the siege of Dieppe, fought at Ivry, and was at the siege of Rouen in 1591–92, until sent on a mission to the court of Queen Elizabeth. He was bitterly disappointed by Henry IV.'s abjuration of Protestantism in 1593, and thenceforth gradually withdrew from the court and devoted himself to writing. He founded in 1593 the Protestant academy or university at Saumur, which had a distinguished history until its suppression by Louis XIV. in 1683. In 1598 he published a work on which he had long been engaged, entitled *De l'institution, usage et doctrine du saint sacrement de l'eucharistie en l'église ancienne,* containing about 5,000 citations from the scriptures, fathers and schoolmen. Du Perron, bishop of Evreux, afterwards cardinal and archbishop of Sens, accused him of misquotation, and a public disputation was held at Fontainebleau on May 4, 1600. Decision was awarded to Du Perron. Mornay was deprived of the governorship of Saumur at the time of the Huguenot insurrection in 1621, and died in retirement on Nov. 11, 1623.

His principal works, in addition to *De l'institution, usage et doctrine du saint sacrement de l'eucharistie en l'église ancienne* (La Rochelle, 1598), mentioned above, are *Excellent discours de la vie et de la mort* (London, 1577), a bridal present to Charlotte Arbaleste; *Traité de l'église où l'on traite des principales questions qui ont été mues sur ce point en nostre temps* (London, 1578); *Traité de la verité de la religion chrétienne contre les athées, épicuriens, payens, juifs, mahométans et autres infidèles* (Antwerp, 1581); *Le mystère d'iniquité, c'est à dire, l'histoire de la papauté* (Geneva, 1611). Two volumes of *Mémoires,* from 1572 to 1589, appeared at La Forêt (1624–25).

See the life of Mornay written by his wife for the instruction of their son, *Mémoires de Mme. Duplessis-Mornay,* vol. i. in the ed. of *Mémoires et correspondances de Duplessis-Mornay* (Paris, 1824–25).

MORNING GLORY, the name given to the widely cultivated twining annual, botanically *Ipomaea purpurea,* family Convolvulaceae, native to tropical America. It bears broad, heart-shaped, short-pointed leaves and large funnel-form, blue or purplish flowers, 2 to 3 in. long. There are many races in cultivation, some with double flowers, and varying in colour. The hedge bindweed (*q.v.*) and the small bindweed (*Convolvulus arvensis*), especially when they become injurious weeds, are called wild morning glory. (*See* Convolvulaceae.)

MORNY, CHARLES AUGUSTE LOUIS JOSEPH, Duc de (1811–1865), French statesman, was the natural son of Hortense Beauharnais (wife of Louis Bonaparte, and queen of Holland) and Charles Joseph, comte de Flahaut (*q.v.*), and therefore half-brother of Napoleon III. He was born in Paris on Oct. 21, 1811, and was registered as the legitimate son of Auguste Jean Hyacinthe Demorny, described (inaccurately) as a landowner of St. Domingo. The comte de Morny, as he was called by a polite fiction, passed through the staff college, and served in Algeria in 1834–35 as aide-de-camp to General Trezel, whose life he saved under the walls of Constantine. In 1838 he established a beetroot-sugar industry at Clermont in Auvergne. Soon there were few great commercial enterprises in Paris in which he had not an interest. He sat in the Chamber as deputy for Clermont-Ferrand from 1842 onwards, and was heard with respect on industrial and financial questions. He was admitted to the intimate circle of Louis Napoleon, and he helped to engineer the *coup d'état* of Dec. 2, 1851. After six months of office as minister of the interior, he resigned. He now resumed his financial speculations, and when in 1854 he became president of the Corps Législatif, he used his official rank to assist his schemes.

In 1856 Morny was sent as special envoy to the coronation of Alexander II. of Russia; he there married Princess Sophie Troubetzkoi. In 1862 Morny was created a duke. Morny's influence with the emperor was very great, and his liberal traditions gave him influence with the leaders of the opposition. He died in Paris on March 10, 1865.

See F. Loliée, *Le Duc de Morny et la société du second empire* (1909) and his *Extraits des mémoires de Morny: Une Ambassade en Russie 1856* (1892).

MORO, ANTONIO (*c.* 1512–1575), otherwise known as Sir Anthony More, the eminent portrait-painter, was born at Utrecht in 1512, according to some, but in 1525 according to Karl van Mander in his *Het Leven der Schilders*. He studied his art under Jan Schoreel and after making a professional visit to Italy he commenced to paint portraits in the style of Hans Holbein. His rise to eminence was rapid. In 1552 (or 1542?) he was invited to Madrid by the emperor, Charles V. Two years afterwards he was in London painting the portrait of Queen Mary for her bridegroom, Philip II. of Spain. This picture is his masterpiece, and is preserved in the Prado museum at Madrid. For it an annual salary and, as some suppose, the honour of knighthood were conferred upon him. From 1555–59 he lived in Utrecht. In Aug. 1559 Moro accompanied King Philip to Spain, returning to Utrecht in 1560, in which year his portrait was painted by Jan Schoreel, now at the Antiquarian Society in London. He then entered the service of the duke of Alva at Brussels and died at Antwerp in 1575. His portraits are full of individuality, and characterized by firm drawing. The gallery at Braunschweig and the collections at Althorp and Petworth contain important works by the master.

MORO ("Moor"), a name given by Spaniards to the people of Sulu, an island and an archipelago between Borneo and the Philippines, on account of their religion; but although the Moros are Muslims they were formerly Hindu in part, while the aborigines, probably of Dayak affinities, are traditionally related to have worshipped tombs and stones of various kinds (*see* ASIA, *Farther*), and one genealogy starts with a prophet who sprang from a bamboo. Besides Malays of Minangkubau (*q.v.*), Bugis (*q.v.*) from the Celebes, Samals from Johore, and Ilanuns from Mindanao have settled in Sulu, and the population has been mixed further by innumerable importations of slaves from all the islands in the Philippines, and in Sulu itself there is a traditional division of the slave population into red-, white-, black-, and blue-eyed in the four quarters of the island. The Moros have legal codes drawn up in Arabic and are like other Malays renowned for piracy, fighting, and love of independence.

See Saleeby, *Studies in Moro History,* etc., and *The History of Sulu* (Ethnological Survey for the Philippines), IV. (1908).

(J. H. H.)

MOROCCO (MAROC), a country of Northern Africa, which forms with Algeria and Tunis a large geographical unit, the Djezira-el-Maghrib (Isle of the West) of the Arab geographers, the Barbary of the Europeans; it lies between 35° and 29° N. lat. and between 10° and 1° W. long. Morocco is bounded on the north by the Mediterranean, on the north-west by the Atlantic ocean, on the south by the Sahara, on which side there is no frontier nor definite boundary, on the east by Algeria. On the Algerian border, the treaty of 1845 between France and Morocco fixed the frontier over only about 100 km. from the sea to the point called Teniet-es-Sassi; beyond that there was merely an indication as to which tribes and ksurs or villages were Moroccan and which Algerian; in the Sahara all delimitation was considered superfluous. From this absence of definite boundaries and from the fact that France did not claim the natural frontier of the Muluya many difficulties have arisen. They were brought to an end by the establishment of the French protectorate over Morocco in 1912, and the question has lost much of its interest. The total surface of Morocco included within a line drawn through the Algerian frontier, Beni-Abbes, Tamgrut and the course of Wad Draʻa is 519,980 sq.km. or 203,117 square miles. (French zone, 415,000 sq.km.; Spanish zone, 104,600 sq.km.; international zone of Tangier, 380 sq.km.)

Physical Geography.—From the point of view of structure and relief, one may distinguish three great divisions; (1) the coastal massifs which border the Mediterranean, separated from the Atlas system by the depression of the Sbu and its right bank affluents; (2) the plains and plateaux of western Morocco; (3) the Atlas and its various chains towards the Sahara.

(1) The coastal massifs, almost unknown until recent years, have now been explored; they correspond, from the political point of view, with the zone of Spanish influence. They comprise three regions, the Jebela in the west, the Rif in the centre, and the Garet on the east. The western portion of the coastal massifs, as far as the valley of Wad Nkur and the Bay of Alhucemas, belongs to the Alpine fold system; crystalline and Palaeozoic rocks outcrop on the coast; then comes a much folded axial zone, made up chiefly of Liassic and Nummulitic limestones; finally there is a frontal zone of southward-directed overfolds which constitute the Pre-Rif. The chains are arranged in an arc of a circle, and form the counterpart of the Betic Cordillera (Sierra Nevada), to which they are related geologically in spite of the break at the Straits of Gibraltar. The higher summits lie between Chechaouen and the valley of the Nkur (Jebel-Tiziren, 2,500 metres). The country is dissected by deep ravines which give it, in places, a chaotic aspect. The slopes towards the Mediterranean are sharp, and the rivers rapid. The height of the chains, added to their exposure to the westerly wind, produces a marked contrast between the Jebela, moister and more fertile, and the Rif, where the vegetation is scantier. The coast, as usual in the Mediterranean, is mountainous and cut into arc-shaped bays; on the Straits of Gibraltar are Tangier, Ksar-es-Serir and Ceuta; between Ceuta and the Nkur lie the bays of Tetuan, of Badis (Peñon de Velez) and of Alhucemas. To the east of Wad Nkur the folds are well marked and the structure of the country much more simple; the dryness increases, and in the Garet the steppe reaches nearly to the coast. To the east of Cape Tres-Forcas lies the Bay of Melilla, near to which stretches the sebkha of Bou-Erg, then comes the bay sheltered by the Cap de l'Eau, beyond which lie the Zaffarine islands, not far from the mouth of the Muluya.

(2) The plains and plateaux of western Morocco stretch from the Atlantic to the foot of the Atlas. They include two different regions: El Gharb and El Huz, or the ancient kingdoms of Fez and Marrakesh. El Gharb has a varied relief, the influence of the coastal massifs extending as far as Fez and the massifs of Zarhun and Zalagh; the hills of El Gharb frame the alluvial plains of the Lukkos and the Sbu, on the estuary of which stand the ports of Larache and Mehedia respectively. The great east to west depression which links Algeria and Morocco by Ujda, Taza, Fez and Meknes, and which separates the coastal massifs from the Atlas, opens on the Atlantic by the plain of the Sbu; it is the corridor of Taza, an important feature of the geography of Morocco. The coast is flat, bordered with dunes and marshes. The Sbu, rising in mid-Atlas under the name of Wad Guigo, receives near Fez the Innauen, which brings it the waters of the corridor of Taza; then the Werra, which drains the southern slope of the coastal massif, lastly the Wad Mikkès, Wad Rdom and Wad Beht, left bank affluents. In its lower course the Sbu meanders and spreads among the marshes or *merdjas;* it has an average discharge of 40 cubic metres (minimum 13 cubic metres); it is tidal as far up as Kenitra and more or less navigable to Mechra-bel-Ksiri. The triangular stretch of country between the Atlantic coast from Rabat to Cape Guir and the Atlas constituted the Moroccan *meseta,* the subsoil of which is formed of anciently folded Archaean and Palaeozoic rocks incompletely covered by thin layers of Secondary and Tertiary age. The ancient rocks in the form of dissected schists and granitic bosses, dominate the region of the Zaër and of the Zemmour, which stretches along the left bank of the Sbu between Meknes and Rabat, the same structure continues farther east in the plateau of Ulmès and in the region of the Zaïan as far as the upper valley of the Umm er Rbiʻa. The retreat of the sea having taken place in successive stages, more and more ancient terraces are found as one penetrates the interior, as the altitude increases from 100–150 metres to 600–700 metres. The coastal plain (country of the Shawuja, of the Dukkala and of the Abda), 60 to 80 km. wide, is very fertile, especially the black clay lands called *tirs;* further from the sea one passes gradually to the steppe. Then cultivation begins again at the foot of the Atlas, thanks to irrigation. The rivers of the *meseta* run in a small number of ravines deeply dissecting the plateau. The Bu-Regrag, reaching the sea at Rabat is unimportant. The Umm er Rbiʻa, on the contrary, is the largest river of north-west Africa; rising in mid-Atlas, it runs at first in a deep narrow tectonic valley as far as Khenifra.

then crosses the plain of Tadla, receives the Wad-el-Abiad and the Tessaut, both rising in the high Atlas, encases itself deeply from Mechra-ben-Abbu to Bu-Lauan and reaches the sea at Azimur; its average discharge is 60 cubic metres, minimum 35 cubic metres. The much smaller Tensift drains the plain of Marrakesh; its left bank affluents, the Wad Rdat, Wad Reraïa, Wad Urika and Wad Nfys, bring it the drainage of the high Atlas. The coast of the *meseta* is extremely monotonous and even, and is, in general, edged with dunes with several shallow lagoons. The surf is very strong, and before the French protectorate there were only open roadsteads.

(3) The Moroccan Atlas (*see* ATLAS) is bounded on the north by the plains and plateaux of the Atlantic slope and by the corridor of Taza; on the south it slopes down towards the great furrow of the Wad Dra'a, beyond which stretch the platforms of the Sahara. It is usual to distinguish three chains of the Moroccan Atlas running south-west–north-east; the high Atlas, flanked on the north by the mid-Atlas and on the south by the anti-Atlas; the two latter being virgations of the high Atlas. The mid-Atlas lying between the Moroccan *meseta* and the *meseta* of Oran is, in general, only slightly folded; under the name of mid-Atlas are included very different regions, to the west of Ulmes, an Archaean peneplane dissected by erosion, to the east of Ulmes Jurassic limestone plateaux covered by recent Pliocene and Quaternary eruptive rocks (country of the Beni Mtir and of the Beni-Mgild), and, lastly to the south and the east, the chain properly speaking, which dominates the valley of the Muluya (3,800 metres at Mussa-ou-Salah). The mid-Atlas, where snows are abundant, is the chief source of water supply of Morocco; from it flows the Sbu, Wad Beht Bu-Regrag, Umm er Rbi'a; inhabited by large Berber confederations, it is also the stronghold of resistance. In the angle formed on the east by the mid-Atlas and high Atlas lies the upper valley of the Muluya, a high plain 1,500 to 1,700 metres in altitude, which merges on the east into the Moroccan Dahra, itself continued in the steppes of the province of Oran. The chief affluent of the Muluya is the Mellulu; it diminishes owing to evaporation in the steppe-land, in some seasons its discharge is abundant, in others the stream is nearly dry; the average discharge at Gercif is reckoned as 6 cubic metres. The high Atlas is divided into two parts, separated by the Tizi-n-Telremet (Tizi is the Berber word for "pass"). In the west are both primary and tertiary folds; schists and porphyrics predominate. To the south of Marrakesh rise the highest peaks in Morocco and in the whole of North Africa; Tubkal (4,225 metres), Wenkrim (4,173 metres), Likumt (3,906 metres); this great chain forms a barrier separating two distinct zones and proving a serious obstacle to communications. To the east of the Pass of Teluet or Pass of the Glaoua (2,600 metres) crossed by the road from the Dra, the Atlas seems to be composed mainly of Jurassic limestones; the outlines are softer, though the altitude is still about 3,000 metres, rising to 3,745 metres in Jebel Aïachi. To the east of the Tizi-n-Telremet (2,200 metres), crossed by the road from Fez to Tafilelt, the Atlas dies down and breaks up into several series of heights separated by plains, and it eventually joins the Sahara Atlas of Algeria. To the south of the high Atlas, a transverse chain, the Sirua (3,000 metres) joins the high Atlas to the anti-Atlas; it is a volcanic massif with crystalline substratum. The anti-Atlas (2,000 metres) has a distinct individuality only between the Sirua and the Atlantic, on the east it is scarcely a plateau, little higher than the surrounding country. The valley of the Sus is framed by the high Atlas, the Sirua and the anti-Atlas. East of the Sirua the drainage is to the Dra'a, which receives the Wad Dades; after the great elbow which it makes south of Tamgrut, it receives only intermittent feeders. The Wad Ziz, which receives the Todgha, called Ferkla and Gheris in its lower course, ends in Tafilelt. These Saharan wadi coming down from the Atlas are marked out by ribbons of irrigation-culture and by oases.

Climate.—The climate of Morocco is a Mediterranean one, modified by the Atlantic. The climate is more favourable than that of the rest of Barbary because the country is bathed by two seas and its high mountains keep the snow longer than elsewhere. The temperature is equable and quite cool for the latitude on the west coast; at Mogador the January mean is 61·5° F and the August mean 72·3°. Towards the interior the climate rapidly becomes more continental, with increased winter cold and very great summer heat; at Fez the January mean is 50° and that of August 80·6°. The rainy season is from October–November to April–May; it becomes shorter and less severe as one goes south towards the belt of the trade-winds. The mean annual rainfall is 829 mm. at Tangier, 494 at Rabat, 391 at Casablanca, 404 at Mazagan, 360 at Mogador; on the coast the dew is very abundant. Towards the interior the rainfall diminishes (Marrakesh, 279 mm.), but it is higher on the western slopes of the mountain massifs. The country of the Jebala, the western mid-Atlas, receives the highest rainfall; the regions of Meknes and of Fez, the corridor of Taza, open to the wet westerly winds, also have abundant precipitation (Meknes 555 mm., Fez 537 mm., Taza 600 mm.). Eastern Morocco, on the contrary, cut off from the moist winds by the great chains, is less favoured (Melilla 481 mm., Ujda 357 mm., Berguent 157, Beni-Unif 154, Bu-Denib 130). Snow falls several times a year at altitudes of above 1,000 metres and disappears from the high peaks only at mid-summer.

Vegetation.—The vegetation reflects the diverse influences of the climate; it is clearly Mediterranean in character; in the south a certain number of plants from the Canaries are found. The presence in the south-west, from Umm er Rbi'a to Wad Noun, of the argana (*Argania sideroxylon*), which belongs to the family Sapotaceae, is a remarkable botanical peculiarity. In the mountains, the vegetation takes on a more northerly character, many central European species and a certain number of Alpine plants occurring there. The well-watered regions are covered by forest except where it has been destroyed by man, as is the case in the plains of the west. The dominant species are oaks and conifers. The cork-oak constitutes the great forest of Mamora (125,000 hectares); in the mid-Atlas there are fine cedar forests (150,000 hectares); the evergreen oak, the *Zen* oak, the thuya and the juniper, are widespread. The argana forms a widely-spaced growth, a kind of forest-steppe. The forest passes into maquis, this into steppe, grassy when the rains are sufficient, and the steppe into desert. The fauna also is Mediterranean; the lion has disappeared, the panther and the macaque are common, as are also the jackal and the fox (fennec). Antelopes (gazelles) are numerous.

Population.—The indigenous peoples of Morocco are Berbers; they call themselves *Imaziren.* The Berber name covers very different human types; the most widely-spread seems to be akin to that of the southern Europeans (Ibero-Ligurian race); there are also amongst them Hamitic elements and some blond peoples whose type resembles the Nordic. There may be several successive layers of Berbers. There are three great groups of Moroccan Berbers, which differ from one another in language, race type and customs; the northern or Rif people, who inhabit the coastal massifs, the central or Berber group, who inhabit the mid-Atlas, and the southern or Chleuh group, who live in the high Atlas and in the Sus. In the plains the Berbers have adopted the Arab language and the Muslim religion, but Morocco, on account of its geographical situation, has been less influenced than Tunisia and Algeria from the eastern Mediterranean; tribes coming from Egypt and Asia have reached Morocco slowly and with difficulty, and the great chains of the mid-Atlas and high Atlas have proved effectual barriers, so that Arabs are met with only in the eastern steppes near the Algerian frontier. About half the indigenous population of Morocco speaks Berber dialects. The natives other than the town dwellers are divided into nomads and sedentary; mode of life has no connection with race, for many Berbers are nomads, especially in mid-Atlas; they have store-castles called *agadir,* for their harvests. Morocco has about 100,000 Jews, amongst whom may be distinguished the old established Jewish settlers and the Spanish Jews (*Guerush Castilla*). The slave trade has introduced a large number of Sudanese, who have influenced the complexion of the populations of the south.

Before the establishment of the French protectorate, there was a distinction in Morocco between the *bled-makhzen,* the region

in which the sultan had succeeded in making the natives pay tax and accept his *kaids*, and the *bled-siba*, which evaded his authority. The two regions had uncertain and fluctuating boundaries, the extent of the *bled-makhzen* depending on the varying powers of the sultan, and at times being reduced to the immediate neighbourhood of certain towns. The Berbers, jealous of their independence and lacking social classes among themselves, were, in general, impatient of any authority; they remained under tribal organization and were administered by small local assemblies called djemaâs; there was a permanent state of war between the tribes.

According to the census of 1926, the French zone of Morocco numbers 4,229,000 inhabitants; there are about 600,000 in the Spanish zone and 72,000 in the international zone, giving a total of about 5,000,000. The population is most dense in the plains of the west, El Gharb and El Huz, and on the border of the mountain massifs, the regions with a great altitude not lending themselves to permanent habitation. The neighbouring regions of the Sahara and of Algeria, except in the very limited areas where irrigation-culture is possible, permit only the low density, characteristic of nomad lands. There is a certain number of important towns; the chief are Marrakesh (pop. 149,263), Casablanca (106,608), Fez (81,172), Rabat (38,044), Meknes (29,930), Safi (26,914), Sali (20,965), Ujda (19,976), Mazagan (19,159), Mogador (18,401). In the Spanish zone Melilla has a population of 52,000, Tetuan 43,000, Ceuta 40,000, El-Ksar 40,000, Larache 20,000. Tangier, in the international zone, has 56,000 inhabitants.

In 1907, apart from the ancient Spanish possessions, there were not more than 5,000 Europeans in Morocco, of whom 4,000 were in Tangier. European immigration has been very rapid since the establishment of the protectorate. In the French zone there are 104,712 Europeans. But this population is, up to the present, essentially urban. Casablanca has 34,984 Europeans, Rabat 13,916, Ujda 8,780, Meknes 4,923, Kenitra 3,901, Marrakesh 3,652, Fez 3,559. Casablanca, in particular, which was only a poor hamlet before the French protectorate, has had an extremely rapid growth. Marshal Lyautey planned the European towns on the best hygienic and aesthetic lines, while respecting the native settlements. The rural population of European extraction is, up to the present, represented by about 2,000 colonists, living on their land and numbering with their families 5,000 to 6,000. Of the 104,712 Europeans in the French zone, 74,558 are French (including 8,335 French subjects and persons formerly under French protection), and 30,154 foreigners (15,141 Spanish, 10,300 Italian, 4,713 Europeans of various origin). To the Europeans of the French zone must be added about 100,000 Europeans, nearly all Spanish, in the Spanish zone (Melilla 30,000, Ceuta 25,000, Tetuan 8,000) and 15,090 in the zone of Tangier (of whom 9,000 are Spanish and 4,000 French).

Products.—Morocco is essentially an agricultural country. Of 500,000 sq.km. about 100,000–150,000 are cultivable, and 25,000–30,000 are effectively cultivated. The regions most favourable to agriculture are El Gharb, the valley of the Sbu, the provinces of the Shawiya and of the Dukkala, the districts of Meknes and of Fez and the valley of the Werra. The natives cultivate chiefly cereals and trees. The cereals grown are hard wheat (six to seven million quintals), barley (seven to eight million quintals), maize (one million quintals), sorghum (300,000 quintals). The natives also grow beans, lentils, chick-peas, flax, hemp, coriander and cummin. The Berbers, like all Mediterranean peasants, are essentially orchard-growers; the chief fruit trees are the olive, the fig, the orange, the pomegranate and the almond. The most important olive groves are in the districts of Marrakesh, Meknes, Fez, Wazzan, Shishawen and the Werra. The almond is grown chiefly in the district of Marrakesh and of the Sus, the orange at Tetuan and Larache, the walnut in the high Atlas. In the Sahara the main cultivation is that of the date-palm; the chief oases are those of Tafilelt and of the valleys of the Ziz, the Todgha, the Gheris, the Ferkla, the Dra'a and the Sus. The natives are stock-raisers; cattle are reared chiefly in El Gharb and the Zaïan (two millions in the French zone), sheep chiefly in the Tadla (nine millions). To these must be added goats (three millions), horses 200,000, especially fine in the Abda and the Chiadma, mules, and, in the Saharan region, camels.

In order to increase production, it is necessary first to intensify cultivation where it already exists, which could be effected, especially in the case of the cereals, by preliminary ploughing and by *dry-farming;* by the use of machinery and manures—by better methods of pruning fruit trees and of raising cattle and sheep. In the second place, it is necessary to increase the cultivated area, which, before the establishment of the protectorate, was extremely limited, owing to insecurity, to the absence of communications and to prohibition of exports. Finally, new crops might be introduced: bread-wheat (700,000 quintals), potatoes and castor-oil are spreading, as well as market gardens (13,000 hectares). It does not seem profitable to develop the growth of the vine to any extent in Morocco, for it would be difficult for it to compete with the products of France and Algeria; cotton, on the contrary, tried particularly at Berkane in eastern Morocco, seems susceptible of some extension. Experiments have been made in the growing of flax for fibre (up to the present it has been grown only for linseed), of sisal and of sugar-beet. Many plans for irrigation works, which would greatly increase the agricultural wealth, are being carried out; they affect chiefly the Umm er Rbi'a, the Sbu, Wad Beht, the Muluya, and the torrents of the high Atlas.

Agricultural progress is linked with that of the European colonization. It has become possible for Europeans to acquire property only since the establishment of the protectorate. The system of registration of land has somewhat reduced the chaotic conditions of native proprietorship (65,000 hectares registered). Land held in common by a tribe is inalienable. Demesne lands may be sold and form lots of large, medium, or small colonization. There are no free grants of land, and purchasers are under obligation to utilize the land bought. From 1918 to 1928 the office controlling agriculture has allocated, under these conditions, 190,000 hectares, in 1,100 lots. Altogether, the area owned by Europeans is 644,000 hectares, of which 608,000 are in French hands; but only a little of this is cultivated in European fashion. Forests occupy 1,900,000 hectares; their chief product is cork. The value of the fishing of the Moroccan ports is nine million francs.

Magnificent deposits of phosphate of lime, the exploitation of which has been reserved to the Moroccan Government, have been discovered; they are superior to those of Algeria and Tunisia, and are practically illimitable in quantity. They are worked in the district of Wad-Zem, near Tadla, at Kurigha and at El-Borudj; exploitation began in 1921, with 8,000 tons and now reaches 1,400,000 tons. Fine iron ores (haematite) are worked in Spanish Morocco, near Melilla in the district of the Beni-bou-Ifrur (250,000 tons per annum). An important deposit of manganese at Bu Arfa, west of Figig, is being exploited. Iron has been noticed in several other places, notably near Kenifra, lead and molybdenum in the high Atlas, zinc, copper and tin. Borings have been made for petroleum, notably near Petitjean; a small coalfield is being worked at Kenadsa, near Colomb-Bechar, on the Algerian frontier, and another has been found at Djerada, south of Ujda; but Morocco is still poor in mineral fuels.

Native industry is essentially home-industry; in spite of the encouragement it has received, it can barely survive European competition except in the making of carpets and Turkish slippers. The chief European industrial establishments are flour-mills, oil-mills, electric power stations and manufactories of implements.

Communications.—Morocco possesses 5,000 km. of good motor-roads, which link the ports and connect them with the two capitals of Fez and Marrakesh and with Algeria. During the World War of 1914–18, a network of military railways (of 0·6 metre gauge) was built, which greatly aided pacification and trade. This network is being gradually replaced by normal gauge lines, but it is still used for military operations in districts which are newly pacified, and as an adjunct to the ordinary railways in the other parts. The railways with normal gauge (1 metre 44) include: (1) The line from Tangier to Fez, opened in 1927; it is 310 km. long, of which 15 are in the Tangier zone, 91 in the Spanish zone and 204 in the French. (2) The line from Casa-

blanca to Fez runs through Rabat, Kenifra, Petitjean and Meknes; it is 322 km. long, of which 111 are on the Tangier–Fez line, which it joins at Petitjean. (3) The line from Casablanca to Marrakesh, finished in 1928, 250 km. long; at Ber-Rechid a branch line of 135 km. goes to Wad-Zem and to the phosphate workings. To complete essential arterial lines in Morocco the 0·6 metre line from Fez to Ujda must be replaced by one of normal gauge. A minerals line is being built from Bu-Arfa to Ujda. In the Spanish zone narrow-gauge lines connect Larache to El-Ksar (36 km.), Ceuta to Tetuan (41 km.), Melilla to San Juan-de-las-Minas and to Tistutin (50 km.).

A harbour is being built at Tangier, on the Mediterranean coast; to the ancient ports of Ceuta, Melilla and the Zaffarines the Spaniards have recently added that of Villa-Sanjurjo in the Bay of Alhucemas. On the Atlantic coast, the harbour of Larache, at the mouth of the Lukkos, has been improved. At Casablanca a new embankment 2,000 metres long, has been built in water 12 metres deep, to shelter the deep-water basins in which ships can unload at the quays; there are special installations for phosphates; Casablanca has 80% of the trade of the French zone (1,824,000 tons). Less important alterations have been, or are being, made at the other ports, which are, from north to south: Mehediya and Kenitra, ports of the Sbu, one at the mouth, the other on the river; Rabat, at the mouth of the Bu-Regrag; Fdla, a little fishing port; Mazagan, Safi and Mogador, which share the export trade of south Morocco and the trade of Marrakesh, and Agadir, the port of the Sus.

The external trade of the French zone of Morocco, which was 95 millions of francs in 1910, 222 millions in 1913, 1,269 millions in 1921, had risen to 2,644 millions in 1927 (imports 1,793 millions, exports 851 millions), representing 2,302,000 tons of merchandise. The difference between the amount of imports and exports arises from the fact that Morocco imports its tools and has not yet fully developed its production, and this difference tends to decrease. The chief imports are sugar (278 millions), cotton goods (210 millions), tea (92 millions), fluid fuels (84 millions), postal packages (80 millions), machinery of various kinds (80 millions), motor-cars (70 millions), iron and steel goods (50 millions), coal (42 millions). The chief exports are phosphates (161 millions), cereals, wheat and barley (175 millions), eggs (82 millions), skins (76 millions), wool (70 millions), almonds (49 millions), linseed (22 millions), sheep (20 millions), cattle (16 millions). France is responsible for 1,562 millions of the trade of Morocco (imports 1,124 millions, exports 438 millions). Great Britain has 268 millions (imports 194 millions, exports 74 millions), Spain has 169 millions (imports 22 millions, exports 147 millions) and the United States 115 millions (imports 100 millions, exports 15 millions). Trade in the Spanish zone reaches 111 millions of pesetas (imports 94, exports 17), the share of Spain being, imports 52 millions and exports 15 millions. The trade of the zone of Tangier realized 175 millions of francs (imports 146, exports 29), the share of France being 87 millions.

BIBLIOGRAPHY.—Sir Lambert Playfair and R. Brown, *Bibliography of Morocco* (London, 1892); Augustin Bernard, *Le Maroc* (6th ed., Paris, 1922); P. Ricard, *Le Maroc,* Guide bleu (Paris, 1925) (English translation); J. Hardy et Célérier, *Les grandes lignes de la géographie du Maroc* (Paris, 1922). Periodicals: *Archives Marocaines, L'Afrique française, Hespéris, Bulletin de la Société de géographie du Maroc, Annuaire de statistique générale du Maroc.* Maps of Morocco, scale 1-1,000,000 and 1-2,000,000, issued by the French army geographical service. (A. BE.)

Defence.—Morocco cannot be said to possess an army in the modern sense of the term, but the tribesmen are seldom lacking in arms and ammunition, and the physical features of the country, with its difficulties of communication, favour their resistance to invaders of their territory. Constant wars, offensive and defensive, have been waged against Spanish possessions on the coast (*see* SPAIN: *Army*), and also, offensive and defensive, against the French, at first in Algeria (1844) and of late in Morocco. An approach to a regular army was formed by certain hereditary troops provided by the Maghzen tribes, the Bolchara (blade), Udaia (mulatto), the Ashragah and Ashrardah (white), the Gaish, Malchhaznia (mixed), all these being horsemen. The infantry (Askaria) were for the most part rough levies. The old army has now dwindled down to a Sultan's body-guard.

Since the latest Riff war, the French Resident General has controlled the military forces in the French zone, which consist of French and French colonial troops, reinforced by various native levies. Provision was made in 1927 for an army of 85,525, including 2,820 officers in Morocco. The Tangier zone is demilitarized. Pending the establishment of a proposed gendarmerie, order is maintained by a force of 780 native *tabors,* under French and Spanish control. The forces in the Spanish zone are similar to the French. Details are given under SPAIN: *Colonial Forces.* (G. G. A.)

HISTORY

Numerous archaeological remains, in particular a series of remarkable megalithic structures, prove the high antiquity of human occupation in Morocco. But the earliest historical records relating to this region are those of Hanno's *Periplus,* which mentions that Carthaginian colonies were planted along the coast. In the last century B.C. Moroccan Berbers are found supplying troops to Pompey or Sertorius, and later, under Augustus, they became incorporated in the Roman province of Mauretania (*q.v.,* and also AFRICA, ROMAN). But the Roman province reached only to the Bū Ragrāg, on which Sala, now Salli, was its outpost; Volubilis, near Mequinez, of which impressive remains are still visible, being its principal, if not its only, inland city. In the fifth century A.D. the country became subject to the Vandals and its fortunes form part of the general history of North Africa.

The coming of the Arabs under 'Oqba ('Okba) in 682 was a turning point in this history, though it was not till 20 years later that his successor, Mūsa ibn Nōsair, undertook a successful expedition as far as Tafīlālt and the Dra'a. The force of 10,000 Arabs and Egyptians with whom Tariq (Tārik) ibn Zāid held the Tangier district in 710 was trebled by the enrolment of the Berbers, who enabled him next year to invade Spain. But in 739 the Moroccan Berbers successfully revolted, setting up their first independent ruler, Maisara. Their kinsmen in Spain followed suit with equal success, and though subdued for a time, they retained their independence in certain parts till the 11th century, when, as masters of Granáda, they subjugated their implacable foes, the Arabs; and finally, under the Murābti and Muwāḥḥadi dynasties, conquered all Mohammedan Spain.

The recorded history of the Moorish empire commences with the settlement near the Roman ruins of Volubilis in A.D. 788 of Idrīs the elder (Idrīs b. Abdallah), one of the fugitive descendants of Mohammed during the struggles between rival claimants of the caliphate. Islām had then been established in these parts for 80 years, and Idrīs and his son, Idrīs II., the builder of Fez, united the Berbers into a kingdom. Their line controlled a limited portion of northern Morocco for nearly two centuries, in part supplanted by the Miknāsā in 922, until displaced by the Maghrāwā in 988. These two dynasties were exterminated in 1061 by Yūsef I. (bin Tashfīn), founder of the Murābti dynasty of Berbers (Almoravides), who annexed the remainder of Morocco and Tlemçen. Their principal existing monument is the city of Marrākesh. In 1149 the Murābti power was overthrown by another religious leader, 'Abd el Mumin at the head of the Muwāḥḥadi horde (*see* ALMOHADES), under whom the Moorish empire reached its zenith at the close of the 12th century. It then included, in addition to the Murābti realm, what now are Algeria, Tunisia and Tripoli, extending to the frontier of Egypt, which they were prevented from occupying by the rise of Saladin. Before the middle of the 13th century they had been driven out of Spain, and had lost all but what is now known as Morocco, whence, between 1217 and 1269, they were ousted by the Beni Marīn (Marinides). (*See* ALMORAVIDES and ALMOHADES.)

Beni Marīn Period, 1213–1524.—The new dynasty differed from the two which had preceded it in being frankly part of a Berber tribe, the Zenāta, who carved out a kingdom for themselves. Having assisted the Murābtis and Muwāḥḥadis respectively at the battles of El Arcos (1195) and Las Navas (1212), the defection of their amīr on that occasion offered an opportunity for Abd-el-Haḳḳ, the son of their general, to attempt the over-

throw of the reigning house. At first the Beni Marīn professed allegiance to Tunis, where the Hafsis, a branch of the Muwāḥḥadis, had thrown off the Moorish yoke and secured acknowledgement in northern Morocco and parts of Spain. But they were soon in a position to proclaim complete independence, and by the time that Abu Bakr, the third son of Abd-el-Haḳḳ to succeed him, died, in 1258, they held sway over all that is now known as Morocco, and 1269 saw the death of the last Muwāḥḥadi prince.

On the death of Abu Bakr there succeeded Yākūb II., one of the few amīrs of Morocco who have left a name for just administration and for philanthropic undertakings. Although of strict religious habits, he displayed no bigotry, studying philosophy, and entering into friendly intercourse with Europeans, whom he encouraged to trade with Salli. In 1261, 1275 and 1277–79, he undertook successful expeditions to Spain, and again in 1284, this time, in alliance with Alphonso of Leon, against his rebel son Sancho. But Alphonso dying during the struggle, Yākūb found himself master of his country, and Sancho had to acknowledge his suzerainty. All Mohammedans within his realm were freed from all taxes, and all the Arabic manuscripts of the country—13 loads—were despatched to the college Yākūb had built in Fez.

But Yākūb did not live to reap the benefits of his conquest, which were enjoyed by his son, Yūsef IV. (1286), who was courted by his father's old foes, entering into amicable relations with Tunis, Egypt, Arabia and the neighbouring European States. With the contemporaneous Beni Zeiyan dynasty of Tlemçen, sworn foes of his house, however, he was still at war when stabbed (1307) in the new town of Tlemçen, which he had built while conducting a siege of the old town. A second siege was begun in 1335, and Tlemçen fell in 1337 to the fourth ruler of the dynasty, Ali V., Abu 'l Hasan, better known as "The Black Sultan." Unsuccessful in his invasion of Spain and Tunisia, Ali had eventually to abdicate in 1351 in favour of his rebel son, the famous "Abu Ainān," Fāris I., who, during a short reign recovered Algeria and Tunisia.

The Beni Marīn were soon driven back, till a few years later Tlemçen alone remained to them, and this they held only till 1359 (*see* TLEMÇEN). Thereafter their empire became habitually divided between rival claimants, and the Portuguese began to obtain footholds on the coast. (B. M.; K. A. M.)

The Wattasi Dynasty.—The Wattasi dynasty which succeeded the Beni Marīn was short lived (1471–1548), the reign of its founder, Sa'id III. "El Wattass," and of his son Mohammed VIII., "the Portuguese," being marked by the conquest of Granada by Ferdinand and Isabella the Catholic (1492), the first expulsions of the Moors from Spain (1502) and the first conquests of Spain and Portugal in North Africa (Melilla, Peñon de Velez, and all the Atlantic ports, except Salle-Rabat). Tetuan was founded by the Moorish refugees from the Continent, who also brought back to Rabat and Fez the Andalusian taste for fine monuments.

The Sa'adi Dynasty.—As a reaction against the conquests of the Christians, a popular and religious movement gave their chance to a new family of "Sharifs," or nobles, more or less of Arab descent (as contrasted with the native Berber), and more or less related to Mohammed by the female side. The Sa'adi dynasty (1550–1668) rose in the Dra'a district, on the Sahara slope of the Atlas. They established themselves independently in Marrakesh from 1524, and their first act was to launch a *jihad,* or "holy war," against the Portuguese. By the end of the 16th century, they had reconquered most of the Atlantic ports.

El Dehebi and the Makhzen System.—After Abd-el-Malek—who perished at the famous "battle of the three kings," together with King Sebastian of Portugal, and Mohammed XI. whom he had deposed,—Ahmed IV. "El Mansur," "the Victorious," also called "El Dehebi," "the Golden," conquered Timbuktu, and brought back great riches (especially slaves and gold, whence his name) from the Sudan. He also proved to be a good administrator, in so far, at least, as the *Makhzen* system of government can be considered as good. It consisted principally in "pitting" certain tribes against the rest (*Bled es-Siba*), by exemption from taxes and tithes;—a doubtful procedure of course, but which finds an explanation and excuse in the geographical features of the country, in the natural anarchy of perpetually warring tribes, and in the fundamental opposition—which can be traced all through the history of Morocco—between the settled urban population and the nomads. "El Dehebi" was also a great builder, erecting, among other monuments, the marvellous pavilion, containing the tombs of the dynasty, in the palace of El Bedi, at Marrakesh, which ranks to this day as one of the most wonderful works of art of Northern Africa.

His most remarkable successor was Zidan, who reigned 20 years (1608–28), and also employed a number of European artisans in the palaces he constructed, or completed.

The Filali.—A fresh outburst of fanaticism partly provoked by the friendship for Europeans shown by Mohammed XIII. (1636–54), the last but one of the Sa'adians, but particularly inflamed by a certain number of *marabouts* (Islamic "saints"), who have always played a great part in the political and religious movements of North Africa, favoured the ambitions of a new dynasty. The Filali or Hassani,—Berbers,—also (more or less) of mixed Arab descent, sprang from one of the oases of Saharan Morocco, the Tafilalt. Their first representative, Mohammed XIV., captured Fez in 1649; though the dynasty only established themselves in Marrakesh (the home of their predecessors) in 1668. The dynasty is still on the throne.

Moulay Ismail, "The Bloodthirsty."—The two brothers of the founder, Rashid II. (1664–72), and especially Moulay Ismail, "the Bloodthirsty" (1672–1727), solidly established their power. Ismail,—though amply deserving his surname,—had the parts of a real sovereign. After his long reign of 55 years he left Morocco, notwithstanding many revolts, a more united empire than it has been ever since, until the French Protectorate. This was due principally to his body-guard (which exists to this day; though its *rôle* is no longer the same) of Negro Slaves (*Abids*) whom he recruited and settled close to his capital, Meknes,—and distributed in *kasbahs* (forts) throughout the country, furnishing them with negro wives, and giving a special position to their sons,—a selection of whom were each taught a craft,—and who were bound to him besides by a special religious tie: an oath on a copy of the book of *hadith* (sayings of Mohammed), by El Bokhari. Whence another name of the body-guard: the Bokharis. He also employed a foreign legion of renegades. Many hundreds of sons and countless daughters were born to him in a harem rivalling that of Solomon, for which he even asked a French princess of royal blood, Mademoiselle de Conti, a daughter of Louis XIV. by Louise de Lavallière (1699).

His death was followed by a period of disorders which only really ceased under Mohammed XVI. (1757–90).

European Intercourse and the Salli Rovers.—Ever since the 16th century commercial relations between Morocco and Europe have been maintained. Though expelled from the other Atlantic ports conquered by her at the end of the 15th century Portugal kept Mazagan up to the year 1769. Ceuta and Melilla were retained by Spain after the loss of her other settlements. She had given Tangier up to England in 1663. Moulay Ismail, who had reconquered Larache from the Spaniards, retook Tangier in 1683. Notwithstanding the piratical raids of the famous Salli rovers (and other pirates) and the many indignities to which thousands of Christians,—sailors, merchants, peasants and even women being often kidnapped on the Spanish or French coasts, even as far as Devon and Cornwall,—were subjected as slaves in Morocco itself, economic intercourse never ceased; and it was considered of sufficient importance to pass over the supplementary humiliation of foreign envoys being received on foot and bareheaded by mounted sultans under umbrellas. On the other hand, certain treaty privileges were conceded to foreign merchants, the coming of whom was encouraged by certain sultans at least This was the origin of certain rights confirmed by treaties which survived into the 20th century and became, of late years, the source of many difficulties between the foreign Powers themselves. The Government of Louis XIV., which always took a resolute stand against the Turkish corsairs on the Algerian coast

(Algiers was bombarded three times between 1682 and 1687), also despatched a fleet to Salli. A treaty of commerce was signed with Moulay Ismail on the occasion of the first embassy he sent to France (1682). During the first half of the 18th century, Dutch and English trade was to the fore; the latter profiting greatly by the warehouses established in Gibraltar after its taking by Sir George Rooke in 1704. But French influence reasserted itself by the bombardment of Larache and Salli (1765), and a new treaty (1767) was concluded, confirming that of 1682 and giving the French Consuls precedence over those of other nations.

THE 19TH CENTURY

The Conquest of Algeria.—With Abd-er-Rahman II. (1822–59), a new phase begins, to which the conquest of Algeria by France in 1830 soon gave a particular leaning. The Moors renounced all claim on the kingdom of Tlemçen, a remnant, with the kingdom of Fez and the kingdom of Tunis, of the vast Empire of the Moroccan Almohades. But infractions of the agreements then entered into led to the war of 1844, in which Marshal Bugeaud distinguished himself at the battle of Isly. A bombardment of Salli in 1859 secured for the French the settlement of various claims. War with the Spaniards followed. Tetuan was taken in 1860.

British Influence in Morocco.—The remainder of the reign of Mohammed XVII. (1859–73) was uneventful. That of his successor, El Hassan (1873–94), was marked by interior troubles, of which he gradually but with difficulty became master. Since 1856, British influence in Morocco had been on the ascent, owing to the talent and the prolonged embassy (1844–85) of Sir Drummond Hay. He was not in favour of opening Morocco to European influences, and tried to limit the "protection" accorded, especially by Spain and France, to certain Moorish subjects. The Madrid conference (1880) gave an exactly opposite result. The possibility of registering "protected" Moors in foreign consulates was extended from the towns to the country and foreigners acquired certain property rights. Great Britain thereupon partly changed her policy. A special British Embassy (1892) tried to obtain an extension of the rights of foreigners, but failed. The following year, incidents in the "Presidios," between the Rifis and the Spaniards, ended in an important Spanish expedition (25,000 men); and the treaty of 1894, while only conceding insignificant frontier rectifications to Spain, involved the sultan in the payment of some £650,000 indemnity.

Abd-ul-Aziz IV.—The same year saw the ascension of Abd-ul-Aziz IV. (1894–1908), whose chamberlain, Si Ahmed-ben-Musa, became Wazir and exercised the real power till his death in 1900. The young sultan, who was desirous of reforms, and had a taste for foreign arts, sought especially, under the advice of his mother, a Circassian slave, the friendship and advice of Great Britain. But he became the prey of schemers and speculators who pandered to his worst traits and squandered his treasure. The *Makhzen* treasury had to be refilled, the taxes were increased and recovered, as usual, at the point of the sword and the natural consequence was local revolts, two of which were important, that of Jelali Zarboni, nicknamed *Bu Hamara* ("the Man on the Ass") on the Algerian frontier, and the rebellion of a local sharif, Mulai Ahmed-es-Raisuli, in the district of Tangier.

The Franco-British Treaty of 1904.—As a result of the entente cordiale, and as a counterpart of France "disinteresting" herself from Egypt, Great Britain gave up her ideas of intervention in internal Moroccan affairs (April 8, 1904). Article 2 is important:

"The French Government declares that it is not its intention to change the political status of Morocco. On the other hand, H.B.M.'s Government recognizes that it belongs to France notably, as a Power conterminous with Morocco to a vast extent, to see to the tranquillity of the country, and to lend it her assistance for all the administrative financial and military reforms it is in need of." (Translated from the French text.)

The principle of the liberty of commerce was guaranteed for thirty years; to be prolonged by periods of five years if not denounced (art. 4). No fortifications to be erected at Tangier (art. 7; liberty of the Straits of Gibraltar). In a last article, the Governments agreed to "give one another the aid of their diplomacies" for the carrying out of the clauses of the treaty.

The Franco-Spanish Conventions.—On Oct. 3, 1904, a treaty was signed between Spain and France. Both declared that they were firm partisans of the integrity of the Moroccan empire. Spain recognized France's "special rights," as already stipulated in the Franco-British treaty of April. On the other hand France recognized Spain's special rights on the northern coast of Morocco. They were not defined in the treaty, but in a secret arrangement which was not revealed until 1911, and were equivalent to the creation of two "zones of influence." Two other secret arrangements followed (1905 and 1907), concerned with the police of the ports, the joint execution of public works, contraband, the customs dues, and the monetary situation (creation of a State Bank).

The Intervention of Germany.—In 1905 came Germany's intervention. She had several times complained of being "ignored" in Morocco, though her direct and special "interests" may perhaps be questioned. Russia's discomfiture in the Far East in her war with Japan, gave Germany her opportunity. The German emperor's spectacular disembarkment at Tangier (March 31, 1905) was followed by conferences with the ministers of Abd-ul-Aziz. As a result, an official proposal by the *Makhzen*, inspired by Germany, for the calling of an international conference, was launched, and France consented to the principle.

M. Delcassé, who had been principally instrumental in the preceding treaties, was none the less forced, under German pressure to resign office (June 6, 1905); an event of far-reaching reaction on French public opinion; and which created the impression (several times renewed since by the Casablanca deserters affair; the Agadir incident, etc.), that Germany was bent on picking a quarrel. During the Algeciras negotiations themselves, she obtained from Abd-ul-Aziz the concession of the building of the port of Tangier, which had already been promised to a French company, and a loan of 10 million marks with a Berlin bank, in violation of an engagement taken with the French banks at the time of a loan contracted with them in 1904.

The Algeciras Conference (1906).—The Algeciras Conference began on Jan. 16, 1906. In accordance with the 1904 treaty, the British delegates gave their loyal support to France; while Austria played the part of a "brilliant second" on the German side. The general Act was signed on April 7, 1906, and accepted by the Sultan on June 18. It consecrated the economic internationalization of Morocco, under the sovereignty of the sultan. Commercial equality for all was, once more, stipulated; but France's "special position" was recognized by Germany herself. The only two particular advantages obtained by France were: (1) the allowance of a predominant part in the capital of the Moroccan State bank, on account of the monetary advances already made by her to the *Makhzen;* (2) the sharing with Spain of the police of the Moroccan ports. The diplomatic corps in Tangier was put in charge of the creation of the administrative and financial reforms stipulated at Algeciras (Moorish police in the ports; State bank; acquisition of land by foreigners; control of the Customs administration; impartial adjudications—without reference to the nationality of the bidder,—of public works and supervision of the public works administration itself; etc.).

Beginnings were difficult. The country was far from tranquil. In May 1906, a Frenchman was murdered at Tangier. At the end of the same year, a Franco-Spanish naval demonstration had to be prepared, on account of the activities of Raisuli against Europeans in the suburbs of Tangier;—of which the famous "Kaid" Sir Henry Maclean himself, colonel of the sultan's bodyguard, was afterwards a victim, and had to be ransomed by the British Government for £20,000. One of the Sultans' *mehallas* finally put into flight the brigand-functionary.

French Landing at Casablanca in 1907.—On March 19, 1907, Dr. Emile Mauchamp was murdered at Marrakesh; and Ujda occupied by French troops until satisfaction should be given to the French demands. On July 30, nine European work-

men, employed in the Casablanca harbour works, were killed; and the passage of a detachment landed from the cruiser "Galilée" having been opposed, and all the Europeans attacked, the town was bombarded. (The occupation of the Shawia district followed, the tribes opposing Generals Drude and d'Amade, and the fighting being heavy.) By June 1908 the district became quiet and the original force of 15,000 men was reduced.

In September 1908 the incident of the six deserters from the Foreign Legion (three of whom were Germans) followed in Casablanca. They had a safe-conduct from the German consul, but were arrested by a French patrol. The German Government demanded that France should express her regret before the facts were fully established. The case was submitted to the Hague Court of Arbitration, which decided substantially in favour of France (May 1909). But the incident created some excitement in France and in Germany. Nevertheless an agreement was reached between the two countries on Feb. 8, 1909, in which France re-affirmed her will to maintain economic equality and Germany her pursuance of economic interests only, recognizing France's special political claims.

Mulai Hafid.—In the meantime, Abd-ul-Aziz had been defeated by his brother Mulai Hafid (1908), who had been proclaimed sultan by the Ulema of Marrakesh the year before. But Hafid's power remained weak. The Rif tribesmen revolted against Spain, who was obliged to send an army of 50,000 men to reduce them to submission (Nov. 1909).

In 1910, Mulai Hafid obtained a loan of £4,000,000 chiefly from France, who had also given the new Sultan a proof of her moderation by the promise of gradual evacuation of the Shawia country, and even of Casablanca, against the creation of a *Makhzen* police force under French instructors and the payment of an indemnity by the Shawia tribes. An agreement on somewhat the same terms was signed with the *Makhzen* by Spain in Nov. 1910. But a revolt had already begun round Fez in October. It continued to spread and the town was besieged by the neighbouring tribes in March 1911. All the consuls called for help; and the sultan himself asked for it. A French expedition released the town. In June, Spain occupied El Qsar and Larache (El Araish).

The Agadir Incident and the Franco-German Treaty of 1911.—On July 1, came the explosion of the Agadir bomb; the German gunboat "Panther" suddenly appearing before the town, "in order to protect German interests." War seemed imminent; but Great Britain stood firmly by the Entente, and announced her formal opposition to Germany's obtaining political rights in Morocco. Complicated negotiations between France and Germany followed; and ended in the treaty of Nov. 4, 1911. France obtained from Germany a certain number of rights—to occupy, by agreement with the Sharifian Government, points where the maintenance of order might render the occupation necessary; and to be the Sharifian Government's obligatory medium in its foreign relations. A Resident General might be appointed, if necessary, at Fez and France should have the right to control the Sharifian finances in order to ensure the payment of foreign debts, etc.

In exchange, the principle of economic equality for all, notably for the concession of mines and railways, etc., was reaffirmed. In a letter annexed to the treaty, a large slice of French Congo was handed over to Germany, to the indignation of a part of French opinion which could not see the link between the two questions. On the other hand, though the word "Protectorate" was not formally used in the body of the treaty itself, a near equivalent could be found in it; and, by a second letter, Germany agreed not to oppose it, if circumstances rendered it necessary.

The French Protectorate and the Franco-Spanish Agreement.—As soon as the treaty had been ratified by the two parliaments, M. Regnault was sent to Fez, and the Franco-Moroccan treaty of March 30, 1912, was signed, by which Mulai Hafid agreed to a certain number of reforms, equivalent to a Protectorate, which was accepted by the Powers. Negotiations with Spain ensued, for the putting into force of the secret treaty of 1904. The new Convention was signed on Nov. 27 and contained a few modifications as to the frontier of the Spanish zone, which follows the Muluya from its mouth to near Meshra 'Klila. Thence turning west, it runs north of a line reaching to Jebel Mulai bu Shota (the Riff) and thence, striking toward the north-west, to the Atlantic, and containing El Qsar and Larache. A Khalifa (Deputy) represents the sultan at Tetuan, where the Spanish Commissioner-General resides. The Spanish Protectorate extends over a zone of about 18,300 sq.m., with an estimated population of 460,000 (1923). The question of the Ifni enclave in the south was also settled. Tangier (*q.v.*) and its neighbourhood (about 100 sq.m.) constitute a special internationalized zone.

The Protectorate was followed by a revolt at Fez (April 17, 1912), in which 13 French officers, 40 soldiers and 13 civilians were killed. General Lyautey was appointed resident-general and took up his post on April 27, 1912. Mulai Hafid, whose collaboration could not be counted upon, retired on Aug. 12, and was succeeded by his brother, Mulai Yusef. The history of General (now Marshal) Lyautey's administration is a remarkable example of France's colonial policy. Internal difficulties were not wanting. The tribes around Fez remained unsettled, especially in the Taza "corridor" leading to Algeria. In the south, the revolt of El Hiba necessitated the occupation of Marrakesh (Sept. 1912) by General Mangin, who was to play such a conspicuous part in the World War. Fighting in Western Morocco continued for some months, but this district and that of Fez were occupied by the spring of 1913. The important strategic point of Taza was taken in May 1914, and Khenifra (centre of the unsubdued Zaïan tribes of the Tadla district), in June.

Morocco and the World War.—On the outbreak of the World War, the French commander received telegraphic orders from the ministers of foreign affairs and of war (July 27–28, 1914) "to reduce the occupation to the principal points on the coast," as "the fate of Morocco would be settled in Lorraine," and asking him to send all available men and material to the French front. Lyautey immediately dispatched 37 battalions and other troops; but refused to evacuate the interior. The tribes round Taza and the Zayan in the west promptly rose once more, but the three great *kaids* of the Atlas and the *bashas* of Tarudant and Tiznit, in the south, near Agadir, remained friendly. The Spanish zone was used by the Germans as a basis of active propaganda and action against the French Protectorate. Throughout 1915 and 1916 chiefs in German pay conducted a campaign along the Wad Wergha. But in May and June 1917 Abd el Malek was driven from Taza. In March 1917, El Hiba was severely defeated at Wijan, his force being dispersed in the following spring. The Tafilelt was definitely occupied at the end of 1917.

Military Operations After the War.—After the War the French continued their operations, taking the offensive now on one and now on another of their four fronts: the northern (Spanish zone, Djebala and Riff tribes); the Berber (Central Atlas); the front of the big *kaids* (round Marrakesh, the Glawi, M'tuggi, Gundafi); and the southern front (Kut Aissa, Tafilelt). By the end of 1923, the French zone was completely pacified. Lyautey's constant aim all through was the conquest of what he called "useful Morocco" (*le Maroc utile*), the last French operations being largely dictated by the need of gaining control of the "Water Castle" of the Central Atlas.

Abd el Krim and Spain (1923).—But Lyautey's military difficulties were not at an end. The Riffis, who, during the World War, had lavishly received arms, ammunition and money from the Germans against the French, turned, from 1919 onward, against the Spaniards. In 1921, Abd el Krim, the son of a Beni Uryaghel (Ouriaghel) chief, some time in the Spanish service, settled at Ajdir, at some distance inland from Alhucemas, stirred up resistance between that point and Melilla, and inflicted a terrible defeat on the army of General Silvestre. With the capture of an enormous amount of arms and ammunition, these Moroccan events led to a crisis in Spain, and, in Sept. 1923, the constitutional Government was replaced by a Military Directorship under General Primo de Rivera, who decided upon a general withdrawal; a courageous but difficult manoeuvre which was not accomplished

until the autumn of 1924. But the evacuation increased Abd el Krim's prestige, and on the other hand, the gradual occupation by France of the northern limits of her Protectorate caused some apprehension to the Riff chieftain.

Abd el Krim and France (1925–26).—In April 1925 Abd el Krim launched a furious attack on the Taza-Ujda roads; the tribes that remained faithful were massacred; Wazzan and Taza were threatened; but Lyautey, although his councillors were, it is said, in favour of a retreat, persistently refused to budge from Taza, just as he had refused to abandon the interior in 1914, thus saving Morocco for France a second time. A regular and severe campaign ensued. A rapid glance at a good map, enables one immediately to appreciate its difficulties. In July, Marshal Pétain was sent on a mission to Morocco while General Naulin took supreme command of the troops, under the high direction of Marshal Lyautey. But, on Aug. 22, Marshal Pétain returned to Morocco. A joint action of France and Spain was agreed upon, at a conference held in Madrid. On Sept. 8 a successful disembarkation of Spanish troops took place in Alhucemas bay and a junction was effected at Syah between the columns of the two countries. Winter suspended the general operations, which really necessitated quite different methods and material from those employed in European warfare, a practical point that appears to have been too often lost sight of. So the Riff "coup-de-main" continued. On May 30, however, 40,000 additional native troops having been recruited, Abd el Krim surrendered unconditionally at Taza to General Boichut, the French commander, and was sent in exile to Madagascar. (*See* ABD EL KRIM.) The French losses during the campaign amounted to 2,162 exclusive of casualties among native troops; but the monetary expense was great, and will be supported principally by Morocco itself (about Fr. 26,000,000).

Meanwhile, Marshal Lyautey had sent in his resignation to the French Government (Sept. 24, 1925), and was succeeded (Oct. 6) by M. Theodore Steeg, who had just been successful as Governor-General of Algeria. A new sultan, Mulai Mohammed, succeeded his father on Nov. 17, 1927.

THE PROTECTORATE

The Sultan and the Makhzen.—In accordance with Muslim law and traditions, the Sultan remains, not only the head and tutor of the whole Sharifian house, but the only legislator. His *dahirs,* countersigned by the Resident-General, are binding, as laws, even on the French residents and colonists in Morocco. His *Makhzen* (Central Government) is composed of the grand wazir, and the wazirs, or ministers of justice, domains, *habus* (land or houses the perpetual usufruct of which is given up by their owners for religious, charitable or public uses), and public instruction; and the presidents of the High Sharifian Tribunal and of the Tribunal of Appeal of the *Chraa* (Islamic law, as opposed to Berber custom).

The Pashas, Kaids, Kadis and the Berber Customs.—Outside their courts, pashas in the towns, and *kaids* in the country, represent the temporal authority of the sultan (as opposed to his religious authority, represented by the *kadis*), have also certain penal powers, and act as judges in cases where movables and commercial matters are concerned. His religious and judicial authority is vested in the *kadis,* local judges, who are in reality religious magistrates, the civil and family status (including inheritance) of a Muslim being regulated by the Koran. The judicial competency of the *kadi* has even been partly maintained in the matter of the acquisitions of landed property (art. 60 of the Act of Algeciras). Hence the importance of the Ministry of Justice. But when land has been *immatriculated* (*see* below), it falls under the new land laws and French jurisdiction. On the other hand, care was taken by Lyautey to preserve, as far as possible, among the Berber tribes, the customs (*izref*) to which they are deeply attached. Disputes as to personal status, property, etc., are settled by the *djemaas* (popular assemblies), according to custom.

The "municipalities" created by Lyautey, and in which the Moors and the French are given an opportunity of collaborating under the double guidance of the Pasha and a French "Civil Controller," have not been constituted on a uniform model (election of the Moorish members in the very important intellectual and commercial centre of Fez for instance; elsewhere, nominated, etc.). The authority of the *kaids* was not allowed the same play near the fighting front as in the south, where the three great feudal lords, the Glawi, the M'tuggi and the Gundafi (the last two died in 1928) wielded great local powers and were left free to use them. The *habus* (*see* above), or *wakfs,* an essentially Muslim institution, were respected but were reorganized. In 1912, owing to maladministration, the receipts of the *habu* ministry only amounted to Fr. 1,870,000. In 1926, they had risen to Fr. 9,000,000 with a cash balance of Fr. 3,000,000, relieving the Moroccan budget from the expenses relative to the salaries of a great number of religious professors in the *medersas;* of the numerous *fonctionnaires* of the mosques (*imams, khatibs, muezzins,* etc.); of the upkeep of the mosques themselves, and the *zauias,* mausolea, etc.

The Central Services.—The whole administration is under the authority of the "Commissaire, Résident Général" (decree June 11, 1912) assisted by a delegate to the *Makhzen,* and a secretary general of the Protectorate. The central administration, which is entirely concentrated at Rabat, comprises (1) the aforesaid general secretariat, to which are attached the following services: civil control, personnel, legislation, general administration, penal justice; and the special direction of native affairs and intelligence service (in the military zones); and the following "directions générales": (2) finance; (3) public works; (4) agriculture, commerce, industry and colonization (with the forest and the land survey and registration); (5) public instruction, fine arts and antiquities; (6) public health; (7) post, telegraph and telephone office.

The "Exterior Services"; the "Civil Controller."—The exterior services are in the hands of a staff of "civil controllers"—the pivot of administration, as is the district officer in British India, a sort of "Jack-of-all-trades of the Protectorate," omniscient, work-beridden, who must be informed (and inform the Rabat headquarters) of everything that is going on, advise and watch the *pashas, kaids* and *kadis,* know the "notables" and headmen, help the French colonists, audit the native provident societies, give his reasoned opinion on the roads and public works projected, keep an eye on the collecting of the taxes, secure harmony between the French and the Moorish population, etc. They are distributed among the civil regions (Ujda, Eastern Morocco), the Gharb (Khenifra), Rabat, the Shawia and autonomous circumscriptions (Doukhala, Mazagan); Abda (Safi); Shiadma (Mogador); Oued Zem, etc. There are four military regions (Marrakesh, Fez, Meknes and Taza). These regions generally correspond to the habitat of a leading tribe; and the tribal distribution itself is, in most cases, commanded by the physical features of the country.

The French Judiciary.—The French judiciary organization (which comes into play whenever Frenchmen or foreigners are concerned) comprises 12 peace tribunals, four tribunals (Casablanca, Rabat, Ujda and Marrakesh); and a court of appeal (with 10 magistrates), also at Rabat.

The Government Council and the French Taxpayer.—In order to secure "a constant and regular collaboration between the Government and French settlers in the country," the presidents and vice-presidents of the French chambers of commerce, chambers of agriculture and mixed chambers of both (according to the regions; 10 chambers in all), whose members are elected, assemble, every two months, at Rabat, for the Council of Government, to which the 7 Directors-General, above enumerated, belong. A third College of the Council was created in 1927. It consists of French citizens not belonging to the second College (Agriculture, Commerce and Industry); that is to say, the liberal professions (lawyers, doctors, pharmacists, etc.), French artisans and workmen, the functionaries and even the few *rentiers.* The first election took place on May 15–29, 1927. It was marked, as in Algeria, by political squabbles among Frenchmen; and so, probably, will not prove an unmixed blessing. On the other hand, it is difficult

to exclude from a participation in the Government, and especially in the examination of the taxes, any category of French citizens who pay them (and the indirect taxes, at least, are fairly heavy). The sitting takes places every two months. The reports on budget questions are often entrusted to the elected president of the chambers of commerce or agriculture. Not counting Tangier, there were seven French daily papers and 30 periodicals in Morocco, and three native papers in Arabic (1923).

Finance.—The 1928 budget amounted to Fr. 640,000,000; the annual debt charge, to Fr. 150,000,000. A new loan of Fr. 819,-800,000 was authorized by the law of March 22, 1928, with the guarantee of the French Government. The former loans (1914, 1916 and 1920) amounted to Fr. 986,000,000, out of which Fr. 770,500,000 have been expended. The new loan is mainly destined for the Fez-Ujda railway line, which is estimated to cost Fr. 800,000,000, Fr. 750,000,000 of which will be at the charge of the Protectorate. It will complete the 752 km. of normal gauge railway lines already exploited or under construction (besides 418 km. planned; and about 1,500 km. of narrow gauge) and constitute an Imperial Highway from Tunis to Casablanca. The Casablanca to Marrakesh line was opened in November 1928.

Public Instruction.—Public instruction is still behind-hand with the natives, as there were only, in 1926, 77 missionary schools with 5,612 pupils; but there was a beginning even with the girls, quite a revolution in the Maghreb (1,041 in 1926); There are also 5 special schools for the sons of the "notables"; 13 apprenticeship schools (461 pupils); and 2 colleges (204 pupils). The 34 Jewish primary schools had a far larger attendance (7,471 for a total Jewish population of 107,000) than the Moors' (6,879 school attendants in all for a population of 4,016,000). The European schools (primary, technical and colleges) had a school population of 21,570 in 1926. (Hi. Br.)

M. Steeg and Moroccan Prospects.—Under the prudent guidance of M. Steeg, the French Protectorate of Morocco gained assurance of a prosperous future. As in Algeria, he had great plans for *la politique de l'eau* (irrigation and water power), and the geographical conditions are better in Morocco. The Wazzan territory was pacified in the spring of 1927, and in December the Ida and other mountain tribes made their submission.

On Jan. 1, 1929, following the law passed by the French Chamber forbidding the extension for more than six months of the "special missions" of members of parliament, M. Steeg resigned and was succeeded by M. Lucien Saint.

Bibliography.—*See* D. Berenguer Fusté, *Campañas en el Rif* (1923); V. Ruiz Albeníz, *Las Responsabilidades del Desastre* (1922); R. Kann, *Le protectorat Marocain* (1921); *La Renaissance du Maroc* (documents issued by the French residency).

MORÓN DE LA FRONTERA or **MORÓN** (anc. Arumi), a town of southern Spain, in the province of Seville; 32 m. S.E. of the city of Seville. Pop. (1920) 18,758. Morón occupies an irregular site upon broken chalk hillocks near the right bank of the Guadaira. It is connected by rail with Utrera. The chief public building of Morón is the large parish church, which dates from the 16th century.

MORON, deficient in intelligence, from Gr. *mōros*, "foolish."

MORONE, the name of two distinguished Italian painters, father and son, of the Veronese school. Of Domenico Morone (*c.* 1442–*c.* 1517) but few works have survived. The frescoes which he executed in San Bernardino at Verona (1503) and in the little church of San Niccolò di Tolentino at Paladon (now in the Museo Civico) are not well preserved. There are, however, two signed works which reveal him as a spirited painter of much grace and decorative quality. One is the large canvas of the Crespi collection, Milan, which was painted in 1483 for the Marquis of Mantua and illustrates the fight between the Gonzagas and the Bonacolsi. The other signed picture is a small "Virgin and Child" at Berlin. The National Gallery has two delightful small scenes at a tournament ascribed to him on stylistic evidence.

His son Francesco Morone (*c.* 1473–1529), after working as an assistant of his father, began work as an independent painter, and in 1495 produced the "Crucifixion" in the church of San Bernardino. His greatest work in fresco was the decoration of the walls and ceiling of the sacristy of S. Maria Organo with incidents freely adapted from Mantegna's "Camera degli Sposi" at Mantua. This work is one of the greatest monuments of local art. In the same church is an altarpiece (1503) representing the Madonna enthroned between two saints, a work fine in colour and design and of remarkable finish. Francesco's pictures are rare outside Verona. The Brera, Milan, has two interesting works. The National Gallery, London, and the Berlin museum each contain a picture of the "Virgin and Child."

MORONE, GIOVANNI (1509–1580), Italian cardinal, was born on Jan. 25, 1509 at Milan, where his father, Count Ieronimo Morone (d. 1529), was grand chancellor. His father, who had been imprisoned for opposing encroachments on the liberties of Milan by Charles V. (whom he afterwards cordially supported), removed to Modena. The son was educated there and at Padua. He was in 1527 nominated by Clement VIII. to the see of Modena, and consecrated in 1533 after a contest. From 1535 he was constantly entrusted by Paul III. with diplomatic missions. In 1542 he was created cardinal, and was further nominated protector of England, Hungary, Austria, of several religious orders, and of the *santa casa* at Loreto. With the cardinals Paul Parisio and Reginald Pole he was deputed to open the Council of Trent (Nov. 1, 1542), the place of meeting having been a concession to his diplomacy. The legates arrived on Nov. 22, but no council assembled. The death of Paul III. (1549) deprived him of a good friend. The views of the Reformers had spread in his diocese, and he was suspected of temporizing with them. He resigned his see (1550), reserving to himself an annual pension and the patronage of livings. Julius III., at the instance of the duke of Milan, gave him (1553) the rich see of Novara (which he resigned in 1560 for the see of Albano) and sent him as nuncio to the diet of Augsburg (1555), from which he was immediately recalled by the death of Julius (March 23). In June 1557 Paul IV. imprisoned him in the castle of St. Angelo (with others, including Pole and Foscherari), on suspicion of Lutheran heresy. The prosecution entirely failed, and Morone might have had his liberty, but refused to leave prison unless Paul IV. publicly acknowledged his innocence. He remained incarcerated till the pope's death (Aug. 18, 1559), and took part in the election of Pius IV. Ochino, in the twenty-eighth of his *Dialogi XXX.*, 1563, has a colloquy on the treatment of heretics, between Pius IV. and Morone, in which the latter maintains: "Errantes in viam revocandi, non occidendi." This really hits the position of Morone, a sincere Catholic, to whom persecution was abhorrent. He presided at the Tridentine Council from April 10 to Dec. 4, 1563. In 1564 he was reinstated in the see of Modena. On the death of Pius IV. (1565) he came near to being elected pope. He died at Rome on Dec. 1, 1580, and was buried at S. Maria sopra Minerva.

See J. G. Frick, "De Joanne Morono," in J. G. Schelhorn's *Amoenitates literariae*, vol. xii. (1730); "G. Moroni," *Dizionario di erudizione* (1847); N. Bernabei, *Vita del cardinale G. Moroni* (1885); M. Young, *Life and Times of Aonio Paleario* (1860); C. Benrath, in Hauck's *Realencyklopädie* (1903); G. Constant, *La Légation du Cardinal Morone, 1563* (1922).

MORONI or **MORONE, GIAMBATTISTA** (*c.* 1525–1578), Italian portrait-painter of the Brescian school, was born at Albino near Bergamo and became a pupil of Bonvicino named Il Moretto. His portraits are full of straightforward life and individuality, with genuine unforced choice of attitude, and excellent texture and arrangement of draperies; there is a certain tendency to a violet-tint in the flesh. Among his works may be mentioned—in the Uffizi Gallery, Florence, the "Nobleman pointing to a Flame," inscribed "Et quid volo nisi ut ardeat?"; in the National Gallery, London, the portraits of a Tailor, a member of the Fenaroli family, Canon Ludovico de' Terzi, and others; in the Berlin Gallery, his own portrait; other portraits are in the galleries of New York, Boston, Vienna, Munich and Milan. Most of his pictures are at Bergamo. He died on Feb. 5, 1578.

MOROSINI, a noble Venetian family whose two chief members were:

Andrea Morosini (1558–1618) was a famous historian and was entrusted by the Venetian senate with the task of continuing

Paolo Paruta's *Annali Veneti*, in Latin. His history of Venice was published by his brother in 1623, and translated into Italian by Senator Girolamo Molin (1782). Among his other works are: *Le Imprese ed espeditioni di terra santa, etc.* (Venice, 1627); *De iis quae veneta respublica ad Istriae oras gessit, etc.* (in the Corner-Duodo collection of mss.); *De forma reipublicae venetae* in ms. in the Bibliothèque Nationale in Paris. His life has been written by Luigi Lollin (1623), by Niccolo Crasso (1621), and by Antonio Palazzoli (1620).

Francesco Morosini (1618–94) was one of the greatest captains of his time. He fought against the Turks and the pirates, and after distinguishing himself at the battle of Naxos in 1650 he was appointed commander-in-chief of the Venetian navy. He conducted a series of successful campaigns against the Turks, but was recalled in consequence of the intrigues of his rival the Provveditore Antonio Barbaro (1661). But when Candia was attacked Morosini was sent to relieve it in 1667; the siege lasted 18 months, but Morosini was forced to surrender to save the surviving inhabitants. He was tried but acquitted of all blame, and on the renewal of the war with the Turkish Empire in 1684 he was again appointed commander-in-chief, and after several brilliant victories he reconquered the Peloponnesus and Athens; on his return to Venice he was loaded with honours and given the title of "Peloponnesiaco." In 1688 he was elected doge, and in 1693 he took command of the Venetian forces against the Turks for the fourth time; the enemy, which had been cruising in the archipelago, withdrew at his approach, so great was the terror inspired by his name. He died at Napoli di Romania (Nauplia) on Jan. 6, 1694.

Bibliography.—Barbaro, *Genealogia delle famiglie patrizie venete*, ms., clas. vii., cod. 927, in the Marcian Library, Venice; Cappellari, *Campidoglio veneto*, ms., clas. vii., cod. 17, *ibid.*; Romanin, *Storia documentata di Venezia*, also other general Venetian histories; G. Dalla Santa, *Due Lettere di umanisti veneziani a Paolo Morosini* (in *Nuovo archivio veneto*, xix. 92); G. Graziani's life of F. Morosini in Latin (Padua, 1698); A. Arrighi, *Vita di F. M.* (Padua, 1449). (*See* also Venice.)

MORPETH, town and borough, Northumberland, England, on the river Wansbeck, 17 m. N. of Newcastle on the L.N.E.R. Pop. (1931) 7,390. The manor of Morpeth is said to have been granted to William de Merlay soon after the Conquest and passed with the borough from his family to the earls of Carlisle, with whom it remains. The town is a borough by prescription and grew up round the castle attributed to William de Merlay. Nothing remains of the castle except the gateway. The valley of the Wansbeck above Morpeth is well wooded, and in it are fragments of Newminster Abbey, a wealthy 12th century foundation, and the ruins of a Norman castle and manor house of the 17th century. A peel tower of the 15th century is seen at Cockle Park. Local industries have included tanning, brewing, malting, iron and brass founding, and the manufacture of flannels, agricultural implements, and bricks and tiles. Charles II. incorporated the town in 1662, and under this charter the borough was governed until the Municipal Reform Act of 1835.

MORPHEUS, in Roman mythology, one of the sons of Somnus, the god of sleep. In Ovid (*Metam.* xi. 635), he calls up human shapes (*μορφαί*) of all kinds to the dreamer, while his brothers Phobetor and Phantasus assume the forms of all kinds of animals and inanimate things. It is, however, possible that Ovid misinterprets his name and that it really means "dark," *cf.* *ὀρφνός*. Whether he is a popular or a literary figure is uncertain.

See Jümpel in Roscher's *Lexikon, s.v.*

MORPHINE, the chief alkaloid of opium (*q.v.*), insoluble in water and ether. It is used in the form of its hydrochloride, sulphate, acetate and tartrate and in various non-official preparations such as dionin, heroin, glycaphorm and peronin. The preparations of morphine are incompatible with salts of iron, copper and mercury, also with lime water and alkaline earths and substances containing tannin. With ferric chloride it forms a deep red colour.

Morphine relieves pain and produces deep sleep. From opium it differs in being less astringent and constipating. No drug yet discovered equals morphine in pain-relieving power. The most frequent mode of administration is the hypodermic, on account of the extreme rapidity with which it is absorbed. In pain due to violent sciatica relief and even permanent cure has been obtained by the injection of morphine directly into the muscle of the affected part, and in the treatment of renal and hepatic colic, given subcutaneously, it will relieve the acute pain. A violent paroxysm of asthma may be arrested by the administration of morphine subcutaneously, but the practice should not be continued, as there is great danger in a chronic disease that the patient may become the victim of morphinism. Morphine is recognized as one of the most useful drugs in the treatment of eclampsia, early injection often arresting the fits. In hæmoptysis morphia is invaluable in quieting the patient and in the cough of phthisis minute doses are of service, though morphine is frequently better replaced by codeine or heroin, which check irritable coughs without producing narcotism. Its use in Bright's disease is dangerous, minute doses producing disproportionately great results. For the same reason it is not administered to children. In bronchitis with profuse expectoration it checks cough but also checks secretion; where cough is harassing small doses may be necessary to procure sleep, but it must be remembered always that renal disease is often accompanied by bronchitis. In the dyspnoea of advanced valvular disease of the heart morphine relieves the distress and restlessness, and induces sleep. It should, however, be withheld if the heart has undergone fatty degeneration. If given in excess the drug is eliminated by the intestines and kidneys. It is also excreted in the milk; hence the danger in the administration of large doses of morphine to nursing mothers. (*See* Poisons; for morphinism *see* Drug Addiction.)

Morphine-scopolamine anaesthesia was introduced in 1902 by Steinbückel. It has been used by some surgeons for the production of anaesthesia previous to the administration of ether or chloroform, but the use of the method is now more usually relegated to obstetric practice to produce the so-called twilight sleep (*see* Scopolamine).

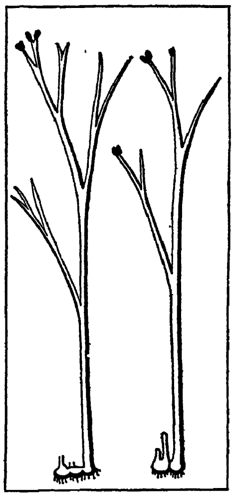
Physical and Chemical Properties.—Morphine, $C_{17}H_{19}O_3N$, crystallizes from alcohol in colourless prisms, containing one molecule of water, which is lost at 100° C. The anhydrous alkaloid melts at 254° C, and has a specific rotation of $[\alpha]^{23°}_{D} = -130.9°$ in methyl alcohol. It is sparingly soluble in most solvents, but dissolves in lime-water and alkalis owing to its acidic character, due to the possession of a phenolic hydroxyl group. (*See* Phenol.) It is also a monoacidic base forming salts, which are usually well crystallized. Many of these are manufactured for use in medicine but those most commonly used are the sulphate, $(C_{17}H_{19}O_3N)_2,H_2SO_4,5H_2O$, and $C_{17}H_{19}O_3N,HCl,3H_2O$, the hydrochloride, which forms colourless, silky needles from water. When morphine or its hydrochloride is heated with hydrochloric acid at 140° C under pressure, it is converted by loss of a molecule of water into *apomorphine*, $C_{17}H_{17}O_2N$, a substance which has lost the characteristic physiological action of morphine and has acquired that of a powerful emetic, for which purpose it is principally used in medicine. Morphine also yields a number of derivatives, in which its characteristic physiological action is retained in a somewhat modified form. Thus when the phenolic hydroxyl group of morphine is methylated, the alkaloid codeine (*q.v.*), $C_{18}H_{21}O_3N$, which also occurs naturally in opium, is produced. Other derivatives, analogous to codeine, have been made for use in medicine, such as ethylmorphine (dionin), benzylmorphine (peronin). Morphine can also be converted into a diacetyl derivative, known commercially as heroin. The third alkaloid of this group, thebaine, is of importance mainly on account of its chemical relationship to morphine and codeine, but is of no value in medicine, since in it the convulsant action feebly manifested in some of the derivatives of morphine is much more strongly developed.

MORPHOLOGY, a term used in zoology and botany to cover all those studies in which the centre of interest is the form and structure of an organism. It is thus the antithesis of physiology (*q.v.*).

The first step in morphology is to determine and record the

shape of a whole animal. This shape never exists as a permanent quality; it is constantly varying with the animal's movements even in the case of animals with a hard skeleton such as the lamellibranchs or the crustacea.

There is nevertheless in the vast majority of cases a definite plan visible at any time for each individual animal. The creature may be free-moving or it may be fixed to the ground either permanently or for the time being. It may have no axis of symmetry and be indefinite in shape like an amoeba, or it may be bilaterally symmetrical like a fish, or radially symmetrical like a star fish. It may like a sea anemone be apparently radially symmetrical but actually possess an underlying bilateral symmetry. Such symmetry as it possesses may be externally perfect, or it may be modified by differences in the development of similar appendages on the opposite sides, as in the case of the great claws of a lobster.



BY COURTESY OF PROF. LANG

A RECONSTRUCTION OF A VERY EARLY TYPE OF LAND-LIVING PLANT, LEAFLESS AND ROOTLESS

External Forms.—The external form of every animal must be such as to enable it to live under those conditions in which it is placed. Thus a study of the external shape of an animal can have little meaning unless it is coupled with an investigation of the function of the various structures and forms which it presents.

Quick movement of an animal either through water or air, whether in contact with a substratum or not, can only be achieved if the animal is bilaterally symmetrical, because only then, the animal moving in one direction, will the impulses which the animal receives from the activities of its muscles be symmetrically disposed so as to ensure a straight track. On the other hand an animal which lives constantly attached to the sea bottom in most cases receives its food from all directions or from above, and must be so designed that it can catch it with equal ease whencesoever it comes. Thus a radial symmetry is most suitable for a sedentary animal.

The analysis of the external form of a single animal can often be carried much further. The motion of a fish swimming in water is hindered by many factors, which have been disentangled by naval architects. Unless its shape conforms to a special geometrical figure, the "streamlined form," it will create eddies which absorb energy, it will produce bow and tail waves, and the water will exert a definite frictional resistance to motion, varying with the smoothness of the skin and with some other qualities. Thus it should be possible to predict the ideal shape for a fish. But this exact form will be unrealisable in actual life, because it is necessarily modified to secure stability, both when the fish is motionless, and also in the sense of maintainance of its course when swimming. Furthermore the needs of feeding and of taking in and expelling the water which is necessary for respiration modify the shape of the anterior part, while the hinder end is conditioned by the area and shape of the tail fin and the muscles which move it.

Thus any explanation of the shape of a fish is necessarily complicated, so many factors entering into it that anything more than a rough analysis is impossible.

But those features of the external form of an animal which have a directly adaptive significance are mere modelling carried out on a basis of fundamental structure which is in essence uniform throughout large groups of allied species.

Subcutaneous Structures.—An investigation of external form if it is to be at all satisfying involves an understanding of those structures which lie beneath the skin.

The skeleton and somatic muscular system are only significant in relation to their function of bringing about movements, either of the animal as a whole, or of the jaws and other organs for such special purposes as the capture of food. Theoretically there is a most efficient shape for each bone and each muscle in the body of a fish, but exactly as in the case of the external form this ideal is never attained, in part because few organs or parts of organs are so isolated that they can be exclusively devoted to one function unmodified by the impact of neighbouring structures, and in part because their fundamental architecture is determined, not by present needs, but by those of a chain of ancestors which may be very remote and very different in habits.

Thus any investigation of structure from a fundamental standpoint necessarily involves a comparison with that of other animals, which may be held to be relatives in the sense that all have been derived by evolution from some common ancestor.

Such a comparison between two similar animals of different sizes will reveal a whole series of proportional differences which depend simply on absolute size. Thus an organ like the ear fulfils exactly the same function in a domesticated cat and in a lion perhaps fifty times as heavy. In each animal it has to determine rotational movements of the head, to determine its position with respect to gravity, and to receive sounds and analyse them into their constituent tones over a certain range. These things are done satisfactorily by the ear of a cat and even more so by those of smaller animals such as bats, and there is no reason for which the size of the organ should be increased however large the animal may become. In fact the ear of a lion is only about three times the volume of that of a cat. But generally the size of an organ necessarily varies with that of the animal of which it forms a part, and varies in accordance with mathematical laws. For example the weights of two similar animals will vary as the cube of their linear dimensions, while the areas are only related as the squares.

Thus if the larger of two cats was a mere mechanical enlargement to twice the length of the other, its weight would be eight times as great, while the area of the transverse section of a legbone would be only four times as large, the pressure tending to crush it being twice as great for a unit area. Thus if there is to be the same factor of safety in the two cases the leg-bone of the larger animal must be thicker, so that its diameter will be $\sqrt{2^3}$ instead of $\sqrt{2^2}$; *i.e.*, instead of twice the diameter, it should be nearly $2\frac{3}{4}$ times as large.

Modifications in accordance with this law apply to all the organs of the body, to the lungs and alimentary canal, to the brain and spinal nerves as well as to the skeleton. But after allowance has been made for all such differences, there will still remain others which cannot be accounted for on mechanical grounds but represent innate characters of the two animals.

If the comparison be carried further afield, as it must be if the nature of the general plan of the structure is to be determined, fresh difficulties arise.

A comparison of a bird with a mammal will show a similarity of external structure in that each is bilaterally symmetrical, has a head, neck, trunk and tail, and two pairs of symmetrical appendages. But in the mammal the anterior pair are walking legs, in the bird they are wings. The problem which at once arises is whether it is justifiable to compare these structures with one another or whether they are *sui generis*.

This problem may be attacked in several ways which depending on different lines of reasoning should give consistent results.

Each appendage is covered with skin, which in the one case supports feathers, in the other fur, but as this skin is continuous with and of the same general character of that which coats the body it is clear that the differences between their qualities is not a special feature of the organ which we are discussing.

Below the skin in each case lies a series of bones and muscles, together with the blood vessels and nerves which are necessary for their maintenance and control.

In each case the skeleton consists of an articulated series of bones forming functionally a series of interconnected levers. The segment lying nearest the body is single, articulating with a cup formed by two bones which lie within the body; the second segment contains two bones lying side by side which at their outer ends articulate with a series of small bones, the wrist, beyond which lie in one case the bones supporting five fingers, in the other a strange bone with a slit dividing it incompletely along its length, which in turn supports others forming three axes. Thus

the proximal parts of the skeletons of the two appendages have a similar arrangement, while distally they differ considerably. The muscles, blood vessels and nerves show similar resemblances and differences.

MORPHOLOGICAL RESEMBLANCE OR HOMOLOGY

It is evident that the differences between those structures that lie distal to the wrist in the bird and mammal are associated with the different functions which they perform; in the bird they have to support the largest feathers of the wing, in the other they have to be divided into fingers so as to enable the animal to gain a firm hold on the ground over which he is walking. It thus seems to be legitimate to regard the two structures as members of a single category, despite their difference in function. The nature of this group can be made clearer by a comparison of the wing of a bird with the parachute of the flying lizard "Draco," which performs similar functions in that it supports the animal in the air. In Draco the parachute consists of a fold of skin stretched out by a series of delicate unjointed bony rods which project to its margin. These rods are the animal's ribs each articulating independently with the backbone. There is in fact no structural resemblance between the two organs despite their functional similarity. The recognition of this difference between resemblances of structure and resemblances of function arose gradually and was only firmly established and defined by Richard Owen in 1843, who applied to morphological resemblance the term "homology" and to functional or "physiological" resemblance, "analogy." In Owen's words, Homology "as the same organ in different animals under every variety of form and function (*e.g.*, fore limbs of Draco volans and wings of a bird)"; Analogy "as a part or organ in one animal which has the same function as another part or organ in a different animal (*e.g.*, parachute of 'Draco' and wings of a bird)."

This distinction between homologous and analogous structures is fundamental; it underlies all morphological studies whether they are concerned with comparative anatomy in the old sense, embryology, or the classification of animals.

Interpreted in evolutionary terms homologous structures are those which can be traced back to a single structure in the common ancestor of the animals compared. Thus if we knew the ancestors of a bird and a mammal for a sufficient distance back, we should see a steady divergence of structure of the fore limb, leading to the bird's wing and to the fore leg of a mammal. In fact the single fossil bird which is old enough to differ materially in structure from those now living, "Archaeopteryx," has three independent fingers agreeing in the number of their phalanges and in their general structure with the first three fingers of a lizard, and we have evidence that the very remote ancestors of a mammal had a similar structure. Thus an investigation of their history confirms the view that the two structures are homologous.

If homologous structures in different animals be derived by evolution from the same structure in an ancestor, it should follow that the mode in which they arise during the development is the same in each case, and a new criterion of homology becomes available.

The "Limb Bud."—In the case of the bird's wing and the mammal's fore leg the mode of origin is the same. In each there first appears a small swelling on the lateral surface of the trunk toward the ventral surfaces, and in each this "limb bud" is an outpushing of the skin by a mass of cells, some of which wander into the region, whilst others appear by the multiplication *in situ* of these cells. From them the bones, muscles and blood vessels are gradually formed, whilst the nerve fibres which supply them grow out into the developing limb from definite parts of those which pass as a regular series from the spinal cord to the muscles which lie between the ribs and to the skin.

The limb bud gradually grows longer, its end becomes enlarged and divided into lobes which finally become fingers. This process is identical in bird and mammal for a considerable time.

If we compare a mammal with a dogfish we find a general similarity in the plan of structure, but whereas in one we have two pairs of appendages, the legs, lying at the extremities of the trunk, in the other legs are absent but two pairs of fins lie in a similar position. At first the structures of these two appendages, leg and fin, seem totally different; one has a bony skeleton surrounded by muscles on all sides, whilst the other has a cartilaginous skeleton with the muscles lying only above and below it. The most obvious point of similarity is that in each case the nerves that supply the muscles come in the same way from the ventral branches of the spinal nerves. If we examine the mode of development of the two organs we find a similarity in that each appears as a limb bud, a fold of skin lying longitudinally and supported by a mass of cells, but whereas in the mammal the muscles arise from these cells, in the fish they grow down from the body musculature. Thus even embryologically there are differences between the two structures.

Nevertheless they are regarded as homologous, even although no real intermediates are yet known

This belief is founded largely on the identity of the nerve supply: it having been found that the evidence as to homology afforded by different classes of structures varies greatly in value.

But it is possible to carry the conception of homology much further; an investigation of the origin of the nerves supplying the fore limb shows that that structure, which is clearly homologous among the vertebrates, may lie at very varying distances behind the head; in a frog its supply comes from the actual second, third and fourth spinal nerves behind the head; in the extinct reptile "Elasmosaurus" it probably came from the 77th to the 80th nerves.

Thus different position in the body of an animal, whose body is in part or whole composed of a succession of similar segments is consistent with homology. But in general character, in mode of origin, and in the nature of their nerve supply, the fore and hind limbs of vertebrates are identical, and thus by an extension of reasoning may be held to be homologous, the homology being of a special nature called serial.

The criteria which may be used for the determination of serial homology between the parts of an individual are in essence identical with those used in discussions involving two distinct animals, identity of general relationships and embryological origin being those chiefly used.

Analysis of the Vertebrate Head.—Perhaps the most elaborate example of an analysis of structure depending on the determination of serial homology is that of the vertebrate head, first attempted successfully by J. W. van Wijhe. A long series of investigations has led morphologists to the view that the head of a vertebrate includes a series of segments, eight in number in most higher forms, which are homologous with one another and with the segments of the trunk. From this conception the prediction could be made that there must once have existed primitive vertebrates in which each segment contained a definite series of muscles, skeletal parts, nerves, blood vessels and gills either identical throughout the series, or exhibiting a gradation in structure from front to back. Such an animal has now been discovered in the fossil "lamprey" Cephalaspis, from the Upper Silurian. Such verification of a prediction by subsequent discovery is the best testimony to the value of the method by which the original prediction was made.

EXPERIMENTAL MORPHOLOGY

The actual structure of any organ in the body of an animal represents a compromise; in its fundamental plan it is determined by the nature of the ancestors of the animal of which it forms a part, while the details are determined by the function which it carries out and by the interference of neighbouring structures. The factors involved are so numerous, and interact so considerably that no analysis based on a comparison with similar forms can hope to be complete.

The correct scientific procedure in such cases is that of experiment; one and one only of the factors believed to influence the final structure is changed artificially in a known way, and the resulting changes investigated. Comparatively little work along these lines has been carried out; the field of work is open and should prove profitable. One aspect of such work has, however,

been largely exploited, the investigations commonly grouped together under the term experimental embryology.

Explanation of Structure-Changes.—These studies have had for their object an explanation of the succession of changes in structure which transform a fertilised egg cell into the body of a larva or an adult. To a very large extent they have been concerned with the earliest part of the process, the cleavage or segmentation stages, and they have succeeded in demonstrating that for many animals these parts of the whole process of development are pre-determined by the structure of the fertilised ovum, which, apparently uniform in many forms, must itself possess an elaborate and definite structure.

But some investigations, especially those of Speeman and his followers, carried into later stages have shown how in Amphibian embryos the course of development is controlled by definite localised parts of the animal, the "organisers," which take control, one after the other, until some organs become self-determining and can develop into their final structure in isolation. The whole of this work is strictly morphological in that it is the form and changes of form which are studied.

The structure of an egg, the events which are associated with fertilisation, and the nature of the zygote are investigated by cytologists, whose technical methods have all been designed to make visible in microscopical preparations the architecture of these bodies. The information so acquired is, however, difficult to relate to that which is inferred to exist in the zygote from the evidence afforded by experimental embryology, and only through the very indirect evidence of genetical research has it become established that the chromosomes, the most visible structures in the nucleus, possess a structure of elements, "genes," with a linear arrangement, which is directly associated with a developmental course which leads to the appearance of structures which exhibit an alternate or Mendelian inheritance.

The investigations of physiologists have made it certain that such elements of an animal's body as muscle and nerve fibres and the surface layer of all cells must possess an ordered arrangement of molecules, whose nature we may hope to discover by the methods of physics and chemistry. Thus in the end the study of biology will involve a morphology, not of organs, tissues or cells, but of molecules and electrons which form the mechanism whose functioning is life.

In philology, morphology is that branch of grammar which examines the form of words as well as the principles of word-formation and inflection. In general use the expression morphology has been extended to comprise the general laws of the grammatical structure of a language, *i.e.*, as synonymous with accidence.

(D. M. S. W.)

MORRILL, JUSTIN SMITH (1810–1898), American political leader and financier, was born at Strafford, Vt., on April 14, 1810. He was a clerk in a store at Strafford in 1825–28, and at Portland, Me., 1828–31, and was a merchant and then a farmer in his native town in 1831–55. He was elected to the national House of Representatives as an anti-slavery Whig in 1854, soon afterwards joining the new Republican Party, and served in the house from 1855 until 1867. From 1867 until his death more than 30 years later he represented Vermont in the Senate. In the house he was continuously a member of the ways and means committee and in the Senate of the finance committee of which he was chairman for nearly 20 years. Soon after entering Congress he became the acknowledged leader of the protectionists, and at the request of John Sherman, then chairman of the ways and means committee, he prepared a new tariff bill, which was introduced in the house in March, 1860. To this relatively conservative bill, which substituted in many instances *ad valorem* for specific duties, and was intended by its author to be a revenue as well as a protective measure, were added many amendments which made the bill more strongly protectionist, and in some cases were vigorously opposed by Morrill. The bill was finally passed by the Senate on Feb. 20, 1861, and was signed by President Buchanan on March 2 following. Morrill is probably best known as the author of the Land Grant Act passed on July 2, 1862, which provided for the foundation and maintenance of colleges "where the leading object shall be, without excluding other scientific and classical studies, and including military tactics (which had not been included in the original bill), to teach such branches of learning as are related to agriculture and the mechanic arts . . . in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life." In 1890 Morrill introduced in the Senate the so-called "second Morrill Act," under which $25,000 is given annually by the Federal Government to each of the "land-grant" colleges. He died at Washington, on Dec. 28, 1898.

See William Belmont Parker, *The Life and Public Services of Justin Smith Morrill* (1924).

MORRIS (Morrison), **CLARA** (1849–1925), American actress, was born in Toronto (Ont.), and at the age of 17 joined a stock company in Cleveland, Ohio. Her first New York appearance (1870) was under Augustin Daly in an adaptation of Wilkie Collins's *Man and Wife;* and she won considerable success as Cora in *L'Article 47,* Camille, Miss Multon and similar emotional parts. In 1874 she married Frederick C. Harriott, and soon afterwards began to write novels and to contribute to magazines. She published her *Life on the Stage* in 1901, and *Life of a Star* in 1906. She died at New Canaan, Conn., on Nov. 20, 1925.

MORRIS, EDWARD PATRICK MORRIS, 1st Baron, cr. 1918, K.C.M.G. 1913 (1859–), Newfoundland statesman, was born at St. John's, Newfoundland, on May 8, 1859. Educated at St. Bonaventure's College and the University of Ottawa, in 1884 he was admitted a solicitor, and in 1885 was called to the bar. The same year he was elected to the legislature of Newfoundland as the representative of St. John's in the Liberal interest. From 1890 to 1895 he was acting attorney-general for Newfoundland, and from 1893 to 1906 he was a director of the Newfoundland Savings Bank. In 1898 Morris left the Liberal party and was leader, first of the Independent Liberals and later of the People's party (1908–19). In 1902 he became attorney-general and subsequently Minister for Justice. He was knighted in 1904. In 1909 he became Prime Minister, retaining this office until 1918, and representing Newfoundland at various Imperial and other conferences. He was sworn of the privy council in 1911 and in 1917 was a member of the Imperial War Conference. Lord Morris edited an edition of the Newfoundland law reports from 1820 to 1905, usually called *Morris's Reports.*

MORRIS, GOUVERNEUR (1752–1816), American statesman, was born in the old Morrisania manor house, in what is now the city of New York, on Jan. 31, 1752. He graduated at King's college (now Columbia university) in 1768, studied law, and was admitted to the bar in 1771. An extreme aristocrat in his political views, he distrusted the democratic tendencies of the Whigs, but a firm belief in the justice of the American cause led him to join their ranks. Morris served in the New York provincial congress in 1776–77, and after the congress had become the "Convention of the Representatives of the State of New York," he served on the committee of that body which prepared the first draft of the State constitution. He served in the Continental Congress in 1777–79, and was enthusiastic in his support of Washington. In 1778 he was selected chairman of the committee to treat with Lord North's conciliation commissioners, and as such presented the famous report, adopted by a unanimous vote of Congress, which declared that the recognition of independence must precede any negotiations for peace.

He settled in Philadelphia as a lawyer, and in Feb. 1780 he published a series of essays on finance, in which he criticized the issue of legal tenders, denounced laws passed for the benefit of the debtor class, and urged the people to tax themselves for the common good. From 1781 to 1785 he was assistant to Robert Morris (*q.v.*), superintendent of finance. In 1782 he prepared an elaborate report on the coinage, suggesting the use of the decimal system and of the terms *dollar* and *cent.* With some modifications introduced by Jefferson, this plan constitutes the basis of the present American system. Morris was one of Pennsylvania's representatives in the Constitutional Convention of 1787, and took an active part in the debates. His influence was weakened, however, by his cynicism and by his ultra-aristocratic

views. He was instrumental in securing the executive veto and in defeating the proposal that the legislature should elect the President. He also gave able support to the nationalist and anti-slavery factions in the convention. He was a member of the committee of revision selected to draft the Constitution in its final form. In 1787 he returned to New York to live.

He went to France in Feb. 1789 on private business, and remained abroad for nine years, passing most of the time in Paris, London and the German capitals. He was appointed U.S. minister to France in 1792, and was the only representative of a foreign country who remained at his post throughout the Reign of Terror; but his ill-concealed attitude of hostility to the Revolution gave offence, and in return for the recall of Genêt, at the request of the United States, the French government, in 1794, asked for the recall of Morris. Business and pleasure, however, still detained him in Europe until 1798, when he returned to New York, resumed the practice of law, re-entered politics and sat in the U.S. Senate as a Federalist from 1800 to 1803. As early as 1801 Morris became interested in projects for improving the communication between the Hudson river and Lake Erie, and from 1810 to 1816 he was chairman of the board of canal commissioners, which prepared plans for the Erie canal. He was bitterly opposed to the War of 1812, and openly advocated the formation of a northern confederacy to escape the rule of the "Virginia dynasty." He died at Morrisania on Nov. 6, 1816.

His half-brother, LEWIS MORRIS (1726–1798), a signer of the Declaration of Independence, was educated at Yale, served in the Continental Congress (1775–77) and went on a mission to the western frontier in 1775 to win over the Indians from the British to the American side. He joined the Army as brigadier general of militia in June 1778, and served in the New York Senate (1777–81 and 1784–90).

See *The Diary and Letters of Gouverneur Morris* (1888), edited by Anne Cary Morris; Jared Sparks, *Life of Gouverneur Morris* (1832), the first volume being a biography and the second and third containing Morris's miscellaneous writings and addresses; and Theodore Roosevelt, *Gouverneur Morris* in the "American Statesmen" series (1888).

MORRIS, SIR LEWIS (1833–1907), Welsh poet, was born in Carmarthen, in 1833. His great grandfather, Lewis Morris (1700–65), had been a well-known Welsh poet and antiquary. He was educated at Sherborne school and Jesus college, Oxford. He won the chancellor's prize for an English essay in 1858, was called to the bar in 1861, and elected hon. fellow of his old college in 1877. He practised for 20 years as a conveyancing counsel, retiring from active legal work in 1881. He was knighted in 1896. *Songs of Two Worlds* (1872, 1874 and 1875) showed a fluent gift of versification, and *The Epic of Hades* (1876–77) has passages of undeniable force and effect. Among his other books were *Gwen* (1880), *Songs Unsung* (1883), *Gycia* (1886), *A Vision of Saints* (1890), *Idylls and Lyrics* (1896) and *The New Rambler* (1906). He died at Carmarthen on Nov. 13, 1907.

MORRIS, ROBERT (1734–1806), American financier, a signer of the Declaration of Independence, was born in Liverpool, England, on Jan. 31, 1734. He joined his father in America in 1747, entered a mercantile house, and in 1754 became a member of a prosperous firm in which he later became partner. In the Revolution Morris sided with the colonists, but associated himself with the conservative group of Pennsylvania Whigs rather than with the more radical faction represented by Thomas Paine. He was vice-president of the Pennsylvania committee of safety (1775–76), and a member of the Continental Congress (1775–78). At first he disapproved of the Declaration of Independence, but he joined the other members in signing it on Aug. 22. He retired from Congress in 1778, and was at once sent to the legislature, serving in 1778–79 and in 1780–81. His greatest public service was the financing of the War of Independence. As chairman or member of various committees he practically controlled the financial operations of Congress from 1776 to 1778, and when the board system was superseded in 1781 by single-headed executive departments he was chosen superintendent of finance.

With the able co-operation of his assistant, Gouverneur Morris —who was in no way related to him—he filled this position with great efficiency during the trying years from 1781 to 1784. For the same period he was also agent of marine, and hence head of the Navy department. Through requisitions on the States and loans from the French, and in large measure through money advanced out of his own pocket or borrowed on his private credit, he furnished the means to transfer Washington's army from Dobbs Ferry to Yorktown (1781).

In 1781 he established in Philadelphia the Bank of North America, chartered first by Congress and later by Pennsylvania. A confusion of public and private accounts during the war, when his own credit surpassed that of the Government, gave rise to charges of dishonesty, of which he was acquitted by a vote of Congress. On the formation of the new Government he was offered, but declined, the secretaryship of the Treasury, and urged Hamilton's appointment in his stead. As U.S. senator, 1789–95, he supported the Federalist policies and gave Hamilton considerable assistance in carrying out his financial plans. After the war he gradually disposed of his mercantile and banking interests and engaged extensively in western land speculation. The slow development of this property, finally drove him into bankruptcy, and he was confined in a debtors' prison for more than three years (1798–1801). He died in Philadelphia on May 7, 1806.

BIBLIOGRAPHY.—The best biography is E. P. Oberholtzer's *Robert Morris, Patriot and Financier* (1903), based upon the Robert Morris papers in the Library of Congress; *see* also W. G. Sumner's *The Financier and the Finances of the American Revolution* (1891).

MORRIS, WILLIAM (1834–1896), English poet and artist, third child and eldest son of William Morris and Emma Shelton, was born at Elm house, Walthamstow, on March 24, 1834. His father came up to London in 1820, and entered the office of a firm of discount brokers in which he afterwards assumed a partnership. William was a delicate and studious child. When he was six the family moved to Woodford hall, where the boy's health improved. He was then sent to a school at Walthamstow, and, after his father's death, when the home at Woodford was broken up, to Marlborough. There he acquired a taste for architecture, fostered by the school library, and an attraction towards the Anglo-Catholic movement. In June 1852 he matriculated at Exeter college, Oxford, but he did not go into residence till Jan. 1853. Among his Oxford friends were Edward Burne-Jones and a little Birmingham group at Pembroke. They were known among themselves as the "brotherhood"; they read together theology, ecclesiastical history, mediaeval poetry, and, among moderns, Tennyson and Ruskin. They studied art, and fostered the study in the long vacations by tours among the English churches and the Continental cathedrals. Morris began at this time to write poetry.

Morris was entered (1856) as a pupil at the office of George Edmund Street, the architect; and on New Year's Day the first number of *The Oxford and Cambridge Magazine* appeared. The magazine existed for only a year. The chief immediate result was the friendship between Morris and Dante Gabriel Rossetti (*q.v.*), who became a contributor. In the summer of 1856 Street removed to London, and Morris accompanied him, working hard at architecture and painting. Rossetti persuaded him to devote himself exclusively to painting. Early in 1858 Morris published *The Defence of Guenevere,* which was almost unnoticed by contemporary criticism, but is now recognized as one of the pearls of Victorian poetry.

On April 26, 1859, Morris married Jane Burden, a beautiful Oxford girl, who had sat to him as a model, and settled temporarily at 41 Great Ormond Street, London. Meanwhile he set about building for himself at Upton a house which was to be the embodiment of all his principles of decorative art. Its furnishing had suggested a fresh activity; Morris now decided to begin decoration as a career. A small company was formed, consisting of D. G. Rossetti, Philip Webb, Burne-Jones, Madox Brown, Faulkner and Marshall, and in Jan. 1862 started business under the title of Morris, Marshall, Faulkner and Co., with offices at 8 Red Lion square. The firm undertook church decoration, carving, stained glass, metalwork, paper-hangings, chintzes and carpets. The business, after inevitable vicissitudes, flourished, but the "house beau-

tiful" at Upton proved to be unhealthily situated. Serious illness obliged the family to remove to town, and in Nov. 1865 they re-settled at 26 Queen square, Bloomsbury. Morris was now unceasingly busy, but he found time to write. In June 1867 he published *The Life and Death of Jason,* which was at once successful; and in April 1868 the first two parts of *The Earthly Paradise.* The rest of this wonderful storehouse of poetic romance appeared in two volumes in 1869 and 1870. In 1871, he took Kelmscott manor house, in the Upper Thames valley, in joint-tenancy with Rossetti, for use principally as a holiday home. In 1872 appeared *Love is Enough,* structurally the most elaborate of his poems; and in the autumn he began to translate the shorter Icelandic sagas, to which his enthusiasm had been directed by two inspiring journeys to Iceland. Business worries, however, interrupted him; the company had grown out of proportion with the existing division of profit and labour, and reconstruction was necessary. Long negotiations ensued, and in March 1875 the old firm was dissolved. Morris now became sole manager and proprietor.

Meanwhile in addition to his work upon the sagas, Morris had actually finished and (in 1875) published a version of the *Aeneid.* In 1876 appeared *Sigurd the Volsung,* a version full of heroic vigour, movement and vitality, but somewhat too lengthy and incoherent in design to preserve the epic interest intact to the British taste. This splendid burst of poetic activity had raised him to a place among the first poets of his time; and in 1877 he was offered the professorship of poetry at Oxford, which he declined. A fresh outlet for his energy was furnished by his foundation in 1877 of the Society for the Protection of Ancient Buildings, which sprang into being as a practical protest against a scheme for restoring and reviving Tewkesbury abbey.

At first Morris inclined, in politics, to the Radical section of the Liberal party, but in Jan. 1883 he joined the Democratic Federation, soon afterwards becoming treasurer of the party. On Dec. 30, 1884, he and others seceded from the Federation and formed the Socialist League, largely on the grounds that parliamentary action on which the leaders of the Federation tended to concentrate, was premature. Morris was appointed treasurer and editor of the monthly organ of the new League, the *Commonweal,* to which he later contributed his *Dream of John Ball* and *News from Nowhere.* The League started by repudiating State Socialism, and later became definitely opposed to parliamentary action. Morris lectured and spoke at meetings, and was several times arrested for obstruction in open-air meetings. But he was beginning to see that the time was not ripe for revolution. In 1890 the Anarchist section of the Socialist League became dominant, and Morris had to relinquish the editorship of the *Commonweal.* He still kept up with the Hammersmith Branch, which became independent, and met at Kelmscott House until its dissolution in 1892. But from this time on he took up a negative position. His *News from Nowhere,* published in book form in 1891, is a delightful and inspiring book, and a classic of the English movement, describing an England in which the socialist commonwealth has been realized.

Long before that time, however, Morris had returned to art and literature. When his business was enlarged in 1881 by the establishment of a tapestry industry at Merton, in Surrey, Morris found yet another means for expressing the mediaevalism that inspired all his work, whether on paper or at the loom—or indeed in political thought. In 1887 he published his translation of the *Odyssey.* He then added another to his multitudinous activities; he assumed a direct interest in typography. *The House of the Wolfings,* which was printed in 1889 at the Chiswick Press, was the first essay in this direction; and in the same year, in *The Roots of the Mountains,* he carried his theory a step further. Some 15 months later he added a private printing-press to his multifarious occupations, and started upon the first volume issued from the Kelmscott Press, his own *Glittering Plain.* For the last few years of his life this new interest remained the absorbing one.

His last piece of work, decidedly the crowning glory of his printing-press, was the *Kelmscott Chaucer,* which had taken nearly two years to print, and fully five to plan and mature. It was finished in June 1896. His vigour had been slowly declining for some time, and he sank gradually during the autumn, dying on Oct. 3, 1896. He was buried in Kelmscott churchyard.

Essentially the child of the Gothic revival, he had put an ineffaceable stamp on Victorian ornament and design, his place being that of a follower of Ruskin and Pugin, but with a greater practical influence than either. In house decoration of all kinds —furniture, wall-papers and hangings (which he preferred to paper), carpet-weaving, and the painting of glass and tiles, needlework, tapestry—he formed a school which was dominated by his protest against commercialism and his assertion of the necessity for natural decoration and pure colour, produced by hand work and inspired by a passion for beauty irrespective of cheapness or quickness of manufacture.

His friend Swinburne said that he was always more truly inspired by literature than by life. His socialism was tinged by a passionate enthusiasm for an inaccessible artistic ideal. Morris, indeed, was not primarily interested in men at all, but in objects. His poetry deals, it is true, with the human passions, but the emotion is always seen as in a picture; he is more concerned with the attitude of the group than with the realization of a character. But the spirit of beauty breathes in every line; a sense of music and of colour is everywhere abundant. Nor does the poet lack power and vigour when an adventurous story is told. Over all hangs the faint atmosphere of mediaevalism, of an England of green gardens and grey towers, of a London "small and white and clean," of chivalry and adventure in every brake. The critic has also to remember the historical value of Morris's literary influence, following upon the prim domesticities of early Victorian verse, and breaking in upon Tennyson's least happy phase of natural homeliness.

See the *Life and Letters,* in 2 vols., by J. W. Mackail; also H. Jackson, *William Morris* (1908); J. B. Glasier, *William Morris and the Early Days of the Socialist Movement* (1921); H. H. Sparling, *The Kelmscott Press and William Morris* (1924); G. Fritzsche, *William Morris' Sozialismus und anarchistischer Kommunismus* with bibliography (1927).

MORRIS-DANCE or **MORRICE-DANCE,** an old English dance, which is said by various authorities to have been introduced by John of Gaunt from Spain or borrowed from the French or Flemings. That it was a development of the morisco-dance or Spanish fandango is not invalidated by the fact that the morisco was for one person only, for, although latterly the morris-dance was represented by various characters, uniformity in this respect was not always observed. There are few references to it earlier than the reign of Henry VII., but it would appear that in the reign of Henry VIII. it was an almost essential part of the principal village festivities. In earlier times it was usually danced by five men and a boy dressed in a girl's habit, who was called Maid Marian. There were also two musicians; and, at least sometimes, one of the dancers, more gaily and richly dressed than the others, acted as "foreman of the morris." The garments of the dancers were ornamented with bells tuned to different notes so as to sound in harmony. Robin Hood, Friar Tuck and Little John were characters extraneous to the original dance, and were introduced when it came to be associated with the May-games. The morris-dance was abolished along with the May-games and other festivities by the Puritans, and, although revived at the Restoration, the pageant gradually degenerated in character and declined in importance. Maid Marian latterly was personated by a clown, who was called Malkin or Marykin. The interest of the subject has revived in recent years in connection with the new movements associated with folk-music generally. (*See* also DANCE; FOLK-DANCE.)

BIBLIOGRAPHY.—Cecil J. Sharp and H. C. MacIlwaine, *The Morris Book;* Strutt, *Sports and Pastimes of the People of England;* Brand, *Popular Antiquities* (1849).

MORRIS MOTORS (1926), LTD., the organisation of Morris Motors (1926), Ltd., occupying works at Cowley, England, and with an output of nearly 100,000 cars a year, had its inception when, at the age of seventeen, after nine months' apprenticeship in the cycle trade, Sir William Morris Bt., decided to go into business on his own account.

When the light car movement began Mr. W. R. Morris (as he then was) rapidly grasped the type of car for which an eager

public was clamouring. Up to this time cars—English cars especially—had been heavy unwieldy vehicles, expensive to run.

The 1912 Morris-Oxford, the forerunner of all Morris cars of to-day, was a light, sturdily constructed car with a highly efficient engine, and economical to run.

In the large works at Cowley, the embryo car is seen in the form of two flat strips of steel which, passing underneath a huge press, costing no less than £10,000, emerge a few seconds later as side members. The cross members are added, all the holes drilled at a single operation and the chassis frame begins its journey upon the assembly line. The chassis grows, passing from one group of workmen to another as each component is added.

The works at Cowley, near Oxford, employ between 3,500 and 4,000 men and have a covered floor space of some $81\frac{1}{4}$ acres, where a wide range of cars is turned out, from the little Morris Minor to a luxury Six-Cylinder Saloon. (C. R. L.)

MORRISON, ARTHUR (1863–), English novelist, was born in Kent on Nov. 1, 1863. He was for a short time a clerk in the civil service, and in 1890 took to journalism. *Tales of Mean Streets* (1894) and *A Child of the Jago* (1896) contained admirable realistic descriptions of London life. He also wrote plays.

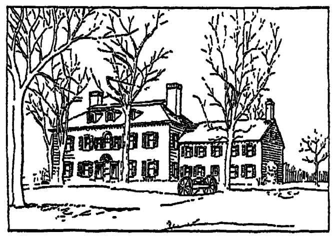
MORRISON, GEORGE ERNEST (1862–1920), British journalist and traveller, was born at Geelong, Australia, and educated at Melbourne University. From 1882 he travelled extensively in the South Sea Islands, where he studied the Kanaka labour question; in Australia, which he crossed on foot from the Gulf of Carpentaria to Melbourne; and in New Guinea. He took his M.D. degree in 1887 and after journeys to the United States and the West Indies he worked in his medical capacity in Spain, Morocco and Australia. In 1893 he abandoned medical work and set off on extensive travels in the Far East. He was special correspondent of *The Times* (London) in Siam (1895), and in Peking (1907–12). He visited every province and dependency in the Empire, with the exception of Tibet, and gained an intimate knowledge of men and affairs. In 1912 after the revolution he resigned his *Times* appointment and became political adviser to Yuan Shih-K'ai, president of the newly formed Chinese Republic. Dr. Morrison's published works include *An Australian in China* (1895). He died at Sidmouth, Devonshire, on May 30, 1920.

MORRISON, RICHARD JAMES (1795–1874), English astrologer, commonly known by his pseudonym "Zadkiel," was born on June 15, 1795. He served in the Royal Navy, but resigned with the rank of lieutenant in 1829. He then devoted himself to the study of astrology, and in 1831 issued *The Herald of Astrology,* subsequently known as *Zadkiel's Almanac.* In this annual pamphlet Morrison, over the signature "Zadkiel Tao-Sze," published predictions of the chief events of the coming year. He died on April 5, 1874.

MORRISON, ROBERT (1782–1834), the first Protestant missionary to China, was born of Scottish parents at Buller's Green, near Morpeth, on Jan. 5, 1782. After receiving an elementary education in Newcastle, he was apprenticed to a lastmaker, but his spare hours were given to theology, and in 1803 he was received into the Independent academy at Hoxton. The London Missionary Society sent him out to Canton in 1807. He became translator to the East India Company's factory there in 1809, and worked at a *Chinese Grammar* and a translation of the New Testament, both published in 1814. In 1817 he published *A View of China for Philological Purposes,* and his translation of the Old Testament (in which William Milne collaborated) was completed in the following year. He established (1820) an Anglo-Chinese college at Malacca for "the reciprocal cultivation of Chinese and European literature," and for the training of native Chinese evangelists who could proceed to the mainland and carry on Christian work with comparative immunity. In 1821 Morrison's *Chinese Dictionary* (6 vols.), was published by the East India Company. Leaving China at the close of 1823, Morrison spent two years in England, where he was elected a fellow of the Royal Society. Returning to China in 1826, he began to prepare a Chinese commentary on the Bible and other Christian literature. He died at Canton on Aug. 1, 1834. Morrison's establishment of a dispensary, manned by a native who had learned the main principles of European treatment, marks him out as the forerunner of modern medical missions.

His *Memoirs,* compiled by his widow, were published in 1839. *See* also R. Lovett, *History of the London Missionary Society,* vol. ii. ch. xix.; C. S. Horne, *The Story of the L. M. S.* ch. v.; Townsend, *Robert Morrison* (1888).

MORRISTOWN, a town of northern New Jersey, U.S.A., the county seat of Morris county; 30 m. W. of New York city, on the Whippany river and the Lackawanna railroad. Pop. (1920) 12,548 (19% foreign-born white and 7% negroes); 1930 Federal census 15,197. The town has a beautiful location, among wooded hills interspersed with lakes, at an altitude ranging between 400 and 700 ft. It is primarily a residential suburb, and has a number of large estates. At Morris Plains, 4 m. N., is a State hospital for the insane (1876). Morristown was founded (as West Hanover) in 1710 by Puritans, who were attracted by the deposits of iron ore. In 1740 the present name was officially adopted, in honour of Lewis Morris (1671–1746), then governor of New Jersey. Washington made Morristown his headquarters from January to May 1777, and again from Dec. 1779 to June 1780. The building in which he was is still standing and contains a fine collection of Washingtonian furniture. Behind the court-house is the site of Ft. Nonsense (now a public park), which he had his soldiers build largely to keep them occupied. Benedict Arnold was tried (Dec.–Jan. 1779–80) in the Dickerson tavern (still standing). The town was incorporated in 1865.



BY COURTESY OF THE MORRISTOWN CHAMBER OF COMMERCE

THE HEADQUARTERS OF GENERAL WASHINGTON IN MORRISTOWN DURING THE AMERICAN WAR OF INDEPENDENCE

MORRISTOWN, a town of eastern Tennessee, U.S.A., 42 m. N.E. of Knoxville, at an altitude of 1,351 ft.; the county seat of Hamblen county. It is on Federal highways 511 and 25E, and is served by the Southern railway. Pop. 5,875 in 1920 (83% native white); 7,305 in 1930 by the Federal census. It is in the fertile and beautiful valley of the Holston river, where poultry-raising, dairying and tobacco-growing are the leading industries. The city has creameries, a tobacco warehouse, storage facilities for 3,600,000 eggs, large chick hatcheries and broiler feeding-stations. Its manufacturing industries include eight woodworking plants, three textile factories and a variety of other establishments. A municipal hydro-electric plant on the river (4 m. N.) was completed in 1926. Morristown was founded in 1830 and incorporated in 1855.

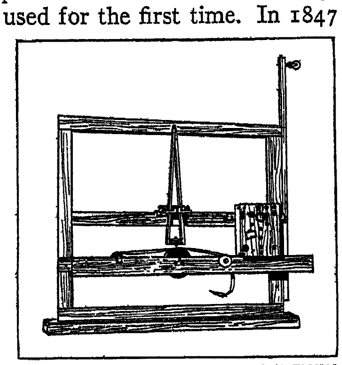
MORROW, DWIGHT WHITNEY (1873–1931), American lawyer and diplomat, was born at Huntington, W.Va., on Jan. 11, 1873. He was educated at Amherst (A.B., 1895) and Columbia (LL.B., 1899), and in 1899 entered the employ of the law firm of Simpson, Thacher and Bartlett. In 1905 he became a member of the firm and soon won a reputation in the organizing and financing of corporations. His many services brought him to the attention of J. P. Morgan and Co., in which firm he became a partner in 1914. His position with this firm during the World War period and after, when there were financial matters of great national and international import under negotiation, gave him wide experience and high standing. He was appointed by President Wilson adviser to the Allied Maritime Transport Council in 1918, and his work in connection with military shipping won him the Distinguished Service Medal in 1919. He was retained by Gen. Pershing for a time at Chaumont as his chief civil aid. In 1925 he was appointed chairman of the president's aircraft board. He was also active in charitable work and prison reform, his report as chairman of the Prison Inquiry Committee of New Jersey in 1917 resulting in a radical revision of penal legislation in that State. In Sept. 1927 he was appointed by President Coolidge ambassador extraordinary and plenipotentiary to Mexico. His friendly spirit and tactful negotiations resulted almost immediately in better relations between the two countries and in the settlement

of controversies over oil properties. He was retained in his position by President Hoover. He was one of the American delegates to, and played an influential part in, the Conference which resulted in the London Naval Treaty of 1930.

MORSE, SAMUEL FINLEY BREESE (1791–1872), American artist and inventor, was born at Charlestown (Mass.) on April 27, 1791. In 1810 he graduated at Yale college, where under the instruction of Jeremiah Day and Benjamin Silliman he received the first impulse towards electrical studies. In 1811 Morse, whose tastes during his early years led him more strongly towards art than towards science, became the pupil of Washington Allston and accompanied his instructor to England. In 1825 he was one of the founders of the National Academy of Design, and was its first president (1826–45). The year 1827 marks the revival of Morse's interest in electricity. But he was still devoted to art, and in 1829 he again went to Europe to study the old masters.

The year of his return, 1832, may be said to close the period of his artistic and to open that of his scientific life. He completed rough drafts of the necessary apparatus, upon which the modern telegraph substantially is modelled. During the 12 years that followed Morse was engaged in perfecting his invention and securing for it a proper presentation to the public. He made his own models, moulds, and castings. It was not until 1836 that he completed an apparatus that would work, and finally, on Sept. 2, 1837, the instrument was exhibited at the university of the City of New York with such satisfactory results as to interest Messrs. Vail, iron and brass workers in New Jersey, who thenceforth became associated with Morse in his undertaking. Morse's petition for a patent was soon followed by a petition to Congress for an appropriation to defray the expense of subjecting the telegraph to actual experiment to demonstrate its value.

Congress, however, adjourned without making the appropriation, and Morse sailed for Europe to take out patents there. In England his application was refused, and, while he obtained a patent in France, it was subsequently appropriated by the French government without compensation to himself. His negotiations with Russia proved futile, and after a year's absence he returned to New York. In 1843 Congress passed the appropriation, steps were taken to construct a telegraph from Baltimore to Washington, and on May 24, 1844 it was used for the first time. In 1847 Morse was compelled to defend his invention in the courts, and successfully vindicated his claim to be called the original inventor of the electro-magnetic recording telegraph.



BY COURTESY OF THE WASHINGTON NATIONAL MUSEUM

FIRST TELEGRAPH-RECEIVING APPARATUS INVENTED BY SAMUEL MORSE

In 1858 the representatives of Austria, Belgium, France, the Netherlands, Piedmont, Russia, the Holy See, Sweden, Tuscany, and Turkey made a monetary appropriation in recognition of the use of his instruments in those countries. He introduced into America Daguerre's process of photography, patented a marble cutting machine in 1823, and in 1842 made experiments with telegraphy by a submarine cable. He died on April 2, 1872 at New York. (*See* TELEGRAPH.)

See S. Irenaeus Prime, *Life of S. F. B. Morse* (1875).

MORSE CODE: *see* TELEGRAPH.

MORSHANSK, a town of Russia in the province of Tambov, in 53° 28′ N., 41° 45′ E., on the Tsna river. It is a grain collecting centre and has an elevator, and has grown since the railway reached it. There are manufactures of glass, cloth, makhorka tobacco and sauce. Pop. (1926) 27,758. The village was founded in the 17th century.

MORTALITY STATISTICS: *see* DEATH RATE.

MORTAR: *see* BRICKWORK, MORTAR IN BUILDING and ORDNANCE.

MORTARA, EDGAR, an Italian Jew, of a Bologna family, whose abduction in early childhood (1858) by the Inquisition occupied for several years the attention of European diplomacy. When five years of age he fell ill. His nurse, a Catholic, arranged with her priest for his baptism in that faith, unknown to his parents, on June 24, 1858. She had tried to convert his elder brother in a similar way, but failed. This time everything was concerted in advance with the ecclesiastical authorities, and immediately after the baptism both child and nurse disappeared. The story became known, and protest was aroused in nearly every European country. Pius IX. maintained that the question at issue was a spiritual one, outside his temporal jurisdiction, and would not take any action, meanwhile indicating the direction of his sympathies by making Mortara his ward. In 1861 the Mortara family induced the Italian Government to demand the prosecution of the nurse, who had meanwhile entered a nunnery, but subsequently, on the threat of intervention by Prussia, they withdraw their plaint. After the capture of Rome by the Italian troops in 1870 Edgar Mortara had the opportunity of reverting to Judaism, but he refused to do so, and became an Augustinian.

MORTARA, town, Lombardy, Italy, province of Pavia, 354 ft. above sea-level, a railway junction situated between the Ticino and the Po, 32 m. by rail southwest of Milan. Pop. (1921), 8,167 (town); 9,740 (commune). It is the capital of the Lomellina district. Here the Austrians defeated the Piedmontese in 1849.

MORTAR IN BUILDING. This consists of granular and siliceous material, such as sand, crushed brick, or stone, chippings, or crushed clinker with a cementitious material, such as lime or cement, mixed and reduced to a plastic state with water. The purpose of mortar is to bed uniformly and to unite blocks of building material in order to provide continuous contact of surfaces for the transmission of loads and stresses, and also to render the joints weatherproof.

Lime mortar is in common use for buildings such as dwellings and for industrial structures of moderate height, but cement mortar is much better adapted for the transmission of great stresses and, therefore, more suitable for use in high buildings, foundations, piers, etc. Cement mortar is also used for pointing or filling of external joints in all buildings where weathertight beds and vertical joints are required. Lime mortar is much weaker than most building materials; cement mortar more nearly approaches the strength of bricks and stones and enables these to withstand higher stresses than if bedded in lime mortar. Where the latter is used for bedding building blocks it should be of the character known as "hydraulic," especially for work at or below the ground level. Pure or fat limes are most suitable for the process of internal wall plastering. Grey stone lime which has slight "hydraulic" properties makes a good mortar for general work above ground.

Mixing.—Lime mortar may be mixed by hand or by machinery. Well slaked lime must be thoroughly mixed and incorporated with fine granular material, using sufficient water to make it plastic for manipulation with the trowel. Where a mill is used, stone chippings, furnace clinker or other substitute for sand may first be ground under the heavy rollers, in water, to a fineness approaching that of sand; the lime may then be added and the mixing accomplished by a similar operation which must not be prolonged otherwise there is a danger of reducing the particles to a much finer state which results in a fattier mass and reduces the probability of setting in the interior of the mass. Mortar made from hydraulic lime or cement or mortar gauged with cement must be mixed in quantities sufficient only for immediate use; cement cannot usefully be reworked after its initial set has begun because its setting properties are reduced, and the resulting mortar is weak and unsound.

Slaking.—This is a most important operation in the process of making mortar. There are three methods of slaking lump lime —the first by immersion, the second by sprinkling with water, and the third by exposing the lime to the atmosphere and leaving it to absorb moisture. Different qualities of lime require varying amounts of water, but the average quantity is about a gallon and a half to every bushel of lime. It should all be added at one time

and the mass then left to slake undisturbed. Hot limes are often used for mortar. These are unsuitable for plastering unless slaked for a long period. When mortars composed of these limes are used immediately after mixing, slaking must continue for a long time absorbing the moisture necessary for setting, making the work liable to serious damage by expansion of the slaking particles and often causing the mortar to crumble to dust in the joints of the brickwork. There was an old Roman enactment which set forth that lime should be slaked for three years before using and in the south of Europe it is still the custom to slake lime the season before it is used.

The results of many careful tests and experiments serve to show that the hardening of mortar is due to several causes acting collectively. With ordinary lime mortars the chief causes of hardening are the absorption of carbonic acid from the air and the combination of part of the water with the lime, which unites with some of the silica of which the sand is composed and forms silicate of lime. The initial setting is due to the evaporation of the excess of water and to the production of minute crystals of hydrate of lime which slowly combine with carbon dioxide from the air. With mortar of rich lime an outer crust is thus formed on the exposed parts which prevents ready access of air to the interior and confines the setting of the interior of the mass to a very slow and often incomplete formation of particles of silicate of lime.

The setting and hardening of hydraulic limes and cements are due mainly to crystallization brought about by the action of water on the silicate of lime. As a consequence we find that good hydraulic limes and cements have the valuable property of setting hard while immersed in water and in many cases growing increasingly hard with the lapse of time.

Extra Constituents. *Magnesia.*—Opinions differ on the question of the suitability for building purposes of limes or cements which contain an appreciable proportion of magnesia, many experts holding the view that the expansion which often occurs in floors and other works of concrete from one to four years after laying may be justly attributed to the presence of this substance. For mortars, however, it may be assumed that the presence of magnesia is not detrimental to the value of the matrix, but on the contrary may be a source of strength, for experiments show that it reduces the energy of slaking and increases that of the setting processes. Cements containing magnesia are pronounced both by Vicat and Chatoney to resist the dissolving action of sea-water better than those in which no magnesia is present and it is pretty well established by experience that cements derived from argillo-magnesian limestone furnish a durable cement for construction in the sea. Recent specifications for Portland cement provide that magnesia contents shall not exceed 2% of the whole and modern writers express the view that magnesia in excess of 4% is dangerous as it reduces the tensile strength of the cement under normal conditions and makes mortar or concrete unsound. (*See* CEMENT.) It is a good plan, where the question of cost precludes the use of mortar made entirely of cement, to add to lime mortar mixed in the usual proportions a small quantity of Portland cement. This is termed "gauged" lime mortar. By this addition the strength is greatly increased at little extra cost.

Adhesive Strengths of Lime and Cement Mortars

	Proportions	Approximate stress
White chalk, lime and sand . .	1 to 3	4¾ lb. per sq.in.
Barrow lias, " " " . .	1 " 3	9 " " " "
" " " " " . .	1 " 4	6¾ " " " "
Portland cement	1 " 4	23 " " " "
" "	1 " 6	15½ " " " "

Adhesion of Mortar.—The above table shows the force required to tear apart common stock bricks bedded in mortar, mixed in proportions commonly used, and left to set and harden for four weeks. These results indicate that the adhesive strength of mortar varies with the proportion of sand used, the resistance decreasing as the proportion of sand is increased. The primary cause of the premature decay which sometimes takes place in mortars and like material is due to the presence of impurities or of decayed vegetable and animal matter in the sand, though the lime or cement itself may be defective. It is therefore of great importance to use a perfectly clean sand for the aggregate, and to select a lime or cement of good quality for the matrix, care being taken that no foreign matters detrimental to the mortar be introduced during the processes of preparation.

Salt.—In some German experiments, cubes of stone were joined together with cement mixed with waters of different character, ranging from pure rain-water to water containing from 2 to 8% of salt. Before the cement was set the blocks were exposed in air at a temperature varying from 20° F to freezing-point, after which they were kept for seven days in a warm room. The samples were then examined with these results: The cement mixed with pure water was crumbled, having lost all its tenacity. The cement made with water containing 2% of salt was in a better condition, while that containing 8% of salt had not suffered from its exposure to frost. The use of salt causes efflorescence on the face of the work, and should therefore not be used where this would be undesirable; nor should salt be employed for work that is to be subsequently painted. The mortar for the brick facing of the Forth Bridge below water was composed of one part of Portland cement and one part of sand mixed with salt water in a mill. Briquettes made from this compound withstood a tensile stress of an average of 365 lb. per square inch when a week old, and of 510 lb. at five weeks after mixing. Salt has no serious effect upon the strength of a mortar, although it definitely retards the setting process.

Sugar.—Cement mixed with a percentage of sugar (usually 2% and under) has been used with varying success. In India sugar is a frequent ingredient in mortar, probably because it has the effect of preventing too rapid setting; it also retards the drying of the material. The sugar must be dissolved in the water used for gauging, as the results obtained when the sugar is mixed with the other ingredients in a dry state are not good. The addition of sugar to water enables it to take up very much more lime than pure water. It is supposed by many writers who have studied the methods of the ancients that old Roman mortars contained strong ale, wort or other saccharine matter, and it is probable that the use of sugar with lime passed from India to Egypt and Rome.

Limes and Cements for Mortar.—The varieties of lime and cement chiefly used for mortar in the British Isles are set forth below:—

Pure or fat limes should not be used for mortar. Grey stone lime, feebly hydraulic, makes a good mortar, but should not be employed for work below ground or in other damp situations. It is obtained in many places including Dorking, Halling, Lewes and Merstham. It is used in the proportion of one part to two or three parts of sand. An analysis of the lime from Castle Bytham gave the following composition:—

Silica	14·00
Iron oxide and alumina	4·25
Lime	77·00
Magnesia	1·25
Carbon dioxide	0·90
Water and loss	2·60
	100·00

Blue lias lime is eminently hydraulic and should be used in good class work. Its use is a necessity for foundations and work in damp situations where Portland cement is not employed. It is used in the proportions of one part to one or two parts of sand. The best-known varieties are obtained from Watchet and Keynsham in Somersetshire, Barrow-on-Soar in Leicestershire, Rugby in Warwickshire, Lyme Regis in Dorsetshire, Aberthan in Glamorganshire, and other places. A typical lias lime showed on analysis the following composition:—

Silica	17·53
Iron oxide	2·87
Alumina	6·83
Lime	65·84
Magnesia	1·00
Sulphuric anhydride	1·36
Water and carbon dioxide	3·85
Insoluble matter and loss	0·72
	100·00

Portland cement is the best matrix known, since it is the most powerful and the most durable. It is used for mortar wherever great strength, hard-wearing properties, and resistance to damp are required. It should weigh 90 lb. per cu.ft. and be ground fine enough to pass through a standard sieve having 32,400 meshes to the square inch and leave not more than 10% residue; not more than 1% residue should remain on a standard sieve having 7,700 meshes per sq. inch. Test briquettes after setting under water for seven days should stand a tensile stress of 400 lb. on a square inch. It is used in the proportions of one part of cement to from one to five parts of sand.

Portland cement of a similar general character to the English cement is made on the continent of Europe and in America. The first American Portland cement was manufactured in 1874 by Mr. David O. Saylor.

The chief works of reference on this subiect are G. R. Burnell, *Limes, Cements, Mortars;* Rivington, *Notes on Building Construction,* Vol. III.; F. W. Taylor and S. E. Thompson, *A Treatise on Concrete, Plain and Reinforced.*

MORTGAGE, the securing "money or money's worth" by making it a charge upon property, real or personal, so that if the debt be not paid by a time agreed upon by the parties, the creditor may foreclose or sell the property and pay himself out of the proceeds. In English law this is done by an actual or executory conveyance of the property to the creditor, subject only to its being defeated if the debt should be paid at the time fixed. Under the altered system initiated by the Law of Property Act, 1925, mortgages are charged without conveyance of the property to the mortgagee. (*See* HYPOTHEC.)

The mortgage of English law is the result of two distinct influences. Its origin and form belong to the common law; the restrictions by which it is made to serve the purpose of a security only, and nothing more, belong to the courts of equity. In the eye of the common law the mortgagee was the owner of the estate conveyed in the mortgage; in equity the mortgagor remains the real owner, and the mortgagee is merely an encumbrancer. At law, after failure of payment, the land belonged absolutely to the mortgagee, while in the meantime, before payment, the legal estate was considered to be vested in him, subject only to being defeated by payment at the proper time. The court of chancery first interfered in the reign of James I. to decree a redemption after forfeiture, and a case in the reign of Charles I. decides that payment after forfeiture has the same effect as payment before. The right of the mortgagor to redeem his estate after it has been forfeited, according to the terms of the deed, is called his *equity of redemption.* No agreement between the parties was suffered to oust the jurisdiction of the court, or to deprive the debtor of his equity of redemption. And this equity, at first regarded as a mere right of the debtor, became established in course of time as an estate in land which descended to the heirs of the mortgagor. In spite of the terms of the mortgage, the owner of the land is still the owner. It may be a question whether a given deed is a conveyance or a mortgage, and the court, in deciding, will look at all the circumstances of the case, and will treat it as a mortgage when it was the real intention of the parties that it should operate as a security only.

A mortgagee may, however, on default of payment file a bill of foreclosure requiring the mortgagor to pay the amount of the debt with interests or costs by an appointed day, or submit to be deprived of his equity of redemption. The effect of failure to pay by the time appointed would be to make the mortgagee absolute owner of the estate; but the court in any foreclosure suit may, at the request of either side, order a sale instead of a foreclosure. The mortgagee is entitled to retain out of the proceeds of the sale the amount of his principal, interest and costs, the surplus belonging to the mortgagor.

An *equitable* mortgage is constituted simply by the deposit of title-deeds in security for money advanced. Any subsequent legal mortgagee, having notice of the deposit, will be postponed to the equitable mortgagee, and when the legal mortgagee has not inquired as to the title-deeds the court will impute to him such knowledge as he would have acquired if he had made inquiry. A Welsh mortgage is one in which an estate is conveyed to a creditor, who takes the rents and profits in lieu of interest and without account, the estate being redeemable at any time on payment of the principal. Any form of property, with few exceptions, may be mortgaged.

United States.—In America the common law mortgage was adopted in many States with such incidents as the English law had attached to it. Equity courts intervened to prevent strict foreclosure or the forfeiture of the equity of redemption upon non-payment of the debt, insisting that foreclosure should be only made by judicial sale. Many States, however, permit the mortgagee to reserve a power of sale in the deed, which he may exercise without the intervention of the court. In about one-third of the American States the common law mortgage no longer exists, a mortgage having the effect of giving the mortgagee a legal lien upon the property, the mortgagor still retaining title. The practical differences between this and the common law mortgage are not great. Chattel mortgages are also common in the United States, recording of such mortgages being required by most States in order that the mortgagee's rights shall prevail against innocent purchasers of the chattel from the mortgagor.

BIBLIOGRAPHY.—L. A. Jones, *Treatise on the Law of Corporate Bonds and Mortgages* (Indianapolis, 1907); W. R. Fisher, *The Law of Mortgage* (6th ed. A. Underhill and A. Cole, 1910); W. Ashburner, *A Concise Treatise on Mortgages, Pledges and Liens* (2nd ed. W. F. Webster, 1911); R. H. Coote, *Treatise on the Law of Mortgages* (9th ed. R. L. Ramsbotham, 2 vols., 1927). *See* also Solicitors' Law Stationery Society, *The Law of Property Acts 1922–1925* (1925). The Library of Congress, *Select List of References No. 814* (1924) is "A List of Recent Works on Real Estate Mortgages." *See* also R. F. Bingham, *Financing Real Estate* (1924); B. H. Dughale, *Mortgage Loan Values* (1922); K. N. Robins, *The Farm Mortgage as an Investment* (1919); U.S. Census Bureau, "Mortgages on Homes," *U.S. Census Monographs, No. 2* (1923); S. N. Reep, *Second Mortgages and Land Contracts* (1928); L. A. Jones, *A Treatise on the Law of Mortgages on Personal Property* (5th ed., 1908); B. Constant, The Law Relating to the Mortgage of Ships (1920).

MORTIER, EDOUARD ADOLPHE CASIMIR JOSEPH, DUKE OF TREVISO (1768–1835), marshal of France, was born at Cateau Cambrésis on Feb. 13, 1768, and entered the army as a sub-lieutenant in 1791. He served in the campaigns of 1792 and 1793 on the north-eastern frontier and in the Netherlands, and subsequently on the Meuse and the Rhine. In the war against his second coalition in 1799 he was promoted successively general of brigade and general of division. Following his conduct of the French occupation of Hanover he was created marshal in 1804. He commanded a corps of the *grande armée* in the Ulm campaign, distinguishing himself by his brilliant action of Dürrenstein; in 1806 he was again in Hanover and north-western Germany, and in 1807 he served with the *grande armée* in the Friedland campaign. In 1808 he was created duke of Treviso, and he commanded an army corps in Napoleon's campaign for the recapture of Madrid. He won the victory of Ocaña in November 1809. In 1812 and 1813 he commanded the Young Guard, and in the "defensive" campaign of 1814 he rendered brilliant services in command of rearguards and covering detachments. In 1815, after the flight of Louis XVIII., he rejoined Napoleon, but at the opening of the Waterloo campaign he fell ill. After the second restoration he was for a time in disgrace, but in 1819 he was readmitted to the Chamber of Peers. In 1830–1831 he was ambassador of France at St. Petersburg, and in 1834–1835 minister of war and president of the council of ministers. In 1835, while accompanying Louis Philippe to a review, the marshal with eleven other persons was killed by the bomb aimed at the king by Fieschi (July 28, 1835).

MORTIFICATION or **GANGRENE.** A medical term signifying death in mass of some part of the body (*e.g.*, a portion of a limb or lung or a strangulated portion of gut) with the subsequent changes undergone by the part. Gangrene is always the result of interference with blood supply, and the appearances differ according as obstruction concerns the arterial supply or the venous return. If the artery is occluded and blood cannot reach the part by collateral circulation the part dies and evaporation from the surface causes it to dry and shrivel (*dry gangrene* or *mummification*). If the veins are occluded the part becomes oede-

matous and undergoes putrefaction (*moist gangrene*). Which of the two varieties will occur depends upon circumstances. If the arteries are diseased as in arteriosclerosis it is dry gangrene that occurs; if the part is inflamed and infiltrated with exudation and blood, as in some cases of comminuted fracture of bone, moist gangrene occurs. In such diseases as diabetes and chronic renal disease, where the nutrition of the tissues is already impaired, or in cardiac conditions in which the effective power of the heart as a pump is impaired, gangrene may arise after minor injuries or even spontaneously. If the nutritive condition of the patient is sufficiently good the dead material is separated from the living in time and cast off by a process of inflammation. This process may often be replaced by surgical amputation. The blackness of a gangrenous part is due to the formation of sulphide of iron from the broken-down red blood corpuscles. Frost bite (*q.v.*) is in reality only a specialized variety of gangrene.

MORTIMER (*Family*). The Mortimers of Wigmore, earls of March and Ulster, were akin to the dukes of Normandy. Their ancestor Hugh, bishop of Coutances in 990, had three sons, the eldest being Ralph, father of William of Warenne, earl of Surrey, and the second Roger of Mortemer-en-Brai. In the battle at his own village, Roger was a leader of the force which defeated the French, but, releasing an enemy of his duke, he was punished by the loss of his castle. The Mortimers' chief seat in Normandy became St. Victor-en-Caux. Roger's son, Ralph, who became heir to his father's lands, followed his kinsman, William Fitz-Osbern, the earl of Hereford, to the marches of Wales, and the Domesday book for Hereford and Shropshire marks the growth of the Mortimer power in those countries. After the rising of the 2nd earl of Hereford, he was enriched by many of the earl's forfeited estates, among them the castle town of Wigmore, which became the chief seat of Mortimer and Cleobury, thereafter called Cleobury Mortimer. His Domesday lands lie in eleven counties, especially in North Hereford and South Shropshire. Ralph rose in 1188 with the other barons of the March, but was reconciled to William II., whom he afterwards supported in Normandy. In 1104 he was a partisan of Henry I., and must have died soon afterwards.

Ralph de Mortimer, the 5th baron of Wigmore (d. 1246), married the daughter of Llewelyn, prince of Wales, and by her was father of Roger, whose bride, Maude de Breuse, brought in a third of the honour of Breuse of Brecknock, and a share of the honour of the earls marshal. So came the lordship of Radnor with other lands, and the history of the Mortimers ceases to be a provincial record. The last-named Roger supported Henry III. in his struggle with the barons. In 1282, he was succeeded by Edmund, the eldest surviving son (d. 1304), Roger, a third son, founding the line of Mortimer of Chirk.

By Margaret de Fiennes, a kinswoman of Queen Eleanor of Castile, Edmund Mortimer was father of Roger (b. 1287), whose great inheritance was increased on his marriage with Joan, daughter and heir of Peter de Geneville, her grandmother being a coheir of Lacy. The whole of the Geneville lands, with the half of the Lacy fief in England and Ireland, came through her to the Mortimers, who now added the castle town of Ludlow and half Meath to their estates. During the war with the Despensers, the force of the Mortimers was cast against the king but after Bridgnorth Castle had been taken, Edmund's son, Roger, was imprisoned for two years before he made his famous escape to France. At the court of Charles IV. the exile met Isabel, the queen of England, and early in 1326 the scandal of her close friendship with the lord of Wigmore had reached England. When the queen landed at an English port in September, Mortimer was with her, and he followed the flight of the king to Wales. He was among the judges of the elder Despenser at Bristol, and of the younger, his chief enemy, at Hereford. After parliament deposed Edward II. and made the young Edward king in his stead, Roger, as the queen's paramour, ruled England. Enriched by the lands of the Despensers, and by those of the earl of Arundel, beheaded at his command, Mortimer, who was created earl of March in 1328, never ceased to add to his possessions. The young king, however, worked secretly for his fall. Montague's men-at-arms entered Nottingham Castle by night, and joining the king, seized the favourite in his chamber next the queen's. Mortimer was hurried to London and condemned by the peers; his death followed suddenly.

Roger, who fought at Crécy in "the king's battle," was restored to a great part of the forfeited inheritance. A founder of the Order of the Garter, he was summoned as a baron and obtained a reversal of his grandfather's attainder. In 1355 he was summoned as earl of March. But following his king in the invasion of Burgundy, he died suddenly at Rouvray in 1360.

His only son, Edmund, succeeded him as 3rd earl of March (1351–1381). His marriage with Philippa, daughter of Lionel of Antwerp, duke of Clarence, by Elizabeth de Burgh, the heir of Ulster, added the earldom of Ulster to his style, and brought his issue into the direct succession of the Crown. Elizabeth, their eldest child, became the wife of the famous Harry Percy, called Hotspur. Their second child was Roger, who succeeded to his father's two earldoms as a boy of seven, and was at once appointed lieutenant of Ireland. He married Eleanor Holand, niece of King Richard, and in the parliament of 1385 the king named him heir-presumptive to the throne. In 1398 he was killed at Kells in one of his petty wars with the Leinster men, and once more a child succeeded to the earldoms. Edmund, 5th earl of March, was, for the king's party, the heir-presumptive of the kingdom, but by the coming to power of the Lancastrian party in 1399, Henry IV.'s first parliament recognized Henry's son as heir-apparent. March served Henry V. in his French wars, and on the accession of Henry VI. the earl was appointed to the lieutenancy of Ireland which had been held by his father and grandfather. He died suddenly of the plague in Ireland on Jan. 19, 1425. With him the illustrious house of the Mortimers, earls of March and Ulster, became extinct. Their lands and earldoms passed to Richard, duke of York, son of Richard of Cambridge, by the last earl's sister.

Bibliography.—*Victoria History of the Counties of England*—Introductions to Domesday book for Hereford and Shropshire; Eyton's *Antiquities of Shropshire; Dictionary of National Biography;* Dugdale's *Monasticon;* Stapleton's *Rotuli Scaccarii Normanniae;* G. E. C.'s *Complete Peerage;* Rymer's *Foedera; Journal of the British Archaeological Association,* vol. xxiv.

MORTISE or **MORTICE,** a term for a socket or cavity cut in a piece of wood, or other material, into which a corresponding projecting end, a "tenon," fits, the two when fitted together forming a "mortise-joint," for fastening two beams or other pieces of timber together. When locks are made to be imbedded in a socket cut in the thickness of a door they are termed mortise-locks.

MORTLAKE, a village in Surrey, England, on the Thames, 6½ m. W. of London. Pop. of parish, in urban district of Barnes, (1921) 19,502. The Oxford and Cambridge boat-race finishes here. The village appears in Domesday, and the manor belonged to the Archbishops of Canterbury until it passed by exchange to Henry VIII.

MORTMAIN, the state or condition of lands or tenements when held by a corporation in perpetual or inalienable tenure. Alienation in mortmain having the effect of depriving the lord of the incidents of seignory, many English statutes were passed directed against such alienation. Later statutes were based rather on economic and social grounds. The earliest is that of Henry III. 36; others being 7 Edward I. 13 (De Viris Religiosis); 13 Edward I. 32; 15 Richard II. 5; and 23 Henry VIII. 10. The present law is regulated by the Mortmain and Charitable Uses Act 1888, as amended by the Act of 1891.

A few British colonies, such as Ontario, have passed similar legislation.

In the United States mortmain acts have been passed in some jurisdictions restricting the right of corporations to hold land and also their power to make devises or conveyances or to receive land by devise.

MORTON, JAMES DOUGLAS, 4th Earl of (*c.* 1525–1581), Scottish statesman, was the son of Sir George Douglas of Pittendriech, and before 1543 married Elizabeth (d. 1574), daughter of the 3rd earl of Morton, to whose titles and estates he succeeded in 1553. Ten years later he became lord high

chancellor of Scotland. He headed the armed force which took possession of Holyrood palace in 1566 to effect the assassination of Rizzio, and it was to his house that the leading conspirators adjourned while a messenger was sent to obtain Mary's signature to the "bond of security." The queen, before complying with the request, escaped to Dunbar, and Morton and the others fled to England. Having been pardoned, Morton returned to Scotland early in 1567. He led the army which defeated the queen's forces at Langside in 1568, and was the most valued counsellor of the earl of Murray during his regency. In Oct. 1572, he himself was elected regent. He effected a pacification with Huntley, the Hamiltons, and the Catholic nobles who supported Mary, and took by arms the castle of Edinburgh.

There were, however, undercurrents which combined to procure Morton's fall. The Presbyterian clergy were alienated by his leaning to Episcopacy, and all parties in the divided Church by his seizure of its estates. When the powerful earl of Argyll and Atholl, a Stuart and Roman Catholic, united with Alexander Erskine, governor of Stirling, and others, Morton offered to resign. He surrendered the castle of Edinburgh, the palace of Holyrood, and the royal treasures, and retired to Lochleven. But his ambition could not deny itself another stroke for power. Aided by the young earl of Mar, he got possession of Stirling Castle and the person of the young king. A nominal reconciliation was effected, and a parliament at Stirling introduced a new government. Morton, who secured an indemnity, was president of the council, but Atholl remained a privy councillor in an enlarged council with the representatives of both parties. In 1580 Morton was condemned by an assize for having taken part in the murder of Darnley, and the verdict was justified by his confession that Bothwell had revealed to him the design, although he denied participation in its execution. He was executed on June 2, 1581.

MORTON, JOHN (*c.* 1420–1500), archbishop of Canterbury, cardinal and statesman, was born either at Bere Regis or Milborne St. Andrew. Educated at Balliol college, Oxford, he graduated in law, and followed that profession in the ecclesiastical courts in London. He is said (*Dict. Nat. Biog.*) to have been "at once admitted to the privy council"; but probably this is a mistake for the ordinary council, of which Morton might well have been made a member when he was appointed master in chancery and chancellor of the duchy of Cornwall. He received a good deal of ecclesiastical preferment from the Lancastrian party, was present, if he did not fight on the losing side, at the battle of Towton in 1461, and was subsequently attainted by the victorious Yorkists. He lived with the exiled court of Margaret of Anjou at Bar until 1470, and took an active part in the diplomacy which led to the coalition of Warwick and Clarence with the Lancastrians and Louis XI., and indirectly to Edward IV.'s expulsion from the throne. Morton landed with Warwick at Dartmouth in September 1470, but the battle of Tewkesbury shattered the Lancastrian hopes, and Morton made his peace with Edward IV.

In 1473 Morton was made master of the rolls; he was sent on a mission to Hungary in 1474, and was one of the negotiators of the Treaty of Picquigny in 1475. In 1479 he was elected bishop of Ely. He was one of the executors of Edward IV.'s will in 1483, but was arrested after the accession of Richard III. He escaped from Brecknock castle to Flanders, and worked in the interests of the earl of Richmond. When Richmond secured the crown as Henry VII., Morton became his principal adviser. He became archbishop of Canterbury in 1486 and lord chancellor in 1487. In the year 1493 Morton was created a cardinal, and in 1495 was elected chancellor of the university of Oxford. He encouraged learning to the extent of admitting Sir Thomas More into his household, and writing a Latin history of Richard III., which More translated into English. He died at Knole on Oct. 12, 1500, and was buried in Canterbury cathedral.

Besides the authorities cited in the *Dict. Nat. Biogr. see* the calendar of Patent Rolls, 1461–85, *passim;* W. Busch, *England under the Tudors* (1892); J. Gairdner, *Henry VII.* (1889) and *Lollardy and the Reformation* (1908), and *Political History of England,* vols. iv. and v. (Longmans).

MORTON, JOHN MADDISON (1811–1891), English playwright, the son of Thomas Morton (1764?–1838), also a playwright, was born at Pangbourne, on Jan. 3, 1811. He was the author of the famous farce *Box and Cox* (1847) and other pieces. He became a Charterhouse pensioner, dying on Dec. 19, 1891.

MORTON, LEVI PARSONS (1824–1920), American banker and politician, was born in Shoreham, Vt., on May 16, 1824. He was in business at Hanover, N.H., in 1843–49 and in Boston in 1849–54. He then became a partner in a New York dry-goods house. He established in 1863 the banking house of L. P. Morton and Company (dissolved 1899), with a London branch which had Sir John Rose (1820–88) as its principal member. The American firm assisted in funding the national debt at the time of the resumption of specie payments, and the London house were fiscal agents of the United States Government in 1873–84, and as such received the $15,500,000 awarded by the Geneva Arbitration Court in settlement of the "Alabama Claims" against Great Britain. He was a Republican representative in Congress in 1879–81, United States minister to France in 1881–85, vice-president of the United States in 1889–93, and in 1895–96 was governor of New York. He died in Rhinebeck, N.Y., on May 16, 1920.

See R. M. McElroy, *Life of Levi Parsons Morton* (1929).

MORTON, OLIVER PERRY (1823–1877), American political leader, "war governor" of Indiana, was born in Salisbury, Ind., on August 4, 1823. After studying for two years (1843–45) at Miami university, he practised law at Centerville, Ind., and in 1852 became circuit judge. In Feb. 1856 he was a member of the Pittsburgh convention which led to the organization of the national Republican party, and in the same year he was a candidate for governor of Indiana but was defeated. He was elected lieutenant-governor in 1860, and when Henry S. Lane, the governor, resigned, on January 16, 1861, Morton became governor. In 1864 he was re-elected. In meeting all the extraordinary demands resulting from the Civil War he displayed great energy and resourcefulness, and was active in thwarting the schemes of the secessionists in the neighbouring State of Kentucky, and of the secret societies of Southern sympathizers and other opponents of the war in Indiana. In 1863 a hostile legislature sought to deprive him of all control over the militia, and, failing in this, adjourned without making the appropriations necessary for carrying on the State government. In this predicament Morton appealed for financial aid to private individuals, bankers, the counties, and even the Federal government. The response was so prompt that he was able to conduct affairs practically single-handed until 1865, when a legislature more favourable to his policies assembled. Morton resigned as governor in Jan. 1867 to accept a seat in the U.S. Senate, in which he served during the rest of his life. He was recognized as one of the leaders of the Radical wing of his party, voting in favour of Johnson's impeachment, and being especially active on behalf of negro suffrage. He was a prominent but unsuccessful candidate for the Republican nomination for the presidency in 1876. He died at Indianapolis on Nov. 1, 1877.

See William D. Foulke, *Life of Oliver P. Morton* (Indianapolis, 1899).

MORTON, THOMAS (*c.* 1590–1646), usually called Thomas Morton of Merrymount, English adventurer in America, was a lawyer of Clifford's Inn, London, and seems to have practised in the west of England. He spent three months in America in 1622; returned in 1625, and settled at Mount Wollaston, in what is now Quincy, Massachusetts; and in 1626, when most of the settlers removed to Virginia, he assumed command of the settlement, and renamed it Merrymount. He came into conflict with the Puritan settlers, by setting up a maypole and also, it should be added, selling rum and arms to the Indians. He was banished to England, but returned in 1629, when he was arrested on trivial charges by the Massachusetts authorities, and was confined in the stocks. Later his house was burned and he was sent to England, where he spent a term in the Essex gaol. After his release he wrote his *New English Canaan* (1637), in which he heaps ridicule upon the New England colonists. In 1643 Morton returned to America. He was imprisoned in Boston in the following year, was brought to trial, remanded pending the gathering of further evi-

dence, and after a year's confinement was fined £100 and released. He retired to Agamenticus (now York), Maine, and in 1646 died poverty-stricken.

See the *New English Canaan,* edited by Charles Francis Adams (Publications of the Prince Society, vol. ix., Boston, 1883); C. F. Adams, *Three Episodes of Massachusetts History* (Boston, 1896); and, for a more favourable view of Morton, *A Few Observations on the Prince Society's Edition of the New English Canaan,* revised and reprinted from the *Churchman* (New York, 1883). Morton's adventures have furnished material for Nathaniel Hawthorne's short story, *The Maypole of Merrymount,* and for John Lothrop Motley's novels, *Morton's Hope* (1839) and *Merry Mount* (1849).

MORTON, WILLIAM THOMAS GREEN (1819–1868), American dental surgeon, was born at Charlton, Mass., on April 9, 1819, and studied dentistry at the Baltimore College of Dental Surgery. In 1844 he opened an office in Boston, where he gave especial attention to the improvement of artificial teeth and their means of attachment. It was necessary in many cases to remove the roots of old teeth, and in order to lessen the pain of this operation he searched for some means of deadening sensation. Dr. Charles T. Jackson (*q.v.*), a Boston chemist who already had made himself unconscious in the laboratory by inhaling sulphuric ether, suggested the use of this gas and demonstrated for Morton the method of inhalation. Morton first used it with success in the extraction of a tooth on Sept. 30, 1846, and on Oct. 16, 1846, he publicly administered ether at the Massachusetts General hospital while Dr. J. C. Warren performed a painless operation. Though Dr. Crawford W. Long (*q.v.*) had performed the first operation under ether in 1842, as subsequently revealed in 1849, it was Morton's independent discovery and his demonstrations which first made the value of sulphuric ether known to the medical world. He never benefited financially from his discovery and died in poverty in New York city on July 15, 1868. Morton published *Remarks on the Proper Mode of Administering Sulphuric Ether* (1847) and several papers in scientific journals.

MORTUARY, of or belonging to the dead, or in particular to the burial of the dead (Lat. *mortuarium,* from *mortuus,* dead, past part. of *morior*). The term was specially applied to the customary oblation or offering due from the estate of a deceased person to the church of the parish to which he belonged, and usually paid in kind to the incumbent. The parliament of 1529 (21 Hen. VIII., c. 6) limited the value of mortuaries to a maximum of ten shillings in estates exceeding forty pounds. Mortuaries, where customary, can be enforced only in the ecclesiastical courts: the custom is now obsolete, though claims have been made from time to time. The modern use of the word for a building in which bodies awaiting burial are temporarily kept is derived from the Latin *domus mortuaria,* mortuary house. But it has also been applied to many subjects connected with death and burial. In monastic institutions it was the duty of the almoner to send round to other monastic houses notice of the death of a member, asking for prayers for the soul of the dead. This notice was often beautifully illuminated. On being returned with the endorsement of the monastery to which it had been sent, it would be copied into the roll. Both the notice and the roll were known as a *mortuarium,* or mortuary.

See Abbot F. H. Gasquet's *English Monastic Life,* 1904.

MORVAN, an elevated region of gneiss and granite forming the northern continuation of the central plateau of France, and extending over a large part of the department of Nièvre, and over portions of those of Yonne, Côte-d'Or and Saône-et-Loire. Its area is a little over 1,000 sq.m. The average elevation is about 1,600 ft., the highest point, the Bois-du-Roi, attaining 2,959 ft. It is traversed by the Yonne, which has its source on Mt. Prénelay (2,789 ft.), by the Cure and by several affluents of the Arroux. It contains much good pasturage and is well wooded; the timber industry is important.

MORVI, a native state of India, in the Western India States agency, Bombay. Area, 822 sq.m.; pop. (1921), 91,355; tribute, £4,000. The chief, whose title is Thakur sahib, is a Jadeja rajput, of the same clan as the rao of Cutch. The chief products are cotton, sugar and grain. There is a state railway from Wadhwan to Rajkot. The town of Morvi is situated on the river Machhu, 22 m. from the sea and 35 from Rajkot; pop. (1921) 13,115.

MORYSON, FYNES (1566–1630), English traveller and writer, son of Thomas Moryson, M.P. for Grimsby, was a fellow of Peterhouse, Cambridge. He spent many years in travel on the continent of Europe, in Palestine and in Asia Minor. In 1600 he became secretary to Sir Charles Blount, lord-deputy of Ireland, where his brother, Sir Richard Moryson, held an appointment. In 1617 Moryson published an account of his travels and of his experiences in Ireland, where he witnessed O'Neill's rebellion, in a voluminous work entitled *An Itinerary.* He died on Feb. 12, 1630.

The *Itinerary* was originally intended to consist of five parts; but only three were printed, a fourth being preserved in manuscript in the library of Corpus Christi College, Oxford (partially printed in 1903 in Charles Hughes's *Shakespeare's Europe*).

MOSAIC, either a method, or the result produced by a method, of forming a surface by placing close together small pieces of marble, glass, tile, enamel, etc., usually for decorative effect. Mosaic is an outgrowth of inlay. In early periods of culture, small carvings of wood, stone or ivory were often decorated by inserting into them minute pieces of brilliant stone or enamel. When the area of such inlays is greater than the exposed area of the original material, which thus becomes merely a base and frame to hold the pieces of inlay, the result may be called mosaic. Many examples have been found in Egypt and Mesopotamia, dating from early cultural periods and chiefly ornamenting jewellery, furniture, small tablets and the like. The Egyptians had a certain grasp of larger possibilities for the material, as excavations at Tel-el-Yehudia in lower Egypt have revealed. Examples of column capitals and wall tiles show decorative richness where bits of coloured glass and earthenware have been inserted into sinkages in the tile or stone to form lotus and other ornaments. Recent discoveries in the Mesopotamian valley prove that the Sumerians had, at least as early as *c.* 3500 B.C., taken the next logical step in mosaic design and glued or cemented the small pieces of coloured stones to a base. A remarkable work in lapis lazuli and pink sandstone, excavated at Ur by the joint expedition of the British Museum and the University of Pennsylvania, is probably a standard, showing on one side an army going to battle, and on the other, a king or noble at a feast. This, probably dating from *c.* 3500 B.C., had the lapis lazuli and sandstone fastened to a wood background with bituminous cement. (See *Illustrated London News,* p. 1176, June 23, 1928.)

The Egyptians of the later empire apparently abandoned the use of mosaic except for jewellery, but in this they developed the amazingly skilful technique in glass mosaic, which is still employed in north Italy in making mosaic jewellery. This consisted of the use of small rods of coloured glass put together in such a way that their ends formed the desired pattern. The bundle thus made was heated, and so, partially fused together, drawn out while still hot to many times its original length so that at the centre, its section was but a small fraction of its original size. The whole was sliced, each slice giving a miniature reproduction of the original pattern. Thus, results of microscopic delicacy were produced, and the well known Egyptian skill produced coloured glass of great brilliance and variety; the most common colour was a greenish blue, widely used as a background.

Greek and Roman.—It is probable that the Greeks of the pre-Alexandrian period had developed at least the rudiments of mosaic technique, but it was only in the late Hellenistic era that this type of decoration became common. The name *opus Alexandrinum* (applied to one type, and its invention sometimes wrongly attributed to the emperor Severus Alexander), undoubtedly points to Alexandria as the great centre for work of this type. Few examples in Greece proper can be dated earlier than the Roman occupation. The House of the Trident of Delos shows exquisite examples of late Hellenistic mosaic. It is also a fact that in Pompeii, many of the finest examples of floor mosaics, such as the famous Battle of Issus, from the House of the Faun, date from as early as the 2nd century B.C.; and even the subject of this, unquestionably the most effective of ancient picture mosaics, with its representa-

tion of Alexander the Great, would seem to point to a Hellenistic origin and a Greek artist. In all of these early floor mosaics, the main body of colour is formed by tesserae, or small cubes, of carefully selected coloured marbles, but occasional bits of glass and tile are sometimes present.

Such large pictorial mosaics as the Battle of Issus in intricately worked detail, were exceptional in Roman floor mosaic work. Usually pictorial features were merely incidental panels in a much larger scheme of floor decoration, a type of design both more practical, and decoratively more satisfactory. Various types can be traced in the hundreds of examples of Roman floor mosaics preserved, not only in Italy, but in Syria, north Africa, France, Germany and England. The simplest, which from its common occurrence in even the most modest houses in Pompeii indicates an extremely inexpensive method of floor covering, consisted of an all-over simple geometric pattern, of two colours only. The tesserae of the background were of many shapes and sizes, put in almost at random, so that the effect approximated that of *terrazzo* (a cement coating embodying an aggregate of small pieces of coloured marbles, highly polished). The second class consisted of those in which a simple, central, rectangular field, usually light in colour, was surrounded by a decorative border of greater or less richness. These borders comprised some of the most effective mosaic designs of the time. In colour they were usually simple, often merely black and white.

Frets of all types were common, and the acanthus *rinceau,* or running scroll, was frequent, drawn in bold silhouette, with the utmost simplicity, appropriate to the material. In similar technique were the silhouettes of dogs, with the inscription *cave canem* ("beware of the dog"), that occasionally decorated vestibule floors. A third type comprised floors where the entire surface was made a rich decorative composition, usually by means of bold geometric patterns of considerable intricacy. Frequently, small panels of pictures were placed in important positions. It is to this type that the finest examples of Roman floor mosaic belong, such as the remarkable series found in and near Carthage, with their simple representations of men fishing, and other similar *genre* subjects, and the great mosaic from the baths of Otricoli, now in the Sala Rotunda in the Vatican. The last class is that of the frankly pictorial mosaic, undoubtedly based on Greek precedent. The famous "unswept room," now in the Lateran Museum, with its litter of fish, vegetables and fruit, and its mouse gnawing a nut, was copied or adapted from a well-known Hellenistic original at Pergamum.

Another type of floor treatment was the large-scale marble mosaic, *opus sectile.* In this, large slabs of coloured marbles, circular or square, were used to form magnificent and simple all-over patterns, usually with an alternation in adjacent units, of square and circular forms; there was sometimes, also, an additional alternation in colour. The most famous example, unique in being still in place and in use after more than 1800 years, is the great marble floor of the Pantheon, at Rome (begun 110), whose alternating squares and circles have been the inspiration for countless marble floors in modern days.

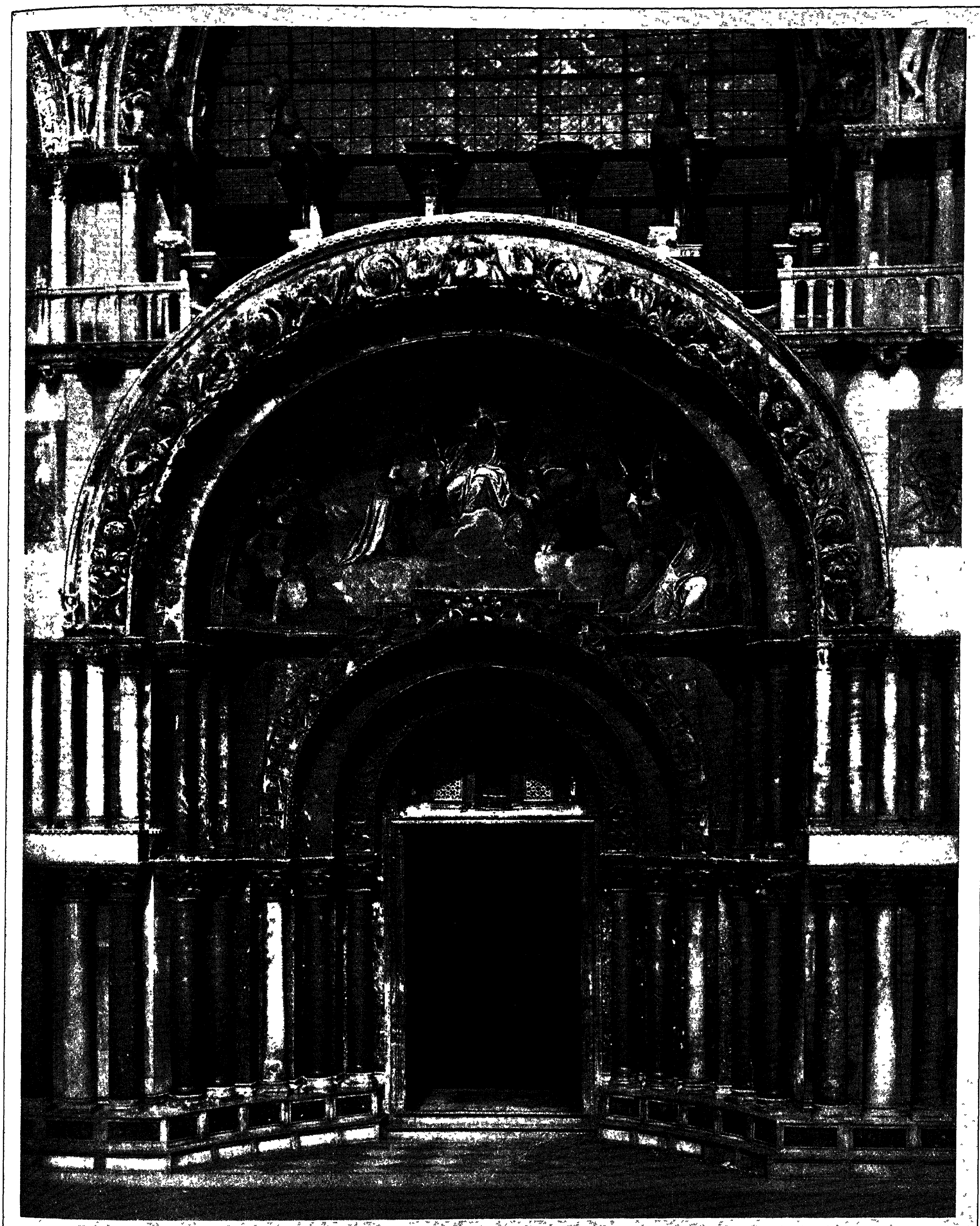
It is known from literary sources that mosaics, chiefly of glass, were much used also on the upper walls and vaults of monumental buildings of the Roman empire. Unfortunately, few, if any, examples of vault decoration earlier than the 4th century remain, and none *in situ.* Pompeii, however, has furnished several instances of more informal uses, especially mosaic columns and several mosaic garden fountain niches. Certain small panels of fine scale, and exquisite draughtsmanship, such as the two panels of rabbits in the Metropolitan Museum, New York, may have been used on walls rather than floors. It is noteworthy that the Pompeiian columns and fountains already show certain features characteristic of later Byzantine mosaics, both in the roughness of the texture, and in the colouring, largely blue-green. Column patterns seem to have been based on textile motives. The finest example of classic Roman vault mosaic is that in the aisle of S. Costanza (dated by Rivoira 324–326). Portions that remain are remarkably rich, varied and skilful in design; parts have leaves; birds and fishes are scattered over a light ground with lavish informality; and other parts show interlacing, geometric patterns. The most famous fragment represents a vintage scene, with the grape gatherers climbing through the vines, whose supporting lattice forms an interesting geometric basis.

In the 5th century mosaics of the tomb of Galla Placidia (*c.* 440) and the baptistry of Neon (5th century), both at Ravenna, the rich mosaics covering walls and vaults still remain dominantly classic and Roman, although elements characteristic of later Byzantine work had appeared. Those of the baptistry, with their great swirling acanthus *rinceaux* in the lower arch spandrils, and the rich architectural ornament of columns and shell-topped niches, at the base of the dome, and the garland or wreath on the under side of the entrance arch of the tomb of Galla Placidia are especially important in showing what must have been the character of the monumental Roman mosaics of the earlier period.

Byzantine.—By the middle of the 6th century, the Byzantine technique of design and execution had become definitely differentiated from the earlier Roman and transitional types. Not only did Byzantine domical design and the flatness of architectural forms give enormous scope for mosaic decoration in church interiors, but also, the very crudities of Byzantine execution, became, themselves, valuable aids to the development of mosaic design. Thus no imitation of painting was possible; crudities in drawing became interesting decorative conventions, admirably fitted to mural decoration; growing roughness of texture gave a play of light and shade that brought out in a new way the possibilities and characteristics of the material. Moreover, the use of gold tesserae, made by compressing gold leaf between two layers of glass, became increasingly common, and gave to the result a tremendously scintillating and vibrant quality. The mosaics of the triumphal arch and apse of S. Vitale, at Ravenna (*c.* 547) are characteristic of the earlier type of developed Byzantine mosaic. The grouping of the figures has just the right decorative rigidity, and the faces are drawn with impressive simplicity. Medallions, groups and decorative features are composed with richness and dignity. Gold and silver were used sparingly. Similar characteristics appear in the earlier Roman mosaics in the triumphal arches of St. Paul's Outside the Walls and S. Maria Maggiore (both 5th century), and remain constant in Italian Byzantine mosaic work well into the 13th century as in the apses of St. Paul's Outside the Walls (13th century) and of S. Maria in Trastevere, the upper part of the 12th century, the lower part by Pietro Cavallini (1291).

The most typical, and in some ways, the most remarkable production of the Italian school of Byzantine mosaic are the half-dome mosaics of the apses of the Roman basilicas. In these, not only is the stylization of the figures themselves entirely satisfactory, but also, the naïve directness of the composition and the simple symbolism of the ornament combine to create reverent and charming beauty. In general, the upper portion of the apse dome is occupied by a half rosette which may embody a symbol of deity. Below, filling the greater part of the curve, stand the figures, varying in number with the subject, but usually the central figure is that of Christ or the Virgin Mary, or, more rarely, the patron saint. Sometimes the figures are in a symbolic landscape, with a river below, and trees on the sides; occasionally, as a base to the composition, there is a row of lambs, representing the souls of the saved, facing a central lamb, carrying a cross and banner and symbolizing Christ. In addition to the examples already mentioned, those of SS. Cosmas and Damian (6th century), S. Agnese Outside the Walls (626) and St. Marco and S. Cecilia in Trastevere (both 9th century) are noteworthy. The apse of S. Clemente (12th century) and of S. Maria Maggiore (13th century) are exceptional; the former, in its bold covering of the dome surface with vine patterns which are, in essence, merely variations of acanthus *rinceaux;* the latter, because of the new spirit resulting from its design by Jacopo da Turrita and Taddeo Gaddi, whose work is more in the line of descent of later Italian painting than of Byzantine mosaic.

Meanwhile, in Constantinople, a different school of Byzantine mosaic had developed. Its earliest great monument, the decoration of S. Sophia (middle 6th century) still remains one of its most



PHOTOGRAPH, ALINARI

PRINCIPAL DOORWAY OF ST. MARK'S IN VENICE

The technical skill of the Byzantine mosaicists was preserved in Venice for centuries, but the decorative genius of the earlier designers decayed swiftly, and by the 16th century—the period of this mosaic—only sterile and clever attempts to imitate paintings were produced. A comparison with fig. 2 on Plate II. reveals at a glance the decorative feebleness of this mosaic

MOSAIC

BY COURTESY OF (1) P JACKSON HIGGS, (2, 6) THE RAVENNA MOSAICS, INC ; PHOTOGRAPHS, (3, 4, 5) ALINARI

PERSIAN AND BYZANTINE MOSAICS

1. Persian faience mosaic from a tomb at Ola, an example of the richness of architectural treatment by the use of ceramic tiles, which was a dominant feature of Persian architecture (*see* TILE). The type of design shown here is that developed at Isfahan, in the year A.H. 885, or A.D. 1482.

2, 5 and 6. Byzantine mosaic at its best. (5) is from the church of S. Apollinare Nuovo, in Ravenna, and dates from the 6th century. Its simple row of ranked saints, so dignified in their powerful restraint, becomes one with the wall it decorates; it is an essential part of the architecture of the building, as firm, as constructive, as the columns and arches below. (2) and (6) face each other from opposite sides of the apse walls of S. Vitale at Ravenna; they, also, date from the 6th century. Less formal than the saints of (5) they still preserve that rhythm, balance, and simplicity of composition that constitute the essence of harmonious architectural ornament. The exact and desirable balance between representation and conventionalism, between pictorial vividness and rigid architectonic quality has seldom been so perfectly achieved. In them is the richness of the Byzantine court, yet they always remain essentially parts of the wall, and essential units in the architectural design

3. The apse mosaic from Sta. Maria in Trastevere, Rome, one of the richest and most satisfactory examples of the work of the 12th century Roman mosaicists. This work, usually classed as Byzantine, combines with strict Byzantine decorative composition a more Roman quality of freedom; a late classic influence is revealed in the shell-like form at the top, and the rich border on the arch

4. This 12th century mosaic from the Capella Palatina (the chapel of the Royal palace) in Palermo, Sicily, showing the angel visiting St. Peter, reveals the increased pictorial quality of the later Byzantine mosaics

effective achievements, and although it is contemporary with the work in S. Vitale, already mentioned, it is strikingly different, both in composition and effect. The novelty appears in the use of gold mosaic as a background for all of the decorative work covering the vaults and the large scale and oriental, non-classic type of ornament; and although the figure work is now covered with Turkish plaster and paint, the portions still exposed give an effect of unrivalled, solemn richness. In general, domes and vaults are treated simply, with large areas of gold and borders, and occasional spots, of direct and simple ornament, often geometric, with occasional leafwork in which forms almost Persian appear. In the pendentives are great figures of the cherubim, represented merely as six great wings, magnificently filling the space in soft bluish grey. Between the windows of the large side arches, and in the apse were the figures now covered up. These have, however, been studied during an examination of the building for its stability under Sultan Abdul Medjid (1847–49); the mosaics were at that time carefully drawn by the Italian architects in charge, the Fossatis, so that it is possible to form a perfect conception of the original appearance. (*See* C. G. Fossati, *Aya Sophia,* 1852.) The most effective of the mosaics still exposed are those of the vaults of the narthex, the gallery immediately above it, and the cherubim in the pendentives.

The precedent of gold grounds set by S. Sophia, controlled, not only all the mosaics of Constantinople and the adjacent regions, for the next 700 years, but is also responsible for the gorgeous interiors of Monreale cathedral, 1170–90, and La Martorana and the Capella Palatina (both in Palermo, 12th century). To it is also due the use of the single great head or figure of Christ in the apse, a type of religious decoration whose awe-inspiring grandeur and daring beauty can best be judged at Monreale. Similarly, the ranked figures over the columns of the nave of the Capella Palatina, recall, distantly, the saints between the windows of the arches of S. Sophia. Even in Venice, the Italian school of Byzantine mosaic is entirely dominated by that of Constantinople, and the narthex and baptistry of St. Mark's (13th century), resemble the oriental patterns of Constantinople much more than the contemporary work in Rome. The vaults and domes of the main body of the church, with glorious gold backgrounds, are equally eastern, but the figures and scenes, dating from the 12th to the 16th century, have been so repaired, altered and polished, and in parts, so disfigured by the Renaissance effort to imitate paintings with an alien material, as to be individually disappointing.

The Constantinople tradition even permeated Mohammedan countries. Thus the entire mosaic decoration of the Koubet-es-Sakra (or dome of the rock) and the El Aksa mosque, both in Jerusalem, were executed by Greek artists, invited to Jerusalem specifically for that purpose. Those from the Dome of the Rock date largely from *c.* 694, with portions from the reconstruction under Saladin in 1187. Those from El Aksa are principally of Saladin's time. Even in Cordova, Spain, Greek artists, brought there by Abd-er-Rahman III., decorated the mihrab of the Great Mosque with rich floral mosaics (929–961).

Although in Europe, Byzantine mosaic passed into decadence in the 13th and 14th centuries and finally disappeared, through the tremendous development of the magnificent school of Italian mural painters, in Constantinople and Greece, mosaic remained the dominant church decoration until the fall of Constantinople (1453). The mosaics of the church of the convent of Daphni, near Athens (*c.* 1100), are interesting examples of the middle period. In Constantinople great areas of mosaics still remain in churches converted into mosques; only in two cases are these exposed: one is a beautiful ribbed dome in the Fetihieh Djami, originally the church of Pammakaristos (12th century), the other, and more important example, is the rich 14th century decoration of the Kahrieh Djami, once the church of the Chora; these show that in the 14th century the earlier hieratic stiffness of figure drawing, and the almost mechanical regularity of composition, decoratively so impressive, of the earlier period, was giving way to a much more pictorial ideal. There are not a few resemblances between some of the scenes here and the almost contemporary decoration in fresco of the church of St. Francis at Assisi. The borders and the ornamental details retain, however, their old character, and the gold ground, and the roughness of texture, still make these decorations essentially mosaic in character, and not the imitated paintings of the later work at St. Mark's at Venice.

Mediaeval Italian.—The opus sectile of Roman marble floors had an equally distinguished mediaeval development. This came through the combination of opus sectile, in which large slabs of coloured marble were cut to a pattern, with opus Alexandrinum, a form of mosaic consisting of many small pieces of marble cut to constant "stock" shapes. These shapes are: right angle and equilateral triangles, lunettes and squares, by the combination of which all sorts of geometric patterns could be obtained. The colours most common are red, dark green, white, black and occasionally creamy yellow. The most usual pattern is that obtained by inscribing in a large triangle, smaller triangles of alternating dark and light colours. With opus Alexandrinum, continuous bands were formed which were inset into the opus sectile to make borders for panels, or running interlaces and guilloches (*q.v.*). The effect thus achieved of contrast of large and small scale was extremely impressive and there was an indefinite supply of coloured marble to be had for the taking from pagan Roman buildings. The circles so frequently used were made by slicing Roman columns. The use of this type of pavement is so common in Italy as to make it difficult to select examples; those of St. Mark's, Venice, and S. Maria Maggiore, S. Maria in Trastevere, and S. Clemente, all in Rome, are particularly striking. The decorative possibilities of this combination of opus sectile and opus Alexandrinum were recognized during the 12th, 13th and 14th centuries for the decoration of altar frontals, ambones, choir screens and parapets. Rome and south Italy are particularly rich in examples (*see* AMBO). Roman workers in this type of mosaic evidently travelled widely, for in Westminster abbey the space in front of the high altar was decorated with it in the third quarter of the 13th century by a Roman artist named Odericus.

In using opus Alexandrinum for church furniture a continual decrease in the size of the units, and an increased delicacy in the scale of the pattern was obtained. In this development it was but natural to substitute glass or enamel, in some cases, for the earlier marble, and it is this type which is known by the name of the family that, during the 13th century, was its chief exponent—Cosmati work. Its use was not limited to flat surfaces. Frequently the spiral columns, then so popular, had grooves cut in the hollow spiral flutes, which were filled with Cosmati mosaic of exquisite delicacy. This is the case in the 13th century cloisters of St. John Lateran and St. Paul Outside the Walls, both at Rome, in the paschal candlestick at S. Clemente, Rome, and in much church furniture in the south of Italy. Without doubt, work of this kind was common in the 13th century all over Europe and mosaic patterns probably exerted a large influence upon the other arts, especially in the case of enamel work on metal. In Westminster abbey the shrine of Edward the Confessor (1269), and the tomb of Henry III. (1291), are both remarkable examples of rich Cosmati work outside of Italy; they were the work of one Peter, a Roman citizen, who was possibly a pupil of the Cosmati.

Mohammedan.—In Mohammedan countries mosaics of the Byzantine type were little imitated by native artists. In Persia a type of mosaic occurs in exterior design, which seems to be either of independent origin, or else due to a distant memory of the burned and glazed brick and tile wall coverings of Assyrian palaces. Small rectangular tiles are put together to form geometric patterns, some of which are based upon rectangularized versions of Arabic letters. The most remarkable examples are those of the mosque at Veramin (early 15th century), the mosque of Chah-Sindeh at Samarkand (1392), and certain details of the tomb of Princess Tchuchuk Bika, at Samarkand (1371). A similar technique is used in the decoration of the great entrance arch and loggia of the Chinili Kiosk in the seraglio at Constantinople, designed by Kemal-ed-din (1466–70). In Persia itself, however, continually increasing skill in painting faïence tiles with floral pat-

terns led gradually to the abandonment of mosaic in favour of the newer and richer method.

Mohammedan architecture of India developed under the Moguls a tremendous skill in an elaborate marble mosaic of opus sectile type in which the most intricate curvilinear patterns are formed in the cut marble, and colour is furnished by the rich use of precious and semi-precious stones, as well as coloured marbles and enamel.

Another characteristically Mohammedan development is that of small scale geometric mosaic in wood, for the decoration of furniture, boxes and implements. This art was especially practised in Cairo, Damascus and north India and persists in parts of the Mohammedan world to the present day. Frequently ivory and mother-of-pearl are combined with different coloured woods in the patterns. A similar technique is employed to-day in parts of Italy. No definite line can be drawn between wood mosaic of this type and that which is known as marquetry (*q.v.*). Similarly the quasi-mosaic work in wood inlays, known as intarsia, of which the most remarkable example is the choir stalls of the church of S. Pietro Casinensi, at Perugia, from designs said to be by Raphael, executed by Stefano da Bergamo (1535), is more truly marquetry than mosaic.

Modern.—With the coming of the Renaissance, mosaic art almost completely disappeared, and where mosaic was used by Renaissance decorators, such as the work of Titian in St. Mark's at Venice, it was merely an attempt to imitate painting. Only in Venice, in the form of jewellery and similar small work, did the vitality of the art continue. There, at least in technique, it seems to have persisted down to modern times, although in design following the fashion of the day. It was not until the revivals of the 19th century that mosaic art resumed any importance whatsoever as mural decoration. The tendency toward decorative lavishness, so characteristic of the Gothic revival, was peculiarly fruitful in resurrecting the art. Almost all of the middle 19th century work is Venetian, and much of it produced by Antonio Salviati. The mosaics of the central hall of the houses of parliament, at Westminster, from designs by Sir Edward Poynter, and those of the reredos of Westminster abbey (1867) are typical. They show the great fault common in these revival mosaics—a surface polished smooth, tesserae so close together that joints between them become almost invisible, and design which neglects the material and aims principally at pictorial effect. Even in the much more successful mosaics from the designs of Sir Edward Burne-Jones, in the American church at Rome, the surface is too smooth to bring out the maximum decorative effect. Similarly, in France, the mosaics of the ceiling of the Escalier Daru, by Lenepveu, the apses of the Madeleine by Gilbert Martin and the Pantheon, by Hébert, show the same fault of texture, though in design revealing the customary brilliance of French mural decoration. During the present century the decorative possibilities, as well as the limitations of the material have come to be more thoroughly recognized, and work as different as that of the Giggleswick school chapel in England, by Sir T. G. Jackson, and the extremely modernist Golden hall in the town hall of Stockholm, by Ragnar Ostberg, alike show a true grasp of the necessity of keeping surfaces rough, drawing simply and allowing the cement in the joints between the tesserae to count as part of the decorative effect.

In the making of the best modern mosaic two general methods are employed. In one, the tesserae are fixed in place by hand, on the wall or vault itself. This is, undoubtedly, the most direct method, and allows the light on each piece to be studied in place. The more common technique is to prepare an outline drawing on heavy paper, which is the reverse of the full size cartoon for the design. Upon this the tesserae are glued in place. When this process is completed, the paper is cut into pieces small enough to be handled easily. The wall to be decorated has in the meanwhile been brought to a perfect surface with a special cement. Fresh cement is placed over this surface, and into it are pressed the tesserae with their faces still glued to the original drawing; when the cement has sufficiently set, the paper is torn off, the joints pointed with cement and the whole cleaned. This method allows the choice of the tesserae and their arrangement to be accomplished at leisure in a studio. If carefully handled with the necessary changes, when the tesserae are in place, slight errors may be satisfactorily corrected, although certain critics maintain that the best results can only be obtained by the direct application of the tesserae to the wall. In recent years new effects have been obtained by leaving the background entirely in cement, only the figure, or pattern itself being in mosaic.

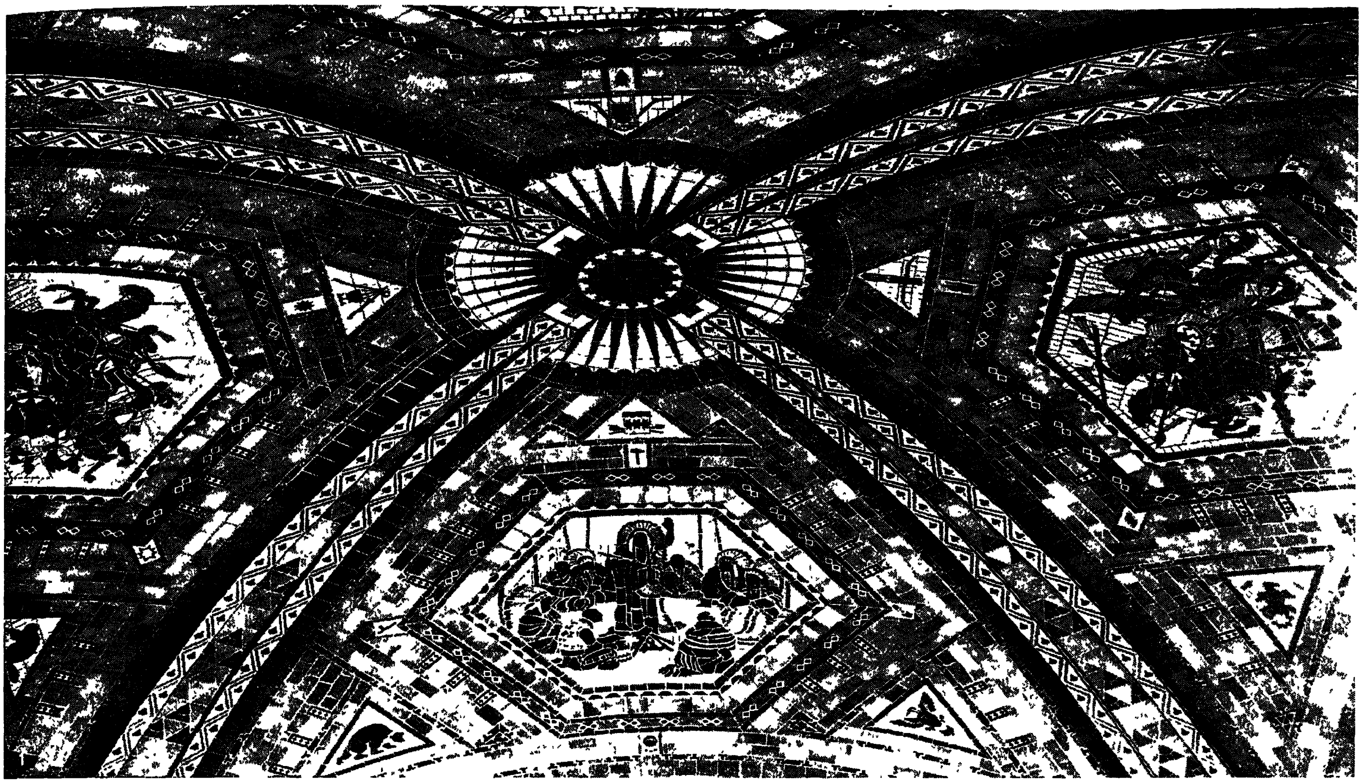
Another strictly modern development of mosaic has resulted from the use of small tiles for floors, wherever ease of cleaning is imperative. Thus mosaics of small, vitrified tile, in uniform shapes—especially squares, hexagons and circles, or of small rectangles arranged in a basket weave design—are common, not only in the halls of tenement houses, public buildings, etc., but also on the floors and as wainscoting in baths, toilet rooms, lavatories, swimming pools and even kitchens.

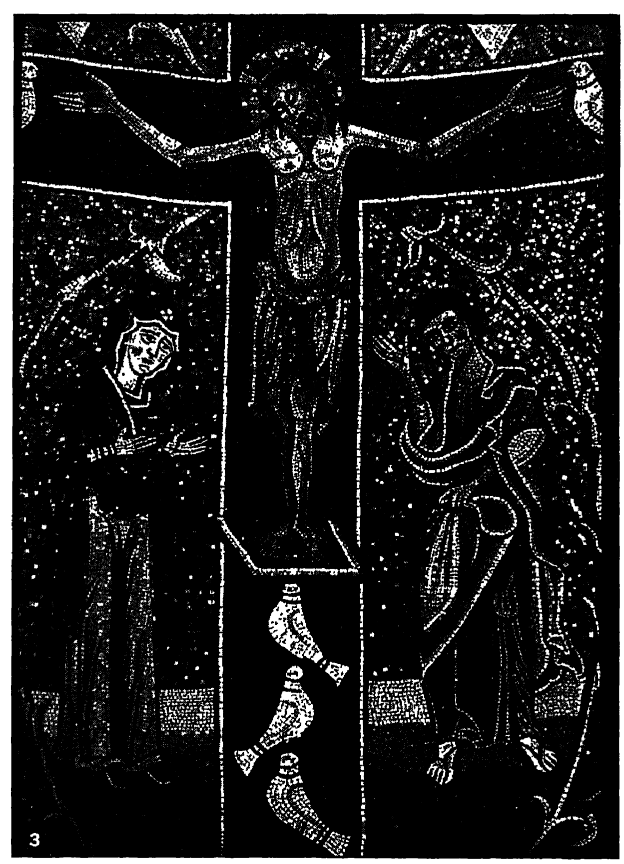
Modern decorative mosaic floors are largely based on the opus sectile of Roman imperial work, and especially in churches, upon those combinations of opus sectile and opus Alexandrinum so characteristic of mediaeval Italy.

(*See,* also, AMBO, APSE, BASILICA, BYZANTINE AND ROMANESQUE ARCHITECTURE, GLASS, MARQUETRY.)

BIBLIOGRAPHY.—S. Lysons, *Roman Antiquities of Woodchester* (1797); F. Mazois, *Ruines de Pompéi* (1812–38); S. Lysons, *Reliquiae britannico-romanae* (1813); Prangey, *Mosquée de Cordoue* (1830); O. Jones, *Alhambra* (1842); A. F. von Quast, *Altchristliche Bauwerke von Ravenna* (1842); J. R. A. Texier, *L'Arménie et la Perse* (1842–52); M. D. Wyatt, *Geometrical Mosaics of the Middle Ages* (1849); C. G. Fossati, *Aya Sophia* (1852); W. Salzenberg, *Altchristliche Baudenkmale von Konstantinopel* (1854); Pliny the Elder, *Natural History,* trans. J. Bostock & H. J. Riley (1855–57); Barbet de Jouy, *Les Mosaïques chrétiennes de Rome* (1857); J. R. A. Texier, *Asie Mineure* (1862); Texier and Pullan, *Byzantine Architecture* (1864); J. H. Parker, *Archaeology of Rome and Mosaic Pictures in Rome and Ravenna* (1866); P. Coste, *Monuments modernes de la Perse* (1867); D. Salazaro, *Mon. dell' arte merid. d'Italia* (1871–81); Gauckler, "Musivum Opus," in Daremberg and Saglio, *Dictionnaire des Antiquités;* Prisse d'Avennes, *L'Art arabe* (1874–80); J. P. Richter, *Die Mosaiken von Ravenna* (1878); D. Pulgher, *Églises byzantines de Constantinople* (1878–80); A. L. Frothingham, "Les mosaïques de Grottaferrata," in *Gaz. arch.* (1883); E. Gerspach, *La Mosaïque* (1883); E. Muntz, *La Mosaïque chrétienne pendant les premiers siècles* (1893); D. Ainalov, *Mosaiken des IV. u. V. Jahrhunderts* (1895); P. Saccardo, *Les Mosaïques de Saint Marc à Venise* (1896); G. Milet, *Le Monastère de Daphni* (1899); E. A. Grosvenor, *Constantinople* (1899); G. B. de Rossi, *Mosaichi cristiani di Roma* (1899); G. Sangiorgi, *Il Battistero della basilica Ursiana di Ravenna* (1900); J. Kurth, i., "Die Mosaiken von Ravenna," *Die Mosaiken der christlichen Aera* (1902); J. P. Richter and A. C. Taylor, *The Golden Age of Classic Christian Art* (1904); Schmitt and Kluge, "Kachrie Djami," in *Bul. de l'institut impériale Russe à Constantinople,* xi. (1906); H. Saladin, i. "L'Architecture," *Manuel d'Art musulman* (1907); A. D. F. Hamlin, i. "Ancient and Mediaeval," *History of Ornament* (1916); J. Strozygowski, *Origins of Christian Church Art* (1923); J. Wilpert, *Die roemischen Mosaiken u. Malereien der Kirchlichen Bauten vom IV. bis XIII. Jahrhundert* (1924). (T. F. H.)

MOSBY, JOHN SINGLETON (1833–1916), American soldier, was born in Edgemont, Va., on Dec. 6, 1833. He graduated at the University of Virginia in 1852, was admitted to the bar in 1855 and practised in Bristol, Washington county, Va., until the beginning of the Civil War. For a time he was adjutant of Gen. J. E. B. Stuart's 1st Virginia Cavalry. In 1863 with Stuart's permission he undertook a quasi-independent command. In Fairfax, Fauquier and Loudoun counties within the Federal lines, he raised and equipped a force of irregulars. On the night of March 8, 1863, with about 30 men, he penetrated the Federal lines at Fairfax Court-house and took 33 prisoners, including Brig.-Gen. Edwin H. Stoughton. He became famous for other such exploits. In the North he was regarded as a guerilla and in 1864, Sheridan, under orders from Grant, hanged seven of Mosby's men without trial; Mosby retaliated by hanging seven of Custer's cavalrymen. On April 21, 1865, 12 days after Lee's surrender, he disbanded his men. Through the influence of Gen. Grant, he was paroled. He returned to his legal practice, joined the Republican Party, canvassed Virginia in 1872 for Grant. In 1878–85 he was U.S. consul at Hongkong, and was assistant attorney in the Federal Department of Justice from 1904 to 1910. He wrote *Mosby's Reminiscences and Stuart's Cavalry Campaigns* (Boston, 1887) and





BY COURTESY OF (1) LOUIS R BOSTWICK, (2, 3) THE RAVENNA MOSAICS INC.

MODERN AND MEDIAEVAL MOSAICS

1. A ceiling in the Nebraska State Capitol (Bertram G. Goodhue, architect), by Hildreth Méière
2. Mosaic from the Golden Hall in the Stockholm Town Hall (Ragnar Ostberg, architect). This example and the preceding show two entirely different successful modern attempts to return to the valid basis of mosaic design—strict architectonic decorative composition
3. A detail from the apse of the church of S. Clemente in Rome, 12th century, showing combined classic form and Byzantine decorative skill (*cf.* Plate II., fig. 3)

Stuart's Cavalry in the Gettysburg Campaign (New York, 1908). He died in Washington, D.C., on May 30, 1916.

See J. M. Crawford, *Mosby and his Men* (New York, 1867); A. Monteiro, *War Reminiscences by the Surgeon of Mosby's Command* (Richmond, Va., 1890); J. J. Willliamson, *Mosby's Rangers* (New York, 1909); J. W. Munson, *Reminiscences of a Mosby Guerrilla* (New York, 1906); J. H. Alexander, *Mosby's Men* (New York, 1907); J. Scott, *Partisan Life with Mosby* (New York, 1867).

MOSCHELES, IGNAZ (1794–1870), Bohemian pianist, was born at Prague on May 30, 1794, and studied music at the Conservatorium under Dionys Weber. He made his name in 1815 with his *Variationem über den Alexandermarsch.* He then toured the capitals of Europe as a pianist. During a visit to Berlin in 1824 he met Mendelssohn, then a boy of fifteen; and a friendship sprang up between them which was severed only by Mendelssohn's early death (see *Briefe von Mendelssohn-Bartholdy an Ignaz und Charlotte Moscheles,* 1888). In 1826 Moscheles married Charlotte Embden at Hamburg, and settled permanently in London. He was a brilliant executant, who interpreted the works of the great masters with conscientious fidelity. In 1846, at Mendelssohn's earnest solicitation, he removed to the Leipzig Conservatorium, then recently founded. Moscheles died on March 10, 1870. His numbered works extend to 142, apart from minor pieces; his most important compositions are his Pianoforte Concertos, Sonatas and Studies (*Études,* op. 70; and *Characteristische Studien,* op. 95); *Hommage à Händel;* and his three *Allegri di bravura.*

See *The Life of Moscheles* (1873), a translation by A. D. Coleridge of Mme. Moscheles' *Aus Moscheles Leben* (1872).

MOSCHEROSCH, JOHANN MICHAEL (1601–1669), German satirist, was born at Willstädt, near Strasbourg, on March 5, 1601. He was educated at Strasbourg, and after various appointments in different places, became privy councillor to the landgravine of Hesse-Cassel. He died at Worms on April 4, 1669. His most famous work is the *Wunderliche und wahrhafftige Gesichte Philanders von Sittewald* (anagram of Willstädt) (1641–1643), for which he took as his model the *Sueños* (visions) of the Spaniard Gomez de Quevedo y Villegas. Hardly inferior to the "visions" is the *Insomnis cura parentum, Christliches Vermächtnis eines Vaters,* (Strasbourg 1643 and 1647). Noteworthy is also *Die Patientia,* discovered in 1897 in ms. in the municipal library at Hamburg.

Selections from Moscherosch's writings have been published by W. Dittmar (1830), F. Bobertag (in Kürschner's *Deutsche National-literatur,* xxxii., 1884), and K. Müller (in Reclam's *Universalbibliothek*). Reprints of the *Insomnis cura parentum* and *Patientia* have been published by L. Pariser (1893 and 1897), who is also the author of *Beiträge zu einer Biographie von Moscherosch* (1891). *See* also M. Nickels, *Moscherosch als Pädagog* (1883); J. Wirth, *Moscherosch's Geschichte* (1888); and bibliography by A. Bechtold, *Kritisches Verzeichnis der Schriften J. M. Moscherosch* (Munich, 1922).

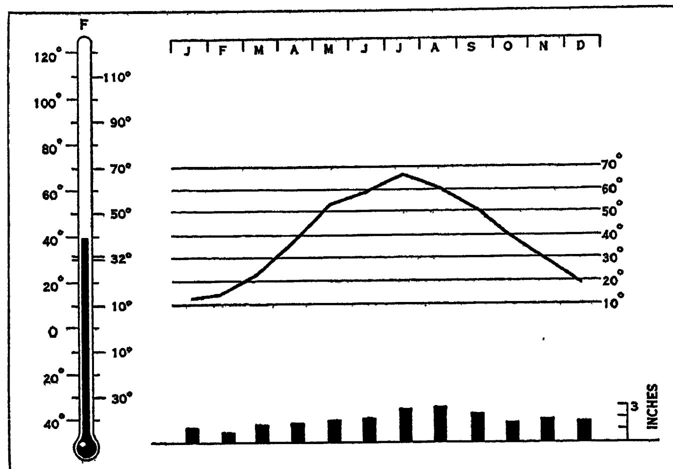
MOSCHUS, Greek bucolic poet, was born at Syracuse and flourished about 150 B.C. He was the author of a short epic poem, *Europa,* and a pretty little epigram, *Love, the Runaway,* imitated by Torquato Tasso and Ben Jonson. The epitaph on Bion and the *Megara* are probably not his, but a few other pieces, undoubtedly genuine, have been preserved. His poems are nearly all in hexameters. They are usually printed in editions of Bion and Theocritus.

The text has been edited by U. von Wilamowitz-Möllendorff, in the Oxford *Scriptorum classicorum bibliotheca* (1905); and in the Loeb *Classical Library,* with translation, in *The Greek Bucolic Poets* (1912); there are English translations by J. Banks in Bohn's *Classical Library* (1853), and by Andrew Lang (1889).

MOSCOW (Russian Moskvá), a province of the Russian S.F.S.R., surrounded by those of Smolensk, Tver, Vladimir, Ryazan, Tula and Kaluga, area 44,980 sq.km.; pop. (1926) 4,534,133. The province is of peculiar interest as the cradle of the "Great Russian" nation which rose after the decay of Kiev. It consists largely of the inter-riverine ("Mesopotamia" in Russian "mezhdurechie") district between the upper Oka and the upper Volga, with the Moskva river flowing through its core to join the Oka. To the west of the province there was a convenient portage between the Moskva and the upper Volga, on which was situated the fiercely disputed Novgorod trading colony of Volok-Lamsk, through which the railway from Moscow to Rhzev now passes.

The region was always densely forested, and even to-day forest occupies 42·7% of the province. The climate is continental, the rivers are frozen for 153 to 160 days, average January temperature 14° F, July 66·5°, snow lies thickly in the winter, and the average precipitation is 21·0 in. per annum, the prevailing winds being southerly and south-westerly.

The province consists of undulating ground (500–850 ft.) with



WEATHER GRAPH OF MOSCOW. THE THERMOMETER INDICATES THE ANNUAL MEAN TEMPERATURE. THE CURVE SHOWS THE MONTHLY MEAN TEMPERATURE. THE COLUMNS INDICATE THE NORMAL MONTHLY PRECIPITATION

broad valleys carved out by the rivers. In the Tertiary period it was already continental, but was partly submerged by the Cretaceous sea. There are no Triassic or Permian deposits, and the Jurassic is represented by its upper formations only. Upper Carboniferous deposits of deep sea origin rest upon the Devonian, discovered in an artesian well at Moscow at a depth of 1,508 feet. The pendulum anomaly, mentioned by Kaspar Gottfried Schweitzer (1816–73), appears in a zone 10 m. wide and extending for about 95 m. from west to east, and is positive (+10·6″) to the north of Moscow and negative (−2·7″) to the south.

Industries.—Coal, of low calorific value, is mined; and in early times the forest and this coal provided fuel for the industries which sprang up around the market at Moscow, where the first fur-preparing and cloth factories were established. The making of textiles began first in the peasants' huts, and even to-day peasant textile industries are widespread in the province and flourish in spite of the great development of the factory textile industry.

In early times a heavy metal industry existed in the district, but with the development of the Ural mining and metal industry it died down in view of the poor fuel supply. In 1876–80, the coalfields to the south of Moscow province provided 15·7% of the coal raised in Russia, but with the introduction of cheap transport on the Oka and Volga for the Don coal and Baku naphtha, the Moscow textile industry ceased to rely on local fuel and the production in 1911–15 was ·7 of the Russian total. After the outbreak of war in 1914, an impetus was again given to the use of local coal which provided 700,000 tons in 1916–17.

Since the 1917 revolution efforts have been made to overcome the fuel deficiency of the industrial regions of the province by the provision of electric power. Peat is abundant and an electric plant at Bogorodsk, east of Moscow, works on peat fuel, while the famous Shatura station, opened in 1925–26, working on peat had a power of 92,000 kw. in 1928, which is planned to be increased to 136,000 kw. in 1929. At Kashira, south of Moscow, a station works on local coal, power in 1928, 34,000 kw., planned to give 78,000 kw. in 1929. Another station works on naphtha and anthracite and the R. E. Klasson electric station had a turbo-generator installed in 1925–26 giving 16,000 kilowatts.

There are intensive textile industries, especially cotton and chintz, with woollens, linens, silk and silk ribbons. Dependent on

these are factories producing dyes, spools, reels, machinery for the textile factories, buttons, needles, ready made clothing and knitted garments. A cellulose industry is developing at Dmitrov, and silicate, cement and machinery industries at Podolsk, near which phosphorite is found. Guns and rope are manufactured at Kolomna. Other factories produce glass, bricks, tobacco, confectionery, alcoholic drinks, leather, galoshes and fur garments. Serpukhov undertakes iron and copper smelting.

Agriculture has been much influenced by its nearness to the great population centre at Moscow. Before cheap corn was imported from the newer grain-growing regions, grain was grown for the Moscow market in spite of poor soil conditions and low yields per acre, but a marked diminution then set in and in 1909–1913, the area under grain crops was a very small proportion of that in 1887. A many field grass system now prevails in place of the old three field system, and much attention is devoted in the regions near the towns to the production of potatoes, cucumbers, cabbages and onions, and also to fruit growing, especially cherries, raspberries, strawberries, gooseberries, currants and plums. Some collective agricultural artels exist.

Intensive dairying is carried on for the town markets, and pig breeding is developing in dependence on it. Flax, which demands much labour, is diminishing rapidly in spite of the factory market, because available peasant labour tends to be absorbed in the factories. The chief grain crops are rye and oats, with a little buckwheat.

The chief towns are Moscow, Orekhovo-Zuevo, Serpukhov, Bogorodsk, Egorievsk (Yegorievsk), Sergiev and Pavlovo-Posad, *qq.v.* Communications are the best in the country; a network of navigation, railway routes and roads concentrates on the town. This fact and the lessened costs of transit from Siberia, the Central Asiatic region, the Caucasus, and the productive regions of the south enabled the industries of the province to survive the development of St. Petersburg (Leningrad) as an industrial centre.

The district has been inhabited since the Stone Age, though bronze implements are rare. In some places stone, bone and iron implements have been found together. Burial mounds of the 10th and 12th centuries seem to be of Finnish origin. Finnish tribes certainly occupied the district at the time of its colonisation by the Slavs, and some racial intermixture took place, thus somewhat emphasizing the difference between Great Russians and Little Russians, the latter of whom have intermingled with the Tatars.

MOSCOW, the capital of the Union of Socialist Soviet Republics and of the Russian Socialist Federative Soviet Republic, situated in the Moscow province, on both banks of the navigable Moskva river, a tributary of the Oka, in 55° 45′ N., 37° 37′ E. Pop. (1926) 2,019,453. In 1156 George Dolgoruki, prince of Rostov, founded the town, probably by erecting wooden walls round his villa and estate and its dependent settlements, which were situated on the hill at present occupied by the Kremlin. This patch of the virgin pine forest had been cleared but recently, and the little church of the Saviour in the Wood, the oldest building in Moscow preserves the memory of the forest clearing. Even in those early times its site had some trading importance and rough tracks, the precursors of the modern roads and railways, linked it with Kiev and old Novgorod, while the Moskva river linked it with the Volga and the south and east. Ivan Kalita, Ivan I., (1328–41) laid the foundations of its future financial importance by acting as tax-gatherer for the Mongol Horde, thus placing the east Russian princes in a position of dependence on Moscow for security from Tatar raids. Under Ivan III. (1462–1505) the conquest of Kazan and Astrakhan opened a trade route from Moscow to central Asia and Persia, and another route was opened through the White sea to western Europe, while the gradual development of western Siberia following on Yermak's expedition of 1582 added further sources of trade. In the latter half of the 19th century began the construction of railways and the development of industry in the Ukraine and on the Caspian, leading to the supply of coal and naphtha for the industries of Moscow. Thus Moscow to-day is the centre of the trade, industry and culture of Russia.

A seventh part of all Russian trade passes through the capital and eleven railways radiate from it, bringing it into communication with Vladivostok and the Pacific, with the central Asiatic republics, with the Black sea and the Caspian, with Leningrad and the Baltic, with Murmansk and Archangel and the Arctic ocean. The Soviet Government is collecting data as to the possibilities of a river and canal link between Moscow and the Pacific (1928) and air communications are bringing Moscow into even closer communication with the rest of Russia and the outside world. The Russian Volunteer Aviation Company, organized in 1925, is expanding the air-routes from Moscow. A bi-weekly service goes to Nizhni-Novgorod and there are routes to Kharkov and Odessa, and projected routes to Yakutsk, Vladivostok and other distant centres. The Russo-German air-fleet has regular services between Moscow and Berlin.

Moscow's industries are mainly textiles, metallurgy and the production of foodstuffs; its factories number 794, and its trading enterprises, 16,407. The marked development of electrification since 1924 is solving the difficulty of inadequate fuel, and giving a fresh impetus to production. Among new industries are the production of glass machinery of the Furko type, agricultural triers, manometers, chrome leather, and glass for clocks and automobiles. There is an excellent tram and bus service and some part of the local railways is electrified. Proposals for an underground railway are being considered, though as yet there is little traffic congestion in the streets, since the general level of poverty does not allow of private motor cars except for a few Government officials. The rapid increase of population consequent on the return of the administration to Moscow since the 1917 revolution, and the great influx of peoples from the varied regions of the vast empire has created a sharp crisis in housing accommodation, which was sadly inadequate even in 1913. In 1923 only 8% of the population had one or more rooms, 54·7% were living 2 to a room, 31·8% five to a room and 4·9% more than eight in one room. In spite of these terrible conditions, great advances in sanitation and the care of children have resulted in a marked diminution of the mortality rate.

In appearance the city presents a striking summary of the national life, the wooden houses of the suburbs reminiscent of the peasant *izba* of the villages, the low built houses of the former aristocracy with their pillar-porticoes, the many storeyed modern flat dwellings, the huge factories, the oriental splendour of the gilded and painted domes of the churches and cathedrals and the magnificence of the former imperial palaces, alongside of which are the barrack-like and utilitarian buildings of recent years. The gaily painted houses, the golden domes and the green and blue and red spires give it a picturesque and semi-Oriental appearance, which is emphasised by the great variety of nationalities, often indicated by their special costumes amongst which Asiatic peoples are well represented. The crowds of beggars and homeless waifs add to the impression. A last strange addition to the contrasts of Holy Mother Moscow is the preservation by the Soviet Government of the ikon of the Iberian Virgin, formerly the most revered of all the ikons, in her chapel shrine, while on a neighbouring wall is the inscription "Religion—opium for the people," put up by the same Government. The illiterate peasant bows and crosses himself to both alike.

The Kremlin.—The citadel, fortress or Acropolis, common to ancient Russian towns and known as the Kremlin, is the centre round which Moscow has grown. It is shaped like an isosceles triangle, one side running parallel with the Moskva river; its huge pyramidal walls of pale pink brick are surmounted by battlements, and pierced by five gates. The Borovitzkiye gate (1490) (bor-wood) is situated on the spot where, in the midst of a dense wood near the mouth of the Neglinka tributary of the Moskva, the first settlement arose on the Kremlin hill. The Neglinka, whose swampy banks formerly added to the safety of the fortress, now runs underground. The Taynitzkiye gate, first erected in 1498, but destroyed by Catherine II. and rebuilt at a later date, had a secret passage (taynik) connecting it with the river. The Spasskiye Vorota (Gate of Salvation) (1491) is the main entrance

(1) BY COURTESY OF THE FRIENDS OF SOVIET RUSSIA

THE KREMLIN AND THE RED SQUARE IN MOSCOW

1. The Kremlin, an old fort which was for many centuries the centre of Russia's political and religious life. It contained within its walls the tsar's palace, great churches, and palaces of the nobility

2. The Red Square, looking toward the Iberian Gate, with the Spassky Gate and Lenin's Mausoleum on the left. The demonstration is by competitors in the 1928 games (Spartakiad)

and opens on to the Red Square. Before the 1917 revolution every passer-by was compelled to uncover to the frescoes representing the Redeemer. In 1625 an Englishman erected the famous peal of bells in the tower above the gate, from which the "International" is now pealed at 12 o'clock and 6 o'clock, and the Russian Revolutionary Funeral March at 3 o'clock and 9 o'clock. These gates, with drawbridges, converted the Kremlin into an island fortress when the bells of the alarm tower gave warning of an approaching Tatar raid. The oaken 12th century walls remained until 1485–95, when the present stronger and more fire-resisting walls were erected. The stone walls formerly surrounding the Kremlin and the Kitai Gorod on the west, north and north-east, were destroyed in the 18th century and replaced by boulevards, and broad streets with gardens on either side have replaced the outer earthen walls and palisades.

An irregular enclosure made in the reign of Catherine II. encloses the outer parts of the city, though the suburbs have extended far beyond it. In the 17th century the Kremlin lost its importance as a fortress and ornamental tent-shaped additions were made to the towers. The tsars and the patriarchs of the Greek Church resided within the Kremlin until the reign of Peter the Great, when the court was removed to St. Petersburg (Leningrad). In the 18th and early 19th centuries it fell into disrepair and many monuments of mediaeval Russian architecture were lost. The arsenal in the Kremlin was held by the pupils of the higher military schools against the Bolshevists in the 1917 revolution and the bombardment carried out by the latter damaged many parts of the Kremlin; the damage has been repaired as far as possible. The Kremlin can now be entered only by special permission of the commandant. Within it along the only street, re-named Communist street, are the residences of former court officials, within which the Kremlin Command and the more important Government officials of the Soviet Union are now housed. In the former Moscow Senate (1775–84) are held the meetings of the All Russian Central Executive, the Central Executive Committee of the Union and the Councils of the People's Commissars (Sovnarkom). In this street are the Poteshny Dvoretz (Pleasure Palace) 1650–51, a lofty green building, now undergoing restoration, the exterior of which has retained its 17th century appearance; the Orujeynaya Palata (1849–51), built in pseudo-Russian style and organized as a museum of the decorative arts (1920–24) to which the more important treasures of tapestry, enamel, jewelled and silver work from the cathedrals and monasteries of Moscow and from the treasury of the patriarch of the Greek Church have been removed; and the Great Kremlin palace (1838–49), a building in white stone with a gilded cupola. Various congresses, including that of the Communist International are held in the former palace throne room. Within the palace are the *terems,* rooms erected in the 17th century by Tsar Michael Feodorovitch for his sons and restored in 1836–49. Another wing of the palace, the Granovitaya Palata (1473–90), consists of a single-vaulted apartment, a state reception room where Ivan the Terrible in 1552 celebrated the conquest of Kazan. Its painted frescoes were destroyed in 1612 during the Polish occupation.

Cathedrals, Churches, etc.—To the east of the Great Kremlin Palace is the cathedral square, surrounded by ancient churches. The cathedral of the Annunciation (Blagovyeschenskiy) with its nine cupolas, was erected by architects from Pskov (1484–89) on the site of an old church first built in 1397. The sacred pictures of Rublev (1405), on the ikonostas of the high altar, have been preserved. The Archangel cathedral was designed by a Milanese architect and built in 1505–09 on the site of the original 14th century cathedral. It contains the tombs of the tsars, from Ivan Kalita (1340) to Ivan Alexeivich (1696), with the exception of Boris Godunov, whose body was removed in 1606 to the Troitza-Sergievskaya Lavra. Of the later tsars only Peter II. is buried here. In 1920–21 the cathedral was restored, and many additions of later centuries were removed. The cathedral of the Assumption (Uspenskiy Sobor) 1475–79, was designed by a Bolognese architect, on the site of the ancient church of the Assumption (1325), which fell to ruins in 1472. It is in the Lombardo-Byzantine style, with Indian cupolas, and its Italian innovations are minutely described in the chronicles and were frequently copied in later Russian architecture. From the 16th century onwards it was the coronation church of the tsars. The frescoes were restored and covered with new paintings for each occasion, and the work of a commission appointed in 1912 was interrupted by the revolution, so that frescoes in various stages now appear in a partially restored condition. Near the south porch stands the carved walnut throne of Ivan the Terrible, with a low relief illustrating the presentation of the insignia of the Imperial power sent to Vladimir Monomach by the emperor of Byzantium.

The Polozhenia Ris (Ordination of priests) cathedral was built in 1484–86, by Pskov craftsmen, and has a beautiful porch with terra cotta columns. A fantastic group of 11 small domes is formed from the cupolas of the church of "The Redeemer Behind the Golden Rails" (1635–36), the church of the Crucifixion (1681) and the church of the Resurrection. The palace of the patriarch (1655–56), like the neighbouring cathedral of the Twelve Apostles, was converted, after the abolition of the patriarchate in the mid-eighteenth century, into dwellings for the monks. In 1918 restorations were begun and are still in progress. Opposite to the Uspenskiy cathedral rises the lofty bell tower of Ivan the Great, one of the public works undertaken by Boris Godunov in 1600 to relieve the famine-stricken population. To the east of it are two other belfries, one, erected by the Italian architect Petroche (1532–43), harbours the chief churchbell of Moscow, whose first stroke at midnight on Easter eve sets the bells of the other 350 churches of Moscow ringing, the other dating from 1624. These two belfries were damaged during the French invasion of 1812, but that of Ivan the Great escaped. Near it stands the Tsar Kolokol, the largest bell in the world, recast in 1735. During the fire of 1737 a piece of the bell broke off, and the bell itself, not yet hung, fell to the ground.

Near the Spasskaya Gate is the former Vosnesensky nunnery (1389–93), restored in the 19th century, the burial place of the wives and sisters of the tsars. The church of St. Michael Malein, with its 15th century interior stone relief, has been converted into a museum of old Russian sculpture. The 18th century Little or Nicholas palace is now used as a club by the Kremlin military school. The Chudov (Miracle) 14th century monastery, rebuilt in 1771, was formerly the residence of the metropolitans of Moscow, and a State prison. Restorations undertaken in 1924 revealed ancient corridors and rooms, and the building is now a museum for the objects of art from the famous Solovetzky monastery on the White sea, evacuated during the civil war following the 1917 revolution. In the monastery courtyard stands the cathedral of the Miracle of the Archangel Michael (1501), an interesting combination of the Vladimir-Suzdal and Italian styles. Opposite the Chudov monastery are the beautifully wrought ornamental Tsar Cannon (1586) and several other ornamented cannons. The now unsightly 19th century barracks, the training school for officers of the Red army, once had a beautiful façade in the classical style later removed by order of the tsar Nicholas who considered it unsuitable to a barracks. The Kremlin arsenal was the main store house for ammunition in Moscow until 1917 and this enabled the officers of the Old army to hold out against the Bolsheviks for some time and resulted in a damaging bombardment of the Kremlin.

The Kitai Gorod.—The Kremlin was the former residence of the aristocracy, and to the east of it lies the Kitai Gorod, formerly the residence of the merchants. It is surrounded by a wall constructed in 1534–38, and next to the Kremlin, is the most ancient part of Moscow, as its narrow, irregular lanes indicate. Kitai (Chinese), is supposed to be derived from the Tatar word for fortress. Since the 1917 revolution, the great Trusts, the People's Commissariats and other Government Offices have been located here and the number of inhabitants is small, four-fifths of it being occupied by offices, an indication of the growth of bureaucracy. The Red Square, a kilometre in length and 130 metres broad, has the Kremlin wall on one side, with arcades now housing Soviet trade enterprises and the administrative offices of the Red army, opposite to it, and Lenin's Mausoleum on another, and the fantastic Pokrovsky or Vasili cathedral opposite to it. The latter,

with its many coloured towers, was begun by Ivan the Terrible in 1554 to commemorate the conquest of Kazan, but not completed till 1679. It was used as a stable by the French cavalry in 1812, but restored in 1839–45; it was converted into a Museum (1921–24) by the Soviet Government. The Red Square, with its stone tribunal, formerly the forum, market-cross and place of execution, has always been the centre of political life.

Here, beneath the Kremlin ramparts, many fierce fights with Tatar raiders took place in the middle ages. In the 17th century an insurrection was crushed and the rebels executed in the square. The great trade routes from old Novgorod, Tver, the East and the Ordynka, or route from the Tatar Golden Horde converged on the Square, at the extreme end of which was the landing-place from the Moskva river, so that in times of peace it was a great market. It was the scene of a great demonstration during the 1905 revolution, when the calling of the Duma, or national council, was extorted from the tsar. In Oct. 1917 fierce fighting took place between the Bolsheviks and the White army, and through it afterwards passed the two great funeral processions of the victims of this civil strife. Since then workers' demonstrations and military parades have been regularly organized.

Near the Kremlin walls are "The Graves of the Brothers," the five hundred Bolshevik men and women who lost their lives in the 1917 revolution. In front of the graves stands the Lenin Mausoleum, a strange wooden structure, painted red, within which lies the embalmed body of Lenin, and to which long queues of worshippers throng, while other worshippers, quite close to them, throng to pay homage at the Shrine of the Iberian Virgin. Opposite the mausoleum, which is to be replaced later by a stone structure, is a monument to the butcher from Nizhni-Novgorod who organized the troops that drove the Poles out of Moscow in 1612. At the northern entrance to the Red Square stands the State historical museum, built in 1883 on the site of the former Moscow university; to it were brought after the 1917 revolution the library and rare manuscripts of the Holy Synod, and a Dostoievsky section was added. Facing the historical museum is the 17th century Kazan cathedral, a memorial of the deliverance of Moscow from the Poles. Among numerous other beautiful examples of architecture are the lovely Praise of the Holy Virgin church (1707), the New Maiden's convent (1524), converted into a museum in 1924, and the church of Gregori Novokessariysky (1668–79).

Museums and Theatres.—The city has numerous museums, of which the most famous is the State Tretyakov gallery (1892), reorganized in 1918 and enriched by some thousands of works of art taken from private collections and nationalized. The former Rumyantsev museum was dissolved in 1924, the works of western painters being transferred to the Museum of fine arts and those of Russian painters to the Tretyakov gallery.

Of the 18 theatres of Moscow the most famous are the Moscow art theatre and the Meyerhold theatre; in the latter there are no wings, no scenery, no footlights and no drop-scene; word or gesture, aided by wooden screens and simple mechanical contrivances, are the only methods of presentation. Its educational institutions include the Moscow State University, the Institute of Oriental Studies, the Academy of Fine Arts, Agricultural, Mining and Technical Schools, various Communist institutions, and some well-equipped schools, including experimental schools. There are schools attached to many factories, both for young workers and for adult illiterates. There are also several children's homes for the unfortunate orphan waifs, the legacy of the years of war, famine and social disorganization. Of the numerous organizations, clubs and societies, the most famous is the Executive Committee of the Third International (Comintern), and others of note are the All Russian Association of Anarchists and Anarchist Communists, the Red International of Labour Unions (Profintern), the International Council of Peasants, the Central Union of the Co-operatives (Centrosoyus), the Communist Youth Association (Comsomol), various clubs for national minorities, the Central Peasants' home and the Children's club.

History.—From its foundation in the 12th century until the end of the 13th century, Moscow remained a dependency of the princes of Vladimir, and was burned and plundered by the Tatars in 1237 and 1293. Under Daniel, son of Alexander Nevsky (1261–1302), the prince of Moscow acquired importance from his wars against Lithuania, and annexed Kolomna at the confluence of the Moskva and Oka. In 1300 the Kremlin was enclosed by a strong earthen and timber wall and a policy of annexation by various means was consistently carried out by Daniel's successors. Under Ivan Kalita (1325–41) the principality of Vladimir was incorporated with that of Moscow. In 1367 the Kremlin was enclosed by stone walls and the town successfully resisted Lithuanian attacks under Olgierd (1368 and 1371). Kalita's grandson, Dmitry Donskoi, annexed Starodub and old Rostov, and took part in an attack on the Mongols at Kulikovo on the Don (1380). In 1382, Moscow was for the last time captured and plundered by the khan of the Golden Horde. By the end of the 15th century Moscow had annexed most of the surrounding districts, though it was not until the reign of Ivan III. (1462–1505) that the prince of Moscow claimed to be "Ruler of All Russia." Ivan IV. (1533–1584) annexed Novgorod and Pskov and subdued Kazan and Astrakhan, but many disasters fell on Moscow at this time. In 1547 two conflagrations destroyed the greater part of the city and the Tatar khan of the Crimea advanced against it, but had to withdraw. In 1571 he captured Moscow and burned all the city outside the Kremlin; the annals record that of its 200,000 inhabitants only 30,000 remained. In 1591 the Tatars of the Crimea again attacked the city outside the Kremlin.

During the latter half of the 16th and the whole of the 17th century, Moscow was the scene of much disorder and internal strife. Revolts against the favourites of the tsars were crushed with merciless ferocity with the aid of the *streltzy,* a class of citizens and merchants rendering hereditary military service to the tsar. The spread of the *raskol* or nonconformist movement and the news of the rebellion of Stenka Razin led to further severe repressive measures. In 1698 the *streltzy* themselves revolted and were suppressed only after fearful slaughter by Peter the Great. In 1703 Peter, wearied of the opposition to his plans of reform, of the conspiracies of the *boyars* and of the distrust of the masses, founded the new capital of St. Petersburg (Leningrad), and Moscow declined for a time. Conflagrations in 1739, 1748 and 1753 caused much misery, but led to the enlarging of the streets and squares. Under Catherine II. some new buildings, the Senate House, the Foundling and other hospitals and the salt stores were built and revival began. In 1812 came the disaster of the Napoleonic invasion. The Russian troops evacuated Moscow on Sept. 13, six days after the battle of Borodino (*q.v.*) and next day the French occupied the Kremlin. That night the capital was set on fire through the carelessness of its inhabitants and the stores in the bazaar were destroyed. The inhabitants abandoned the city, which was given up to plundering by troops of both armies. The burning of the city, however, was the signal for a general rising of the peasants against the French. The want of supplies, the impossibility of wintering in a ruined city continually attacked by Cossacks and peasants, compelled Napoleon to leave Moscow on Oct. 19, after an unsuccessful attempt to blow up part of the Kremlin. After a few years of desolation, the city was rebuilt in the Russian "Empire" style.

In the second half of the 19th century, following on the abolition of serfdom and the development of railroads and industries, Moscow grew rapidly. Many large factories arose on the banks of the Moskva, and the workmen settled in the Khamovniki district, once the abode of the serf weavers and the serfs of several monasteries. This rapid development of the proletariat in poor conditions of housing and labour, with no legitimate means of redressing grievances, led to a growing feeling of discontent and the outbreak of 1905 was only suppressed after a fortnight's hard fighting. After the October 1917 revolution fierce fighting again broke out, but the Bolshevists ultimately triumphed. Between 1917 and 1920, great hardships were endured by the population owing to the difficulties of food and fuel supply; winter conditions of semi-starvation and lack of warmth were severe, and the population diminished from 2,000,000 in 1917 to 800,000 in 1920, in spite of the transference to Moscow of the administrative centre.

In 1918 there were social revolutionary and anarchist risings. The terrible famine year 1920–21 added to the difficulties of provisioning the city, as did the attempts to dispense with the use of money. After the introduction of the new economic policy, more normal conditions began to return.

In 1923 electrification schemes were inaugurated to decrease the fuel famine (*see* Moscow, province), and a great influx of population again began. But during the famine period many wooden houses had been destroyed for use as fuel, for which purpose too, much of the wooden pavements had been removed. No repairs had been carried out and building had ceased. Thus a serious and dangerous situation was created, not only by the lack of housing accommodation, but by the difficulty of supplying food to so vast a population. Repairs and building construction began in 1923, but the short building season hampers progress and it must be many years before living conditions in Moscow approach the normal. The supply of food, though better, is still inadequate and food queues are common. Overcrowding has most disastrous results in the case of infants, and in order to meet this aspect, the Soviet government has nationalised some former palaces and turned them into crêches for babies, and many factories also have crêches attached where mothers may leave the children during the day. This does not, however, avoid the perhaps as serious stunting moral and physical results of overcrowding at a later stage and large building plans have been sketched by the housing commissions, though lack of capital hampers them.

MOSCOW, a city of northern Idaho, U.S.A., 90 m. S. by E. of Spokane, near the Washington State line, on Paradise creek, at an altitude of 2,578 ft.; the county seat of Latah county and the seat of the University of Idaho. It is on Federal highway 95, and is served by the Great Northern, the Northern Pacific and the Union Pacific railways. The population in 1920 was 3,956 of which 90 per cent was native white; in 1930 the population had grown to 4,476 according to the Federal census. The city is a trading and distributing centre for a rich non-irrigated region (part of the "Palouse country"), producing chiefly grain, live stock and fruit. It has a large flour mill and meat-packing plant, creameries and other manufacturing industries. The university (established 1889) has a beautiful situation on high ground southwest of the city. A southern branch is maintained at Pocatello. Its campus and farm at Moscow cover 600 ac.; its College of Agriculture maintains experimental sub-stations at Caldwell (320 ac.), Sandpoint (170 ac.) and Aberdeen (80 ac.) and one of 180 ac. at Felt, for experiments in dry farming and irrigation at high altitude; its School of Forestry has an experimental tract and field laboratory of 640 ac. on Moscow mountain, 6 m. N. of the campus. The State Bureau of Mines and Geology has its headquarters at the university. Moscow was settled about 1870 and incorporated in 1887.

MOSCOW NARODNY BANK, LTD. The original Moscow Narodny Bank (*i.e.*, People's Bank) was the bank of the Russian Co-operative Movement before the Revolution. It first established an agency in London in 1916. In 1919 this was transformed into an English Company under the title of the Moscow Narodny Bank Ltd. with a paid up capital of £250,000. Subsequent issues of capital have brought the authorized amount to £1,000,000 sterling, of which £750,000 is now paid up. In addition, the reserve funds of the bank amount to £115,000. The shares of the bank are held exclusively by co-operative organisations in the U.S.S.R. The largest shareholders are the two leading co-operative banks, *i.e.*, the All-Russian Co-operative Bank (*Vsecobank*) and the All-Ukrainian Bank (*Ukrainbank*) holding between them 73% of the shares; Centrosoyus, representing the Consumers Co-operative Movement, holds 12·5% of the shares, and the Agricultural Co-operative Societies (Selosoyus), holding 12·5%. Smaller Co-operative Societies account for the 2% balance of the shares.

The balance sheet figures show the speed at which the Bank has developed its operations. The assets of the Bank on December 15, 1919, totalled £633,522, and on July 1, 1928, they amounted to £7,287,550. In the year 1920 the turnover was approximately £19,000,000. In the first ten months of 1928 it exceeded £220,000,000.

The principal purpose of the Moscow Narodny Bank is to finance the export and import operations of the Central Co-operative organisations in the U.S.S.R. trading on foreign markets. Besides performing the usual banking operations the Bank acts as a medium through which credits may flow to the co-operative organizations for financing their foreign trade. Such credits take the form of advances against goods in the course of export or stored abroad or in course of import into Russia, as well as the discounting of bills for the payment of purchases made abroad. The bank also assists co-operative organizations in financing the collection of raw materials for export, partly from its own resources and partly by discounting or rediscounting or guaranteeing bills drawn by the exporting co-operative organizations.

It is mainly concerned with the export of agricultural produce, *i.e.* dairy produce, butter, eggs, cheese, etc., furs, flax, hemp, tow, bristles, horse-hair, poultry, tobacco, skins and hides. The imports into Russia in which it is chiefly concerned are tea, wool, agricultural machinery and implements, and tools of various kinds.

In addition to its offices in London the bank has offices in Paris, Berlin and a representative in New York. It holds a controlling interest in the Co-operative Transit Bank in Riga, through which Russian operations in Latvia are financed. It acts as the centre abroad through which the Russian co-operative organizations are brought into banking contact with leading banks in London, New York, Berlin, Hamburg, Paris, Belgium, Holland, Switzerland and Canada. It is naturally giving special attention to the development of its relations with the co-operative and labour banks in England, France, Germany, Belgium and Switzerland and with the labour banks in America. Though its share-holders are Russians, it is an English company subject in all respects to English law; its chief offices are in London, and its main operations are carried on in sterling in accordance with British banking practice. (N. Ba.)

MOSELEY, HENRY GWYN-JEFFREYS (1887–1915), British physicist, was educated at Eton and Trinity College, Oxford. As lecturer in physics in Rutherford's laboratory at Manchester university, then as John Harling fellow, and subsequently at Oxford, he worked first on radioactivity and finally he carried out a brilliant series of researches proving the existence of a simple relationship between the X-ray spectrum of an element and its atomic number (*q.v.*), thus establishing a new and valuable method of chemical analysis and solving the outstanding problems of atomic structure and spectral lines (*see* Spectroscopy and X-ray). He was killed in Gallipoli on Aug. 10, 1915.

MOSELEY NUMBER, an alternative name for atomic number (*q.v.*), owing to the fact that the first direct experimental evidence for the allocation of atomic numbers to elements was provided in 1913 by H. G. J. Moseley (killed in action, 1915).

MOSELLE, a department of north-eastern France, formed of the portion of Lorraine which was annexed by Germany as the result of the war of 1870. Area, 2,403 sq. miles. Pop. (1926), 633,461. It is bounded on the north and north-east by Luxembourg and Germany, including the Saar territory, on the east and south-east by the department of Bas-Rhin, and on the south, south-west and west by the department of Meurthe-et-Moselle. The department is largely floored by Triassic rocks, which form a surface, for the most part, between 600 and 1,000 ft. above sea-level, and are drained by the Moselle and its feeders, and it has a number of small lakes towards the east. Across the German border, south-east of the Moselle, stand the heights of The Hunsrück and the Palatinate, but the valley of the Moselle and the passes of Saverne and Haguenau across to the Rhine valley have made this area a double gateway between Germany and France, and it has long been in spirit a frontier province of the latter. The average winter temperature, reduced to sea-level, is below 35·5°, the average summer temperature is above 66°, thus giving conditions not very different from those of the Vosges. Being almost surrounded by higher land, the department has a rainfall for the most part below 30 in. per annum. Moselle is a region in which, partly because it has taken great effort to transform the soil, and partly because wars have retarded social change, the traditional system of concentrated villages and

infinite subdivision of strips has persisted. The valley of the Moselle in the region of Metz is famous for its vineyards. There are very important mines of coal and iron in the department, and famous salt deposits. The chief industries are salt-working, metal-founding, lime-burning and cement-making, and the manufacture of glass, crystal, pottery and porcelain (Sarreguemines), machinery, chemical products, textiles, paper, wooden objects, preserved foods, brushes, boots and shoes, pipes and leather goods. There are nine arrondissements (Metz-urbain, the capital, Metz-rural, Boulay, Château-Salins, Forbach, Sarrebourg, Sarreguemines, Thionville-east and Thionville-west), 36 cantons and 763 communes. The department forms part of the VIth. and XXXVth. military regions, and Metz is the seat of a bishopric.

MOSELLE (Ger. *Mosel*), a river of France and Germany, 314 m. long, a left-bank tributary of the Rhine. It rises on the west flank of the Vosges, near the Col. de Bussang. It first flows north-west, crossing the Hercynian gneisses, turns north at Remiremont, passes off the gneisses at Épinal to cross the Trias and Jurassic rocks. From Toul past Nancy, Metz and to Diedenhofen it flows along a subsequent valley, after which it turns north-eastward to cross the Trias and Devonian rocks and join the Rhine at Coblenz. It leaves France below Diedenhofen, for a short distance forms the frontier between Germany and Luxembourg, and then enters Germany. The chief tributaries are the Moselotte, Meurthe, Seille and Saar on the right, and the Madon, Orne and Sauer on the left. Navigation for small vessels extends downwards from Fronard, a little below Nancy. The river meanders about in its lower valley, where are the vineyards from which the well-known Moselle wines are produced. (*See* RHINE.)

MOSELLE LINE, the designation of a line of French barrier forts on the upper Moselle between the fortresses of Épinal and Belfort (*see* these articles, also MEUSE LINE). This line, the separate forts of which commanded the relatively few lines of advance from upper Alsace through the Vosges, had for its purpose, in French policy and strategy prior to the World War, the deflection of a possible German invasion from Alsace towards Belfort, or towards the open gap between Épinal and Toul called the Trouée de Charmes, where it could be nipped in flank by a prearranged counter-stroke.

MOSELLE WINES. The vineyards of the Moselle are of greater antiquity than those of the Rhine; they were originally planted by the Romans at a time when the Rhine was the boundary of the Roman empire. It is only from Treves to Coblenz that the vineyards of the Moselle produce white wines of truly great distinction, exceptionally fine bouquet and sufficient merit to command abroad much higher prices than local consumers are willing or able to pay.

Under the name of Moselle are included not only the wines from the vineyards on both banks of the Moselle from Treves to Coblenz, but also those from the vineyards of the Saar and Ruwer, two tributaries of the Moselle. The Saar joins the Moselle a few miles above Treves; its finest vineyards are those of *Scharzhofberg, Bockstein, Geisberg* and *Euchariusberg;* very fine wines are also made at *Scharzberg, Agritiusberg, Wiltingen* and *Oberemmel.*

In the valley of the Ruwer, a small river which joins the Moselle below Treves, some very delicate and fascinating white wines are made, none better nor better known than those from the ancient ecclesiastical vineyards at *Grunhaus.* From there to Coblenz, upon either bank of the Moselle, are grown the finest wines of the Moselle proper. To name but a few: *Piesport* and *Braunberg,* on the left bank of the river, *Berncastel,* further north, on the opposite bank, and from thence northwards the vineyards of *Graach, Wehlen, Zeltingen* and *Trarbach,* on the right, and those of *Erden, Machern* and *Urzig,* on the left, are among those which produce the most delicate Moselles, wines which are light, pleasantly dry, and possessing a "bouquet" which is as distinctive as it is charming.

BIBLIOGRAPHY.—André L. Simon, *In Vino Veritas* (1913), *The Blood of the Grape* (1920), *Wine and the Wine Trade* (1921), *The Supply, Care and Sale of Wine* (1923); Frank Hedges Butler, *Wine and the Wine Lands of the World* (1926); P. Morton Shand, *A Book of Wine* (1926), *The Wines of Germany and other European Countries* (1928). (A. L. S.)

MOSER, JOHANN JAKOB (1701–1785), German jurist, was born at Stuttgart on Jan. 18, 1701. He studied at the University of Tübingen, where, at 19, he was appointed extraordinary professor of law. He moved to Frankfort-on-the-Oder in 1736, but resigned on account of differences with the king of Prussia. In 1751 he was recalled to Württemberg as district counsellor, and in 1759 was imprisoned at Hohentwiel on account of the steps he had taken in connection with this office against certain tyrannical proceedings of the duke. In 1764 he was released and was restored to office. He died on Sept. 30, 1785. Moser was the first to discuss in an adequate form the subject of European international law. He wrote more than 500 volumes, his principal works being *Deutsches Staatsrecht* (1737–54), *Neues deutsches Staatsrecht* (1766–75), *Deutsches Staatsarchiv* (1751–57), *Grundriss der heutigen Staatsverfassung von Deutschland* (1754).

See Schmid, *Das Leben J. J. Mosers* (1868); Schulze, *J. J. Moser, der Vater des deutschen Staatsrechts* (1869).

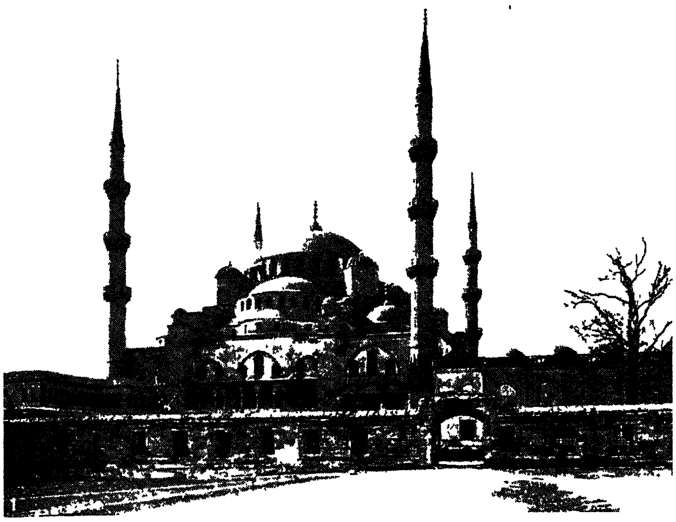
MÖSER, JUSTUS (1720–1794), German publicist and statesman, was born on Dec. 14, 1720, at Osnabrück, where he became *advocatus patriae* (state attorney), and held other important legal appointments. He died at Osnabrück on Jan. 8, 1794. Möser's ideas on history and economics exercised considerable influence on Herder and Goethe. His principal works were *Osnabrücks Geschichte* (2 vols., 1768); *Patriotische Phantasien* (1775–86; new ed. by R. Zöllner, 1871), in which he pleaded for a national organic development of a state in the place of arbitrary laws imposed by the sovereign.

See his *Sämtliche Werke,* ed. B. R. Abeken (10 vols., 1842–44); also J. Kreyssig, *Justus Möser* (1857); L. Rupprecht, *Justus Mösers soziale und volkswirtschaftliche Anschauungen* (1892); K. Mollenhauer, *Mösers Anteil an der Wiederbelebung des deutschen Geistes* (1896).

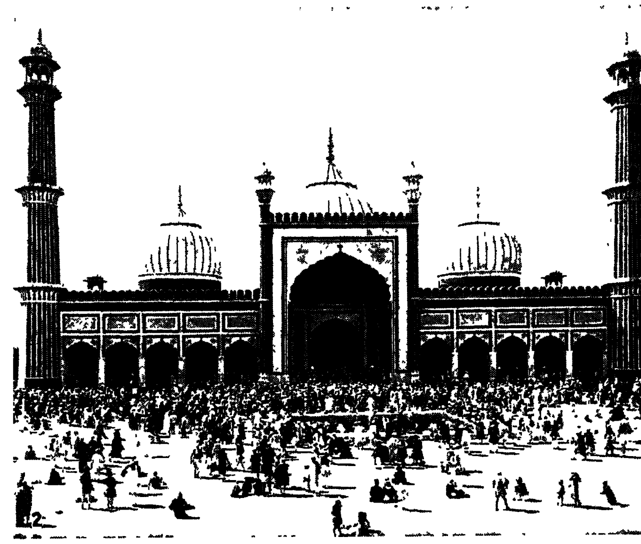
MOSES (Gr. Μωυσῆς, Μωσῆς), the great Jewish lawgiver, prophet and mediator, and leader of the Israelites from Egypt to the eastern borders of the promised land. The records of his life and work are noticed in the articles EXODUS, NUMBERS, DEUTERONOMY, where the several sources of the narratives are described. He appears in Midian at the "Mount of God" (Horeb) dwelling with its priest Jethro (*q.v.*), one of whose seven daughters he married, thus becoming the father of Gershom and Eliezer. Of his earlier life it was said that he was born in Egypt of Levite parents, and when the Pharaoh commanded that every new-born male child of the Hebrews should be killed, he was put into a chest and cast upon the Nile. He was found by Pharaoh's daughter, and his (step-)sister Miriam contrived that he should be nursed by his mother; on growing up he killed an Egyptian who was oppressing an Israelite, and this becoming known, he sought refuge in flight.

At the holy mount, Moses received the divine revelation, and was commissioned to bring the people a three-days' journey out of Egypt to sacrifice at this spot (Exod. iiii. 12, 18; v. 3, viii. 27). The deity revealed himself in a new name, Yahweh, and with signs and wonders fortified Moses for his task. On his return he experienced a remarkable incident which is obscurely associated with the rite of circumcision. The plagues with which the reluctant Pharaoh was coerced culminated in the destruction of all the first-born, and Israel escaped to the Red Sea. The pursuing Egyptians were drowned and the miraculous preservation of the chosen people at the critical moment marks the first stage in the national history (*see* EXODUS, THE).

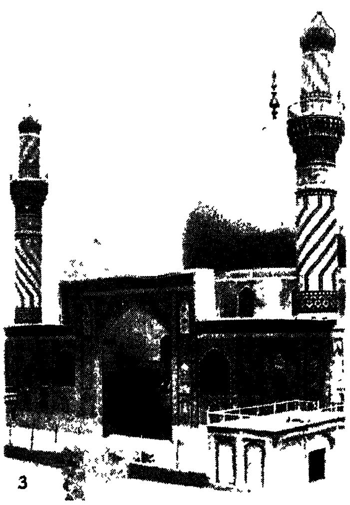
The other events need not be detailed. Kadesh (holy) was the chief centre. This was the scene of the "strife" at Meribah (striving) where Yahweh "shewed himself holy" (Num. xx. 1–13); a parallel account joins the name with Massah (trial, proof) where Yahweh "proved" the people (Exod. xvii. 1–7). These two names (Deut. ix. 22, xxxii. 51) with their significant meanings recur with varying nuances (Ps. lxxxi. 7, xcv. 8 *seq.*). Here also in the wilderness of Shur, and possibly at En-mishpat (well of judgment, *i.e.,* Kadesh, Gen. xiv. 7), Yahweh made for Israel "statute and judgment" and "proved them." This is apparently viewed as the goal of the three-days' journey (Exod. xv. 22–25). In this district the defeat of the Amalekites is more naturally located (Exod. xvii.; *cf.* I Sam. xxvii. 8) and here, finally, for some



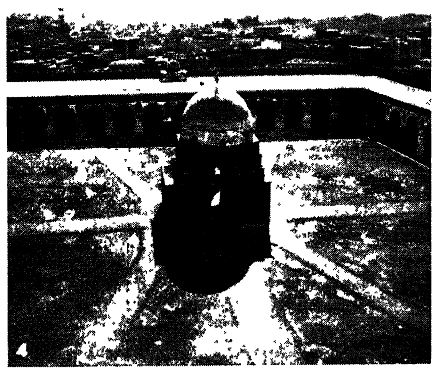
1



2

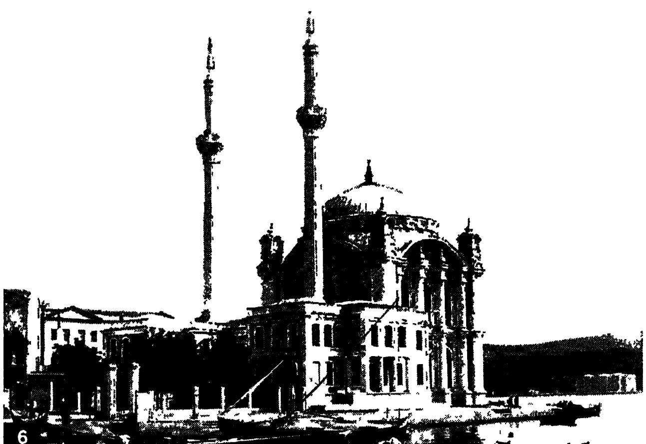


3

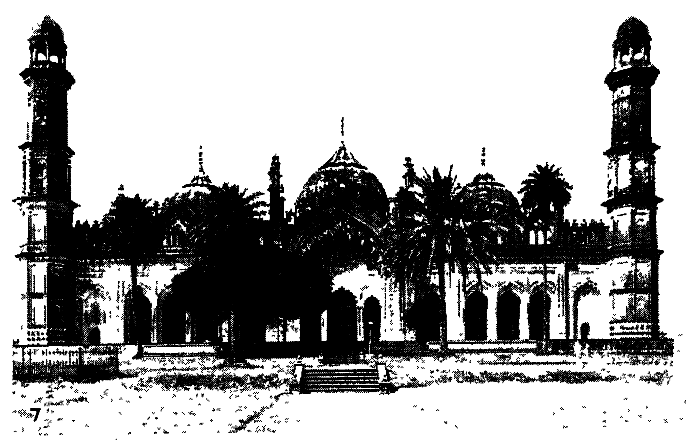


4

5



6



7

BY COURTESY OF (2) HERBERT G. PONTING F.R.P.S. (3) MISS A. C. CONWAY; PHOTOGRAPHS, (1, 4, 5) PUBLISHERS PHOTO SERVICE, (6) EWING GALLOWAY, (7) DECOU FROM EWING GALLOWAY

MOHAMMEDAN MOSQUES

1. The Mosque of Sultan Ahmed, Constantinople, 17th century, characteristically Turkish in its development of Byzantine dome forms
2. The Jumma Musjid (Great Mosque), Delhi, India, built by Shah Jahan in the 17th century, showing typical Mogul lavishness in its use of coloured marbles
3. The Mosque at Samarra in 'Iraq showing characteristic Persian simplicity of surfaces with polychrome faience tile decoration
4. The Court of the Mosque of Ibn Tulun, in Cairo, begun in 878, an almost perfect example of the early Syrian-Arabic-Egyptian arcaded mosque
5. The Mosque of Omar (Kubbet-es-Sakhra) at Jerusalem, begun in 643, an early Muslim variant of Byzantine forms
6. The Mosque of Sultan Abdul Medjid at Ortakeui, near Constantinople, showing the mixture of European and Mohammedan forms which was general in Turkish 19th century architecture
7. The Moti Musjid, Lucknow, India

cause, now obscured, Moses and his brother Aaron (*q.v.*) incurred Yahweh's displeasure (Num. xx. 12, xxvii. 14; Deut. xxxii. 51; Ps. cvi. 3). Pisgah or Mt. Nebo (the name suggests a foreign god), to the north-east of the Dead Sea became the scene of the death of Moses; his burial-place was never known (Deut. xxxiv.).

Close study of the Pentateuch, in connection with the political and religious history of Israel as presented to us in other parts of the Old Testament, makes it difficult if not impossible to accept the tradition which ascribed to Moses every detail of Israel's legal and cultural institutions. It was inevitable that these should be traced back to the great hero, and there is evidence which suggests that in some quarters other elements in Israelite life, repudiated by the orthodox Jew, were once attributed to him. The snake worship of Jerusalem was thus assigned to him, and it is at least possible that at one time he was held to be the author of the bull worship of Bethel and Dan (II Ki. xviii. 4).

Beyond question Moses must be regarded as the founder alike of Israel's nationality and of Israel's religion. His leadership in the Exodus and his prominence in the great covenant at Sinai (or Horeb) are hardly to be doubted. It was he who welded into one people the various kindred tribes under his leadership, and it was he who introduced Israel to Yahweh and Yahweh to Israel. But further details must be a matter of conjecture. Even the earliest code of laws in the Bible (Ex. xxi.–xxiii.) is simply a local and national form of the civil law common to Babylonia, Assyria and the Hittites, and (since it presupposes an agricultural community) was probably adopted by Israel after the settlement in Canaan. The familiar Decalogue (Ex. xx. 1–17) is sometimes attributed to Moses in its earliest form, but all we can say with certainty is that it probably represents the ethical principles he laid down. Yet, with all this doubt, the fact remains that Moses stands out as one of the greatest figures in history.

(S. A. C.; T. H. R.)

MOSES, ASSUMPTION OF, an extra-canonical apocalyptic work of the Old Testament. (*See* Apocalyptic Literature.) It is a prophecy of the future relating to Israel, put into the mouth of Moses, and addressed to Joshua just before the great lawgiver died. Founded upon the book of Deuteronomy, it contains a brief history of Israel from Moses to the Messianic age. The most striking feature in this work is the writer's scathing condemnation of the priesthood before, during, and after the Maccabean period, and an unsparing depreciation of the Temple services.

The book has been assigned to most dates between the death of Herod the Great and that of Bar-Cochba; but the true date appears to lie between 4 B.C. and A.D. 30. Herod is already dead (vi. 6), hence it is after 4 B.C.; and Herod's sons are to rule for shorter periods than their father, hence it must have been composed before these princes had reigned thirty-four years—*i.e.*, before A.D. 30. But there are grounds for assuming that A.D. 7 is probably the earlier limit.

The author was not an Essene, for he recognizes animal sacrifices and cherishes the Messianic hope. He was not a Sadducee, for he looks forward to the establishment of the Messianic Kingdom (x.). Nor yet was he a Zealot, for the quietistic ideal is upheld (ix.), and the kingdom is established by God Himself (x.). He was clearly a Pharisaic Quietist, a Pharisee of a fast disappearing type, recalling in all respects the *Chasid* of the early Maccabean times, and upholding the old traditions of quietude and resignation. His object is to protest against the growing secularization of the Pharisaic party through its adoption of popular Messianic beliefs and political ideals. But his appeal was in vain, and so the secularization of the Pharisaic movement culminated in due course in the fall of Jerusalem.

Bibliography.—*See* the edition by R. H. Charles (1897), and his article in *Apocrypha and Pseudepigrapha of the Old Testament* (ed. Charles, 1913), vol. ii., where full bibliographies are given.

(R. H. Ch.)

MOSETENAN, an independent linguistic stock of South American Indians, whose name is derived from the Mosetenes, one of its most important tribes. They live in northern Bolivia along the Beni river and east of it, approximately between 15° and 16° S. Lat. They are rather light in skin colour. They are a sedentary and largely agricultural folk, living in reed and thatch huts, and wear brilliantly coloured cotton sleeveless home made tunics. They do not use canoes, but make rafts. The bow is their main weapon. Little or nothing is known of their original culture.

See R. Schuller, in B. Biboloti, *Moseteno Vocabulary and Treatises* (Northwestern University, Chicago, 1917); A. D'Orbigny, *L'Homme Americain* (Paris, 1839).

MOSHEIM, JOHANN LORENZ VON (1693–1755), German Lutheran divine and Church historian, was born at Lübeck on Oct. 9, 1693. He studied at Kiel, and became professor at Helmstädt in 1723. His *Institutionum historiae ecclesiasticae libri IV.* (1726), established his reputation. Mosheim was consulted by the authorities when the new university of Göttingen was being formed; and in 1747 was made chancellor of the university. He died at Göttingen on Sept. 9.

See C. Heussi, *Johann Lorenz von Mosheim* (1906).

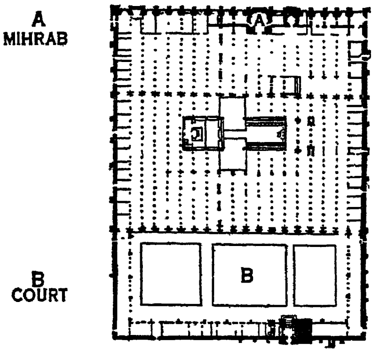
MOSLER, HENRY (1841–1920), American artist, was born in New York city on June 6, 1841. In 1863 he went to Düsseldorf, where for almost three years he was at the royal academy schools; he subsequently went to Paris, where he studied for a short time under Ernest Hébert. His "Le Retour," from the Paris salon of 1879, was the first American picture ever bought for the Luxembourg. He received a silver medal in Paris 1889, gold medals at Paris 1888 and Vienna 1893. Examples of his work are in the Sydney art museum, N.S.W., and the art museums of Springfield, Mass., Cincinnati, O., and New York. He died in New York on April 21, 1920. His son, Gustave Henry Mosler (1875–1906), a pupil of his father and of Léon Bonnat, exhibited at the salon in Paris, receiving a medal for his "De Profundis."

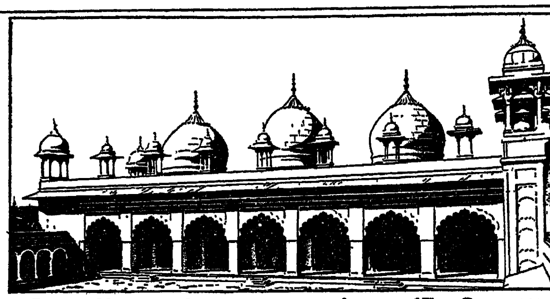
MOSLEY, SIR OSWALD ERNALD, 6th Bart (1896–), British statesman, was born on Nov. 16, 1896, and succeeded his father in 1928. He married in 1920 Lady Cynthia Curzon, daughter of Marquess Curzon of Kedleston. Educated at Winchester he served with the 16th Lancers and in the Flying Corps during the World War. He entered the House of Commons in 1918 as Conservative member for the Harrow division. In the election of 1922 he stood as an Independent, and in the 1924 parliament he sat as a Labour member. Mosley was an active worker in the Independent Labour Party, and was in MacDonald's cabinet of 1929 as Chancellor of the Duchy of Lancaster, but resigned the post in 1930. Lady Cynthia Mosley was elected M.P. for Stoke in the 1929 election.

MOSQUE, a building erected for Mohammedan religious services. The early type of mosque is determined by the position of the Mihrab or prayer niche indicating the direction of Mecca and the ritual custom of having all the worshippers arranged in parallel lines facing in this direction. Thus the Mihrab is placed in the centre of a long wall and accommodations for the lines of worshippers furnished by a series of arcades parallel or perpendicular to the wall in which the Mihrab is placed. The covered portion thus formed is usually a rectangle, wider than it is deep, enclosed by walls at the back and two ends, but open through the final arcade at the front on to a court, frequently surrounded by colonnades, and containing, in its centre, a fountain for ritual ablutions. Beside the Mihrab was placed the Mimbar, or pulpit, which usually consisted of a tall, shrine-like platform against the wall, covered with a pyramidal roof, and approached by a long, straight flight of steps. In later mosques there was also frequently a large raised platform supported on arcades, known as a Dikka, from which portions of the service were read. At Mecca, the first mosque consisted of a series of arcades surrounding a rectangular court in which was the Ka'ba, or sacred rock; obviously no Mihrab was necessary, and the arcades themselves, surrounding the court, formed the prayer hall.

This primitive type of arcaded or colonnaded mosque underwent many changes in various parts of the Mohammedan world. As the Mohammedan builders were peculiarly apt at learning the technique of the peoples whom they conquered, mosque design necessarily absorbed different influences in each country; the influence of Byzantine art was especially strong throughout western Asia. Five differing general schools may be recognized: First,

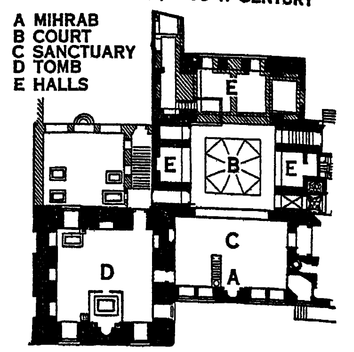
MOSQUE AT CORDOVA,
MOORISH, 8TH CENTURY
PLAN



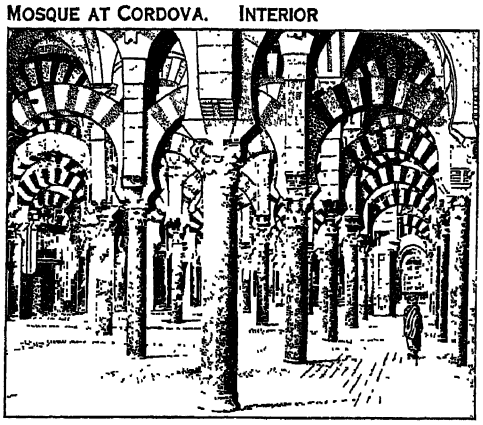


PEARL MOSQUE, AGRA, INDIAN, 17TH CENTURY

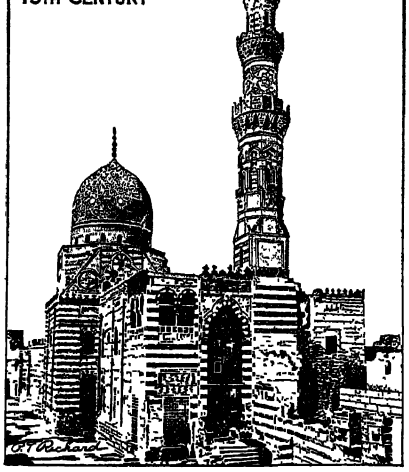
MOSQUE OF KAIT BEY OUTSIDE CAIRO
EGYPTIAN, 15TH CENTURY



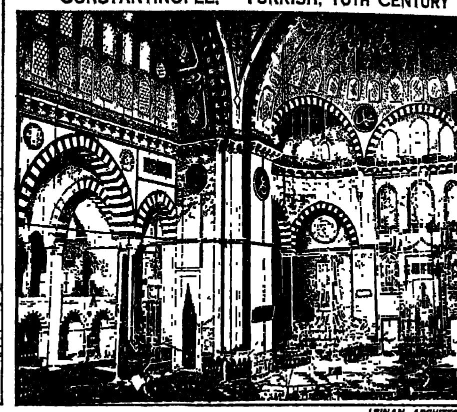
MOSQUE AT CORDOVA. INTERIOR



MOSQUE OF KAIT BEY
OUTSIDE CAIRO
15TH CENTURY

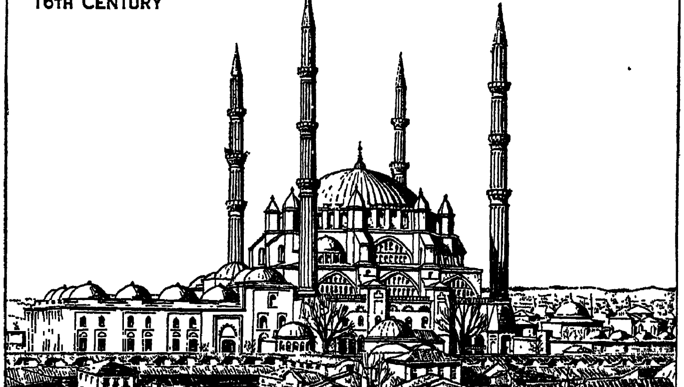


MOSQUE OF SULEIMAN THE MAGNIFICENT,
CONSTANTINOPLE, TURKISH, 16TH CENTURY



(SINAN, ARCHITECT)

TURKISH,
16TH CENTURY



MOSQUE OF SULTAN SELIM, ADRIANOPLE, (SINAN, ARCHITECT)

TURKISH,
17TH CENTURY

MOSQUE CALLED YENI-VALIDEH-DJAMI CONSTANTINOPLE

THE MOSQUE AT CORDOVA IS A MOORISH VARIATION OF THE ORIGINAL SIMPLE ARCADED TYPE. THAT AT AGRA SHOWS THE CHARACTERISTIC INDIAN MOGUL DEVELOPMENT OF THIS EARLY FORM. THE MOSQUE OF KAIT BEY OUTSIDE CAIRO SHOWS THE LATER TYPE OF EGYPTIAN MOSQUE WITH VAULTED HALLS AND A DOME. THE THREE TURKISH EXAMPLES SHOW THE SKILLFUL ADAPTATION AND DEVELOPMENT OF BYZANTINE DOME IDEAS WHICH MAKE THE BEST TURKISH MOSQUES MONUMENTAL AND LOGICALLY BEAUTIFUL

the school of Egypt and Syria; second, the school of north Africa and Spain; third, the school of Persia; fourth, the school of the Turkish empire; and last the school of India.

Early Mosques.—It is in the early mosques of the first school that the primitive form appears most completely. The mosque of Amru or Amr (begun 642) and that of Ibn Tulun (878), both in Cairo, and the Great Mosque at Aleppo (978) as well as that of Medina, in Arabia (707), are all remarkably complete examples; those of El-Aksa, at Jerusalem (685) and the great mosque at Damascus (707) are both built with materials taken from Christian churches. The result is necessarily different from the normal type, and the nave, transepts and aisle scheme of a Christian basilica may still be recognized, despite the additional ranges of colonnades and the changes in direction. In both of these, moreover, the Byzantine decorative influence is marked, and especially in El-Aksa, mosaics are used in an entirely Byzantine manner. In the famous Kubbet-es-Sakhra or mosque of Omar (a shrine rather than an ordinary mosque), a purely Byzantine plan, with a circular domed central nave and surrounding octagonal aisles is used. Only the slightly pointed arches differentiate it from a Christian building, and the whole bears witness to the power of Byzantine tradition on early Mohammedan mosques, and is also the earliest example of a dominant dome, which later became a characteristic feature of many mosques.

The mosque of Ibn Tulun, at Cairo, is one of the earliest in which no Byzantine or Roman materials are used; the pointed arch is used throughout and the decoration of the stucco which covers the rough construction already shows that preoccupation with flat surface ornament which is characteristic of later Mohammedan art.

By the time of the Mamelukes a love for more unencumbered interiors, and a growing skill in domical construction had worked

a profound change in Egyptian mosques, and led, as well, to a continually growing richness of exterior treatment, and the use, both outside and in, of much rich stalactite ornament. Moreover, a type of plan, originally used for colleges or medressehs, consisting of four great vaulted halls around a central square court, became usual. The most beautiful example of this is the great mosque of Sultan Hassan at Cairo (1356); even more rich in its decoration, and unusual in its plan, is the mosque of Kait Bey Outside the Walls (1472).

These Egyptian and Syrian mosques furnish excellent examples for tracing the development of the minaret (*q.v.*), the tower from which the call to prayer is given—an integral part of every developed mosque—from the primitive tower of Ibn Tulun, with its outside stair, like that of an Assyrian ziggurat or pyramid temple, to the slenderness and rich balconies of Kait Bey.

Moorish.—The Moorish school of north Africa and Spain, because of its distance from Byzantine centres, preserved the primitive type of mosque plan even longer. The Great Mosque of Kairawan (begun 675) bears many resemblances to those of Amru and Ibn Tulun. It is noteworthy, however, that in the Mihrab, dating from 837, although the capitals are still of quasi-Roman type, the surface decoration already approaches the Moorish type that flowered later in the Alhambra, and that perhaps due to Roman influence domes of considerable size appear at both ends of the central aisle leading to the Mihrab. Equally primitive in its type is the great mosque at Tlemçen (1136); the same type is preserved in many other smaller mosques, such as those of Sfax (prior to the 11th century) and the Great Mosque at Algiers (1018). By far the most important of the Moorish mosques is the Great Mosque at Cordova (begun 780 and much extended in the 10th century), so that the prayer chamber occupied the enormous area of 148,000 sq.ft., with 16 rows of arcades. The whole is decorated with a lavishness unknown in other examples of the style and is noteworthy for the complicated interlacing arches, the doubling of the arcades, the intricate plaster ornament and the frequent use of cusped arches.

Persia.—In Persia, the tradition of Sassanian vault building, and of polychrome, glazed tiles led to mosques of a character entirely different. Thus, although the plan of the great mosque of Isfahan (begun 760, enlarged 1080, repaired in the 16th and 17th centuries) retains the many columned prayer hall or maksoura and the great court of the primitive type, it has a structural grandeur, and an architectural character, totally different, as the centre of each side of the court is occupied by an enormous vaulted chamber opening on the court by a great arch, and instead of the intricate relief ornament there exist large simple surfaces to receive exquisite polychrome tiles. Throughout Persian mosque design domes have an importance not observable in Egypt or Moorish countries, and are frequently of bulbous outline. During the 15th and 16th centuries the colonnaded prayer halls disappeared in favour of large, square, domed interiors, occasionally surrounded by lower vaulted side aisles, as in the Blue mosque at Tabriz (1437–68), famous for its faience mosaic; the imperial mosque at Isfahan (1612) retains the original court with its four impressive porches, but all the covered portions are roofed with vaults. The main prayer hall, covered by a bulbous dome, and preceded by the enormous pointed arched porch, flanked by slim minarets, is perhaps the climax of Persian mosque design.

Turkish.—It is natural that the Ottoman school should be the closest to Byzantine tradition. The Great Mosque at Konieh (1220) shows a mixture of influences—Persian, Syrian, Byzantine, Armenian. The monumental doors are Persian, but the use of carved, relief ornament borrows much from early Armenian churches. In the Yechil-Medresseh or collegiate mosque at Nycea (1420), the Byzantine influence is already dominant; dome forms, the use of alternate dark and light stones, and the entire composition are wholly Byzantine. The green mosque at Brusa (begun 1424) is noteworthy in its attempt to combine with the purely Byzantine domed scheme details such as stalactite ornament, doors in niches, surface decoration and elaborated pendentives which are distinctly Mohammedan, and developed from both Persian and Syrian sources.

The capture of Constantinople by the Turks in 1453 consolidated a tradition already strong—the attempt to build a mosque which should be structurally Byzantine, but decorated with details Mohammedan and especially Persian. The development of the mosques of Constantinople and Adrianople, from the simple dome of the Mosque of the Conqueror, at Constantinople (begun immediately after the conquest), by the Greek architect Christodoulos, and built with materials taken from the church of the Holy Apostles, to the piled masses of the Achmedieh mosque (1609), is continuous. In the piling up of dome over dome and half dome the expression of buttressing masses and the consistency of exterior effect, as well as the creation of vast, unencumbered interior spaces, the Ottoman architects went far beyond the precedent set them in S. Sophia. Although Persian tiles, and the rather garish interior painting never equalled the Byzantine marble and gold mosaic as interior decoration, the climax was reached in the mosque of Suleiman the Magnificent by Sinan (1557), whose beautiful silhouette is almost matched by the simple dignity of its interior. In the 18th century, daring lightness of construction was sought at the expense of every other quality, as in the little mosque called Nour-i-Osmanieh, "the lantern of Osman," whose dome, carried on four great arches, seems almost to float. In detail, however, European influence was making itself felt, and the building of mosques rapidly declined.

Indian.—Indian mosques usually betray the Persian origin of the Muslim conquerors. Nevertheless, as mosque building continued, more and more native influences made themselves felt. In the mosque of Ajmeer (begun 1200) the plan is of characteristic early mosque type, save that the arcades are covered by typical Jaina octagonal domes, but the front to the court, with its high, central arch, capped by twin minarets, is basically Persian. In the mosque of Kutub at Delhi, of approximately the same date, the plan is similar, but the details entirely Indian, and the great minaret (*see* illustration under Tower), with its massed alternation of vertical and horizontal shadows is characteristically Indian. In the 14th and 15th centuries, as in the mosques at Jaunpur (Redgate mosque and Jumma Musjid) the Indian delight in beam construction and the distrust of the arch give a character essentially non-Muslim. Under the Moguls there was a new influx of northern Muslim influences; the emperor Berber called to his service several pupils of Sinan from Constantinople, and the following hundred years saw the Great Mosques of Agra, Bijapur and Fathepur-Sikri, and the later work at Delhi, in which the Indian love for rich surface, the Mogul lavishness in the use of gleaming white marble, often inlaid with coloured stones, and a characteristic use of pointed, cusped arches, combined with the Persian love of great size to produce results of vivid beauty. The most important examples are the Great Mosque at Agra (middle 16th century), the mosque of Fathepur-Sikri, nearly contemporary, especially remarkable for its magnificent gateway, and the Pearl mosque at Agra, of the middle 17th century, famous for its simple plan and delicate inlays.

Chinese.—Mosques are common in China, but in almost every respect follow Chinese temple precedent slavishly. Frequently the only thing which differentiates them from ordinary Chinese temples is the existence of a Mihrab in the form of a pointed arch niche, as in the mosque at Hangchow, with decoration distantly based on Arabic sources.

Modern.—The most interesting of modern mosques is that at Paris, by Fournez, Mantout and Eustache (1922–24). This, built generally on the model of the Medresseh Bou Anania at Fez is a beautifully planned, carefully detailed and lavishly executed modern interpretation of 14th century Moorish design.

See H. Saladin, *Manuel d'Art Musulman,* v. i., 1907. *See* also MOHAMMEDAN ARCHITECTURE. (T. F. H.)

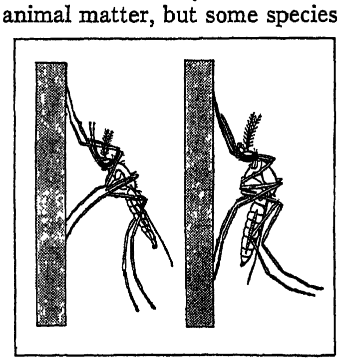
MOSQUITO, the name applied to species of blood-sucking flies belonging to the family *Culicidae,* or gnats, of the order Diptera (*q.v.*). Prior to the year 1899 mosquitoes received very little attention from entomologists and relatively few species were known. At the end of the 19th century the researches of Ross in India and Grassi in Italy proved that mosquitoes are the agents concerned with the dissemination of malaria, and the establish-

ment of this important fact has led to the collection and study of these insects in all parts of the world. About 1,500 species of mosquitoes are now recognized and it is probable that the number of kinds actually existing is nearly 2,000.

Mosquitoes bear a close general likeness to many harmless midges (*Chironomidae*) but may be distinguished by the following characters. (1) The lower lip or labium is prolonged into an elongate proboscis which forms a sheath enclosing the needle-like mouth-parts (fig. 1). (2) The presence of scales on the body, wings and other appendages. (3) The costal vein runs completely round the wing. (4) The antennae are densely plumose in the males and less hairy in the females, while the palpi project forwards and are not pendulous.

The family occurs in all parts of the world and although the tropics are much richer in genera and species than northern latitudes, mosquitoes are abundant even in arctic regions. Under the latter conditions they are found during the short summer and often occur far from the haunts of man and even in regions uninhabited by quadrupeds. In these lands they may go through a number of generations without tasting blood, nevertheless the blood-sucking instinct is so strong that they rarely fail to avail themselves of the first opportunity for responding to it that may present itself. As a rule the blood-sucking habit is confined to the female which differs from the male in possessing piercing mandibles: the males largely feed on plant juices and the females apparently subsist upon a similar diet in the absence of blood.

Breeding Habits.—The early stages of all mosquitoes are passed in water, more usually fresh and less often salt or brackish water. Some domestic mosquitoes will breed in small accumulations of water in discarded cans or other vessels: the larvae of other species occur in natural pools or ditches, while there are kinds which inhabit collections of water in hollow parts of trees or in the water-collecting receptacles of certain plants. Among other peculiar situations are pools flooded by the sea at high tides, mountain streams, wells, and the salt waters of Saharan oases. In each of these different habitats certain species of mosquitoes regularly breed and it therefore follows that knowledge of such facts is of vital importance in mosquito control. The eggs are usually deposited on the surface of the water and the number laid by a single female varies from 40–100 up to 300 or more. They may be deposited singly as in *Anopheles* or in compact masses or rafts as in the common *Culex pipiens*. The larvae are very active, with large heads and jaws and possess a pair of "brushes" which waft food-particles into the mouth. Their food chiefly consists of minute fragments of vegetable or animal matter, but some species are carnivorous, preying upon other, or even their own species. Larvae of the group *Culicinae* have a prominent breathing syphon on the 8th abdominal segment and when taking in air this organ perforates the surface film, the creature itself hanging head downwards. In the group *Anophelinae* there is no respiratory syphon and they usually lie horizontally just beneath the surface film with the plate bearing the spiracles in free communication with the outside air. The pupae of mosquitoes are active creatures, crescentic in form, and breathe by means of a pair of respiratory trumpets which break the surface film of the water when air is taken in.



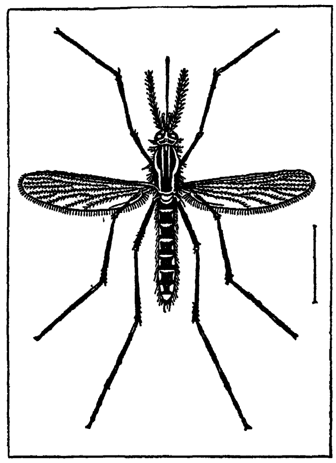
BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM (NATURAL HISTORY)

FIG. 1.—RESTING POSITIONS OF (LEFT) MALARIA MOSQUITO (ANOPHELES) AND (RIGHT) CULEX

The Anopheline mosquitoes generally have spotted wings and rest with the body and proboscis in one straight line, often obliquely with the supporting surface: the *Culicinae*, on the other hand, rest with the body parallel with the supporting surface and with the proboscis inclined at an angle with the thorax (fig. 1).

Many species of *Anophelinae* act as carriers of the pathogenic organism of malaria and in Europe one of the commonest kinds thus implicated is *Anopheles maculipennis*. *Aedes aegypti* (often known as *Stegomyia fasciata*) which is concerned with the transmission of yellow fever belongs to the *Culicinae* (fig. 2). The terrible disease of elephantiasis is due to a parasitic worm being disseminated by various mosquitoes, one of the most important being the common tropical species *Culex fatigans*. Other human and animal diseases are spread by mosquitoes (*see* ENTOMOLOGY, MEDICAL).

Control Measures.—Various measures for controlling mosquitoes have been introduced. Freedom from the attacks of these insects is largely obtained by living in mosquito-proof dwellings or by utilizing mosquito curtains while sleeping. A variety of substances have been recommended for application to exposed parts of the body, essential oils of various kinds being largely advised. The destruction of mosquitoes in dwellings may be carried out by the fumigation of rooms, while traps in the form of boxes, lined with dark blue or black cloth, which can be readily closed, have been recommended. The elimination of standing water and the drainage of marshy lands afford the chief means of reducing the larval breeding-places. Areas of water which cannot be done away with are treated with oil or oil mixtures which spread to form a thin covering film, thus destroying the larvae as they come to the surface to breathe as well as acting as a deterrent to egg-laying females. Wells require screening while tanks and irrigation canals may be stored with species of fish which are known to devour mosquito larvae. Large areas of shallow swamps, rice fields and bayous in the United States have recently been dusted with Paris green discharged from aeroplanes, which has resulted in the destruction of the larvae and this method appears to promise extensive developments in the future.



BY COURTESY OF THE U.S. DEPT. OF AGRICULTURE

FIG. 2.—AEDES ARGENTEUS (STEGOMYIA CALOPUS), A CARRIER OF YELLOW FEVER

BIBLIOGRAPHY.—The literature on mosquitoes has assumed enormous proportions; some 26 species of mosquitoes occur in the British Isles and most of them are admirably described by W. D. Lang, *A Handbook of British Mosquitoes* (London: British Museum, Nat. Hist. 1920). Much useful information relative to the British forms and control measures is also given in the pamphlet by F. W. Edwards and S. P. James, *British Mosquitoes* (British Museum: Nat. Hist. Economic series 4A, 1925). For the North American species, L. O. Howard, H. G. Dyar and F. Knab, *The Mosquitoes of North and Central America* (Washington, 1912–17, 4 vols.) is a storehouse of information: a handier and more recent treatise is H. G. Dyar, *The Mosquitoes of the United States* (Proc. U.S. National Museum, vol. lxii., 1922). For control measures *see* W. E. Hardenburg, *Mosquito Eradication* (London and New York, 1922); W. V. King and G. H. Bradley, *Airplane dusting in the Control of Malaria Mosquitoes* (U.S. Dept. of Agric., Circular 367, 1926); *see* also text-books of medical entomology. (A. D. I.)

MOSQUITO COAST or **MOSQUITO RESERVE** (Mosquitia or Reserva Mosquita), a section of the eastern coast of the Republic of Nicaragua, once held as a protectorate by the British Crown, and now comprised largely in the Province or Department of Zelaya, Nicaragua. It includes the important town of Bluefields, the town of Prinzapolca on the river of the same name, and much of the territory involved in various Nicaraguan revolutions on the Caribbean coast. The name Mosquito coast is sometimes applied erroneously to the whole eastern seaboard of Nicaragua and often to the adjoining region of Mosquitia in Honduras, *i.e.*, the coast region as far west as the Río Negro or Río Tinto. The Mosquito coast is more accurately defined, however, as a narrow strip, about 40 m. wide, skirting the Caribbean sea from 11° 45′ to 14° 10′ N., a length of about 225 miles. The northern boundary would be along the Wawa river, the western on the edge of the Nicaraguan highlands, and the southern along the river Rama. Bluefields, with a population of about 8,000, is the capital and the most important town.

The Mosquito coast is named from its ancient Indian inhabitants, the Mosquito or Misskito Indians, *see* below (the corruption of the name is attributed to the first European settlers). The Indians still have a loose tribal organization, but are completely mixed with negroes escaped from the plantations in colonial times or wrecked on the shores here. The first white settlement was made in 1630, on two small cays or islands by representatives of an English chartered company of which the earl of Warwick was chairman and John Pym treasurer. The English established a protectorate over the Mosquito Indians in 1655 and claimed this suzerainty until 1850. The United States, Spain and the Central American republics disputed this claim, and it was finally settled by the Clayton-Bulwer Treaty between the United States and Great Britain, under whose terms Great Britain withdrew her claims to the Mosquito coast in return for the mutual pledge, with the United States, that neither power would fortify, colonize or exercise dominion over any canal that should be built through Central America; this was later revised under the Hay-Pauncefote Treaty of 1900. (*See* PANAMA CANAL.) Prior to the Clayton-Bulwer Treaty, however, there had been various efforts to establish British colonies in the Mosquito Reserve, but with little success, and in 1848 the seizure of Greytown (San Juan del Norte), farther down the Nicaraguan coast, by Mosquito Indians, with British support, aroused excitement and protest in the United States, and war was talked of.

Greytown was the eastern terminus of the proposed Nicaraguan canal, and the move upon it was taken as indicative of Great Britain's determination to build a British canal through Nicaragua. The matter was closed by the Clayton-Bulwer Treaty two years later. The British Government delegated its protectorate of the Mosquito coast to Honduras, in 1859, but this was unsatisfactory both to Nicaragua and to the Mosquito Indians, and by the Treaty of Managua, in 1860, Great Britain ceded to Nicaragua all claims to the eastern coast of Nicaragua, from Cape Gracias a Dios, the present border point between Honduras and Nicaragua, to Greytown. Autonomy was granted the Mosquito Indians within the Mosquito coast deliminated above. It was also provided that the chieftain of the tribe should receive a subvention of £1,000 a year until 1870. On his death in 1864 the Nicaraguan Government declined to continue the payment to his successor, or to recognize his authority, but local Indian government continued despite this lack of Nicaraguan support. In 1880, the question, which had been referred for arbitration to the emperor of Austria, was decided in favour of the Indians, and the sovereignty of Nicaragua was limited by non-interference in local affairs. This almost complete autonomy continued for 14 years, when the Indians voluntarily surrendered it and on Nov. 20, 1894, were incorporated into the Department of Zelaya of the Republic of Nicaragua. (W. THO.)

Ethnology.—The Mosquito Indians of the Atlantic littoral of Nicaragua are a mixed race basically South American in culture. Although discovered by Columbus in 1502 they did not come into contact with Europeans until the rise of the buccaneers in the 17th century. As a result of this association they have a strong infusion of both white and negro blood. Linguistically the Mosquito are allied to their neighbours, the Sumo, and both tribes may be related to the Chibcha of Colombia. Culturally the Mosquito are canoe-using people, manufacturers of wooden bowls and spoons, bows, flutes, bark cloth, etc. They have several elaborate ceremonies marked by the excessive use of intoxicants and by conical masks suggesting those found among Amazon valley tribes. They have a tradition that long ago they lived on the Pacific coast between the Lake of Nicaragua and the ocean. Driven out by northern invaders, they moved to the present Department of Chontales. Being attacked again, they recalled an ancient prophecy that they never could be driven from the Atlantic coast and they moved there under the leadership of the national hero, Wakna. Under his son, Lakia Tara, they conquered the coast from Honduras to Costa Rica. About A.D. 1100 some strange people of higher culture settled in their territory for a time, but finally moved away again.

See E. G. Squier, *Notes on Central America* (1855); Walther Lehmann, *Zentral Amerika,* 1 teil, i. band (1920).

MOSS, a seaport and watering place of Norway, in Smaalenene *amt* (county), on the Oslo Fjord, 37 m. S. of Oslo by the Gothenburg railway. Pop. (1927) 8,453. Here was signed, on Aug. 14, 1814, the convention which united Norway to Sweden. It has sawmills, shipbuilding, and a waterproofing industry.

MOSSAMEDES: *see* ANGOLA.

MOSSLEY, market town, municipal borough, Mossley parliamentary division, Lancashire, England, 10½ m. N.E. from Manchester on the L.M.S. railway. Pop. (1931) 12,041. It lies on the river Tame, near the boundary between Lancashire, Cheshire and Yorkshire. The Huddersfield canal passes it. Ancient earthworks (Bucton castle), with a Roman road passing them, occur outside the town. Mossley has foundries, mill works, woollen factories and large cotton-spinning mills. It was incorporated in 1885.

MOST, JOHN JOSEPH (1846–1906), German anarchist, was born in Augsburg, Bavaria, on Feb. 5, 1846. He worked as a bookbinder in Germany, Austria, Italy and Switzerland (1863–1868), and then became editor of Socialist papers in Chemnitz and Vienna, both suppressed by the authorities, and of the *Freie Presse* in Berlin. For his attacks on patriotism and on conventional religion he was repeatedly arrested. From 1874–78 he sat in the German *Reichstag,* but he failed to be re-elected, was expelled by the Socialist organization, went to France, which he was forced to leave in 1879, and finally settled in London. There he founded *Die Freiheit,* and after being imprisoned for the views expressed in this journal, he went to America and resumed its publication in New York. He again suffered imprisonment in 1886, 1887 and 1902, and died at Cincinnati on March 17, 1906.

His works include: *Proletarier Liederbuch* (5th ed., 1875) and *Die Bastille am Plötzensee: Blätter aus meinem Gefängnis-Tagebuch* (1876). *See* also his *Memorien* (New York, 1903); R. Rocker, *J. Most Das Leben eines Rebellen* (1924); E. Drahn, *Johann Most* (1925).

MOST, a town in N.W. Bohemia, Czechoslovakia, on the river Bělá. Situated in the centre of a great lignite basin it is the headquarters of the State mining authority and the seat of many varied industries including sugar, chemical, porcelain and shoe factories, breweries and metallurgical undertakings. A long and stormy history is due to reasons reflected in its modern importance as a railway junction. Pop. (1920), 27,354, with a strong and growing Czech minority.

MOSTAGANEM, chief town of an arrondissement in the department of Oran, Algeria, 44 m. E.N.E. of Oran, on a plateau 278 ft. high, half a mile from the Mediterranean coast. The town is separated into European and native quarters by a deep ravine, the Ain Sefra, through which passes a considerable stream. The native quarter, called Tijit, occupies the eastern slopes of the ravine and the level ground above, and is dominated by the kubbas of two marabouts. A railway line, 122 m. long, connects Mostaganem with Tiaret, another line links it with Arzew and Oran.

Mostaganem appears to date from the time of the Almoravides. It passed into the possession of the rulers of Tlemçen and was captured by Arouj Barbarossa in 1516, and became part of his brother Khair-ed-Din's kingdom. In the 16th century the town enjoyed a period of great commercial prosperity, and its population rose to 40,000. The re-awakening of the town dates from the French occupation in 1833. Mostaganem was partly destroyed in November 1927 by a flood. Pop. 26,355, of whom 12,639 are Europeans, 10,411 being French.

MOSTAR, the capital of Hercegovina, Yugoslavia, lies on the Naretva, just south of the celebrated Naretva defile, amid gaunt and rugged mountains. It is on the road and railway from Serajevo to Ragusa, and during the Austrian occupation (1908–18) all heavy traffic between Bosnia and the Adriatic passed through Mostar. Pop. (1921) 18,176. A beautiful bridge, 61 ft. high, probably 16th or 17th century Turkish work, here crosses the river; some antiquarians, however, ascribe its foundation to the Romans, who certainly had a settlement here. Mostar is the seat of a district court and of both a Roman Catholic and an Orthodox bishop, and has a large Orthodox cathedral. It possesses a gymnasium, State schools of viticulture and horticulture, and

a State stud farm. The principal industries are wine, tobacco, fruit, vegetables and walnuts. Anthracite is found in the district.

The present name of the city is derived from the Serbo-Croatian *most*, a bridge, and *star*, old. Its earlier Slavonic name was Vitrinicha. Immediately upon their conquest of Hercegovina, the Turks chose it as their headquarters. Within a few miles are the sources of the Buna, a small affluent of the Naretva, which issues from a cavern amid scenery noted for its wild grandeur.

See Sir G. Wilkinson, *Dalmatia and Montenegro* (1848) vol. ii.; J. Asboth, *An Official Tour through Bosnia and Herzgovina* (1890); R. Munro, *Bosnia and Herzgovina* (Edinburgh, 1900), pp. 179–188.

MOST FAVOURED NATION CLAUSE, in a commercial treaty, an article which concedes to the State with which it is concluded whatever advantages in the matters comprised within its stipulations have been allowed to any foreign or third State. It does not in itself directly confer any particular rights, but sums up the whole of the rights in the matters therein mentioned which have been or may be granted to foreign countries. The value of the privileges under this article accordingly varies with the conditions as to these rights in each State which concedes this treatment.

Prior to 1778, a promise of most favoured nation treatment when granted was universally understood to mean a promise of treatment equal to the best which might be accorded to any other country, regardless of the terms under which special favours to other countries might be conferred. Owing to discriminations and exclusions by other countries, the United States found this interpretation too wide. In their first commercial treaty, that with France of April 30, 1803, Art. VIII. provided that "the ships of France shall be treated upon the footing of the most favoured nation in the ports of Louisiana." France accordingly claimed that the advantages granted to Great Britain in all ports of the United States should be secured to France in the ports of Louisiana. This claim was rejected by the United States upon the ground that the clause did not say and could not be understood to mean that France should enjoy as a free gift that which was conceded to other nations for a full equivalent. In the treaty of commerce between Great Britain and the United States of July 3, 1815, which took the place of the Jay Treaty of 1794, it was provided that "no higher or other duties shall be imposed on the importation into the territories of His Britannic Majesty in Europe of any articles, the growth, produce or manufacture of the United States, and no higher or other duties shall be imposed on the importation of any articles, the growth, produce or manufacture of His Britannic Majesty's territories in Europe, than are or shall be payable on the like articles, being the growth, produce or manufacture of any foreign country." Great Britain regarded this clause as unconditional and maintained that if one of the parties in a treaty with a third power gave a lower tariff on any such articles, the other party was entitled also to be charged at the lower rate.

The American interpretation of the most favoured nation treatment as being based on reciprocity, qualified by the power to make special arrangements with particular countries, has been upheld by the Supreme Court of the United States in *Bartram* v. *Robertson*, 122 U.S. 116, and *Whitney* v. *Robertson*, 124 U.S. 190.

The same conclusion was reached by the court of customs appeals as to concessions for reciprocal considerations made under s. 3 of the Tariff Act of 1897, in *Shaw and Co.* v. *United States*, 1 Ct. Cust. App. 426. The Court said, "S 3 of the Tariff Act 1897 was a general law: its attitude toward every nation was uniform. It offered no special favour to France or Germany or Italy or any other country. Every foreign nation was treated alike by the terms of the law. It was equally within the opportunity of England to negctiate a reciprocity treaty as it was within the opportunity of France." This American interpretation is regarded by Oppenheim as unjustifiable (*International Law*, vol. I., p. 750) and by Sir Thomas Barclay as resting on policy alone and no sound principle of law (*Problems of International Law and Practice*, p. 138). It is, however, approved by De Martens (*Traité de Droit International*, vol. II., ss. 51–55), and by Westlake (*International Law*, vol. I., p. 283). The opinions of De Martens and Westlake are to be preferred. The American interpretation rest upon a sound legal principle. The law looks to the intention of the parties to an agreement. Nations, like individuals, when they have granted mutual concessions for valuable considerations, do not usually intend to give the benefit of such concessions to third parties for nothing. If they do, they usually take care to say so in express terms, and do not as a rule leave it to be inferred from a vague general stipulation. This is not only good law, but sound common sense.

Whatever jurists may think, however, in practice the American interpretation has to be taken into account. For instance, the treaty between Great Britain and Uruguay of July 15, 1899, specifically restricts the application of the existing most favoured nation clause:—"It was also agreed that the stipulations contained in the treaty which is to be renewed do not include cases in which the Government of . . . Uruguay *may accord special favours, exemptions and privileges to the citizens or products of the United States, of Brazil, of the Argentine Republic, or of Paraguay in matters of commerce.* Such favours cannot be claimed on behalf of Great Britain on the ground of most favoured rights as long as they are not conceded to other States."

Post-War Treaties.—Since the World War the United States has made a number of commercial treaties with an unconditional most favoured nation clause. In the treaty with Germany of Dec. 8, 1923 (existing treaties between the Allied and Associated Powers and Germany having lapsed) the clause is as follows:—"with respect to the amount and collection of duties on imports and exports of every kind, each of the two High Contracting Parties binds itself to give to the nationals, vessels and goods of the other the advantage of every favour, privilege or immunity, which shall be accorded to the nationals, vessels and goods of a third State, and regardless of whether such favoured State shall have been accorded such treatment gratuitously, or in return for reciprocal compensatory treatment. Every such favour, privilege or immunity which shall hereafter be granted to the nationals, vessels or goods of a third State shall simultaneously and unconditionally, without request and without compensation, be extended to the other High Contracting Party for the benefit of itself, its nationals and vessels."

But from this all-inclusive provision the United States excepts its treatment of commerce with Cuba and its possessions. Coastwise traffic is also excepted. This measure is thus a compromise between conflicting views. "The introduction," says McClure, "of preferences in the matter of shipping would, in any but the narrowest sense, be inconsistent with, and would in all probability practically destroy the development of an unconditional most favoured nation tariff policy."

When before the Committee on Foreign Relations this treaty was declared to be a model for subsequent commercial treaties and accordingly similar agreements with similar reservations have been reached with Brazil, Czechoslovakia, Dominica, Estonia, Finland, Greece, Guatemala, Hungary, Latvia, Lithuania, Nicaragua, Rumania and Siam.

Since the Peace Treaty of 1919, Great Britain has entered into a great number of treaties of commerce and navigation in which she has taken care to make the unconditional character of the most favoured nation treatment quite clear.

The commercial treaty between France and the Seychelles islands of April 16, 1902, having been denounced, the convention between Great Britain and France of June 5, 1920, contained provisions entitling certain products of the Seychelles islands to the lowest custom duties applicable to similar products of foreign origin in France and giving a preference to French wines imported into the Seychelles islands.

In the Treaty with Latvia of June 22, 1923, the language of the most favoured nation clause becomes more precise and unconditional. The relevant provisions are as follows:—"Art. 1. There shall be between the two Contracting Parties reciprocal freedom of commerce and navigation. The subjects or citizens of each of the two Contracting Parties shall have liberty freely to come with their ships and cargoes to all places and ports in the territories of the other to which subjects or citizens of that Party are or may be permitted to come, and shall enjoy the same rights, privileges,

liberties, favours, immunities and exemptions in matters of commerce and navigation, as are or may be enjoyed by subjects or citizens of that Party. The subjects or citizens of each of the Contracting Parties shall not be subject, in respect of their persons or property or in respect of their commerce or industry, to any taxes whether general or local, or to imports or obligations of any kind whatever, other than those which are or may be imposed upon subjects or citizens of the most favoured nation."

"Art. 2. The Contracting Parties agree that in all matters relating to commerce, navigation and industry, any privilege, favour or immunity which either Contracting Party has actually granted, or may hereafter grant, to the ships and subjects or citizens of any other foreign State, shall be extended simultaneously and unconditionally, without request and without compensation, to the ships and subjects or citizens of the other, it being their intention that the commerce and industry of each Party shall be placed in all respects on the footing of the most favoured nation."

"Art. 5. Articles, the produce or manufacture of the territories of one of the Contracting Parties, imported into the territories of the other, from whatever place arriving, shall not be subject to other or higher duties or charges than those paid on like articles, the produce or manufacture of the territories of any other foreign country. Nor shall any prohibition or restriction be maintained or imposed on the importation of any article, the produce or manufacture of the territories of either of the Contracting Parties, into the territories of the other, from whatever place arriving, which shall not equally extend to the importation of the like articles being the produce or manufacture of the territories of any other foreign country."

"Art. 6. Articles, the produce or manufacture of the territories of either of the Contracting Parties, exported to the territories of the other, shall not be subjected to other or higher duties or charges than those paid on the like articles exported to any other foreign country. Nor shall any prohibition or restriction be imposed on the exportation of any article from the territories of either of the Contracting Parties to the territories of the other which shall not equally extend to the exportation of the like article to any other foreign country."

"Art. 7. As an exception from the general undertaking given by the Latvian Government to accord the most favoured nation treatment to the commerce of His Britannic Majesty's Government, it is understood that His Britannic Majesty's Government will not claim the benefit of any customs preferences or other facilities of whatever nature which are or may be granted by Latvia in favour of Russia, Finland, Esthonia or Lithuania in regard to Russian, Finnish, Esthonian or Lithuanian goods respectively, so long as such preferences or facilities are not extended by Latvia to any other foreign country."

A similar commercial convention was entered into on July 24, 1923, by the British empire, France, Italy, Japan, Greece, Rumania and the Serb-Croat-Slovene State of the one part and Turkey of the other.

In the treaty of commerce between Great Britain and Germany of Dec. 2, 1924, the most favoured nation treatment of the provisions of the treaty with Latvia is followed, subject to certain reservations as to favours granted or to be granted to third States. Similar provisions are contained in the treaties of commerce of Germany with Spain (May 7, 1926) and with Switzerland (July 14, 1927).

In the treaty of Nov. 24, 1926, between Italy and Greece the most favoured nation clause is expressly unconditional except as to favours to be accorded to adjacent States with a view to facilitating frontier traffic, such frontier zone not to extend more that 15 kilometres. The fullest most favoured nation treatment is accorded in the treaty between Switzerland and Czechoslovakia of Feb. 16, 1927, as regards importation and exportation, subject to these exceptions: "(1) In exceptional circumstances in regard to war supplies; (2) for reasons of public security; (3) to meet requirements of health and veterinary regulations with a view to the protection of animals and plants against disease, insects, parasites and other dangers of every kind; (4) in order to subject foreign goods to prohibition or restrictions which are or may in future be imposed within the country of internal legislation on the production of or traffic in and transport or consumption of native products of the same kind. This applies particularly to goods which are the subject of a State monopoly in the territory of one of the Contracting Parties."

Numerous similar treaties might be mentioned, but it must suffice to say that the most favoured nation clause which immediately after the War fell into disfavour, has again found general acceptance. In view, however, of express reservations, of attempts not infrequently made to avoid its consequences, and of the various interpretations placed upon the clause even where clearly expressed, it has been suggested that a standard form of the clause and its interpretation should be adopted by an international conference, which might be inserted in commercial treaties and which would grant the most favourable treatment, without restrictions or conditions, equal to that granted or to be granted to any third State.

See *League of Nations Treaty Series* for text of treaties; G. W. Wickersham, *Report on Most-Favoured-Nation Clause*, Publications of the League of Nations V. Legal, 1927, v. 10; *American Journal of International Law*, vol. 22, supp. no. 1, 133 (1928). (H. H. L. B.)

MOSUL, a vilayet, one of the divisions into which Mesopotamia was divided under Turkish rule, corresponds roughly to ancient Assyria. The vilayet which included the sanjaks of Mosul, Shehrizor and Sulaimaniya had an area of about 29,000 sq.m., although the actual area in dispute between Turkey and 'Iraq, and finally included in the kingdom of 'Iraq in 1926 has an area of over 35,000 sq.m. The vilayet lies mostly on the eastern bank of the Tigris: it is separated from the Bitlis vilayet and the newly constituted Hakkiari on the north by a boundary which, with slight modifications, follows the so-called Brussels or Brantling line which runs east from the Tigris through the Slopi and Lower Tiari country to the neighbourhood of the Gadir Pass. On the east the frontier line runs through the Persian mountains including the head-waters of the eastern tributaries of the Tigris. The western frontier is a purely artificial line through the Syrian desert; Baghdad vilayet forms the southern boundary. The whole vilayet belongs geologically to the Zagros mountain system and is of immense importance strategically because these mountains and their northern outliers form a very necessary and almost impregnable protective zone to Baghdad and consequently the whole kingdom of 'Iraq, which would have been seriously threatened had the vilayet remained in Turkish hands. Economically the value of Mosul is equally great. It contains vast oil resources as yet practically untapped, it forms one of the principal grain growing regions of 'Iraq, while the mountain areas produce wool, hides, gall-nuts and gum. Administratively the vilayet is now divided into the liwas of Arbil, Kirkuk, Mosul and Sulaimaniya. The population, whose exact figure is uncertain, estimates ranging from half to three-quarters of a million, is mainly Sunni Muslims. It includes Kurds, who live in valley villages for nine months in the year and migrate to the mountains of Zakho and Amadia in the summer, nomad Arabs, Christians, who constitute a very special problem (see *History* below), Turks, Yezedis and Jews.

See *Report of the Commission of the League of Nations on the Mosul Boundary* (1924–25) and "The Geography of the Mosul Boundary" (Major Lloyd, *Geographical Journal* LVIII. 1926). (L. H. D. B.)

HISTORY

By the Armistice of Mudros hostilities were suspended between Great Britain and Turkey from midday Oct. 31, 1918, at which time the British had advanced to a position north of Shergat, 60 m. south of Mosul. Nevertheless on Nov. 3 General Cassels informed the Turkish authorities that he had been ordered to advance beyond the armistice line and occupy the town of Mosul. This apparent violation of the armistice terms was subsequently declared to be justified by Article 7 of the armistice which laid down that "in the case of any situation arising which might menace the security of the Allies, the latter shall have the right to occupy all strategic points." The Turks on the other hand maintained that no such menace existed and protested strongly against this action on the part of Great Britain. Later on, further advances were made by the British forces; on Sept. 30, 1924, a pro-

visional frontier known as the Brussels Line was proposed by the League of Nations and accepted by both Great Britain and Turkey, pending a final settlement of the dispute. This Brussels line was at its nearest points no less than 150 m. north of the armistice frontier. It ran from the Hazil to the Khabur river, then across the mountains north of the valley of the Great Zab and then due east to the Persian frontier. Roughly speaking it runs on the crest of the mountains cut through by the three rivers named.

The Mandate of 'Iraq including the vilayet of Mosul was undertaken by Great Britain on behalf of the League of Nations; yet the question of the ultimate possession of the vilayet figured prominently in the discussions at the Lausanne Conference (*q.v.*). Clause 3 of the Treaty of Lausanne provided that the dispute between Britain and Turkey should be brought before the League of Nations unless settled by agreement within nine months; the Turks had agreed to this on Lord Curzon assuring them that "the decision of the council upon which the Turkish Government will be represented, will have to be unanimous, so that no decision can be reached without your consent."

In accordance with the Treaty of Lausanne, direct negotiations began in Constantinople during May–June 1924. Sir Percy Cox, the British representative with a view to securing a complete scientific frontier and a home for the Assyrian refugees demanded further the three Cazas of Julamerg, Beit-ul-Shabab (the ancient Betmanin) and Giavar lying north of the Brussels line; the Turks on the contrary refused to abate their claim to the whole of the former Mosul vilayet. The negotiations proved fruitless. In August the matter came before the League, which appointed a commission to study the question; in September the Turks crossed the provisional frontier and drove some 8,000 Assyrians to take refuge in Amadia, where they were supported by the 'Iraq Government. Thereupon at a special meeting in Brussels in October the League defined a provisional frontier, the Brussels line, which Turkey agreed to accept as a *status quo*. The Commission reached Baghdad in Jan. 1925 and suggested that Mosul should be left to Turkey if Britain intended to withdraw from 'Iraq in 1928, but assigned to 'Iraq if Britain was willing to undertake a mandate for 25 years.

Turkey contended that the League could not give a binding decision; the question was referred to the Hague Court, and was pending when further military movements by the Turks in the neighbourhood of the Brussels line in Sept. 1925 resulted in the violent deportation into the interior of Turkey of Christians living immediately to the north and in some cases even to the south of the provisional frontier; while some 3,000 Chaldeans took refuge in a destitute condition in 'Iraq. The League appointed a second commission to examine the complaints on both sides and report any violations of the frontier.

This report was presented to the League in December and left no doubt as to the harshness with which the refugees had been handled by the Turks. The ruling of the Hague Court—that an arbitral decision was binding—had already been received; but the Turkish delegate refused to accept the decision of the League and withdrew. Turkey however renewed her proposal of a plebiscite of the Mosul population, and further offered (1) a four nation Pact (Britain, Turkey, 'Iraq and Persia) which should guarantee the integrity and independence of 'Iraq; (2) the cession of the valuable Dyala basin containing some of the oil fields of the vilayet and the main sources of 'Iraq's irrigation. In the absence of the Turkish delegate, the League awarded Mosul to 'Iraq under certain conditions which were accepted by the British House of Commons five days later.

The Inclusion of Mosul in 'Iraq was finally agreed by the treaty signed on behalf of Great Britain, 'Iraq and Turkey at Angora on June 5, 1926. By this treaty Turkey accepted the Brussels line with small modifications as the frontier between Turkey and 'Iraq, the exact line to be determined by a mixed commission on the spot. A pact of security for ten years was agreed between Great Britain and Turkey and 'Iraq. Turkey enjoys a share in the royalties on Mosul oil for a period of 25 years. Subsequently an agreement was reached on the compensation to be paid for Turkish public works in the former vilayet. An exchange of notes following the treaty gave Turkey the option of capitalizing her share of the oil royalties at a present value of £500,000. This was an important event both for politics and oil.

The final Turko-'Iraq boundary line was a compromise arrangement between Great Britain and Turkey and as such it deprived the surviving Assyrian Christians of their old mountain homes in the Hakkiari and Jelu region in the north, leaving the people south of the line as refugees, and their homes north of it. It broke into two the heart of historic Kurdistan and separated from each other the two sections of the Kurdish race—the Bohtan and the Bahdinan. It interfered with the time-honoured trade route as carried on by river rafts, cutting off the regions of Jeziré-ibn-Omar and Sairt politically from their natural market at Mosul. Finally it destroyed the chances of an evolution of the Kurdish tribes as a nationality for generations to come. On the other hand it did prevent the renewal of war, at this particular time the most valuable service that could be rendered in this part of the world.

In the summer of 1927, the mixed boundary commission as provided by article 3 of the treaty completed the delimitation of the frontiers by laying down sign-posts and boundary marks. A convention was signed between the three parties concerned in November ratifying the final agreement.

Bibliography.—E. G. Mears, *Modern Turkey* (1924); *Minutes of the Thirty-Fifth Session* in *League of Nations Official Journal* (6th Year, No. 10; Geneva, 1925); *Report of the Wirsen Commission on the Frontiers of Turkey and 'Irak* (League of Nations, 1925); *Report of the Laidoner Commission* (League of Nations, 1925); H. C. Luke, *Mosul and its Minorities* (1925); *La Question de la Frontierè entre la Turquie et l'Irak* (1926); V. F. Minorsky, *The Mosul Question* (1926). The text of the treaty of June 5, 1926 is printed as a White Paper (C.d. 2672 of 1926). *See* also *La Question de Mossoul 1918–25* (Turkish Red Book). (A. S.)

MOSUL, the third most important town of modern 'Iraq, the other two large towns being Baghdad and Basra. Mosul lies on the right bank of the Tigris in 27° N. 43° E., opposite the site of ancient Nineveh, and 230 miles north-west of Baghdad. The population is estimated at between 70,000 and 90,000, mostly Muslims, although the city contains a number of people of various sects, among the most noticeable being the "Christians of St. John the Baptist" a remnant of the Gnostics. The Churches belonging to these sects are some of the most interesting features of the town. The most important Muslim building is the great Mosque, formerly a Christian Church. The streets consist of narrow undrained lanes. The houses are made either of sundried bricks or of local stone set in gypsum cement. The river is here 675 yards broad and is crossed by a bridge of boats. Mosul is the centre of an ancient agricultural district and the town is the chief market for the local products of cereals, fruit, sheep and goats. There are a large number of flour mills. Although the city no longer produces muslin, to which it originally gave the name, a good deal of weaving is still done there. As a natural corollary of the live stock production of the neighbourhood considerable leather work is done, especially shoe making and tanning. The metal workers of Mosul have also acquired a just fame, especially the sect of St. John the Baptist already referred to. In exchange for these products Mosul imports cotton goods, iron and copper, and carpets. The position of Mosul trade is however seriously hampered by geographical conditions and by a lack of modern communications. So long as trade was conducted by ancient and primitive methods the position of Mosul was very favourable. It lies on the Tigris valley road to Aleppo, the best road to the west, avoiding the danger of the Bedouins. It communicates with the Persian gulf by the Tigris river or the river road, via Baghdad; there are communications with Samsun on the Black Sea by mule or waggon to Diarbekr, and from that point on rafts down the Tigris. Mosul also lies on a caravan route to Persia via Erbid and Rowandiz. It must not be supposed that caravan methods of transport are obsolete in this region; within the last year a new route has been opened up into Persia via Rowandiz, the caravans taking up tea and returning with almonds and dried fruits, but this caravan route short circuits Mosul and goes to railhead at Kerkuk. The trade of Mosul looks mainly

southwards towards 'Iraq and the Persian gulf and in this direction it is singularly badly equipped. To the north and west Mosul is neither worse off nor better than most of the other towns and it can pick up railhead at Aleppo. South however it is in a bad position. Down the Tigris to railhead at Shergat is a desert road through an uninhabited country. The trade down the river is limited to downstream traffic, excellent for the export of Mosul's grain, but not permitting a return trade. The foothill road passes by populous centres, and has a railhead at Kerkuk. If the railway is continued through Erbil to Mosul as has been suggested, Mosul will then have an outlet for her trade in the natural direction and is likely to prove one of the most important producing centres in 'Iraq, and to revive its importance for the southern trade and also as a railhead for northern Mesopotamia and Kurdistan.

Bibliography.—*Colonial Office Reports* (annually) H. C. Luke, Mosul and its Minorities 1925.

MOSZKOWSKI, MORITZ (1854–1925), Polish musical composer, was born at Breslau on Aug. 23, 1854, and studied at Dresden and Berlin. In 1897 he settled in Paris. He was a prolific composer both for pianoforte and for orchestra, but is best known by his Spanish dances, written for four hands on the piano, and his waltzes. His opera *Boabdil* was performed at Berlin in 1892. He died in Paris on March 8, 1925.

MOTACILLIDAE: *see* Wagtail; Pipit.

MOTET, a musical art-form of paramount importance in the 16th century. The word is of doubtful etymology, and probably has more than one origin. Thus *motulus* suggests *modulus* or melody, and probably connects with *motetus* or *motellus,* which designates one of the middle parts in early vocal compositions. On the other hand, the Italian word *mottetto* (diminutive of motto) suggests the French *mot* (in the sense of *bon mot*) and is associated with a profane art-form contemporary with the *conductus* and *rondel* of the 13th and 14th centuries.

The only mature art-form denoted by the word motet is that of 16th century pieces of liturgical polyphonic music in one or two (rarely more) continuous movements. The word is, however, used for any single Latin-text composition in continuous form, not set sectionally verse by verse, and not forming a permanent part of the mass. Thus Palestrina's *Stabat mater* is included among his motets; though the text is metrical and rhymed, and the style is that of the homophonic litanies. The title of motet is also loosely used for non-ecclesiastical works, such as the dedicatory motet at the beginning of Palestrina's fifth book.

The most important kind of motet is that which is written for a particular holy day. Such motets are sung between the *Credo* and the *Sanctus* of the mass. They are often founded on the Gregorian tones of their texts, and the mass is founded on the same themes, thus giving the whole service a musical unity which has never since been approached in any Church music even under Bach. When a motet was not founded on Gregorian tones it was still possible for the composer to design a mass on the same themes, and the titles of 16th century masses, when they do not indicate a secular or diplomatic origin, indicate either the motet or the Gregorian tones on which they are founded. The accompanying illustration is one of the most perfect examples existing, and the illustration in the article Mass shows how Victoria uses the themes of this motet in his mass with the same title. In the present illustration, the bar-strokes (unknown in 16th century part-books) are drawn irregularly so as to show the free rhythms. Typical points are the runs and slow triple rhythm at "gaudent"; the note-against-note swinging rhythm at "amicti stolis albis" and the naïve illustration of "sequuntur Agnum." When such a motet is associated with a mass it is a crime to perform the mass without it. Sometimes one composer founded a mass on another composer's motet; thus Soriano's fine *Missa Nos autem gloriari,* is based upon a motet by Palestrina, and Palestrina's Missa *Quem dicunt homines* is on a motet by Willaert. When a motet was in

Original notation a 3rd lower, but this is about the pitch intended. The note is Hypomixolydian (VIII). The first note in the treble is a Long, = 2 breves = 4 semibreves.

T. L. da Victoria. 1st book of Motets.

two movements the second movement always ended with the last clauses of the first, both in text and in music, thereby producing a distinct impression of *da capo* form.

In later times the term motet indicates any piece of Church music of clearly single design, regardless of language or of place in a liturgy. Bach's motets are great German choral works in several movements, with no written accompaniment, though there is internal and external evidence that they were accompanied from score by the organ. The Motet Choir of the Thomas-schule at Leipzig was Bach's second choir, junior to his Cantata Choir. Handel's motets belong to his Italian period and are Latin cantatas with instrumental accompaniment. (D. F. T.)

MOTH, in entomology, any lepidopterous insect in which the antennae or feelers taper to a point or, if clubbed, as in butterflies, the two wings of a side are held together by a bristle or frenulum; the latter device is never found in butterflies. (*See* LEPIDOPTERA.)

MOTHER, the female parent of a child. The word, like father, is common to Indo-Eur. languages (*cf.* Ger. *Mutter,* Lat. *mater,* Fr. *mère*). The Skt. *mata* points to an original derivation from a stem *ma,* to measure, or make. As a title "mother" is applied to the head of a religious community of women. (For "mother-of-pearl" *see* PEARL.) There is a particular application of "mother" to the scum which rises to the surface of a liquor during the process of fermentation, and also to a mass of gummy, stringy consistency formed in vinegar in the process of acetous fermentation, hence known as "mother-of-vinegar" (*see* VINEGAR). This is probably derived from Du. *modder,* mud, mire.

MOTHER-OF-PEARL, a substance which lines the interior of many species of molluscs; it is similar in nature to the pearl itself. Its beautiful iridescence and lustre are due to that well-known optical phenomenon, the interference of light. It is extensively used in decoration for inlays, for the handles of knives and for cheap jewellery. (*See* PEARL; LIGHT.)

MOTHER RIGHT: *see* MATRIARCHY.

MOTHERS' PENSIONS: *see* PENSIONS IN THE UNITED STATES; NATIONAL INSURANCE; WIDOWS' AND ORPHANS' PENSIONS.

MOTHERWELL, WILLIAM (1797–1835), Scottish poet, antiquary and journalist, born at Glasgow on Oct. 13, 1797, was sheriff-clerk depute at Paisley in 1819. He collected materials for a volume of local ballads, *The Harp of Renfrewshire* (1819). In 1827 he published *Minstrelsy Ancient and Modern,* with an excellent historical introduction. He contributed verses to newspapers and magazines, *Jeanie Morrison, My Heid is like to rend, Willie* and *Wearie's Cauld Well* being his best-known poems. He became editor of the *Paisley Advertiser* in 1828, and of the *Glasgow Courier* in 1830.

A small volume of his poems was published in 1832, and a larger volume with a memoir in 1846, reissued, with additions in 1848.

MOTHERWELL AND WISHAW, a police burgh of Lanarkshire, Scotland. Pop. (1931), 64,708. It is situated near the right bank of the Clyde, 13 m. S.E. of Glasgow by the L.M.S. railway. Motherwell takes its name from an old well dedicated to the Virgin, and the burgh owes its rapid increase to the coal and iron mines in the neighbourhood. It has large iron and steel works, and bridges, steam-cranes, iron roofs, etc., are made Motherwell and Wishaw were united into one burgh in 1920.

MOTION: *see* PRACTICE AND PROCEDURE.

MOTION, LAWS OF. Before the time of Galileo (1564–1642) very little attention had been paid to scientific study of the motion of terrestrial bodies. With regard to celestial bodies the case was somewhat different. The regularity of their diurnal revolutions could not escape notice; and before the end of the 2nd century A.D. the Greek astronomers had observed and recorded a great deal about the more complicated motions of the sun and moon and planets. They adopted uniform motion in a circle as a fundamental type of motion, and expressed the motion of each body by a combination of motions of this type. This scheme did not suggest any relation between celestial and terrestrial motions. Copernicus (1473–1543) simplified it by taking the sun as the centre of the solar system. The first astronomical discovery which was a direct contribution to a general theory of motion was made by Kepler (1571–1630) a contemporary of Galileo. A time had come, at the end of the 16th century, when the theory of planetary orbits, from which tables were calculated, had been shown to be seriously faulty. So it was necessary to correct it, either by a rearrangement of the old scheme, or in some other way. Kepler undertook the difficult work of reconstruction, stimulated by a conviction that there was something of an orderly kind to be discovered; and in 1609 and 1619 he published his new laws of planetary motion. (*See* ASTRONOMY.) The establishment of the approximate agreement of these laws with a theory of motion founded on terrestrial experiments was one of the first steps in Newton's subsequent work on the subject.

Galileo.—About 1590 Galileo made his famous experiments on the motion of falling bodies. Taking account of the resistance of the air, he arrived at the conclusion that, in a vacuum, all bodies would fall in exactly the same way, namely, with a certain constant acceleration. This may be called Galileo's acceleration. He also found that bodies allowed to slide down a smooth fixed inclined plane moved with constant acceleration, which diminished as the angle of inclination was reduced; and he inferred that an unimpeded body, moving on a smooth horizontal plane, would move with uniform velocity in a straight line. Dealing then with projectiles, he treated their motion as the result of compounding horizontal motion with constant velocity and vertical motion with his constant acceleration, so that the path of a projectile, in a vacuum, would be a parabola. This composition of motions is illustrated by the path of a stone dropped from the mast of a ship, sailing at uniform speed, so that it alights at the foot of the mast. These results, and Galileo's careful teaching, some of which is recorded in his dialogues, effectively introduced a new view of the whole subject, namely, the idea that the acceleration of a moving body is the feature of its motion which the surrounding conditions determine, and that, if it were freed from all influence due to other matter, it would move with uniform velocity in a straight line. This doctrine, and Galileo's composition of motions, are directly applicable only to a body whose motion can be treated geometrically as that of a point. But any material system can be regarded as built up of particles of this character, conceived to be as small as may be necessary for the purpose of calculations.

The most important contributor to the subject, in the period between Galileo and Newton, was Huygens (1629–95). He investigated the acceleration of a point moving in any curve, and understood the nature of centrifugal force; and when it was discovered, by means of clocks, that the acceleration of falling bodies varies with the latitude, he suggested the earth's rotation as a cause of this. He also took the considerable step of comparing the motions of pendulums consisting of rigid bodies of various shapes, finding their centres of oscillation. He based this calculation on an assumption which amounted to a denial of what is popularly called perpetual motion. It would be classed now as an application of the theory of energy. At the same time various experiments were made on the collision of hard bodies, establishing a comparison of their masses by inertia, which agreed with the comparison by weighing. Inertia is the general term applied to the resistance of bodies to a change of motion.

Galileo-Newton Theory.—We owe to Newton (1642–1727), the consolidation of the views that were current in his time into a general theory of motion, the application of which, throughout the solar system, satisfied the requirements of astronomy, and at the same time placed terrestrial dynamics on a sound footing. This may be called the Galileo-Newton theory. It has been adopted ever since as the foundation of dynamics, except so far as its scope has been restricted by the theory of relativity (*q.v.*). It was expounded by Newton in the *Principia* (1687), the link connecting the acceleration of falling bodies with celestial motions being supplied by the law of gravitation. The Galileo-Newton theory, in combination with the law of gravitation, has been verified within the solar system to a high degree of accuracy, though not flawlessly; and it is inferred to be more generally valid. It assumes a space with Euclidean geometrical properties. This is a proper and useful assumption, so far as it will carry us.

For the purpose of the Galileo-Newton theory of motion, mass is the property of a body which is exhibited by inertia. It is shown, for example, by the difficulty of stopping a rapidly rotating grindstone, compared with a similar body made of wood. Presumably this would be the same on the moon as on the earth. Newton conceived mass to be an inalienable property of every portion of matter, such that the mass of any body is equal to the sum of the masses of its parts, and is expressible arithmetically by its ratio to the mass of a standard body. He regarded this property of terrestrial bodies as having been established consistently. The ratios to one another of the masses of celestial bodies were to be chosen to fit the theory of their motions. Newton called his measure of time an absolute measure, and it may be defined as the measure of time which all practical clocks aim at recording. A clock is an instrument which counts the repetitions of some operation, such as the swing of a pendulum, which is repeated under conditions as nearly as possible identical; and it is assumed that all operations give the same measure of time. (*See* TIME, MEASUREMENT OF.) The rotation of the earth is found to be more accurate than any clock, and is therefore referred to as a standard.

Newton required, for the measurement of motion, the specification of a base relative to which it is to be reckoned. Such a base might be the walls and floor of a room, or of a cabin of a ship, or any other rigid frame with regard to which all points have distinct measurable positions. A bead moving uniformly on a cord, stretched between two legs of a table, has uniform velocity in a straight line relative to the table. But if the table is being moved about a room, the bead has a quite different motion relative to the walls and floor of the room. Newton's procedure practically amounted to choosing a base such that the motions of bodies, relative to it, would conform to his laws. Their observed motions were to be reduced to order in this way. He called motion relative to this base absolute motion. The base is sometimes called a Galilean base. The laws of motion deal only with changes of velocities; therefore if a Galilean base has been found, any other base which moves relative to this with uniform velocity, without rotation, is also a Galilean base. The key to the discovery of such a base is that the mutual forces, which are now to be defined, between any two particles, are to be equal and in opposite directions. The base adopted is a base attached to the centre of mass of the solar system, and without rotation relative to the directions of the fixed stars.

The laws governing motion relative to a Galilean base may be stated as follows: A material system is conceived to consist of particles, represented geometrically by points, to each of which

a mass is assigned. Any given particle, A, of mass m, has a certain acceleration, f, in a certain direction. To account for this acceleration, it must be the resultant of a number of accelerations, α, β, . . . , each along the line from A to some other particle. Multiply each of these accelerations by m, so that we have quantities mf, $m\alpha$, $m\beta$, . . . each of them associated with the direction of the corresponding acceleration, and such that the first of them is the resultant of all the others, according to the law of composition followed by accelerations, that is to say the parallelogram law. The first is called the *resultant* force acting on A, and the others are called *component* forces in the lines joining A to other particles. All other particles, B, C, . . . are to be treated in the same way. And the theory is that this can be done so that the component force applied to A, in the line AB, is equal and opposite to the component force applied to B in this line, and the same for other pairs of particles. Masses being suitably assigned to the bodies in question, all accelerations relative to a Galilean base are to be attributable, in this way, to equal and opposite forces between pairs of particles. This implies that the centre of mass is a point whose acceleration is zero. In general, any actual calculation deals only with a portion of the whole system; so that the forces to be taken into account are the mutual forces between the bodies in question, and so called external forces representing the influence of external bodies.

The Law of Gravitation.—The application of this theory of motion depends on the discovery of a classification of forces, or laws of force. We have experience of mutual actions between terrestrial bodies, such as pressure between bodies in contact, and magnetic attractions and repulsions. To this experience Newton added the law of gravitation, namely that between any two particles there is a force of attraction, proportional to the product of their masses, and inversely proportional to the square of the distance between them. It might be supposed that this law could be tested at once by laboratory experiments, but the force between bodies that can be handled is so small that it is difficult even to detect it; thus Newton depended mainly on astronomical verification. Laboratory measurements have been made since, from 1798 onwards, in particular cases; the principal result being that the mass of the earth in pounds is known. Newton made an estimate of this which proved to be nearly correct, but it was not essential for his work.

In the *Principia* we have Galileo's acceleration attributed to gravitation, and shown to be consistent with the moon's orbit about the earth; there are also calculations, according to the law of gravitation, extending to the whole solar system, treated as isolated, including the theory of precession of the equinoxes due to motion of the earth's axis. The orbits of comets, and the theory of tides, and a variety of other problems, are also considered. The verifications of the Newtonian theory, thus obtained, were overwhelming. Kepler's laws, with a slight modification introduced by Newton in the third law, were shown to agree with the orbit each planet would perform if it and the sun alone existed; and the perturbations of these orbits, so far as they had been detected, to be such as might be attributed to the coexistence of all the planets. With regard to the perturbations of an orbit of one body about another, due to a third body, the best data at Newton's disposal were the irregularities of the orbit of the moon about the earth. Attributing these to the disturbing influence of the sun, Newton showed how they could be accounted for—a remarkable mathematical feat for a first attempt at a thing of this kind.

Relativity.—Further verifications of the Newtonian scheme for the solar system were carried on during the next two centuries. They were not absolutely perfect; but no definite establishment of a flaw in the theory occurred till 1915, when a small error in the motion of the planet Mercury, as calculated from known data by Newton's methods, was shown by Einstein to be accounted for by his theory of relativity. Seventy years earlier, when Uranus seemed to go astray, the errors were accounted for by perturbations due to the planet Neptune, previously unknown. For Mercury a similar explanation had been diligently sought, but had not been found. The theory of relativity is held to have established that, for a planet so near the sun, and possessing, as Mercury does, an orbit whose eccentricity is not very small, Kepler's elliptic orbit is at fault to a perceptible extent, and will be replaced by a slightly different fundamental orbit. The solar eclipses of 1917 and 1922 confirmed this by showing apparent displacements of stars seen near the sun which were predicted by the theory of relativity; a new property of bodies, associated with mass, being thus verified. The result is that the Newtonian theories have become an approximately correct fragment of a wider and more fundamental theory, and their scope and degree of accuracy have been to some extent ascertained.

Every scientific theory is provisional, and is subject to corrections and limitations; and the discovery of these is an important step in the direction of progress. E. Mach's *Science of Mechanics* may be consulted with reference to difficulties that have been felt in the past with regard to a presumed universal validity of the Newtonian apparatus. Such difficulties are now happily at an end, and the measures of mass by inertia and by gravitation are rationally harmonized. (*See* RELATIVITY.)

Terrestrial Dynamics.—Let us return now to terrestrial dynamics, dealing with the motion of material bodies relative to the earth. Here the Newtonian theories are found to be sound; but all exact calculations are rather complicated, chiefly on account of the earth not being a Galilean base. Practically it is necessary to discover, for each class of problem, what sort of approximation gives a sufficiently correct result. The simplest approximate device, in many cases sufficient, though no feature of it is accurate, is the obvious one of treating the earth as if it were a Galilean base, and applying to each particle its weight by way of external force, treated as constant. Here weight is not technically a force, but is employed to represent the joint effect of gravitation and the earth's motion. It is Galileo's acceleration multiplied by the mass of the particle. A closer approximation to exact conditions gives a falling body a divergence from the plumb-line vertical, which would amount to about half an inch in a fall of 230ft. at the equator. This sort of effect is shown clearly by the trade winds. The theory of such an apparatus as Foucault's pendulum, or the gyro-compass (*see* GYROSCOPE), requires more exact account to be taken of the earth's motion. And in the theory of ocean tides, the main factor is the diurnal variation of gravitational force, due to changes in the positions of the sun and moon relative to the earth as it rotates. Here we have a thing which should affect the regularity of a pendulum clock; but, when the magnitude of the effect on a clock is calculated, it is found to be too small to be observed. (*See* MECHANICS and TIDES.)

The 19th century saw the important development of the theory of energy, which linked the dynamics of material bodies with other branches of physics and with chemistry, and thus stimulated wider applications of dynamical theory. But the quantum theory (*q.v.*) has now demonstrated limitations of this procedure in the case of atomic systems. Thus we see that, during the first quarter of the 20th century, a definite thing has been accomplished with regard to the Newtonian theories, in that the range over which they are practically valid, which had remained uncertain for more than two centuries, has been to a considerable extent marked out.

BIBLIOGRAPHY.—G. Galilei, *The System of the World* (trans. T. Salusbury, 1661) and *Mechanics and Local Motion* (trans. T. Salusbury, 1665); Sir Isaac Newton, *Principia* (translation A. Motte, 1848; 1st ed. 1729); W. Rouse Ball, *An Essay on Newton's "Principia"* (1893); A. Berry, *A Short History of Astronomy* (1898); E. Mach, *The Science of Mechanics* (trans. T. J. McCormack, 4th ed., 1919); H. Crabtree, *Spinning Tops and Gyroscopic Motion* (2nd ed., 1914); *see* also text-books on Dynamics. (W. H. MA.)

MOTION PICTURES. The motion picture is the latest machine tool in the service of expression. The endeavours to transmit emotional stimuli and experience by re-creating events have resulted in language, oral and written, the plastic and graphic arts, the stage, music and lastly the screen. Hitherto, motion had been consciously contrived for and successfully *suggested* in the fine arts, *e.g.*, in the cavalcade in the frieze of the Parthenon. The

1

2

3

4

THREE IMPORTANT EARLY FILMS

1 and 2. Scenes from D. W. Griffith's production of the Civil War film, "The Birth of a Nation" (1914). In this historically important classic of American motion pictures, the technique of the drama was blended with the capacities of the camera, thus laying the foundation of modern screen technique

3. Sarah Bernhardt in "Queen Elizabeth," the first feature-length production, released by Adolph Zukor (1912). This four-reel drama, Europe's most pretentious effort at the time, instituted the "feature-picture" era

4. A scene from Mary Pickford's production of "Little Lord Fauntleroy," an early example of double exposure. Miss Pickford played both the part of the boy Cedric, on the right, and that of "Dearest," his mother, the younger woman in the group on the left

BY COURTESY OF (2, 4) THE PARAMOUNT FAMOUS LASKY CORPORATION; PHOTOGRAPHS, (1) OFFICIAL PHOTOGRAPH, U.S. ARMY AIR CORPS, (3, 5, 6) GENERAL PHOTOGRAPHIC AGENCY

WORKROOMS AND SETS IN A MOTION PICTURE STUDIO

1. Aerial view of a motion picture studio lot
2. Shoe racks in a woman's wardrobe department
3. Wild animal photography in the studio. A fight between a mongoose and a snake, which when filmed will appear to have taken place in a natural desert setting
4. The workroom in the women's wardrobe department
5. Studio setting for "The Trial of Donald Westhof," showing a busy street scene. The upper parts of the buildings are not built into the set but are photographed from models constructed in miniature
6. Studio setting for a Siberian salt mine

motion picture camera brings action into graphic art.

The motion picture first emerged from the laboratories of abstract science in 1894 as the Edison peep-show device known as the kinetoscope. By 1925 the motion picture seemed ready to begin clarification and refinements of its technique. Hardly had this apparent position been reached when the electrical and radio laboratories brought forth an array of improved photo-electric cells and methods of electrical amplifications which by 1928 resulted in the spectacular and revolutionary intrusion of the sound or "talking" picture.

Contrary to popular belief, this development of the talking picture in 1927–28 was the first true junction of the motion picture with electrical science. The silent motion picture, being mechanical, optical and chemical, was in no way an electrical invention, nor, in any strict sense, dependent upon the service of electricity. The talking or sound picture is, however, electrical in that it is a device for the conversion of sound vibrations into electrical light variations photographically recorded, to be in turn electrically reconverted into sound.

History.—For the development of photography see that article. The scientific study of the optical appearances of objects in motion had begun with the investigations of Peter Mark Roget in England, resulting in a paper presented by him, under the title of "The Persistence of Vision with Regard to Moving Objects," before the Royal Society in 1824. Roget's paper inspired several scientists to engage in various experimental investigations, among them Sir John Herschel, and Michael Faraday. In Europe, Dr. Joseph Antoine Plateau of the University of Ghent and Dr. Simon Ritter von Stampfer, in Vienna, simultaneously discovered a method for viewing a series of pictures, representing phases of motion. The pictures were mounted in chronological sequence on the rim of a disc and were observed through slots in a similar disc mounted on the same rotating shaft. The pictures, antedating photography, were necessarily drawings of assumed phases of motion. Baron Franz von Uchatius, an Austrian artillery officer, in 1853 combined the disc device with the magic lantern and projected the pictures upon the screen. The capacity of the machine was obviously limited to a short cycle of movement. The Plateau-Stampfer labours gave rise subsequently to the invention of the zoetrope, or "wheel of life," which continues to be a familiar toy.

Photography.—As early as Leonardo da Vinci's experiments, photography (*q.v.*) had been in slow evolution. In 1860, Coleman Sellers, a mechanical engineer, in Philadelphia, made the first known endeavour to relate photography to the principle of the zoetrope. He posed his sons in a series of photographs showing them, in successive phases of a cycle of action, driving a nail into a box. The photographs were mounted on the blades of a paddle wheel, which when revolved from a given point of view produced a zoetropic effect. This machine was patented as the kinematoscope in the United States (Feb. 5, 1861). Photography then required exposures so long that a true record of motion was not possible.

A complete anticipation of the motion picture was embodied in a patent application by Louis Arthur Ducos du Hauron, in France, filed April 25, 1864. The Sellers method of photographing posed phases of motion was applied to a projecting zoetropic device by Henry Renno Heyl, an engineer and inventor, in Philadelphia, exhibited on Feb. 5, 1870. This was in effect the application of photography to the invention of Baron Uchatius. The Heyl device was christened the phasmatrope. It carried photographs of six poses of a waltzing couple, repeated three times, giving a capacity of 18 pictures. It is of interest to note that the wheel on which the pictures, glass plate transparencies, were mounted was actuated by a ratchet and pawl mechanism giving each image a period of rest on the screen, a method and principle which had to be rediscovered a quarter of a century later.

Two years later, in 1872, and without any intended relation to motion picture development, Leland Stanford, a California railway magnate and sportsman, wished to investigate the gaits of the horse. Stanford assigned the photographic problem to John D. Isaacs, an engineer on the staff of the Central Pacific railway. Isaacs contrived a battery of cameras with electrical shutter controls. The shutter mechanisms were improved and the speed of photographic materials was increased, permitting at last the first real photographic records of objects in rapid motion. Exposures as brief as $\frac{1}{2,000}$ of a second were made. Eadweard Muybridge operated the Isaacs apparatus installed at Palo Alto on Stanford's stock farm. The pictures made were records in analysis of motion. Synthesis was still to come. (A description of these experiments was published in Dr. Wellman's *The Horse in Motion as shown by Instantaneous Photography*, London, 1882.)

While visiting in Paris, Stanford displayed some of these pictures and word of them reached Jean Louis Meissonier, the painter, who was then in a heated controversy with French academicians over the postures of horses in his pictures. Meissonier sought Stanford and found vindication in the photographs from California. The artist prevailed on Stanford to send Muybridge to France. The differing academicians were confronted with the photographs, and as a final proof Meissonier synthesized the photographic analysis into motion pictures by projecting transparencies on a machine similar to the Heyl phasmatrope.

The method evolved by Isaacs and operated by Muybridge resulted in a changing point of view for the pictures as the action swept past the battery of cameras. The pictures obtained, synthesized on the screen gave the illusion of the moving object in a single spot while the scenery ran past. Wallace Goold Levison of Brooklyn, N.Y., devised a camera which exposed successive plates in a single camera, obviating this difficulty. It was utilized only for scientific demonstration.

Edison's Inventions.—In 1887, Thomas A. Edison of New Jersey, attacked the problem. He was aware of Muybridge's product. But Edison's efforts were dominated entirely by the phonograph idea. His first motion picture machine recorded spirals of tiny pictures on a cylinder, in the pattern of a phonograph groove. The pictures were given an intermittent motion and viewed under a microscope. The results were inadequate and Edison determined upon larger images to be handled on a tape or belt. He built a device for this purpose and experimented with various materials, including films made of collodion varnish coated with photographic emulsion. The material was unsatisfactory. In Aug. 1889, George Eastman of Rochester, N.Y., began the manufacture of photographic film on a nitro-cellulose base, a material evolved to meet the mechanical problems of "roller photography" for the Eastman Kodak. Edison heard of this material and purchased a sample strip 50 ft. in length for $2.50 and tried it with success in his picture machine. The demonstration of the Edison kinetoscope at West Orange, N.J., on Oct. 6, 1889, with a strip of Eastman film made the motion picture an accomplished fact.

The Kinetoscope.—The kinetoscope was a peep-show device in which the film ran with a continuous movement between a magnifying lens and a light source. The capacity of the machine was limited to 50 ft., the length of the tables on which the film was manufactured, which gave a motion record of 48 exposures a second, and lasted about 13 seconds. The size of the film, the image and the arrangement of the sprocket holes by which the film was driven in that first machine, continue as the standard of the motion picture of to-day. The machine was patented by Edison in 1891 in the United States only. It stood idle in his laboratory until it came to the attention of Thomas R. Lombard, of Cornelia, Ga., a promoter of the phonograph, who sought it as a novelty for display at the Columbian Exhibition in Chicago. The machines, despite statements to the contrary, were not ready in time and made their first public appearance at a kinetoscope parlour at 1155 Broadway in New York city, April 14, 1894. Thus began the commercial history of the motion picture.

That autumn several machines were exported. From these machines the English and European development of the motion picture sprang. Edison's invention was not protected by patents abroad. The pictures for the kinetoscope were produced at West Orange in a tiny studio costing $637.67. The invention of the motion picture had now cost Edison $24,118.04. The tar paper studio, dubbed "The Black Maria," revolved to keep the stage in sunlight. The kinetograph, or camera, was almost a ton in weight

and all events had to be brought to it. The subjects were necessarily those restricted in range of action: bits of vaudeville acts, snatches of prize fights and dances.

By the winter of 1894 a demand arose for a machine which should combine the kinetoscope's film record with the magic lantern so that the picture might be liberated from the peep-show and shown to a large audience for greater revenue. Edison had experimented in projection but discouraged the idea, expressing the belief that exhibitions to large audiences would too rapidly exhaust the novelty of the pictures. Several other experimenters attacked the problem of projection. On Feb. 22, 1895, Maj. Woodville Latham, of Virginia, a Confederate ordnance officer in the American Civil War (father of Otway and Grey Latham, kinetoscope exhibitors), gave a New York press exhibition of his pantoptikon, projecting a kinetoscopic film. On May 20 this machine was placed on public exhibition. It was highly imperfect. A second version of this device had a brief international career under the name of the eidoloscope. A more satisfactory machine known as the cinematographe was produced by Louis and Auguste Lumière, photographic manufacturers at Lyons, France. They took out a French patent on Feb. 13, 1895, and demonstrated their machine March 22, 1895, in Lyons.

The Vitascope.—In June 1895 Thomas Armat of Washington discovered the principle of the modern projector, a film movement which gave each successive image a period of rest and illumination in excess of the period of movement from image to image. This machine was first shown publicly at the Cotton States exhibition at Atlanta, Ga., in Sept. 1895. It displayed Edison kinetoscope pictures. It was subsequently known as the vitascope. In Feb. 1896 Robert W. Paul of London, manufacturer of scientific instruments, gave a demonstration of a projection machine called the theatrograph. He had meanwhile manufactured duplicates of the kinetoscope, and had produced films for these machines with a camera of his own devising.

The commercial career of the motion picture on the screen began with the presentation of the Armat machine as the vitascope at Koster and Bial's music hall at Herald square in New York on the night of April 23, 1896. A vaudeville career opened before the motion picture and the capacity of the machine was quickly increased to 1,000 ft. of film (sufficient to occupy the typical time of a stage turn), thus establishing the existing standard film unit of one reel.

The Lumière influence on the art soon became important. The cinematographe was adjustable, making it a camera, a film-printing machine and a projector. It was mobile and could record the outdoor world. The Lumières also reduced the rate of exposure from Edison's 48 images a second to 16 a second, the theoretical standard of the silent pictures of to-day. The Lumière photographer-exhibitors were sent touring around the world carrying the films to far places and recording remote peoples for the screens of Europe and America.

The development of the art was, however, for some time under two important early handicaps. In Europe the screen suffered from the Charity Bazaar fire in Paris, May 4, 1897, in which 180 people perished. The fire was traced to the motion picture machine. That autumn Edison launched a legal campaign for the protection of his invention from infringers and competitive machines and a violent and involved patent war hampered the industry for more than a decade. In that same year, 1897, R. G. Hollaman of the Eden Musée on the roof of a New York office building, produced the Passion Play in three reels, with a cast and dramatically arranged settings, thus instituting production for the camera. Meanwhile in March of that year, Enoch J. Rector, earlier associated with the Lathams, had pictured the Corbett-Fitzsimmons fight at Carson City, Nev., in some 11,000 ft. of film.

The motion picture still continued as an incident of vaudeville. About 1909 George Melies of the Théâtre Robert Houdin in Paris, a magician, applied the camera to feats of magic and gave the motion picture new life, incidentally adding fade-outs, dissolves and double exposures, now commonplaces of the technology. In 1903, Edwin S. Porter, an Edison cameraman, alarmed at the decline of the industry, sought to give it new impetus by novelty. He compressed all the known thrills of the screen into a single picture, *The Life of an American Fireman.* This succeeded so well that he tried again with a cheap novel story entitled *The Great Train Robbery.* This picture, occupying a whole reel in length, established the "story picture" and founded the art of narration for the motion pictures, and placed them on an independent basis. With this production for its programme the first motion picture theatre, a "nickelodeon," was opened in Pittsburgh, Pa., in Nov. 1905, and started the screen on a new career.

(T. RA.)

MOTION PICTURE PRODUCTION

Early Pictures.—The first story pictures were simple. Like the earlier topical novelties, they were merely records of events. In 1907 David Wark Griffith, a young American director, evolved a screen technique of far-reaching significance. He brought into first practical use certain methods of pictorial emphasis, such as the "close-up," "cut-back," "fade-out" and "dissolve." The story pictures of this period were in one reel. *Ben Hur* was made in 1907 in 16 scenes. Multireel pictures began to appear in 1909 but the sentiment of exhibitors was strongly against them and they were released one reel at a time. A year later screen history was made by releasing multireel pictures in their full length.

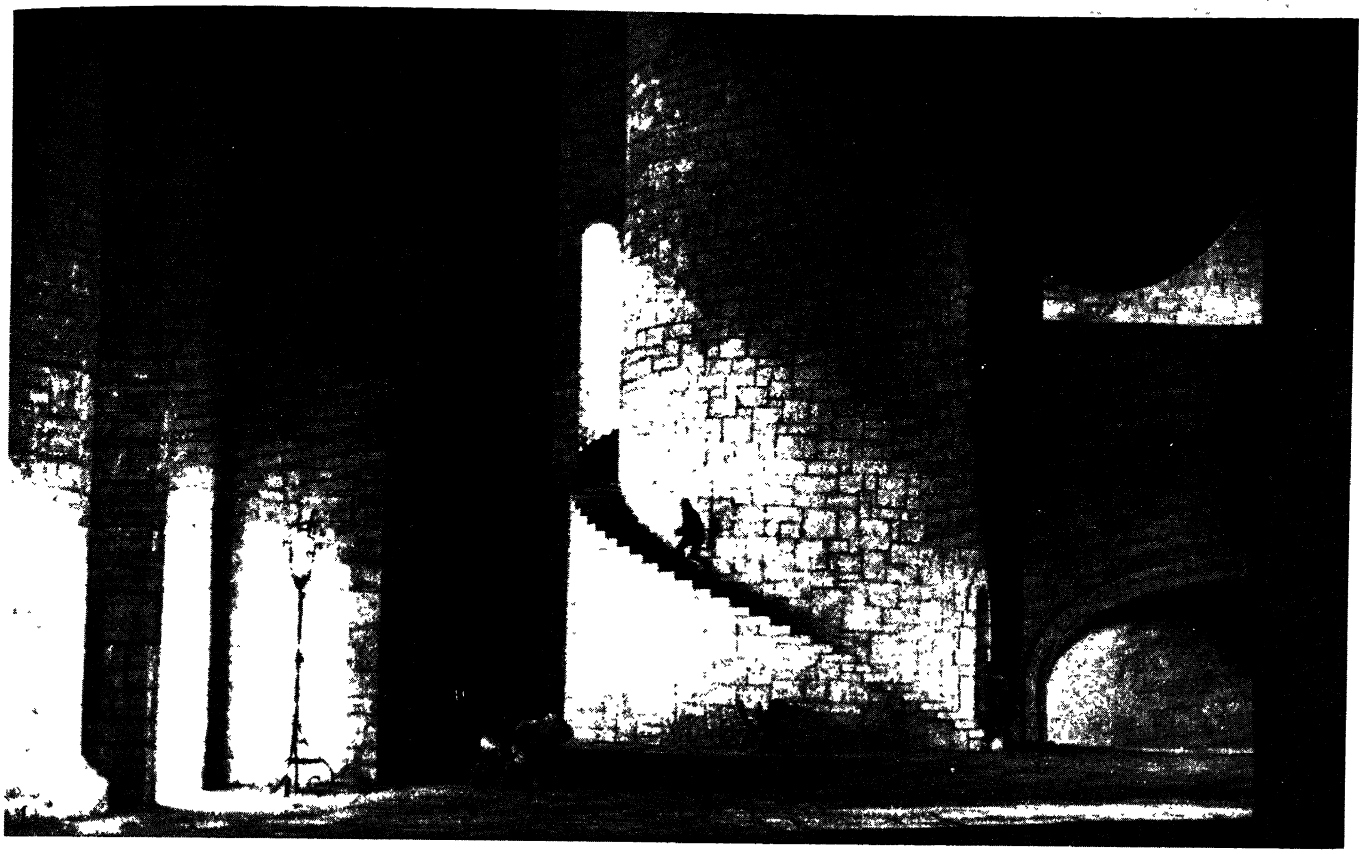
Progress.—Many of these early productions, aiming at sensational entertainment, overstepped the bounds of good taste. The advent of Griffith and a few others had a refining influence; the themes and characters were humanized and a technique was evolved which disclosed the dramatic possibilities of the screen to an extent hitherto undreamed. The one-reel pictures passed into virtual obscurity as pretentious productions using three, four, five and six thousand feet of film were made.

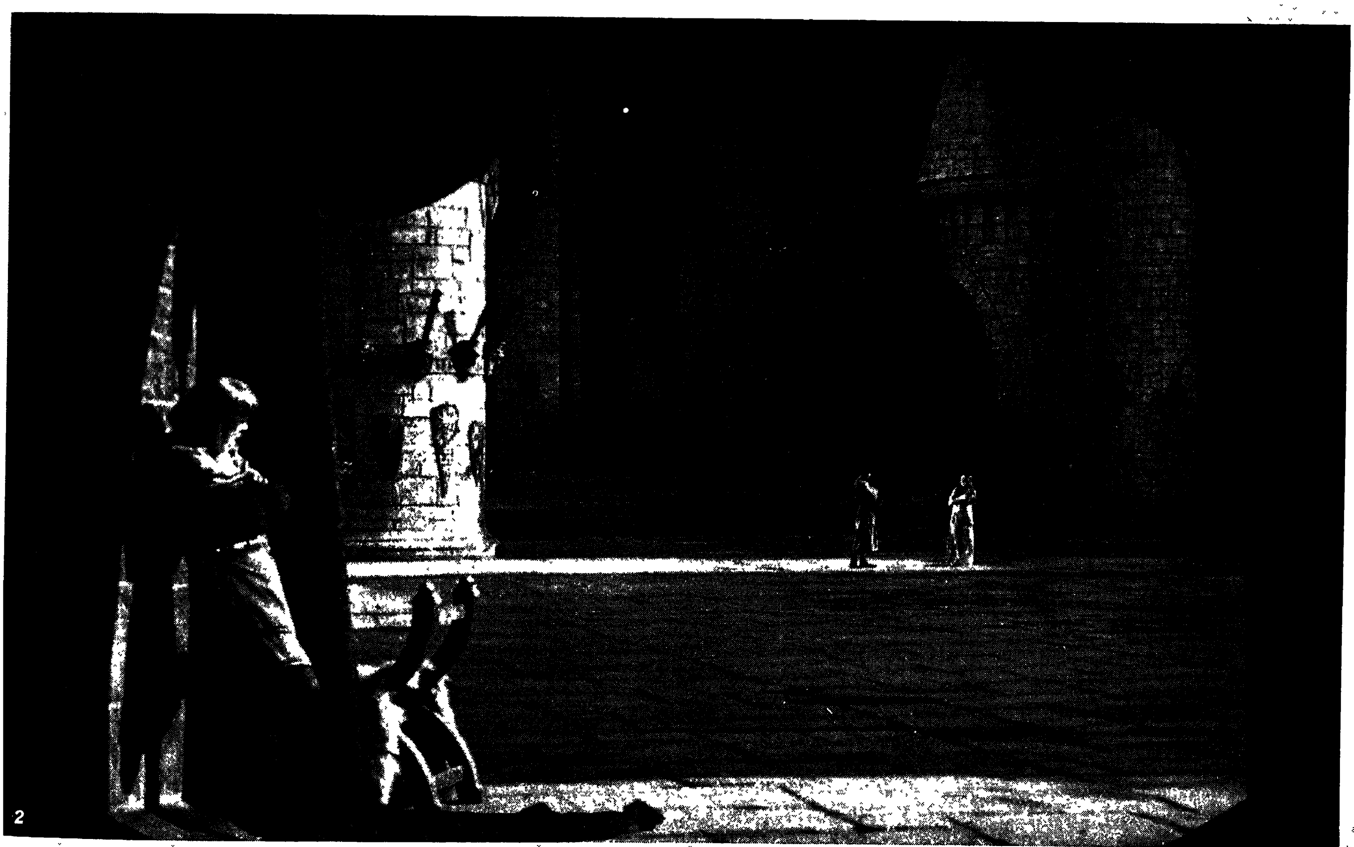
For many years the players appeared under a mask of anonymity, but as certain of them were seen with recurring frequency, the public began to anticipate them in future pictures. Favourites were created which resulted in "stars." While the majority of the stage artists regarded pictures disdainfully, a few were prevailed upon to pose before the camera. It was the idea of Adolph Zukor, a pioneer producer, to bring famous names to the screen in famous plays. The success attendant upon his exhibition of Sarah Bernhardt in *Queen Elizabeth* in 1912 indicated the merit of his idea. Zukor's influence was felt throughout the entire industry. Producers who had heretofore concentrated on one-reel pictures now engaged in multireel enterprises. From 1912 to 1915 was a period of transition in which Zukor led the way to what is now known as feature pictures. *Quo Vadis* in 8 reels in 1913 met with unusual success and gave greater impetus to the Zukor idea. This picture also brought into being the road-show style of presentation whereby a legitimate theatre was leased for the exhibition of pictures, instead of the "nickelodeons" which then prevailed.

Griffith brought to the screen in 1913 a new conception of screen entertainment with *Judith of Bethulia.* The same year Jesse L. Lasky, in conjunction with Cecil B. DeMille, established a studio in California and produced *The Squaw Man.* The most stupendous undertaking in the films during this period occurred the following year when Griffith produced *The Birth of a Nation,* in 12 reels. The wave of public excitement which followed in the United States showed in a greater measure than ever before the far-reaching influence of motion pictures. It was at this stage of cinema history that Mack Sennett, who made comedies in California, upset screen traditions by producing a multireel comedy, *Tillie's Punctured Romance.* The serial idea had its inception at this time and met with great success in addition to creating several new "stars." *Intolerance,* produced by Griffith in 1916, was yet another milestone in the early history of the films, although it did not achieve the signal success of *The Birth of a Nation.*

MODERN TENDENCIES

Internationalization of Cinema.—The ability of pictorial art to cast aside the barriers imposed by languages made it apparent at an early date that motion pictures had an international appeal. While the art was still in its inventive stages, films were exchanged between the United States and Europe. At one period





2

SETTING FOR ROBIN HOOD

Two settings designed by Wilfred Buckland for Douglas Fairbanks' production of "Robin Hood." The large simple architectural forms on which the light is projected make an interestingly designed background, and in fig. 1 (similar to Plate V. fig. 2) especially, make the figure appear diminutive by comparison. In fig. 2, the framing, by the arch, produces depth, and a sense of witnessing the action with the figure in the foreground

SKETCHES FOR MOTION PICTURE SETS

1. Sketch of mediaeval Paris by William Cameron Menzies, for "The Beloved Rogue," a film based on the life of François Villon. The aerial perspective is interesting and produces a fine pattern of design
2. Sketch for a motion picture set by William Cameron Menzies; a fine massing of forms to concentrate the interest

the productions made by Paul in England dominated the American market, while the films of the Lumières met a popular reception in the United States. Subsequently, American productions discovered world markets, penetrating even the remote areas of civilization. After story pictures came into vogue difficulties oftentimes were encountered. Types of stories which appealed to the domestic population had the opposite effect on foreign audiences. Producers sometimes met difficulties of this sort in their own countries. The outstanding example, perhaps, is Griffith's *The Birth of a Nation* which, because of its theme, created racial enmities and even bloodshed.

Early in the 20th century great studios sprang up in America, England, France, Germany and Italy, but with the coming of the World War in 1914, the production in England and on the continent was virtually suspended. During the immediate succeeding years, American producers dominated the world market and established themselves so strongly that the freshened production activities in Europe following the World War were unable to dislodge them.

The success of the American producers in foreign fields made evident to them the importance of fostering international goodwill. The stories on which their pictures were based began to show an international flavour. A notable exception to this rule was the case of western cowboy pictures, inherently American, which met with a pronounced success in all parts of the world. The average pictures were designed to appeal to all races, classes and creeds, giving offence to none. Classics of literature were combed for screen material. Historical photoplays not only brought heroic eras to the screen but also exercised a distinct educational effect. Most modern photoplays, however, depict modern life in its multitudinous phases and it is the form of screen entertainment that will in all probability continue dominant in the future. Of recent years there has been a tendency to minimize vice, sordidness, drabness, melancholy and other unwholesome elements in screen plays. Humour in pictures of serious import has become increasingly evident, with a fair proportion of six, seven and eight reel comedies.

The rehabilitation of the European studios closed by the World War brought forth many interesting photoplays, but because of the domination of world markets by the Americans, these pictures did not have as wide a distribution as they might otherwise have enjoyed.

Sound-pictures.—Even before the invention of motion pictures it was the aim of many inventors to combine animated pictures with sound. (*See* Motion Picture Technology, p. 867.)

The years 1928 and 1929 found the major American film studios producing "talking" pictures. The advent of sound on the screen had a revolutionary effect on many phases of production. Electrical and acoustical engineers became important factors at the studios, many sound-proof stages were erected and motion picture players developed voices for what hitherto had been solely a pantomimic art. Installations of sound reproducing apparatus in the principal theatres of the United States were completed in 1929, but inasmuch as the great majority of theatres in small cities and towns were not equipped for the projection of "talking" and sound pictures, it was necessary in many instances to make two versions of each production: one silent and one synchronized with voice and sound. American pictures designed for release in foreign countries (excepting the English-speaking nations) were required to be either silent or synchronized with sounds and music only, due to the commercial impracticability of making dialogue recordings in languages other than English at the American studios.

An outstanding development of the sound pictures is in topical subjects. This is of incalculable value, inasmuch as it permits recording for both present and future generations the images and voices of famous personages.

Colour-pictures.—Coloured motion pictures have long been the goal of experimenters. (*See* Motion Picture Technology, p. 867.)

Ambitious undertakings along this line have been made during the last few years. Cecil B. De Mille's American super-spectacle, *The Ten Commandments,* made use of colour, while the Douglas Fairbanks feature, *The Black Pirate,* was filmed in natural colour in its entirety. A still more recent use of colour was in the Paramount production of American Indian life, *Redskin,* which utilized the technicolor process.

The perfection of equipment that will produce natural colour films with the same facility that governs present day black and white films will in all probability bring about a decided trend in favour of colour pictures.

Projection.—From the early period of motion picture history, when exhibition of films was effected by an operator who carried his projection machine and equipment from town to town, this branch of the art has made strides comparable with those taken by production. Modern projection is accomplished in mammoth theatres seating as many as 5,000 persons. Symphonic orchestras provide music suiting the various moods of the picture, while special stage effects are designed to enhance the presentation on the screen. The early projection machines, which threw a small, unsteady, flickering image on the screen, have been improved to the point where the projected image simulates real life. Auditoriums are designed so that spectators may enjoy an undistorted picture without eyestrain. Hazards from fire due to the inflammable character of the film have been almost completely eliminated by steel or concrete enclosed projection rooms. Multireel pictures made it necessary for the use of two projection machines in order to eliminate a waiting period between reels.

During the last few years greater attention has been given to the creation of special visible and audible effects to accompany the picture. A device known as the Magnascope permits the image on the screen to be increased to several times its normal size, thereby accentuating certain episodes of the picture. This device, which involves the use of special magnifying lenses on the projection apparatus and a screen of threefold proportions, had its first demonstration in the epical American photoplay *Old Ironsides.*

Motion pictures synchronized with dialogue, music and natural sounds have in many instances enriched the literature of the screen. It is now possible to depict certain types of stories to better advantage than permitted by silent films, for the human voice sometimes adds a quality of expression which is impossible to achieve solely with pantomime and subtitles. Many screen stories, however, are most effective when depicted in silence, and in some cases synchronized music and sound effects combine to make the pictorial matter more entertaining than would be the case if spoken dialogue were used. Pictures of the calibre of *Wings* and *Redskin* have a greater appeal as silent films synchronized with sound and music than if they had contained talking sequences. In other words, some screen stories are adapted to the human voice and some are not, and it is necessary to make judicious use of each of these elements if the best results are to be obtained.

Topical Films.—The topical picture now has its greatest manifestation in the news reel, which has grown to be an industry of monumental proportions. The greatest events of the day are shown in all the theatres of the world a few days after they occur.

The incalculable value of the cinema as an educational force is being appreciated more and more. (*See* Educational Films, p. 866.)

A new type of photoplay of recent years indicates still another field for the cinema to penetrate. This is the "nature picture," in which the story is of minor consequence, the players untrained and the sets those provided by nature. *Nanook of the North,* made several years ago and depicting the life of the Eskimos, is a classic example. This picture was made in the Arctic with Eskimos for players and with no story other than that of the lives of the players themselves. *Grass,* the story of nomadic Persian tribes; *Aloma of the South Seas,* which told of the life of island dwellers in the Pacific; *Chang,* depicting the existence of natives in the jungle and *Stark Love,* a story of mountain folk in the southeastern part of the United States, fall into this category.

Camera Magic.—One of the earliest discoveries in connection with the cinema was that physically impossible things could be shown on the screen. Camera trickery, by means of which countless feats of magic could be shown, became part of the cinema's stock-in-trade. The experiments of Muybridge in California were of a scientific nature, but it was not for many years that science

began to make use of this new device. The early topical novelties presented flowers blooming in the space of a few seconds, buildings disappearing piece by piece and inanimate objects moving without human assistance. "Slow-motion" effects gained by the use of super-speed cameras not only resulted in many novelties but also proved of vast scientific value. In the field of medicine, microscopic motion pictures have opened a new field of research. Microscopic slow-motion pictures of surgical operations are being made so that students in remote sections of the country may observe the methods of great surgeons. The X-ray, in connection with the cinema, has been of invaluable assistance in observing the functioning of the human heart. In the field of natural history it has been possible to effect remote control of cameras, and thereby make pictures of wild animal life which could not have been obtained with an operator present. Special diving bells have been constructed which permit the mysteries of submarine life to be shown to the world. Of recent years, through ingenious optical devices and miniature scenes, it has been possible in many instances to eliminate massive settings and backgrounds.

STATISTICS

The tremendous size of the motion picture industry is shown by the following statistics:

It is estimated that in 1925 there were approximately 50,000 places throughout the world where motion pictures were exhibited. These include theatres, auditoriums, halls, etc. Of this number approximately 20,000 are in the United States, compared with 9,000 in 1910. There are 3,500 picture theatres in Great Britain, 2,500 in Latin America, 2,200 in Italy, 4,000 in Germany, 3,000 in France, and the remainder distributed in other parts of the world. In the United States 300,000 persons are identified with the motion picture industry. Approximately 700 feature pictures are made annually in America. It is estimated that 115,000,000 individuals attend the cinema each week in the United States and the admissions paid to see pictures there totals $1,560,000,000 annually. There is a permanent investment in motion picture enterprises in the United States of $1,500,000,000. The United States exports 65,000,000 feet of unexposed negative and positive film each month. The Eastman Company alone produces 900,000,000 feet of raw film annually. In 1925 there were 132 producing organizations in the United States, and these companies invested $93,636,348 in new productions. Salaries of "stars" and featured players are higher than those obtained in almost any other field of endeavour. Purchases of story material cost millions of dollars annually. Productions costing $1,000,000, $1,500,000 and $2,000,000 each are not unusual. The average feature picture costs from $200,000 to $300,000. An average of more than 11,000 persons were engaged in the production of pictures each month.

Exports of American film jumped from 32,000,000 feet in 1913 to 178,000,000 feet in 1924, with a further increase to 235,000,000 feet in 1925. The European market absorbed 17,000,000 feet of this total in 1913, 60,000,000 feet in 1924 and 86,000,000 feet in 1925. Latin America imported 1,500,000 feet in 1913 and 63,000,000 feet in 1925. Far East countries in 1913 imported 4,500,000 feet and 54,000,000 feet in 1925.

American pictures are shown in 70 countries and their subtitles are translated into 37 languages. In 1925 Germany ranked second in world film production with an output of approximately 150 features. Approximately 80% of all feature plays shown in England are made in the United States. France is the second nation in Europe in the importation of American films, absorbing 19,000,000 feet in 1925. Germany has increased its importation of American film from 25,000 feet in 1913 to 6,500,000 feet in 1925. Sixty per cent of all pictures shown in German theatres are American.

MODERN PRODUCTION METHODS

The growth of the cinema in 30 years has brought it to a point where, in order to meet the enormous demands for its product, it has been necessary systematically to organize all phases of production. While the motion picture is essentially an art, the very nature of the ingredients entering into its composition brings it into the class of a vast industry. Whereas, in sculpture, music, painting and other forms of art, the creation is usually the product of one person, the cinema is the product of hundreds and in some cases thousands of individuals. In order that there may be co-ordination of effort it has been necessary to organize production under the direct control and supervision of one mind. The scope of motion pictures has widened to such a degree that the art is divided into many divisions and in all probability always will be.

So great are the sums involved in production that studios are organized on a basis similar to that of large commercial enterprises.

(J. L. La.)

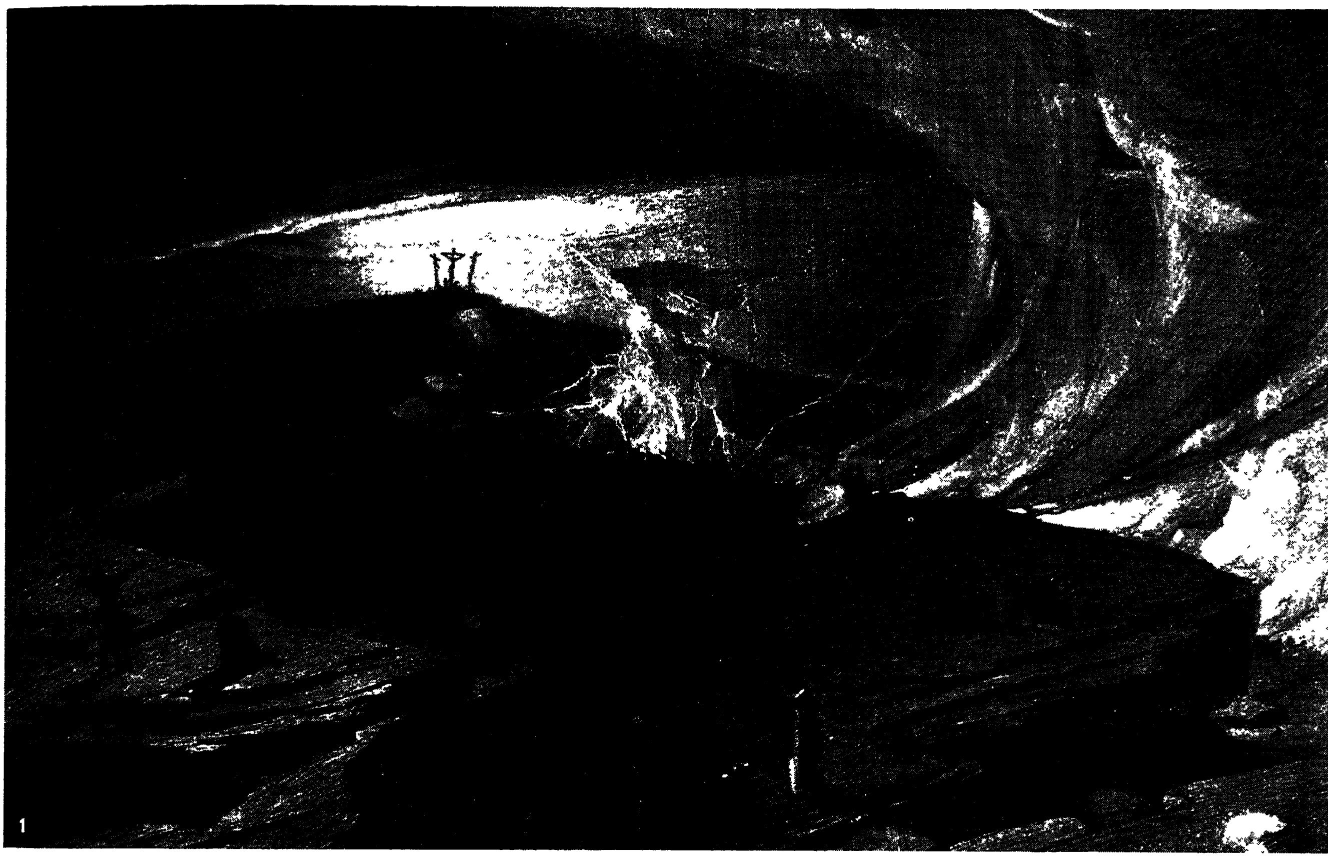
MOTION PICTURE SETS

Motion picture sets constitute the organized settings and equipment that form the environment of a scene that is to be photographed. The first motion picture settings were built on outdoor stages, for natural light was then considered necessary. Later came the glass stages, hung with white and black diffusing cloths that could be pulled over them, as the light changed during the day. The set construction was extremely simple, consisting mainly of "flats" much like those of the stage; *i.e.*, wooden frames over which were stretched linen or muslin in sizes 2′×12′, 4′×12′, 6′×12′, 8′×12′, 10′×12′. All architectural detail was painted, including fireplaces, furniture and the pictures on the wall. Then there came a craze for wall-paper, so that when anything particularly fine was wanted in the way of a set, wall-paper was called in as first aid. The larger the design and the more contrasting in values, the better. Before this mass of conglomerate design, the actor was in continuous competition for the attention of the audience—and often he lost. Until this time the screen world had developed no definite ideas about settings. Anyone, from the property boy up, took a hand at designing them. Scene painters and stage designers, recruited from the theatre, contributed their share, though in many cases the carpenters were given a picture torn from some book or magazine and told to copy it. Eventually, men with some degree of technical knowledge were employed; draughtsmen were engaged to draw the plans; panelling was drawn in detail, and sets then began to take on the appearance of real interiors. Unfortunately they lacked that subtle quality known as good taste, and the draughtsmen, in their endeavour to create a rich man's home, seized upon the more ornate styles of architecture, resulting in an unprecedented riot of ornamentation, weird furniture and fantastic draperies.

Increasing Taste.—From this came a demand for simple and realistic sets, and, quite naturally, the producers turned to the theatre for their designers, Wilfrid Buckland was the first man of recognized ability to forsake the theatre for the motion picture, and to him are attributed the first consistent and well-designed motion picture sets. He brought to the screen a knowledge of mood and a dramatic quality which until then was totally lacking. Following him came Hugo Ballin, a noted mural and portrait painter. Ballin's approach to the problem was that of the painter with considerable architectural knowledge. His settings possessed a simplicity that was most refreshing. He eliminated almost all unnecessary detail, leaving the eye free to concentrate upon the actors and the action of the scene.

Modern settings are almost without exception realistic and architectural. In plan they follow much the same idea as in modern homes, with the exception that all rooms are not necessarily connected. The hall-way is sometimes set up with the living-room, and the dining-room is placed on another stage. The designer depends upon those who cut the picture to establish the geography of the settings. The interior sets usually consist of three sides and are built on indoor stages surrounded by light platforms to carry the lighting equipment.

Problems of Perspective.—A set, as it appears to the casual observer, is much the same as a real interior, with the exception that it is painted in monotones and the mouldings and other breaks exaggerated. The increasing depth of the mouldings and other breaks is to overcome the flattening effect of diffused lighting. The more frequently the wall is broken, either with jogs or recesses, the more interesting it becomes photographically, as it gives opportunity for light and shadow. The primary function of the set is to form a background for the actor. When the set



DESIGNS FOR MOTION PICTURE SETS

1. Setting designed by Anton Grot for the Cecil de Mille production of "King of Kings," based on the life of Christ; a remarkably dynamic design in its masses and use of light
2. Setting by Anton Grot for the de Mille production, "Road to Yesterday," an interesting design similar to Pl. III. fig. 1

BY COURTESY OF (1, 2) THE FOX FILM CORPORATION, (3, 6) THE METRO-GOLDWYN-MAYER PICTURE CORPORATION, (4, 8) THE PARAMOUNT FAMOUS LASKY CORPORATION, (5, 7, 9) THE UNITED ARTISTS CORPORATION

REPRESENTATIVE MOTION PICTURE ACTORS

1. Tom Mix, popular star in cowboy and Western-hero rôles, and Eva Novak, in "No Man's Gold," an old-type Western story. 2. Theda Bara in "Salome." 3. Lon Chaney, noted as a portrayer of grotesque characters. 4. Wallace Beery, well known character actor. 5. Charlie Chaplin, famous comedian, and Merna Kennedy. 6. Rudolph Valentino, romantic hero. 7. Douglas Fairbanks, actor of breezy, adventurous heroes in spectacular costume plays, and Dorothy Revier, in "The Iron Mask." 8. Adolphe Menjou, portrayer of sophistication. 9. Mary Pickford, popular in child rôles

becomes more than the background, except in the case where it is necessary to characterize some mood, it is decidedly out of place. To create an appearance of great scale, it is sometimes advisable to increase the size of the detail. For instance, a close-up figure of a man standing at the base of a column 10 ft. in diameter leads the spectator to believe that he is standing before an enormous edifice of which the large column is but a detail. In the picture *Ben Hur,* the Circus Maximus was a setting unlike any circus that ever existed. The designer was confronted by three important problems: It was to be seen, first, in a long shot (photographed at a distance); an impression of great scale was wanted; the imperial power of Rome was to be felt; the spectators were to be treated as part of the design. Second, there was to be a chariot race photographed from practically every conceivable angle. Third, whenever groups of moving chariots were photographed, it must be against some detail so enlarged that the audience would not lose consciousness of the arena's scale. At each end of the *spina* the two crouching figures were about 30 ft. high, so that when the chariots turned, in racing, one recognized their minute proportion in contrast with the enormous detail in the background.

NEED FOR CO-ORDINATION

Buildings as Local Colour.—Unfortunately for the work of the designer, there is considerable reproducing of existing buildings, both in the interiors and exteriors. As the story may wander anywhere over the globe, it can readily be seen that a well-known structure is sometimes needed to indicate a certain city or country, such as the Grand Central station for New York; the Eiffel Tower for Paris; the Houses of Parliament for London. It is good practice, however, to avoid the reproduction of any of these things, and to imagine some more simple means of embodying one's geography. Certainly a plain wall with a few pieces of furniture is not suggestive of any particular country until, say, a Scotchman in kilts walks through. Then we know we are in Scotland. Because of the various production problems, the designer is sometimes given a script and told that the picture must start within a week or ten days. Suppose the scene is mediaeval France and requires, as background, an old castle on a hill and a village at the base. This has to be ready to photograph, let us say, in 15 days, which is by no means unusual time. The designer, then, has little opportunity to give really careful study to the matter of design, though the most important essential of the set is to create for the picture a background of that period. He has practically no time to do anything but handle the general masses and composition. He depends, to a very great extent, upon his knowledge and something that he has at some time half-imagined. All this is thrown almost helter-skelter into a castle and village setting. That the result is as satisfying as sometimes develops, is a source of continual amazement to most designers of sets. However, the best results do not always follow such fast work, and as the production of motion pictures is becoming more smoothly organized the producers are realizing the economic value of proper preparation before the actual photographing of a picture commences.

Technical Detail.—The problem of design is far from being the only one that confronts the set designer, for within a few days' time he may be called upon to lay out and make sketches of a lady's boudoir, the boiler-room of an ocean liner, a modern hotel kitchen, an Eskimo's igloo, a Chinese temple and an African village. Much of this requires careful research. On some of the interiors and exteriors dealing with the present time, it has been possible to introduce some of the most modern forms of architecture, and as these are simple and provide an excellent background, there is no reason why they should not become increasingly popular. They demand a greater inventiveness and consequently less restraint, thus gaining considerable freshness in their visual aspect.

Proper Lighting.—Unlike the stage designer, the designer for moving pictures has seldom the opportunity, to supervise the lighting of his sets. A set is always planned with some particular type of lighting in mind, and because of lack of adequate co-operation on the part of the cameraman, it often appears much less effective on the screen than would have been the case had the lighting suggested in the sketch been carried out. The cameraman claims that primarily he is lighting people, that is, the performers, and that the settings are secondary. This is quite true, but a setting properly lighted will give prominence to the actors. Proper lighting, without exaggeration, is almost equal in importance to design.

The Moving Eye.—It seems that the mobile value of the camera is as yet little appreciated, though more and more it is being moved, even during the actual photographing. This quality of the camera is invaluable in making certain effects convincing, as may be realized when one considers that the camera is the eye through which the audience sees. To illustrate: When the camera is moved from one position to another or is moved during the scene, it is as if in a theatre the audience were picked up and moved *en masse* from one side of the stage to the other; moved closer to certain characters and further away from others as needed for accentuation of certain action. A moving camera gives a stereoscopic feeling that is never obtained with a stationary one. Also we must not forget that the motion picture setting, in comparison with the stage setting, is seen from many more different angles. The camera is continually moved from long-shot to close-up, from close-up to cross-angle. Hence, the motion picture set must be designed to fit an ever-shifting camera, which should be and is of considerable advantage because by this very movement we can suggest a certain sense of plan.

As a good photograph must look like a photograph and not like a painting, a painting should never look like a photograph. Consequently, what is photographed should represent something real or something that may exist; not necessarily something someone has seen or encountered before, but not purely abstract, as has been the case with many stage settings. Generally, a set must be as normal as the characters who people it. It is doubtful if moving pictures will ever develop a particular style of set, as the modern stage has done, because the range of the settings in a single picture usually covers so many more and such different scenes. On the stage, an audience sees with its own eyes; on the screen it sees the set through the eye of the camera. It will accept and believe much more on the stage than it will on the screen. If, on the stage, the door in closing shakes the wall, the audience accepts it and thinks nothing about it; if the same thing should occur on the screen it would be resented as being false.

Interiors.—The designer of screen sets should be a combination of three things—painter, architect and dramatist. The screen set calls for certain architectural principles applied to a given subject. This must be done more with the eye of the painter or illustrator than the eye of the architect. Take, for example, an interior to be used for a nursery. Any architect knows very definitely that the brighter and better ventilated this room can be, the better the nursery, yet when the same interior is demanded for a set, none of these things are taken into consideration. Let us assume that in the story, the child is neglected by its parents, who leave him in the care of nurses. The set must then embody the following: It should be cold in appearance—no warmth or sunlight; the toys scattered about should be too advanced or complicated for the child, or toys which he has outgrown. It should be a playroom in which he cannot play—almost a prison—which presents quite a different problem from that which confronts the architect when he is required to design a real playroom. And so with other interiors.

Architecture is designed to see with two eyes. The camera has but one lens (or one eye) and hence obtains no stereoscopic view of anything. The swelling of a column is, as most people know, to overcome the top-heavy feeling of a straight shaft. For the camera no swelling is necessary for the obvious reason that the column is being seen with one eye. And so on through many other architectural formulae.

Dressing the Sets.—The movement of the camera is so sustained in a picture that it is practically impossible to design so that in each set-up the composition is good. The designer, after a time knows almost intuitively where the grouping of actors will be most effectively photographed. Originally, the director in

photographing his action would start with a long-shot showing the entire setting and all the characters. To-day this is seldom done. The designer pays less attention to the position of long-shots and more to the individual camera positions.

After the set has been designed and constructed upon the stage it must be "dressed," and by dressing is meant the placing of furniture, hanging of draperies, accessories and appointments. In the large studios this is done by the property department under the general supervision of the designer. In the smaller studios, having less organization, the designer must enter into the actual dressing of his settings to a much greater degree. Through some distortion of the lens, a couch placed directly in front of a fireplace in the side-wall would appear to be several feet away. To correct this the couch is placed down-stage so that it does not face directly into the fireplace but faces the wall between the fireplace and the camera. The same applies to a table which is to be made as if it were in the centre of the room. It should be placed much nearer the camera than to the back-wall of the set. On the stage an open foreground is considered an advantage. It has little or no effect upon the appearance of the setting and gives the actors a chance to move about more freely. On the screen the opposite is the case. The foreground should be rather "well-dressed." By that is meant two or three pieces of furniture silhouetted against the setting which give a roundness to its composition and a feeling that there is a fourth wall. In a real interior one enters, sits down, looks around, and soon ascertains whether certain compositions of furniture in themselves are pleasing or not, assuming here that the interior is supposed to be well-balanced, and the composition and design carefully considered. A point usually overlooked is that a "dresser" will attempt to make the set as much like a real interior as possible. In doing this he often has a tendency to overcrowd with furniture, forgetting that a screen set is never photographed, except in rare cases, without the actors in the scene. Hence, allowances should be made in its furnishings for the placing of the actors. The "dressers" of the sets also have their handicaps. They have too little time for careful arrangements and the consideration which most sets require. Only rarely does the "set-dresser" have more than a few hours to complete an assignment. However, more time is allowed in the dressing of exterior scenes such as villages and streets.

Looking Forward.—The future of motion picture set design is problematical. Naturally sets will always be controlled by the type of story produced. In *The Cabinet of Dr. Caligari*, made some time ago in Germany, the story was told in retrospect by an inmate of an insane asylum. Settings seen through his insane eyes were strangely distorted, with leaning walls and painted lights and shadows. They were a rare exception and have had but little effect on the trend of motion picture settings. The best of the modern settings have almost reached their limit in pure pictorial beauty. Whether this type of set will continue to satisfy is a question, or whether, as in modern art, beauty for its own sake will not be demanded. If realism can be abandoned, we may look for a setting which in itself will be as completely modern as is modern painting or sculpture. (C. Gr.)

MOTION PICTURE ACTING

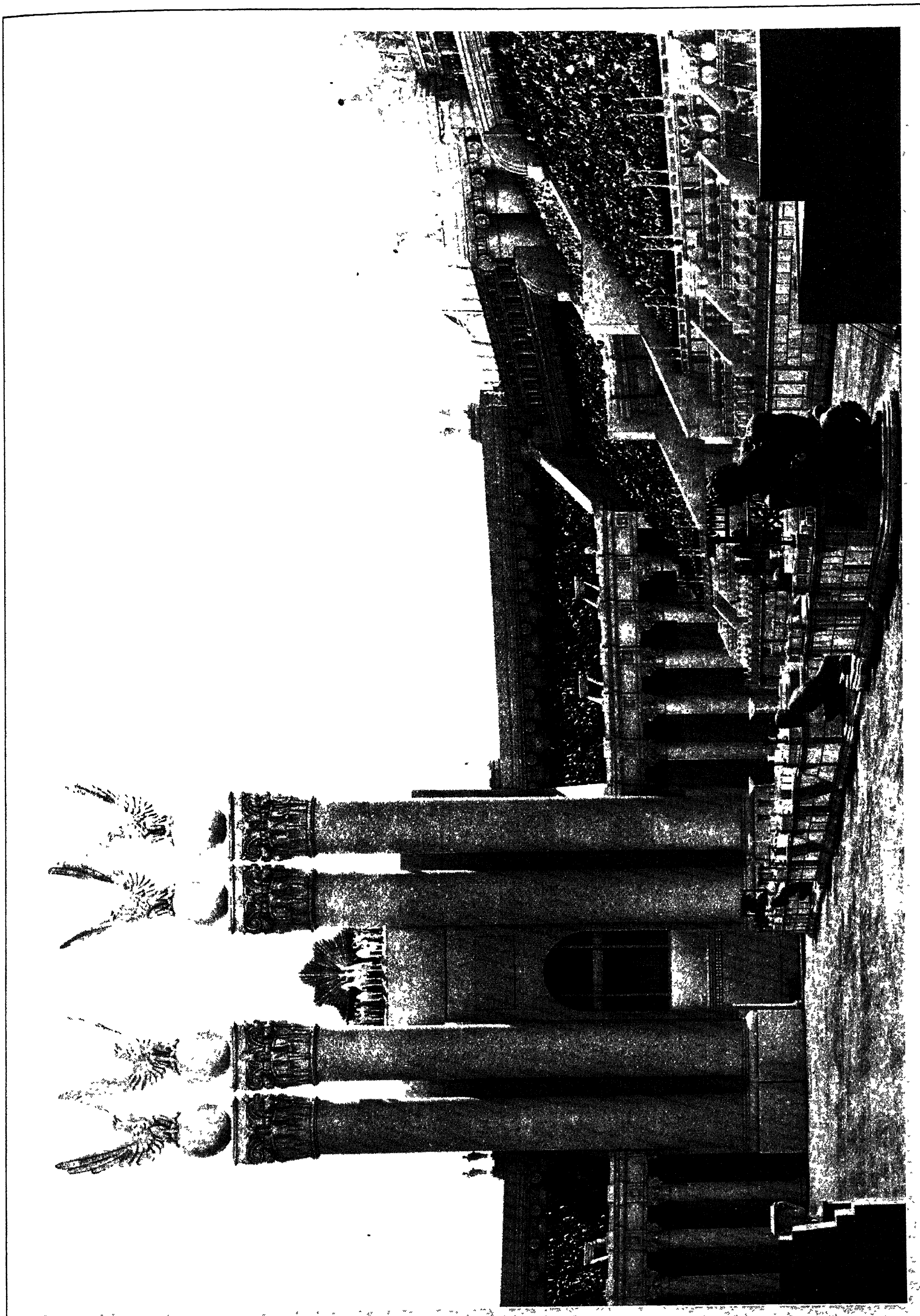
The earliest actors and directors for the screen were drafted from the stage; they carried with them its methods and traditions, translating them as best they could to suit the exigencies of the camera. It soon became apparent, however, that the motion picture demanded a revision in technique. Whereas the stage depended chiefly upon the ear of the audience for the reception of its dramatic message, the screen depended exclusively upon the eye, and it thus became increasingly the problem of writer, director and actor to eliminate as far as possible the spoken word, and to employ visual symbols—facial play, gesticulation and the movement of the body—to express thought and emotion and to envisage the action of the story. In short the motion picture quickly set up as its characteristic medium the inarticulate behaviour of articulate human beings. This prescribed a harsh limitation on acting, automatically suppressing in considerable measure that major portion of our civilized intercourse, speech, and concentrating on its more elemental phases, the dumb grief of stricken women, the silent yearning of youth, the speechless fury or the stunned remorse of men. The motion picture had to reckon with a public, unfamiliar with the hieroglyphics of the film, and with actors so dependent on speech as to be unresourceful in visual symbolism, and easily prone to strain and exaggerate their expression of feeling in an effort to convey it to their audience. Until both audience and actor could be educated to a subtler art, physical action of a broad and even violent character was in vogue. Much of the earlier work of G. M. Anderson ("Bronco Billy"), Maurice Costello, King Baggott, J. Warren Kerrigan, Hobart Bosworth and even William Farnum and Francis X. Bushman, was in consequence crude, obvious and melodramatic. Moreover, many of the earlier players found their way to the screen after having been rejected by the theatre, and for a long period the better class of stage actors scornfully withheld themselves from the temptations of the studios.

The Trend Toward Motion Picture Acting.—It was not until about 1914 that the more competent legitimate actor began to discover the artistic possibilities of the motion picture, and to migrate to that medium. About this time it became apparent that the screen, indeed, lent itself to a very subtle form of expression. The sensitive acting of Henry B. Walthall, in such pictures as *The Avenging Conscience* and *The Birth of a Nation*, bore witness that the mere shadows of hands and eyes could be infinitely eloquent of the more delicate nuances of human feeling. In truth, no subsequent acting has surpassed his in its peculiar fitness for the film. From Mary Pickford also the screen had caught the reflection of a wistfulness and charm that have secured for her an outstanding position. Contemporary with hers, the acting of Mae Marsh and more especially that of Lillian Gish was welcomed for the beauty of its poignant or plaintive, gay or tragic melody. The new notes sounded by these pioneers were soon caught up by their successors. While such actors as William S. Hart and Tom Mix have carried on the old melodramatic tradition, it has been largely relegated to the background, and the outstanding players of recent years have cultivated a more restrained, subtle and realistic art.

Further Technique.—In comedy, Charles Chaplin and Harold Lloyd, superseding John Bunny, Ben Turpin, Roscoe Arbuckle and Mack Sennett, have evolved a highly specialized technique for provoking laughter, based on a philosophic conception that mishaps and misfortunes are the object of social ridicule because they represent human maladjustment to the environment, coupled with Bergson's notion that living beings, when they act like mechanisms, become curiously incongruous. Chaplin, in addition, has intensified his comic effects by the insinuation of a forlorn pathos and a tragi-comic nobility into his stock characterization. He is the clown with the broken heart.

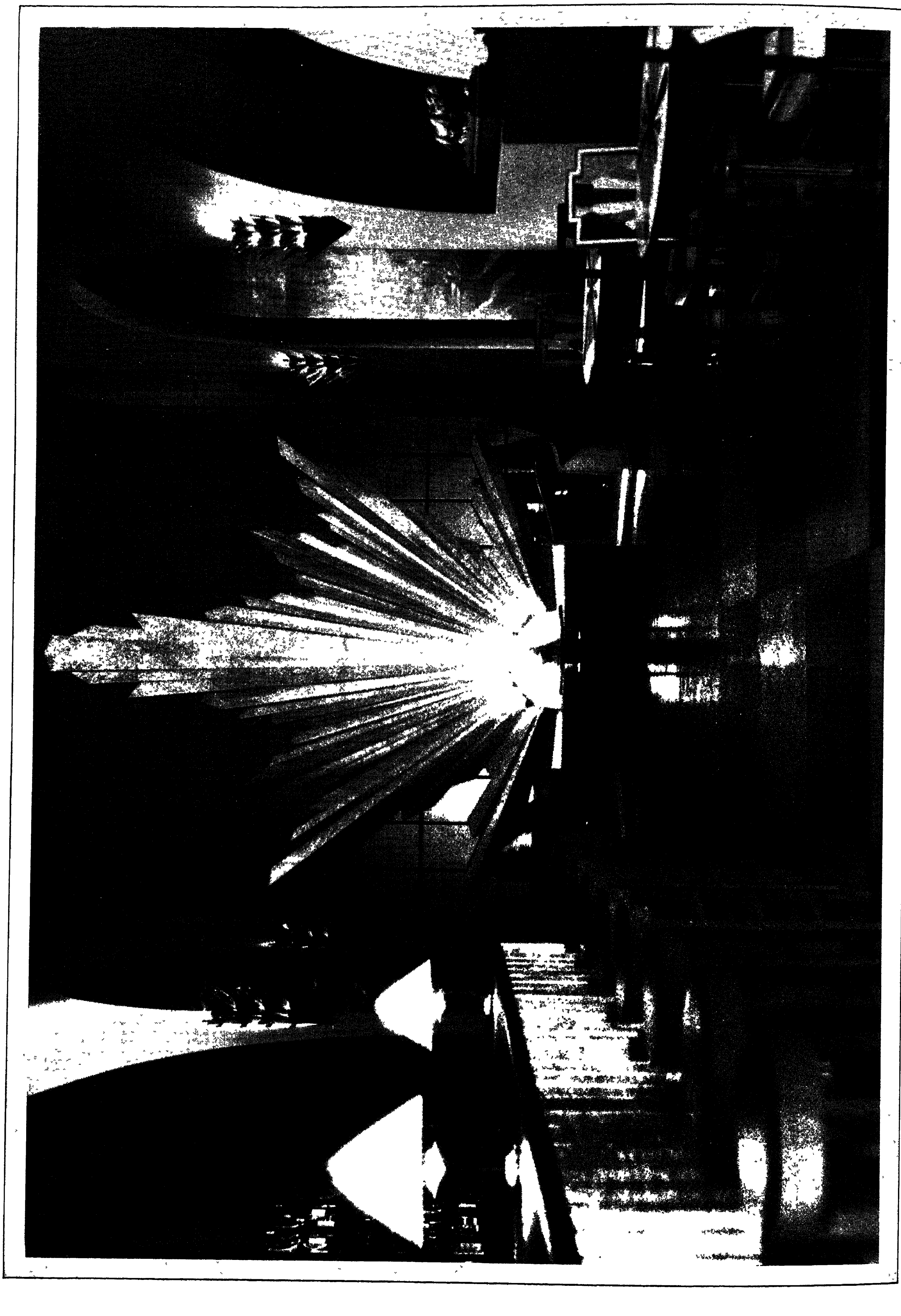
Among the women, Clara Kimball Young, Norma Talmadge, Gloria Swanson and Greta Garbo have exploited the allurements and fascinations of the modern type. Partly owing to a shift in popular interest, they have turned away from the ingenuous heroine of earlier days in favour of the more sophisticated woman of the world. Pola Negri in *Passion* brought a frank realism to the depiction of a woman whose emotions were uninhibited by conventional restraints, and startled the motion picture world by the superb abandon of her tempestuous characterization. In sharp contrast, the more recent portrayal of Janet Gaynor in *Seventh Heaven* suffused the screen with the tender radiance of an indefeasible hope and faith, lyric in its exquisite quality.

In the sphere of character acting the classic performance of Ernest Torrence in *The Covered Wagon* remains memorable for its grim and rugged humour and its graphic force and vitality. Notable also was the work of Lon Chaney and Thomas Meighan in *The Miracle Man*, and of equally outstanding merit were the performances of Richard Barthelmess in *Tol'able David* and of Percy Marmont in *If Winter Comes*. Among the more recent actors who have gained prominence are Adolph Menjou, Ronald Colman and John Gilbert. The epitome of the male flirt, Menjou, by the shrug of a shoulder, a bored half-stifled yawn or the wry



SETTING OF THE CIRCUS MAXIMUS FOR "BEN HUR"

Setting of the Circus Maximus of Imperial Rome, designed by Cedric Gibbons for the Metro-Goldwyn-Mayer production of "Ben Hur"



A MODERNISTIC SETTING

Modernistic bar set designed by Cedric Gibbons for the Metro-Goldwyn-Mayer production of "The Cardboard Lover," suggesting a sophisticated modern atmosphere

cynical flicker of his moustache, can suggest the fascinating wickedness of a calculated sophistication. The more florid and impulsive style of Gilbert's acting suits the reckless, devil-may-care young man, a vagabond among hearts, living in the present and sowing his wild oats, which he so cleverly portrays. Finally, in Emil Jannings the screen finds a master craftsman who, in *Henry VIII., The Last Laugh, Variety* and *The Way of All Flesh,* has evinced a remarkable versatility in characterization. Equally skilled in comedy or tragedy, he is at his best in depicting the gradual physical and moral disintegration of the erring and repentant man. In each of these examples the actor's technique is notable for its expertness in innuendo, suggesting much by little, leaving much to the imagination of the audience.

Present-day Tendencies.—Thus through some 30 years of intense elaboration there has developed a technique of pantomime, which, through the ingenious invention of "business" and a highly skilled use of the new alphabet of gesture and facial play, has learned to spell out much of the complex meaning of modern civilized life. Recently this development has shown signs of slowing up; for some time the art of acting for the screen has remained relatively static; it has made little advance either in technique or in significance. The general tendency has been in the direction of greater restraint and refinement—in a word, toward less "acting," and the dominant ideal has become a distinct realism in style. "Overacting" has always been more apparent on the screen than in the theatre.

In some quarters there is a growing suspicion that the so-called close-up, in which the face of the actor fills the entire screen, has been overworked. The progressive director now realizes that this vice is in great measure due to the circumstance that in cutting and assembling the bits of film taken from varying camera distances, of which the final picture is composed, the close-up can be substituted for long stretches of action in more remote views which are likely to seem slow and tedious. Its function has been to give a speedier tempo to the film and maintain its dramatic tension, vividness and significance; but frequently it has been indulged in at the sacrifice of important histrionic values. There are actors whose work is more expressive at longer range in which the fluent play of hand and body becomes symbolic of thought and feeling. To preserve these values, the director and actor must co-operate in effecting greater artistic economy and concentration of significance in the longer shots.

Future Possibilities.—If in the future there is to be any important change in histrionic method, it seems now that it must follow some new mechanical development. For example, the advent of the talking motion picture may effect a revolution in the fundamental conventional structure of the literary form which now lies at the basis of the film and compel a drastic revision in technique by the reintroduction of the player's voice. Such a development by enlarging his scope and medium may freshen and reinvigorate the creative imagination of the actor. With each producer vying with his fellow for patent rights in sound-reproducing mechanisms, the talking picture seems destined to grow. A complete reversion to the methods of the stage, however, seems neither possible nor desirable. The motion picture talking camera will still possess the advantage of being able to isolate for eye and ear the essential moment of the action, to concentrate vividly on it to the exclusion of all irrelevancies and distractions, and to keep the focus of the drama always sharp. Acting for the screen will continue to be done piecemeal.

STAGE AND SCREEN

The environment in which the motion picture actor works is entirely different from that of the theatre. The sympathetic presence and response of the living audience with its meed of laughter, tears and rapt attention—factors so integral to a stage production—are entirely lacking in the film studio. Its inspiration can never find more than a sorry substitute in the lens of the camera, which must for the actor's imagination become the living eye of the world. Meantime, he is beset by the innumerable distractions surrounding him, the clicking mechanism which so indifferently records his behaviour, the lighting apparatus with its numerous attendants, the irrelevant and discordant noises of his workshop. For all of these he must school himself to utter oblivion. While actually filming a scene, he must learn to catch the director's frequent shouted instructions, undisturbed by their intrusion. Much of his work must be done in real settings, and with all the difficulties of actual nature to contend with—wind, rain, fire, flood, snow, cold, the heat of the desert, the glare of the sun, innumerable physical obstacles with which the actor in the theatre need not reckon. Yet under the most trying circumstances he must remain facile in the expression of the emotion appropriate to the scene. Amid the overpowering fumes and pandemonium of a steel mill, or the tossing of a ship in a storm, he must be capable of tears or laughter, of tenderness or rage, forgetting his external environment and living absorbedly in the inner world of his imagination.

Coming from the theatre to the studio, the actor is at once confronted with two unaccustomed limitations in space and time. The full stage has been his field of action and a half-hour scene to one of two hours its duration. Now he is restricted in his movements to the photographic field and the focal plane of the camera and to the short duration of the film contained in the camera's magazine. A scene can last very little longer than three minutes; most scenes are very much shorter than three minutes. Acting for the screen therefore is done piecemeal, in small bits, each of which represents a shift in the position of the camera, a change of angle for the purpose of following and emphasizing the significant elements of the scene. The actor's art is accordingly an art of flashes, of highlights, a mosaic in which each particle must be a highly polished jewel. He has no opportunity for sustained emotional flight, but must be capable of kindling the feeling appropriate to the rôle on the instant. Moreover, as it requires weeks and sometimes months to film a complete picture, throughout this stretch of time, and in spite of innumerable interruptions, the actor must keep vividly in mind the character he is portraying and develop it in a sustained, smooth and continuous curve.

As for the field of the camera and its focal plane, these of course vary with the actor's distance from the camera lens. Most of his important work is done at a distance varying from 15ft. to 2 or 3 feet. In order to keep within the hypothetical sidelines of his field, he must acquire an expert half-conscious sense at all times of where those lines actually lie, and yet avoid any suggestion of feeling hampered that may interfere with his imaginative concentration on his rôle and his freedom in delineating it.

While the normal speed of the camera in filming a performance is 16 pictures per second, or 60ft. of film per minute, when the picture is projected in a theatre, it is the custom to run it at the rate of 24 pictures per second, or 90ft. per minute. This, together with the fact that the film does not record movement as adequately as the eye, makes it necessary for the actor to adopt a more deliberate *tempo* than that of the stage or of real life. He must learn to time his action in accordance with the requirements of the camera, making it neither too fast nor too slow—a process of education only to be acquired through experience in the studio. The first mark of a novice is the rapidity and jerkiness of his movements, registered upon the screen as blurred and meaningless streaks. Another essential feature of the screen actor's technique is a careful spacing of significant items which constitute the sequence of the scene. One thing and one thing only must be done at a time, and this in a clean-cut and distinct style with no distracting, irrelevant or unnecessary movements. In scenes *vis-à-vis* another actor, although deprived of the medium of audible speech and dependent almost solely on facial expression to convey his ideas, he must never appear to play to the camera, but must be clever in finding occasion naturally to bring his full face to the front. Further, without being apparently conscious of it, he must at all times, in co-operation with the camera-man, play within a prescribed range of lighting most advantageous for composition and pictorial or portrait effect. As the screen magnifies the image of the actor, and brings it intimately close to the audience, the minutest play of the facial muscles, and especially of the eyes takes on significance. In consequence they must be trained to a great yet controlled expressiveness. They are the actor's

most potent instruments. The faintest flicker of a brow or the tremble of a lip may concentrate the quintessence of infinite meaning.

The rapid development of the talking motion picture has created new difficulties for the actor and director. Mechanical limitations make necessary the filming of long scenes without interruption. Long shots, medium shots and close-ups are taken simultaneously by a battery of several cameras, synchronized with the voice recording device. Later the requisite lengths of these various shots are selected and pieced together to form a complete episode. This forces upon the actor a more sustained effort and demands from him an interpretive intelligence in the reading of lines, hitherto required of the actor on the stage.

Another change interesting to note, is that whereas in the silent picture the film is exposed at the rate of 16 pictures per second, in the talking motion picture the film is run at the rate of 24 pictures per second. The habitual method of the silent motion picture actor has always been deliberate and measured. The new form calls for a more accelerated tempo, both in the acting of the individual player and in the direction of *ensemble* scenes. The sense of pace, hitherto left to the ingenuity of assembler and cutter, must now be appreciated keenly by both actor and director during the filming of the scene.

In the new enthusiasm over talking, which has swept through the studios, there has been a tendency to revert to the methods of the theatre. The consequence has been to glut pictures with dialogue at the expense of the values which the silent motion picture has so carefully and laboriously developed. This will undoubtedly provoke a reaction in the other direction. The ultimate result will be the preservation of the old motion picture with the elimination of the printed title and the substitution for it of the spoken word, only where the spoken word is essential for the progress of the drama.

The heavy cost of producing pictures precludes the opportunity for long rehearsals in which to develop and study a rôle: the motion picture actor must be trained in the ability to respond quickly to the director's instructions and execute them with glib facility. His work thus becomes a kind of improvisation. What it thereby loses in finish, however, it gains in spontaneity, vitality and verve. The screen captures the first fresh inspiration of the actor which the player on the stage has frequently a long struggle to recover and reconstruct during or after his period of rehearsals. Finally, the screen actor is burdened with a great responsibility. The film once complete, it becomes changeless and irrevocable; it represents his finished and final characterization, whereas the actor on the stage can continue to develop his rôle through a long series of performances.

Interesting as the screen actor's achievements have been, the art of motion pictures is still a tentative art in its formative stage, feeling its way by trial and error; it yet awaits its Garrick and its Siddons, its Duse and its Booth. (*See* ACTING; PANTOMIME; THEATRE.) (M. Ss.)

Among the more important departments in the studio which combine in the fabrication of the photoplay are:—

Architecture.—This division is one of the most important in the studio, dealing as it does with the creation of the scenes or "sets" used in the various productions. It may be called upon to manufacture replicas of scenes from all parts of the world and all periods of history. This work, under present-day requirements, must be highly accurate.

Costume.—This department has developed into virtually an industry within an industry. It furnishes costumes for oftentimes thousands of players in one production, and these costumes, like the "sets," must be accurate. Their creation must at times be the work of a few days, necessitating the employment of many skilled workers. Many of the smaller studios, because of infrequent demands for costumes, do not maintain this department, but rent costumes from firms engaged in this business. The large studios, however, operate their own departments equipped for this work.

Casting.—The casting division is divided into two groups. The first, which deals with the selection of stars and featured players, is operated by the studios themselves and is in charge of a man trained for this work. The second group applies to the "supers" or "extra" players who are used as "atmosphere." In Hollywood, the hiring of the latter is done through a central casting organization maintained by the large studios.

Research.—Modern production demands a high degree of exactitude in re-creating the life and scenes depicted in its photoplays. Careful research is essential, with the result that comprehensive libraries are maintained where data, pertaining to costumes, customs, scenes, etc., of various nations may be readily obtained. The architectural and costume departments depend in a large measure on the work of the research department.

Scenario.—Specially trained writers well versed in the technical phases of picture making comprise this department. Before a photoplay can be made it is necessary to have a scenario and continuity which divides the play into separate scenes. In most pictures, many individual scenes are made on the same "set." For economic reasons it is customary to film all such scenes before proceeding to another "set" irrespective of the continuity of the scenes in the picture. In cases where stage plays or novels are used for photoplay material, the scenario writer must make a comprehensive "treatment," translating spoken or written drama into terms of pictorial drama.

Editorial.—Inasmuch as it is usually necessary to photograph individual scenes several times in order to get the desired effect, a completed photoplay usually runs to many times the length in which it is seen by the public. The task of eliminating these surplus scenes is done by technicians specially trained for the work. It is their business to arrange the multitude of scenes into a smooth, logical and pleasing continuity. Other specialists prepare the captions or titles for the production. Unique effects can be obtained in the cutting of a picture, and so important is this field that many photoplays have been made successful or ruined in the process.

Laboratory.—The millions of feet of film consumed in the making of photoplays annually makes necessary the operation of large laboratories at many studios. Here the negative film from the cameras is developed and the hundreds of positive "prints" produced. The work is of a highly specialized nature and exceedingly important.

Electrical.—Sunlight is no longer essential as a source of light in motion picture work. Electricity has so completely superseded the sun that only exterior scenes depend on it for illumination. Various types of arc and mercury-vapour lights have been in general use for more than two decades. Because of the expense in the operation of large batteries of such lights and because of the ever-present danger of injury to the eyes of the players who work before them, experiments have lately been conducted with incandescent lamps. The success resulting from their use has brought about a more general application and to-day several studios are using incandescent lights almost entirely. Incandescent lamps, which are noiseless in operation, are essential in filming scenes for talking pictures.

Camera.—The photographing of modern photoplays lies in the hands of expert technicians well versed in the ways of cinematographic magic. Recent years have brought new qualities of pictorial art to the screen which have been made possible not only through the perfection of the raw film and lenses for the camera, but through the artistry of the camera-men.

Sound.—The sound department, where the delicate apparatus which records the voice, music and sounds for talking pictures is situated, has become one of the most important in modern motion picture studios. The highly technical work of sound recording and its associated processes, such as developing, printing and cutting of sound film, is in charge of experts. (J. L. LA.)

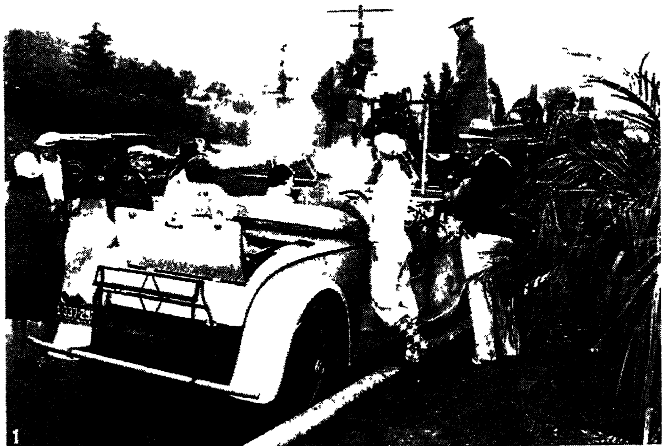
MOTION PICTURE DIRECTION

The Director.—The director of to-day has evolved from the crude stage-manager of the early school of pictures. His business, originally, was merely to move the various characters so that they did not hide one another from the camera and to see that important action was so placed that it registered in the lens.

BY COURTESY OF (1, 5) THE METRO-GOLDWYN-MAYER PICTURE CORPORATION, (2, 3, 4) THE UNITED ARTISTS CORPORATION, (6) THE FOX FILM CORPORATION, (7, 8) THE PARAMOUNT-FAMOUS LASKY CORPORATION, (9) THE FIRST NATIONAL PICTURES, INC.

WELL-KNOWN MOTION PICTURE ACTORS

1. John Gilbert, popular romantic actor, as Vronsky, and Greta Garbo, as Anna Karenina, in "Love," the film version of Tolstoy's novel "Anna Karenina." 2. Norma Talmadge, noted for her emotional acting, in "The Woman Disputed." 3. Ronald Colman, leading man, and Vilma Banky, romantic heroine, in "Two Lovers." 4. Gloria Swanson, popular actress of emotional parts, in "Sadie Thompson," the motion picture version of "Rain." 5. Lillian Gish, well-known for her portrayal of pathetic, ingenuous characters, and Lars Hanson in "The Wind." 6. Janet Gaynor, leading woman, and Charles Farrell, leading man, in "Seventh Heaven." 7. Pola Negri, portrayer of exotic, emotional heroines, in "The Woman from Moscow." 8. Emil Jannings, powerful character-actor, in "The Sins of the Fathers." 9. Milton Sills, actor of virile hero parts, in "The Barker"

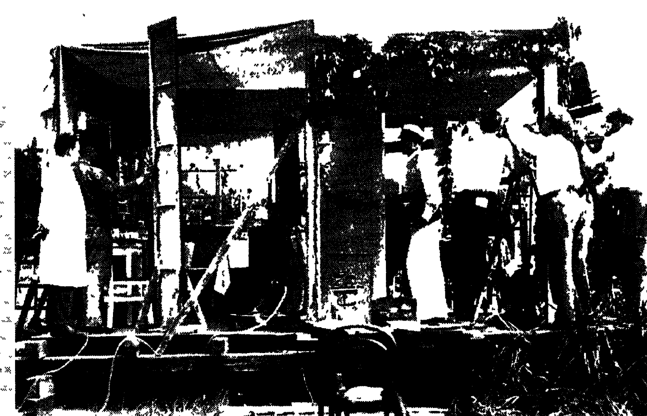

1


2


3


4


5


6

BY COURTESY OF (1) THE PARAMOUNT FAMOUS LASKY CORPORATION, (2, 3, 4) THE METRO-GOLDWYN-MAYER CORPORATION, (5) THE UNITED ARTISTS CORPORATION, (6) U.F.A.

DIRECTION OF VARIOUS TYPES OF SCENES

1. Directing an automobile close-up. The camera is attached to the front so that the picture may be taken while the car is in motion. Malcolm St. Clair, directing Richard Dix and Gertrude Olmsted in "Sporting Goods"
2. Directing a street scene. Sam Wood, director, standing by the camera is grouping the characters preparatory to "shooting" the scene. A piano is played during the action to help place the actors in the desired mood. Music is frequently used by directors for this purpose
3. Directing a close-up love scene. John P. McCarthy is directing Eleanor Boardman and Lawrence Gray in a scene for "Diamond Handcuffs." The close-up is used in many ways by different directors, its basic dramatic purpose being to bring out the significance of a given moment by focussing attention on the thought or emotion of given characters
4. Directing a small group in an outdoor scene. The problem of group direction is to keep the picture at all times well balanced although it shifts and changes its form at every instant. Harry Beaumont is directing a bridle path scene for "Dancing Daughters"
5. D. W. Griffith, director, and his technical staff during the filming of a scene for "The Drums of Love"
6. Directing a scene in an outdoor set for the German picture "Schuldig" (Guilty)

His art has developed as the other arts contributing to the motion picture have given him a more sensitive and complicated instrument upon which to play. The greater the number of arts and crafts which combine in picture making the more complex and difficult becomes the work of the director. The very nature of the director's position makes him a co-author of the work. The script of a picture play cannot be as complete as the manuscript of a stage play, since the very detail of movement and business which the director is called upon to supply, corresponds to the lines of dialogue in verbal drama. The script of a photoplay is not a motion picture; it is a blue print from which the picture will be built. The director's function may best be explained by considering the relationship of the various arts which combine to make a motion picture; and by the limitations of the fixed budget for his picture.

The Scenario.—The first element, the story, may be an adaptation from a play or a novel, or it may be an original story conceived and written for the screen. In the latter case it does not have to undergo the difficult process of adaptation which is necessary in the case of a work made for another medium of expression. There are three distinct steps in the creation of a scenario, and a different writer may handle each step: the writing of the story itself; the "treatment" or rough outline of the screen play as adapted from the story; the "continuity" or detailed scene by scene script from which the director actually makes the picture. This last form of writing calls for a high degree of technical screen knowledge on the writer's part, and it is with this phase of the writing that the director is most closely associated. He must work with the writer in balancing dramatic values of individual scenes so that the picture may have true dramatic progression. This must be carefully worked out beforehand for the problem differs from that of a play in the theatre in that each portion of the picture must be finished before another portion can be made, and changes to balance the complete work are most difficult to make after the scenes have been filmed. Unless the director has a clear idea of the contextual value of each scene he is apt to over-develop one portion of the story and find himself without sufficient "footage" left to develop adequately the part which follows.

Motion picture scenarios may be roughly classified under two general headings: the master-scene script, which tells the story incident by incident, but does not indicate division into camera shots, and the "camera continuity," which gives in exact order every camera scene in the picture. It is a matter of choice which type of script is used. For the most part, master-directors prefer not to be too closely prescribed for in the matter of handling their cameras; they like to leave a certain amount to inspiration, to the "feel" of a scene and that spontaneous conception of a moment which frequently occurs when a scene's physical elements—the set, the actors and the lights—are assembled for the first time.

The Set.—In his relation to set design, the director usually confers with his scenic artist and gives him a general outline of the dramatic values which are to be emphasized and the atmosphere which will harmonize with his directorial treatment. He then studies preliminary sketches with an eye to the general movement of masses and individual characters. Special effects are discussed with the art director and the technical department, and at these conferences it is decided what methods are to be used: whether a given set will be completely built to full scale, or whether it will be partly built in miniature or painted on glass and so photographed as to create the illusion that the spectator is seeing a vast building which towers hundreds of feet in the air, when in reality he is looking at a portion of a building, a bit of miniature and a painting. The method of multiple exposure is also used to create illusion, trick effects being sometimes combined with normal exposure; a real ocean scene may be photographed around a ship built on the stage. It is the director's business to see that all these highly technical and pictorial effects harmonize with and carry on the dramatic progression of his story.

The wardrobe department of the studio plays an important rôle, especially in cases where thousands of costumes have to be made, with due regard to the camera values of colour. In productions dealing with contemporary life the dressing of each character becomes a part of characterization, and care is taken to see that each costume is not only true to type but harmonizes dramatically with the scene in which it plays.

Photography.—Next to the writer, the director's most important collaborator is probably the photographer. Good photography adds immeasurably to the director's work and inadequate photography may render it useless. Once the scenario is written, the camera-man becomes the director's interpreter in the matter of atmosphere. The director composes and draws the picture, but it is the camera-man who paints the drawing. He must understand the dramatic colour of each scene, and by the use of lights, lenses and exposure create upon the film the atmosphere of gaiety or gloom, of reality or fantasy; the hot glare of African sand, or the cold glare of Arctic snow. Camera-men vary in individual style as widely as do painters on canvas, and while it is usual for the director to set his "camera-line" and compose the picture, he is quite dependent on his photographer for texture, focus and the quality of the photograph.

Lighting.—Matters of lighting come largely under the jurisdiction of the camera-man. The lighting of motion pictures has made tremendous strides in the last few years. The raw sunlight of early days has given way to the carefully balanced and diffused lighting of the studio. Broad strokes are painted with sun-arcs of over a million candlepower, delicate effects sketched in by incandescent lamps. The direction of every light is arranged so that an effect very nearly stereoscopic is achieved. Many sets are built with a view to special lighting, and, frequently, a set could not be shown except when lighted as planned by the scenic artist. Thus a set may be planned for various planes of light; planes of shadow alternating with or crossing brighter planes, so as to give great depth to the picture and overcome the flat effect which a too evenly lighted set is apt to have.

In handling large sets and masses of people the director does his grouping in connection with the scheme of lighting, working his people through planes of brightness and of shadow until the effect of a great painting is attained. So far has the art progressed that the modern tendency is to do away with tinting the film, effects of colour being achieved by lighting alone, and to-day it is not unusual to photograph an entire picture without the use of make-up on the characters.

Acting.—The element of acting is obviously of vital importance to the value of the photoplay, and it is an element which comes most closely under the director's control. He not only chooses his cast with great care that each part is suited to the actor, but he has much to do with the actor's performance. He controls his actors as the conductor controls the instruments of his orchestra. His function is not to teach acting any more than the conductor's is to teach his musicians how to play their instruments. But he must co-ordinate character conceptions so that each may stand in relation to the other as the story's true development demands. There is constant temptation to let an interesting character become too important for the proper story value of the moment, to over-emphasize a part in its relation to the whole. Careful contrasting of types, balancing a cast, harmonizing and moulding the conception of his characters until each is perfectly adjusted to the dramatic mechanism of which it is a part, are among his most delicate and most important duties. In his relation to the actor, the director must study the individual personality and method of each player and, if he is wise, he fits the part to the actor as much as he fits the actor to the part; he must, to some extent, vary his method to suit the need of each actor, if he is to attain the greatest result of which the actor is capable.

Technique.—In general, the director faces this problem: to perfect each moment of the story separately and then to combine these bits into a smoothly flowing drama in which every moment will bear its proper relation to every other moment. In this connection, the question of *tempo* becomes most important, for the *crescendo* and *diminuendo* of drama are partly achieved through the varying *tempi* of successive scenes. Here again, the

analogy of the motion picture to the symphony is close. But the director is powerless to control the speed at which the picture is projected in the theatre, and his carefully done work is frequently hurt by being run so fast as to lose all semblance of human life.

Another major point in the technique of direction is the determination of distance from the camera to the focal point of interest. It is no easy task to arrange that, as the composition of the picture changes from moment to moment, the spectator's eye is naturally drawn to the particular object which is, at that instant, the most important part of the story. It may be one man's face in a group of 50; it may be the turn of an eye or the massed movement of 1,000 men, the ticking of a clock or a distant bugle call—in each case the object of greatest dramatic significance must be the most visible thing upon the screen. This is the true art of telling a story in pictures, the juxtaposition of different scenes being no less important than the composition of the scenes themselves. When the story action is being carried forward by the movement of characters, greater distance from the object is required than when the significant action of the moment is the thought transition of a single person. The physical aspect of each salient point in a train of thought must be so photographed that when the various pictures are arranged in proper succession the whole thought progression is revealed clearly and smoothly. A dramatic progression may consist of the mental action and reaction of several characters upon one another. To keep dramatic progression flowing smoothly the continuity may flash quickly from one man's face to the hands of another and thence to the tapping foot of a third; or to express in picture the essential thought of a given moment the camera may show the whole figure and then sweep up to concentrate on the face alone. Detail of photographic continuity may be suggested by the writer, but it is essentially the director's function, as the actual placing of the camera with respect to the object is vitally important in its dramatic effect. The most effective distance varies greatly according to the delicacy of the thought to be expressed. In a large close-up the movement of an eye can tell volumes; two feet further away from the camera this movement would be ineffective if not lost entirely, and the thought would require broader movement to express it.

This feeling for line and distance is as important to the director as touch is to the pianist. Frequently distance is varied without actually moving the camera by using lenses which magnify the object and seem to bring it nearer. Thus a lens of two-inch focal length (the normal lens of the average picture) may be set side by side with a three-inch lens and a four-inch lens. If all three cameras are 12 ft. from the object the three-inch lens seems to bring the object to a distance of 8 ft. and the four-inch lens brings it to within six feet. In this way difficult scenes may be photographed simultaneously from various angles and different distances. The large close-up is used in many ways by different directors; its basic dramatic purpose is to bring out the significance of a given moment by focussing attention on the thought or emotion of a given character; to record his transition of thought or to separate him from the group of which he is a part.

Grouping and mass movements are most important and call for the highest degree of directorial skill, for the picture should at all times be well-balanced although it shifts and changes its form at every instant. To move a group while shifting the dramatic focus from one character to another and yet to preserve good composition in the whole is no mean art. In large mass movements the director has many assistants who take command of a half or a third of the entire mass; under each assistant are several trained actors, each being responsible for a subdivision, and under each of these actors is a group of extras who form the body of the mass. This method of subdividing direction and responsibility gives variety to the mob and tends to avoid the old-fashioned automatic crowd, so familiar in early days.

Assembling and Editing.—The director studies in the projection room the results of the previous day's work, and learns what values he actually has upon the screen; values which frequently prove to be quite different from what he thought he had. He is thus enabled to correct mistakes and retake such scenes as may be necessary.

As the picture progresses it is assembled in a rough cut which corresponds to the first draft of a play. Every scene and incident is in this first assembly, which almost invariably runs from twice to four times the length of the finished product. But in studying this rough assembly the director gets the "feel" of his picture; he senses its length and *tempo* and, frequently, changes his idea of its relative values. He guides himself accordingly in that part of the picture still to be made; he sees that certain incidents are less effective in their context than they felt when they were being made; that others are capable of further development than the first outline indicated; and so, sometimes groping his way, sometimes with true inspirational vision he finishes the "shooting" of the picture.

Then follows the task of editing the film; of reducing 30 reels to ten; of seeing the picture for the first time concretely, as a whole; of studying the new values which inevitably appear and, frequently, of compensating for values which seem to have disappeared. In the process of shortening the film captions must be rewritten, some left out as unnecessary, others put in where action has been so changed in the cutting that it is not sufficiently clear in pantomime alone. The importance of the cutting-room can hardly be overstated; it is here that the director selects and proportions the elements of his picture until its final form is achieved.

In the last analysis the director is a story-teller. His must be the art of combining the arts of others into one creation, and he must balance the values contributed by those other arts so that none of them is out of proportion to the true symmetry of the whole. He may not have conceived the story first, but he has to make it part of himself before he can put it on the screen; he may not have written it, but it is he who tells it; and upon the force, the clearness and the art of his telling depends the value of the work. (C. B. DeM.)

MAKE-UP

The need of make-up in motion pictures was evident from the beginning, but few of the principles of stage make-up could be applied to the new art. Actors found that the make-up of the stage appeared in films in a vastly different way. Red, orange and brown photograph as black or nearly so; blue, pink, yellow and mauve photograph as white. Pink cheeks became a dirty grey, gold fillings in teeth appeared as black specks; freckles "picked up" more black than the eye could see; disguises applied after the stage fashion became, under the merciless eye of the camera, ludicrous. Actors, in experimenting with different colours, found that pinks with bluish tones photographed better, and to-day some stars use a make-up that appears purple. Women, especially, found that applying the laws of photography to their make-up enabled them to correct defects in their faces. For instance, many actresses paint the upper eyelids green, which photographs as a light grey, and tends to make eyes that protrude slightly recede. Double chins can be partly obliterated by a tint of red, which, photographing in a darker tone than the rest of the face, places the offending chin in an apparent shadow. Red under the nose casts an optical shadow, and various colours are used about the eyes to make them appear as desired on the films.

These first make-ups, of course, were achieved by the use of the grease-paint and powder of the stage. But on the stage such make-up is worn only a short time; in films the actor has to wear it all day. Perspiration, dust and great activity before the camera made necessary frequent renewals of the grease-paint make-up. Cosmeticians began experimenting to find combinations that would last longer. Liquid make-up was devised, in which the colouring pigment was suspended in a solution containing a gelatine-like material. This make-up was found to require less patching or repairing. Later a gelatinous make-up was developed, containing materials rich in violet, which requires less light to photograph. The invention of the panchromatic film gave a greater latitude to the camera in dealing with colours, thus permitting the natural face to be filmed, and eliminating the "straight" make-up, which

BY COURTESY OF (1, 2, 3, 6, 7) THE METRO-GOLDWYN-MAYER PICTURE CORPORATION, (4, 5, 8, 9) THE UNIVERSAL PICTURES CORPORATION

LON CHANEY. AMERICAN ACTOR, IN MAKE-UP FOR A VARIETY OF RÔLES

1. As Sergei in "Mockery." Grease paint without powder gives the greasy effect. 2. As the ancient Chinese mandarin in "Mr. Wu," a make-up produced with plastic material. The folds of the head-covering aid in making the face appear thin. 3. As the vampire in "London After Midnight." 4. front teeth. 5. Mr. Chaney without make-up. 6. As the clown in "Laugh, Clown, Laugh." 7. Close-up showing wrinkles, painted on by "liners" or grease paint pencils. 8. As Quasimodo in "The Hunchback of Notre Dame." 9. In "The Trap"

BY COURTESY OF (1, 2, 3) THE METRO-GOLDWYN-MAYER PICTURE CORPORATION, (4, 5, 6, 9) THE UNIVERSAL PICTURES CORPORATION, (7) THE PARAMOUNT FAMOUS LASKY CORPORATION, (8) U.F.A.

THE TECHNIQUE AND EFFECT OF MAKE-UP FOR THE SCREEN

1, 2, 3. Stages in the process of making up a young actor, John Mack Brown, for the part of an old man

4, 5, 6. Three poses of Mary Philbin, showing the striking differences effected by make-up: (4) as Dea, the blind girl, in "The Man Who Laughs"; (5) without make-up; (6) as the little slavey in "Stella Maris"

7, 8. Emil Jannings as the Russian aristocrat in "The Last Command," and in "The Last Laugh," showing two completely different facial outlines and types, produced by skilful make-up

9. Conrad Veidt as Gwynplaine in "The Man Who Laughs." The make-up was effected by false teeth, false eyebrows and a wig

is designed to allow the face to be more readily photographed. To-day men use little or no make-up for "straights," and women use a make-up which tends to bring out the good points of their faces and hide the poor ones, but in both cases the make-up is much simpler than ever before. With a knowledge of the fundamentals of stage and screen make-up and the many possibilities in the use of various paints and pigments, it remains for every screen actor to study the anatomy of his own face in order to appear "natural" before the searching close-up of the camera. The following instructions should be kept in mind for practical make-up.

METHODS OF MAKE-UP

Materials Used.—The necessities for make-up are: cold cream; grease-paint or liquid "ground" colours, graded from No. 1, a very light pink, to No. 13, a very dark brown, with No. 14, lavender, and No. 15, white; lining pencils, in black, brown, grey, blue, green and red; powder, ranging from white to olive; rouge and lipsticks, in four shades of red; starch or aluminium powder for whitening hair, also liquid colourings and brilliantine; nose putty; plasto, or undertaker's wax, for building up face, and collodion or "new skin" for scars; gutta-percha, black wax and white enamel for teeth; spirit gum and crêpe hair.

Straight or Foundation Make-up.—Apply cold cream, then wipe it off, to fill pores. Put on "ground" colour, grease-paint or liquid, and spread evenly, fading to nothing at nape of neck. After make-up for eyes, nose, etc., suggested below, powder thoroughly with lighter shade than "ground" paint, as it darkens when dry. To remove the entire make-up, apply plenty of cold cream and wipe off with towel.

The Eyes.—Shading is done with blue or violet lining pencils for soft shadows. Some use reds or grey-greens to shade blue or grey eyes. Black can be used, but with extreme caution, shading gradually to the eyebrows. For the eyelashes, women especially use mascara or sometimes a heavy black grease-paint.

The Nose.—A broad nose may be narrowed by drawing a high-light down the ridge of the nose with light paint, shading with red at the sides to determine the contour. Small nostrils are widened by inserting red around the edges, and large ones can be narrowed by high-lighting the same way.

The Lips.—Work the "ground" colour well into the edges and reshape with lip rouge, making corners come to a point. A small mouth can be enlarged by extending the red beyond the corners, and vice versa.

Hints on Character Make-up.—Shaping the nose, building up the cheek-bones, blotting out the eyebrows and making the eyelids heavy can best be accomplished by the use of putty or plasto wax. To puff out the face, cotton wool is often inserted between the teeth and the cheeks. This material is also used for making bags under the eyes. Cut into a crescent shape, affix with spirit gum and paint over, mixing a little olive oil with the paint. To broaden the nose, negro style, cut three-eighth inch ends of two rubber cigar holders and insert into nostrils. For scars, brush on collodion, which draws the skin; apply a second coat for deeper scars. To remove, add more collodion to soften the scar, then peel it off. For very old age, a thin coat of putty can be applied to the face and lines graved into it with a sharp point for criss-crossing deep wrinkles. Trace the lines with red water-colours. Do not line the eyes. Make shadows with colour a little darker than the foundation, and where face would sink the most make the shadow darkest, always keeping the anatomy of the face in mind.

For Chinese make-up use bits of library mending tissue to draw back the corners of the eyes, thus giving a slant to them. Cover with the "ground" colour, and then paint the eyebrows with an upward tilt. A number of light black lines downward from the inner corners of the eyes and upward from the outer corners accentuate the slant.

False teeth can be made by fitting dental rubber over the natural teeth, carving the sort of teeth wanted on this and painting with tooth enamel. False beards should be made with crêpe hair a little lighter than the natural hair. Comb out well, press in a book, cut off a straight edge, and after applying spirit gum on the face attach the straight edge to the face, and trim with scissors to the required shape. To grey the hair, apply starch or aluminium powder. The latter is better but much harder to wash out. "Polished brass" bronze powder, sold by paint stores, will "blonde" a brunette.

For the negro in film make-up use medium-brown grease-paint, not burnt cork. Cover the lips with the "ground" colour, and build them up with cotton or false teeth from the inside. Do not use a wig, but clip the hair and cover the head with a brown grease-paint. (*See* MAKE-UP.) (L. C.)

A UNIVERSAL LANGUAGE

The motion picture, by virtue of its intrinsic nature, is a species of amusing and informational Esperanto, and, potentially at least, a species of aesthetic Esperanto. Of all the arts, if it may be classified as one, the motion picture has in it, perhaps more than any other, the resources of universality. Even a simple waltz by Johann Strauss may remain alien and unassimilable to the musical ear of the Chinese; a Michelangelo fresco may fail to impress its significant beauty upon a Japanese or Hindu; a drama by Ibsen may remain completely unintelligible, even in competent translation, to a maharaja of India, just as Chinese music must ever remain strange, peculiar and incomprehensible to the Anglo-Saxon ear. But the motion picture art of Charlie Chaplin will inevitably make a Japanese laugh as heartily as a Dane.

The reason is simple. Pantomime is the aboriginal means of human communication and intercourse, and pictures bring to a child his first acquaintance with and understanding of the world about him. The motion picture, combining the two, is thus addressed to a common human understanding. It begins with the elementals of human perception and comprehension; it starts at the outset with the advantage of the fundamentals of human intercommunication and explicitness. It is for this reason that the moving picture has spread through the world and has been accepted far and wide in what has seemed an unbelievably short space of time.

The motion picture tells its stories directly, simply, quickly and elementally, not in words but in pictorial pantomime. To see is not only to believe; it is also in a measure to understand. In theatrical drama, seeing is closely allied with hearing, and hearing, in turn, with mental effort. In the motion picture, seeing is all—or at least nine-tenths of all.

This, of course, is the screen in its fundamental aspect. This is the motion picture simple and unsophisticated. This is the universal *engine* that is the cinema. The motion picture, plainly enough, in certain of its manifestations may remain largely vague and ambiguous to a people alien to the source of its imagination, preparation and making. But the motion picture in itself and in the aggregate is based upon materials of easy, common appreciation. Love, hate, desolation, despair, joy, ecstasy, defeat, triumph—these are universal emotions. Conveyed by words, as drama conveys them, they may offer difficulties to remote and various peoples. But conveyed by the movements of the human face and body, by smiles and tears, troubled brows and dejected shoulders, sparkling eyes and fluttering hands, they are immediately recognizable. A laugh or a sob is the same the world over. They need no words to explain them.

In another phase of the cinema, the so-called news-reel has already proved itself to be a form of journalistic Esperanto, just as the so-called educational moving picture has shown itself to be a form of informational Esperanto. The news-reel has brought to the far corners of the earth the life and daily activities of all nations and people. The educationals, as they are known, have acquainted the audiences of the world with various phenomena associated with invention, manufacture, discovery, ingenuity and enterprise peculiar to a certain country. The news-reel has informed every country of its neighbour, his leaders, his achievements, his troubles, his pleasures, his problems. It has spread a direct acquaintanceship with alien lands, peoples and customs to other lands. It has provided an international newspaper self-adapted to the understanding of all peoples, and a running commentary on contemporaneous history.

The motion picture is at once the common story-book, news-

paper and text-book of the 20th century. In its loftier aspects, it may conceivably elude the comprehension of audiences remote from its birthplace. That is, when it abandons its more elemental nature and strives for isolation as an art form. But that is the fate of art, all art, wherever it be found. Art is for the few, unfortunately; the generality of people have difficulty in taking it into their understanding. Shakespeare and the Orient may remain strangers; Leonardo and Dostoievsky may find no sympathy and hospitality in the consciousness of half a dozen lands. But there is probably no land where the spectacle of soldiers marching off to war or a fat man being struck with a custard pie is not instantaneously hailed with understanding. It is in *elementary* excitements and humours such as these, together with the thousand and one others that they connote, that the motion picture, reaching constantly after higher things, finds the mainspring of its wide and comprehensive appeal. It deals for the most part with primitive instincts, primitive impulses, primitive human peace and alarm, happiness and ache, ambition and dream. These may be dressed in strange costumes and may be shown through strange peoples, but underneath they are the emotions and inspirations and trials of all the human race. The backgrounds may be unfamiliar, but the hearts that beat and struggle, triumph or fall, are the hearts of all mankind. And so the world laughs with Chaplin and Lloyd, cries with Seastrom and Murnau and Griffith, startles at the revelations of Eisenstein, gasps pleasurably at Fairbanks and Valentino, feels tenderness with Mary Pickford and warms to the homely lovableness of Wolheim and Beery. (L. GI.)

EDUCATIONAL FILMS

The United States.—The term "educational" has been commonly used in the motion picture industry to describe all pictures not made for recreational purposes or of an informative nature that may be employed by social organizations as aids to their aims and interests. Religious and historical drama and pictures of travel, science and industry have been thus classified.

Among the first educational motion picture productions was the *Passion Play,* a religious and historical drama filmed in 1898. Its use in religious services by a well-known evangelist introduced motion pictures for purposes of propaganda. *Tearing Down the Spanish Flag* was an historical drama which expired after the Spanish War. Brief pictures of troops taken by camera men during the Spanish War were the prototypes of the news weekly. The news weekly came on the screens of the United States in 1910 when Pathé Frères of Paris circulated a weekly issue of their Pathé Journal. The American edition was the Pathé News. One of the first scientific pictures was exhibited about 1902 by Charles Urban of London. Other products of European laboratories shown in enlargement, with slow or arrested motion, included subjects such as the growth of plants, the emergence of the butterfly from the caterpillar, the crystallization of chemicals and other processes. Treated as "fillers" in theatrical programmes composed of dramas, comedies, serials and news weeklies, they soon drew attention to the value of this new medium of expression as a teaching aid in schools. The animated drawings invented by J. R. Bray in 1911, provided a new means of indicating places on a map and of showing processes that could not be photographed.

Stimulated by this interest, the Motion Picture division of Thomas A. Edison, Inc., Selig, Essanay, Universal and other companies invested heavily in educational pictures. Charles Urban, George Kleine, Pathé and Gaumont, imported French, British and Italian films.

In 1912, the General Film Company distributed pictures made by the most important American producers and in the educational department of this company were assembled a large collection of educational films.

Between 1915 and 1925 some seven companies were organized to produce and distribute educational films for schools, churches, clubs, public institutions and industrial organisations. Over-production, print costs, national distribution of an expensive and "perishable" commodity to an unorganized market led to the failure of these organizations. Several motion picture companies continue to devote some effort to casual selling of these films: the Pathé Exchange, Inc. has established a large educational department and has maintained a steady output.

While producing and distributing groups were making efforts to open up new channels of distribution of educational films outside the theatre, organized social groups in increasing numbers were seeking ways and means of using motion pictures in their own work. Progressive schools used motion pictures that were available for auditoriums and class-rooms. Religious, social, industrial and civic groups have selected suitable pictures with the help of such agencies as the National Board of Review, the National Federation of Parents' and Teachers' Associations and certain women's magazines.

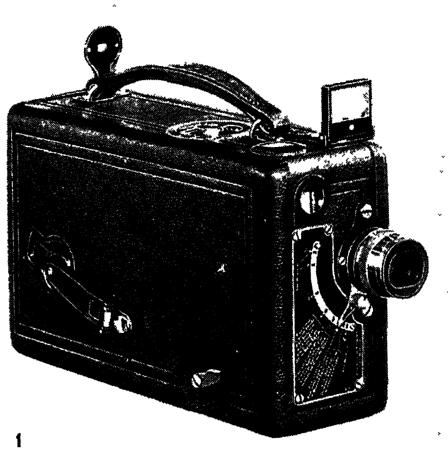
Experiments conducted by educators have proved that motion pictures have a place in the school and college curriculum. The Chronicles of America Photoplays, a series of pictures showing important episodes in American history, were produced by the Yale University Press. The divisions of anthropology and geology at Harvard university are co-operating with producers in the filming of a series of pictures on human geography and a series on physical geography. The University Film Foundation, sponsored by the Harvard Corporation, has extensive plans for the production of educational and scientific pictures. The recent development of sound motion pictures may extend the influence of educational films for class-rooms and other mediums.

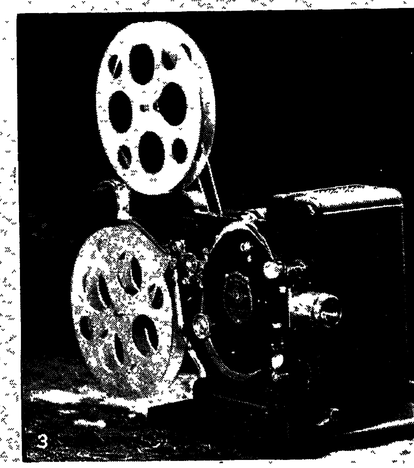
Commercial producers who are making important educational motion pictures for class-room use are Eastman Teaching Films, Inc., the De Vry Corporation and Pathé Exchange, Inc.

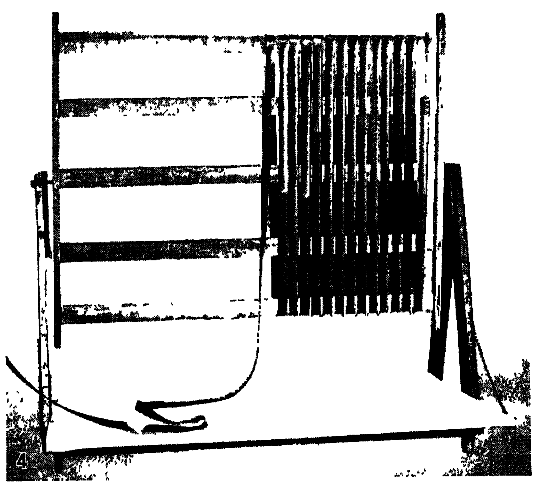
BIBLIOGRAPHY.—V. Lindsay, *The Art of the Moving Picture* (1915); Hugo Münsterberg, *The Photoplay: A Psychological Study* (1916); J. J. Weber, *Comparative Effectiveness of Some Visual Aids in Seventh Grade Instruction* (1921); M. J. Wrigley, *The Film: Its Use in Popular Education* (1922); G. and H. Bollman, *Motion Pictures For School and Community Needs* (1922); Anna V. Dorris, *Visual Instruction in the Berkeley Schools* (1923); Ellis and Thornborough, *Motion Pictures in Education* (1923); includes a bibliography of producers and distributors of motion picture films, projectors, screens, etc.; F. N. Freeman, *Visual Education* (1924), a volume presenting and discussing a series of experiments conducted to determine the value of visual instruction as compared with other methods of teaching; Sir James Marchant, *The Cinema in Education* (1925); Oscar W. Neale, *Picture Study in the Grades* (1925); *The Annals of the American Academy of Political and Social Science* (1926); A. P. Hollis, *Motion Pictures for Instruction* (1927); William H. Johnson, M.A., Ph.D., *Fundamentals in Visual Instruction* (1927); J. J. Weber, *Picture Values in Education* (1928); T. E. Finegan, "An Experiment in the Development of Classroom Films," *The General Science Quarterly* (1928); *The Educational Screen* (1922 *seq.*), the only magazine in the field of visual instruction, having absorbed *Moving Picture Age* and *Visual Education;* Daniel C. Knowlton, *Making History Graphic* (1925); *The Motion Picture;* and *National Board of Review Magazine;* A. V. Dorris, *Visual Instruction in the Public Schools* (1928). (E. R. D.)

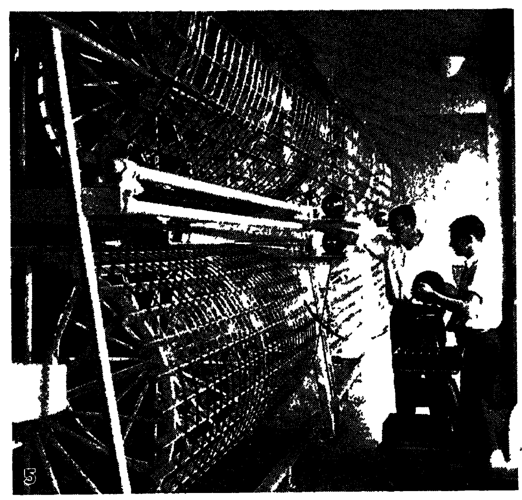
Great Britain.—The development of the educational film field in Great Britain, has been largely the work of a few commercial pioneers. The production of instructional films has necessarily been limited and without definite objective. In order to meet, in some degree, the cost of production, they have had to be edited with a view to making a popular appeal. Such films as "Hine Moa," "Livingstone," "Palaver," though originally produced for entertainment purposes, are now constantly in demand for instructional use owing to their value as illustrations to the teaching of geography and history. Films made by the enterprise of industrial companies or trade organizations for advertisement or propaganda purposes, such as the fine film issued by the London *Daily Telegraph,* illustrating the making of a great newspaper, are now sought as valuable aids to technical training.

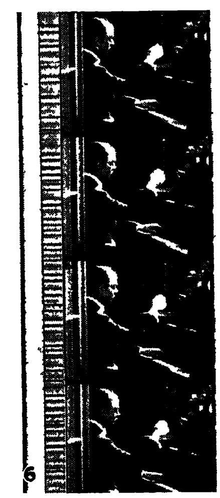
There are, however, definitely educational films which are the result of scientific research and enterprise and have been produced in collaboration with experts and educationists to record processes of nature, demonstrate the workings of the human system and present various forms and phases of animal life. These include the films of Professor Chalmers Mitchell, Secretary of the Zoological Society, and F. Martin Duncan, analysing animal movement and recording animal psychology; the intensive film studies of bird and insect life by Cherry Kearton and Captain Knight; studies of marine life produced under the auspices of

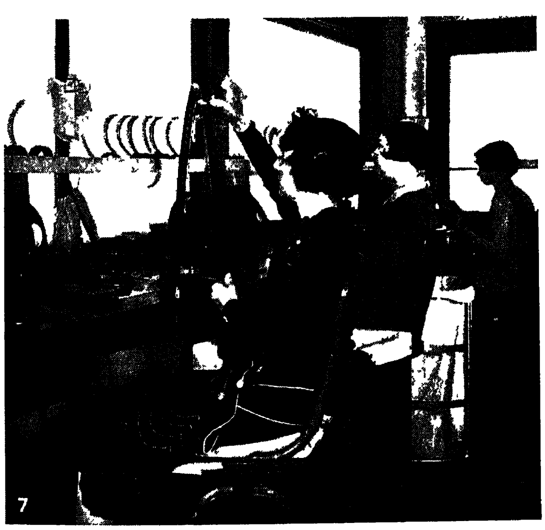


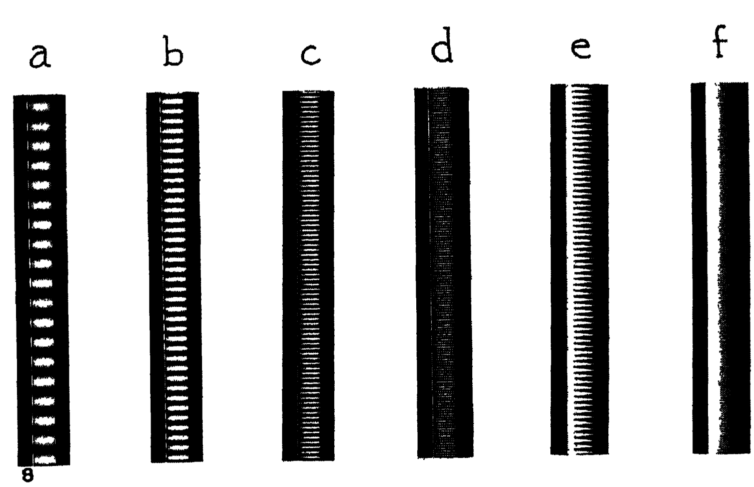












BY COURTESY OF (1, 3, 4, 6, 8) THE EASTMAN KODAK COMPANY, (2, 7) THE METRO-GOLDWYN-MAYER PICTURE CORPORATION, (5) THE PARAMOUNT PICTURES CORPORATION

TECHNOLOGY OF AMATEUR AND PROFESSIONAL MOTION PICTURES

1. Amateur motion picture camera adapted to take a 16mm. film, producing a picture about one-sixth the commercial size
2. A battery of cameras in the studio
3. Motor-driven amateur motion picture projector for the 16mm. film
4. Wooden developing rack on which the film is wound for submersion in a tank containing the developer
5. The sample copy drum room in the laboratory of the Paramount West Coast studio. It is in this room that all of the day's film is dried for immediate projection for the director and the players
6. An example of motion picture film showing pictures with corresponding sound record along the edge. The track is about 1/10 of an inch wide and sound is recorded on it photographically by two methods, the results of which are illustrated in detail in figure 8
7. Negative cutting. When the picture is finished to the satisfaction of the producers, a "master print" is sent to the laboratory for negative cutting. From the cut negatives hundreds of prints are made to be sent out to the theatres
8. Photographic sound records. a, b, c, d: variable density type, representing pure sine waves having frequencies of 100, 200, 400 and 700 respectively. e, f: variable width type, representing pure sine waves with frequencies of 100 and 400 respectively

the Marine Biological Association of Plymouth, etc. In medical science there are important films such as the X-ray photography of F. Melville, which records the pulsations of the heart, and the films of Dr. Canti, showing the development of the living tissues.

Many universities and colleges are at present supplied with projection apparatus but the use of them is very restricted. The elementary and secondary schools have shown a definite interest in the development of the cinema as a medium for classroom teaching. A stimulus to this interest was given in 1928 by the action of the London County Council in sanctioning officially the installation of projection apparatus in classrooms.

In 1928, the Oxford Education Committee undertook some interesting experiments for testing the value of the cinema as an instrument of teaching. Their report emphasized that, for senior work, there were relatively few films in existence designed primarily for teaching. Children's cinema shows are now emerging into the realm of practical business propositions and the demand for films is increasing. The Federation of British Industries has recently made the first attempt to compile a list of the educational film material available. This list, of 300 to 400 films, covers subjects which include Natural History, Botany, Human and Natural Geography, Zoology, Mechanics, Health, etc.

France.—In France the State has promoted visual education. In 1923, the Ministry of Agriculture drew up a scheme for developing the instructional cinema, a grant was made and a permanent cinema commission established. The Agricultural Film library now contains 2,450 films, including instruction on health, social hygiene, child welfare, first aid and kindred matters.

In 1915 an education commission recommended the desirability of introducing the cinematograph into every type of school, of instructing teachers in training colleges in its use, and of setting up an educational censorship. The Musée Pédagogique in Paris administers a State Library of 2,500 educational films and has established a wide system of loan distribution to schools; in 1926 34,000 feet of film were supplied.

Germany.—The majority of the educational films from Germany have been produced by the UFA Company and contain some of the most beautiful material yet available. Science and art here make a wonderful combination. The principal organization dealing with the educational cinema is the Film Department of the Central Institute in Berlin. Local Teachers Associations are formed to act as distributing agencies for the district schools. The German Film Alliance issues a list of German educational material, embracing such subjects as History, Mathematics, Political Economy, School Methods, Athletics, etc.

Italy.—In Italy the production and distribution of films of educational value is encouraged by the State.

Under the auspices of Mussolini an organization has been formed called L.U.C.E. (*L'Unione Cinematographica Educativa*), to produce films recording current events and dealing with educational subjects. All cinema houses must incorporate a certain percentage of "Instructional" films in their programmes.

Russia.—It would appear that the Soviet Government has ambitious programmes in hand and certain scientific films dealing mainly with vivisection exhibited at the European Educational Conference at the Hague (1928), showed a high degree of excellence in production. Considerable use is being made of the cinema in all branches of education, even in the teaching of the alphabet, as in a film showing the letters coming to life and running around the streets of Moscow. In 1927, the educational authorities ordered 2,000 new portable projectors from Germany for demonstration in schools and colleges.

Scandinavia.—The Scandinavian countries are all active in promoting interest in the Educational Cinema. In Sweden, a central body (the *Svenska Kinematografiska Sailskapet*) deals with all such matters, and schools are being induced to instal projectors.

Belgium.—The Educational Film Society of Belgium distributes regularly to its 26,000 members, a fine collection of pictures for weekly exhibition in its many centres.

Holland.—A Municipal Cinema has been established at The Hague, to which teachers may bring their classes to see instructional films. (M. Loc.)

MOTION PICTURE TECHNOLOGY

Motion picture work is technically a branch of photography. The general principles which cover the production of photographic images therefore apply to it, and the article on PHOTOGRAPHY should be consulted. The manufacture of the film is dealt with under PHOTOGRAPHY.

The Film.—The film is supplied in rolls 35 mm. (1·38 in.) wide and 200–1,000 ft. long in the case of the negative films, which are used in cameras. The positive film, on which the prints are made, is supplied in rolls 1,000 ft. in length in order to diminish the necessity for making joins. Negative film is generally supplied in two speeds, known as *Par-speed* and *Super-speed*, while a variety, sensitized by means of dyes, is known as *Panchromatic* film. On the edge of the film are perforations by means of which it is moved through the apparatus, and the exact dimensions of the film and of the perforations are very carefully standardized. Fig. 1 shows the standards adopted by the American Society of Motion Picture Engineers.

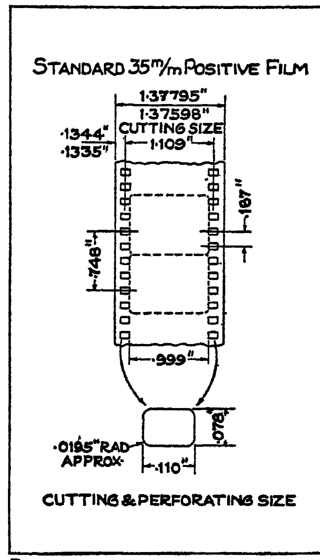


FIG. 1.—DIAGRAM SHOWING DIMENSIONS OF STANDARD 35 MM. FILM

The Camera.—The motion picture camera (*see* fig. 2) is arranged to move the film step by step through the *gate*, in which it is exposed to the light coming through the lens, the intermittent movement being accomplished usually by means of a claw, which

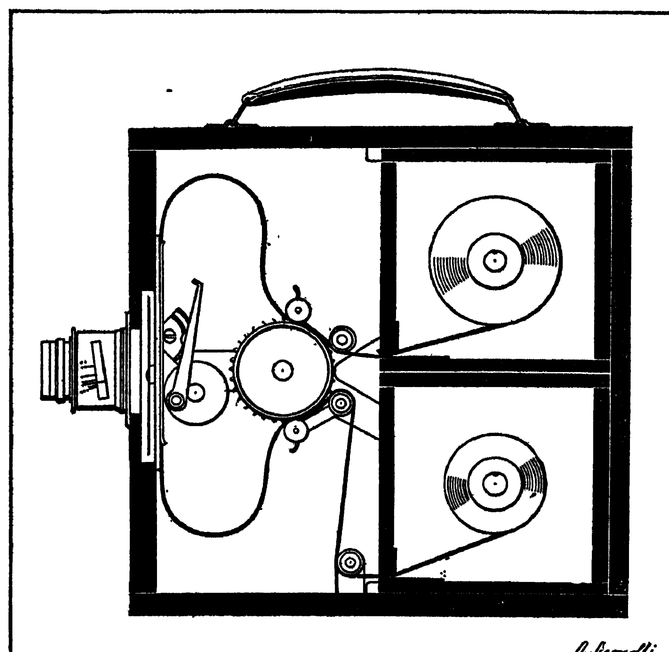


FIG. 2.—DIAGRAM OF MOTION PICTURE CAMERA AND LUMIÈRE CAM

is operated by a cam. The commonest form uses a triangular cam known as the *Lumière* cam because of its introduction by A. and L. Lumière of Lyons, France. By means of a sprocket, the film is fed continuously from the magazine, in which it is held, to the claw, and after passage through the gate is wound on to another magazine by the same or a second sprocket. Between the lens and the gate there is fitted a rotating shutter which protects the film from the light while it is being pulled down by the claw and then exposes it while it is stationary.

The cameras actually used in the motion picture studios are

beautiful pieces of engineering work, costing several thousands of dollars, and are distinctly heavy and complicated. They are supplied with several finders, by which the scene can be viewed or focused on the film. The lenses are carried in a rotating turret or in changeable mounts, so that lenses of different focal lengths can be used on the same scene without the camera being moved, and they are fitted with auxiliary apparatus by which "dissolves" and "fades" can be made and by which portions of the scene can be masked out. An important attachment to these cameras when used for field work is that by which high speed motion pictures can be made, these being taken usually at eight times standard speed. When such pictures are projected on the screen, everything appears to move at one-eighth the standard speed. This is used both for the analysis of motion and also to produce interesting or absurd effects.

For news and "topical" photography, portable cameras are generally employed, a number of these being driven by spring mechanism, so that they can be used in the hand without any tripod. Such a camera makes possible effects which would be very difficult to obtain in a hand-driven camera. Thus, it can be placed in front of an on-rushing train and a photograph obtained without any difficulty or danger, where an ordinary camera would require the excavation of a pit and a considerable amount of risk for the operator.

The studio cameras have magazines taking 200 or 400 ft. of film, a few of them, however, being now made with special magazines to take 1,000 ft. When making a sound film 1,000 ft. reels are used and the cameras are enclosed in special sound proof booths fitted with thick windows of optical glass.

Lenses.—The lenses used on motion picture cameras are almost invariably of large aperture, f/3·5 being about the minimum for the standard lenses, while frequently greater apertures are used up to a maximum of f/1·5. The standard focal lengths are 2 in. (50 mm.) and 3 in. (75 mm.), although for special work lenses of longer focal length are often used, 4 in. and 6 in. lenses being common. For photography of wild animals, etc., very long focus lenses are often used, it being possible by the use of a very steady tripod and an auxiliary support for the lens to use as great a focal length as 17 in. All these lenses are of the anastigmat type, every type of photographic objective, including tele-objectives, being used in motion picture work. (*See* PHOTOGRAPHY APPARATUS.)

The exposure is controlled both by the adjustment of the opening of the shutter and of the aperture of the lens. The standard taking speed is 16 pictures a second, so that if the shutter is set at 180°, the exposure of each frame is $\frac{1}{32}$ of a second.

Studio Lighting.—A few years ago studios were illuminated chiefly by mercury vapour tubes, but now the great preponderance of illumination is obtained by the use of powerful arc lamps known as "Kleigs," "sun arcs," and "broadsides." The current consumption for a small set, involving one room, will be commonly of the order of 300–1,000 kw. "Spot Lights" are used very largely to accentuate highlights, these varying from large projection "sun arcs," so called, to "baby spots" used for small areas. With the introduction of panchromatic film, the use of tungsten lamps is growing rapidly. These are used both in banks for general lighting and also in specially designed reflectors and projection systems for spots.

The great advantage of the tungsten lamp is its lightness and convenience, the chief cost of the lighting in a set being the large staff of electricians required to handle the lamps and point them in any direction required. The light and simple tungsten lamp equipments require a much smaller staff. For use in sound recording the silent tungsten lamps are very advantageous.

Development and Printing. *Development.*—After exposure, the negative film is developed, each scene usually being treated separately so that the best possible results can be obtained. It is customary to cut a short length from the end of the scene, which is purposely made too long, and to develop this by trial. The film is then wound on a rack and developed for the time which has been found best. In this way exposures corresponding to different contrasts in the subject may be developed to give uniform negatives. The racks on which the film is developed are of the type shown in Pl. XIII., fig. 4. Development is done in deep tanks, the film being moved carefully in order to reduce possible marks to a minimum and prevent air bubbles remaining on the film.

The use of machine development for negatives is now commencing, several of the large laboratories experimenting with a view to the development of all their negatives on the machine. This makes the individual treatment of scenes very difficult, but it has the advantage of insuring uniformity and of the avoidance of marks caused by the flowing of the developer around the end of the rack.

The developers may have as their base pyrogallol, metol and hydroquinone or glycin. A developer which diminishes the graininess of the picture uses metol-hydroquinone and contains a very large amount of sulphite, the alkali being borax. Typical formulae are as follows:

	Metric	Avoirdupois
Metol	2·0 grams	13 oz.
Sodium sulphite (desiccated)	18·8 "	7¾ lb.
Hydroquinone	0·5 gram	3¼ oz.
Sodium carbonate (desiccated)	12·5 grams	4¼ lb.
Potassium bromide	0·75 gram	5 oz.
Water to make	1 liter	50 gallons

Average time of development: 6–12 minutes at 65° F (18° C).

	Metric	Avoirdupois
Sodium sulphite (desiccated)	3·0 grams	20 oz.
Glycin	3·0 "	20 "
Sodium carbonate (desiccated)	6·0 "	2½ lb.
Water to make	1 liter	50 gallons

Average time of development: 15–25 minutes at 65° F (18° C).

	Metric	Avoirdupois
Metol	2 grams	13 oz.
Sodium sulphite (desiccated)	100 "	41 lb.
Hydroquinone	5 "	2 lb.
Borax	2 "	13 oz.
Water to make	1 liter	50 gallons

Average time of development: 12–25 minutes at 65° F (18° C).

The fixing, washing, and drying of the negatives are carried on with the greatest care since they are extremely valuable owing to the cost of the production and must be preserved for many years.

For many purposes duplicates are now made from negatives. These are made by printing upon a special duplicating film prepared by impregnating a fine-grained positive film with yellow dye. In this way, low contrast, great latitude, and high resolving power can be obtained. The prints are then barely distinguishable from those made from the original negative.

Printing.—After development a first print is made from the negative. These first prints, known as *rushes,* are viewed as soon as possible so that any scenes that have to be remade can be retaken at once. The negatives are then assembled and a first print is made which is passed over to the producing company to be *cut* and assembled in a form corresponding to the finished picture.

The printing of the negative is performed on a printer which may take one of two forms; in one, the two films are moved intermittently through a gate just as in the camera, the positive film being printed through the negative by means of a light which is cut off by a shutter while the films are being moved. In the other form of printer, the negative and print are moved continuously past a narrow opening and are printed in contact while moving. In both forms it is necessary that the intensity of the printing light should be modified from scene to scene according to the density of the negative. To effect this, a chart is made showing the exposures which it is necessary to give to each scene, and the negative is so notched that as the notches come into place in the gate they will operate a contact mechanism which, acting through a solenoid system, will change the intensity of the printing lamp. Sometimes these changes are produced by the operator.

Positive Development.—The positive film can be developed in the same way as the negative, being wound on racks for this purpose, but in modern practice it is more usual to develop it on an

automatic machine, of which there are several types. In one the film passes through a number of tubes in which it travels from the top to the bottom and then up again, tubes being assigned in succession to the operations of developing, fixing, rinsing, and washing, after which the film passes through a drying cabinet, from which it emerges ready for projection. In another form of continuous machine, tanks are used in place of the tubes, the film travelling in a spiral through the tanks. These continuous machines have a great capacity, it being quite usual for a machine to process as much as 20,000 ft. a day.

Much of the film used is made with a tinted base, the colour being applied to the base during its manufacture. This use of tinted base has supplanted the dyeing of the finished print, partly because it was difficult to apply the dye evenly and partly because the dye used made the gelatine brittle. Not infrequently also the image is toned by various processes, so that by a combination of tinting and toning, pleasing results can be obtained upon the screen. A small proportion of film is coloured either by hand or by the use of stenciling machines, while a growing amount is produced by the processes of natural colour photography (*q.v.*).

Motion Picture Colour Photography.—All the processes of colour photography used for motion picture work are derived from those developed originally for use in still photography. Reference should therefore be made to the section on colour photography included in the article on PHOTOGRAPHY.

The earliest process of motion picture photography was an *additive* process brought out under the name of "Kinemacolor" and developed by G. A. Smith and Charles Urban in 1906. In this process colour sensitive negative film was exposed alternately through red and green filters which so rotated in the camera that one picture was taken through the red filter and the next through the green, twenty-eight individual pictures per second usually being taken. After development, the negative was printed in the usual way, and the positive was projected through a machine fitted with a similar rotating colour shutter. The eye integrated the alternating red and green colours by persistence of vision, and a picture in natural colours was projected on the screen in which, however, the blues were lacking owing to the use of two colours only. The objections to the process were the use of special projecting machines; the loss of light in projection owing to absorption by the filters; the alternation of the colours which produced a flickering effect unpleasant to the eye; and a striping of red and green in the case of rapidly moving objects owing to the red and green objects being taken when in different positions. For brevity, this may be referred to as the "striping defect."

It will be convenient to consider here the problems involved in the design of cameras for taking motion pictures in colour. Such cameras can be of three general types:

1. The pictures can be taken in succession, as in the Kinemacolor process. This involves the "striping" defect.

2. The pictures through the filters may be taken simultaneously by the use of several lenses. Since these lenses must be in slightly different positions, each lens will see the object from a slightly different point of view, and if the scene taken has considerable depth, it will be impossible to register near and far objects simultaneously. This may be referred to as the *parallax* difficulty.

3. The several pictures may be taken simultaneously through one lens, the beam of light being subdivided by systems of prisms. This obviates both the striping defect and the parallax difficulty, but it involves a loss of light which owing to the absorption of the filters is always a great difficulty in colour work. In practice, it is advisable to use all three types of cameras. The first is convenient when photographing still objects, titles, etc. The second is the best for use in the photography of objects moving rapidly, and where there are no objects nearer than 15 ft., the parallax difficulty is entirely negligible. Where close-ups are required and rapid movement is involved, the third type of camera is absolutely necessary, and the difficulty with the exposure must be met by the provision of sufficient light intensity.

In addition to the Kinemacolor process, the "additive" process of colour motion picture photography was used by Gaumont, who employed three lenses, making each picture three-quarters of the standard height. The pictures were taken simultaneously in a three-lens camera and projected simultaneously by means of a triple lens projector. The results were excellent, but great difficulty was experienced in keeping register on the screen, variations in the film shrinkage producing differences in register which had to be corrected while the picture was being projected.

All the natural colour pictures which are available at the present time are made by the "subtractive" processes of colour photography. Essentially, these are two-colour processes in which the two pictures are printed on opposite sides of a film provided with emulsion on each face. A double negative is made in one of the types of cameras described above, and from this all the red filter negatives are printed on one side of the emulsion and all the green filter negatives on the opposite face in exact register with the first set. The two images are then converted into dye images by one of the processes described under colour processes in the article on PHOTOGRAPHY.

The only process which has had much commercial success is the "Technicolor" process. In this process the two negatives were originally printed on separate strips of film with thin base, great care being taken mechanically to preserve exact register at each step of the process. The prints of the two film negatives were converted into reliefs by tanning and washing off and they were then dyed. The two films were then cemented together back to back in exact register to make a film of standard thickness carrying a coloured image on each side. In a later modification of this process, reliefs are prepared by the method described, on thick base, but after dyeing, the dyed images are transferred in register to a clear gelatine coating on ordinary film base, the dye transferring to the gelatine by imbibition. The resulting prints are in character identical with the ordinary black and white film and are therefore more convenient for projection than the cemented double film.

None of the screen plate processes have up to the present been applied to motion picture photography, but the Berthon process (*see* PHOTOGRAPHY) was designed primarily for motion picture photography and has recently been brought on the commercial market as a process for amateur cinematography under the name of Kodacolor. In this process 50 ft. rolls of 16 mm. width film, coated with a panchromatic emulsion and embossed on the back with cylindrical lenses, are supplied in daylight loading spools to fit the 16 mm. amateur standard cameras. The lens, which must be of high aperture, f/2 or over, is provided with a special diaphragm containing a compound filter which takes the place of the ordinary hood. The only changes necessary to make colour photography possible, therefore, are the addition of the special filter to the lens and the use of the embossed panchromatic film. After exposure, the film is processed by a reversal process, by which it is converted into a positive ready for projection. The projector is fitted with a lens having a filter corresponding to the camera filter and on projection natural colour pictures are obtained on the screen, the only limitation being that the loss of light caused by the absorption of the filters involves the use of a screen approximately one-sixth of the area that would be used for black and white.

Projection.—The projection room is a very important part of the motion picture theater. The projectors are installed in a special room fitted with ports through which the light beams are thrown and with arrangements for protection against fire. It is usual to have several projection machines, so that a long picture can be projected without interruption, a new machine being started as each reel runs out.

The projection machines are essentially of the same type as the camera; that is, they involve an intermittent movement of the film during which the light is cut off by a shutter, but this intermittent movement is usually accomplished by means of what is known as the Maltese cross or Geneva movement (*see* fig. 3). This moves intermittently when the operating wheel carrying the pin which enters the cross is moved continuously, and the movement has the advantage over the claw and cam system that it is very robust and can be made to work immersed in oil.

The shutter has usually two blades, one of which is used to cut off the light during the movement of the film, the other inter-

rupting the light, while the film is still, thus diminishing the flicker seen on the screen. This flicker, however, together with the demands of the program, has induced the practice of projecting at a much higher speed than that at which the film was taken in spite of the unnatural effect produced in movements shown on the screen. The standard taking speed is 16 pictures a second or 60 ft. a minute. A typical minimum projecting speed is 85 ft. a minute, while speeds as high as 100 or more are common. It is this which produces the curious action particularly noticeable in people walking.

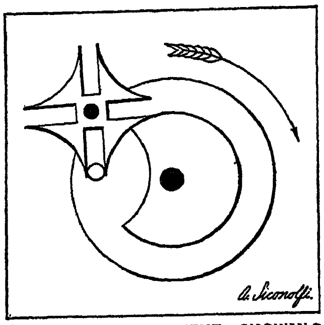


FIG. 3.—ENLARGEMENT SHOWING MALTESE CROSS MOVEMENT

The light sources used for projection are chiefly arc lamps. In modern theatres either high intensity arcs having carbons loaded with chemicals are used or mirror arcs in which the crater of the arc is turned away from the gate and the light from it is thrown forward by a large concave reflector. For projection at a short distance or with small screens good results are obtained by the use of high intensity incandescent lamps.

A great deal of work has been done on continuous projectors in which the film moves through the gate continuously and the image is kept stationary upon the screen by means of some optical system of rectification, such as a rotating ring of lenses which compensate for the movement of the film or rotating prisms or mirrors which hold the image still. These machines have not come into general use though some of them appear to be satisfactory mechanically.

After projection the film must be rewound and should be examined carefully and all damaged or weak places repaired.

Amateur Cinematography.—Cameras have been placed on the market by means of which amateurs can take motion pictures without the use of the elaborate and expensive apparatus employed by the professional cinematographer. Some of these cameras, while of small size, use motion picture film of standard width (35 mm.) and differ from professional apparatus only in the short length of the film which they take and in their low cost. Cheaper forms of projectors taking standard film are also supplied for the use of amateurs, but the cost of the films and of their development and printing has prevented any rapid extension of the use of this apparatus among the general public.

Cameras have been made taking sub-standard film particularly intended for use in amateur cinematography. Two sizes have been introduced: In France, a film 9½ mm. wide has been introduced by the Pathé Co. Nine metres are supplied in magazines for use in a small camera, and the film after exposure is developed by means of a reversal process which transforms the original negative into a positive which is then ready for use in a projector.

The Eastman Kodak Co. in 1923 introduced a film 16 mm. wide to make a picture approximately one-sixth of the area of standard pictures, and they and other manufacturers have placed on the market cameras and projectors adapted to take this small size of film. The film is packed with paper leaders attached to the end on a special reel so that it can be placed in the camera without the use of a darkroom, and after exposure the processing is done by means of a reversal process which transforms the negative into a positive ready for projection. The reversal process gives to the original prints very great freedom from grain, so that when projected they are entirely satisfactory upon the screen. Duplicates can be made from the original positives, standard size film can be reduced to the 16 mm. size, and the 16 mm. film can be enlarged to give pictures of standard size, although in doing this a certain amount of graininess in the resulting print is inevitable.

The cameras supplied for this purpose are portable and are driven by a spring motor (*see* fig. 1, Plate XIII). The projectors also are motor driven and convenient in use (fig. 3, Plate XIII.) so that amateur cinematography is increasing very greatly in its use and applications. In addition to its employment for personal pictures and for the recording of travel, it is much used for scientific and medical work, special apparatus being available for motion picture photomicrography and for high speed photography. Copies of theatrical films are available from libraries and are also sold in large numbers. The small and portable 16 mm. projectors are finding a considerable application in industry and in schools.

Synchronization with Sound.—During the past decade much work has been done on the synchronization of sound with motion pictures. In fact the development of the motion picture itself by Thomas A. Edison was due largely to his desire to have pictures to accompany his newly invented phonograph. The practical realization of the synchronized sound and picture records has been made possible, however, only by the recent rapid progress in electrical methods for the reproduction and amplification of sound.

Thus far, two general methods for obtaining the desired results have been developed. One of these embodies the synchronization of the motion picture with the sound record recorded on a composition disk. This was demonstrated successfully first in 1926 under the name of "Vitaphone." A flat composition disk carrying the sound record is attached to a motion picture projector in such a way that the sound is synchronized with the projected picture. The vibrations imparted to a needle operating in the grooves of the sound disk cause variations in an electrical circuit; they are then amplified by means of a suitable assembly of three-electrode valve-tubes, and finally reproduced through an electrical loud speaker.

The other general method involves the recording of the sound along the edge of the motion picture film by photographic means. The picture area is diminished slightly and a narrow strip approximately $\frac{1}{10}$ inch wide is devoted to the production of a sound record. Records made by the photographic method may be divided into two classes: (a) variable density records, and (b) variable width records. In making the sound record the film is drawn at a uniform linear velocity past a very narrow "slit" which may be either an actual physical slit placed very close to the emulsion surface of the film, or an optical image of a physical slit or narrow light source placed at some distance from the film surface. In the case of the variable density method the intensity of the radiation passing through the "slit" is so modulated that the record consists of a series of lines and spaces extending laterally across the sound track. This type of record is illustrated in Plate XIII, fig. 8. The sound is picked up by means of a microphone such as is used in radio broadcasting stations. The electrical currents are then amplified and used to modulate the intensity of the light incident on the slit. The intensity of the light incident on the slit may be modulated by either of two methods: changing the brightness of a lamp of the gas-filled, glow-tube type, or else in changing the width of an aperture having this dimension variable. The records shown at *a, b, c* and *d,* in this figure represent a pure sine wave having a frequency of 100, 200, 400, and 700, respectively.

In case of the variable width type of record the spot of light illuminating the slit is moved back and forth laterally, the movement being controlled by the amplified electrical currents coming from the microphone. This results in a record similar to those shown at *e* and *f* in fig. 8 of the Plate, these representing pure sine waves of frequencies of 100 and 400, respectively.

The manner in which the sound is reproduced in the motion picture projector is illustrated schematically in fig. 4. The filament of the lamp is imaged by the condenser on a narrow slit as indicated. The objective re-images this slit on the sound track carried by the film. Transmitted light then falls upon a photo-electric cell in which it produces a current depending upon the intensity of the light. (*See* PHOTOELECTRICITY.) As the film travels at a uniform linear velocity, the amount of light passing through the film and falling on the photo-electric cell is controlled by the variation in density or by the variation in width of the sound track image. The variable current flowing through the photo-electric cell is then amplified by the usual three-electrode valve-tubes and finally reproduced as sound by means of a loud speaker. In

some cases the objective shown in the figure may be dispensed with and the slit itself placed very close to the film.

In fig. 6 on Pl. XIII. is shown an example of a motion picture positive film with the accompanying photographic record in the sound track at one edge.

Both systems for the reproduction of sound in synchronism with pictures are capable of giving excellent results, especially where

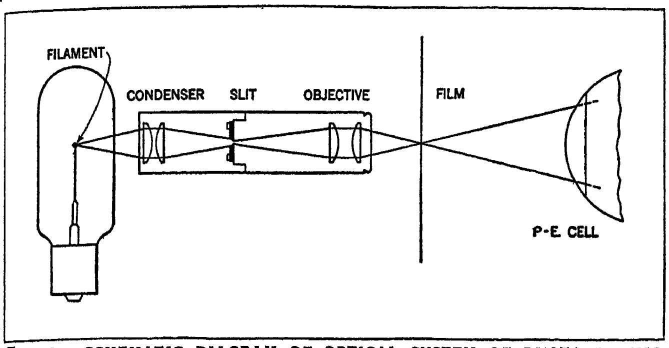


FIG. 4.—SCHEMATIC DIAGRAM OF OPTICAL SYSTEM OF PHOTOGRAPHIC SOUND REPRODUCTION

incidental music suitable for the film is to be supplied, and it is probable that such musical films will to a considerable extent displace the use of orchestras in small theatres. (C. E. K. M.)

BIBLIOGRAPHY.—F. A. Talbot, *Moving Pictures* (1923); Terry Ramsaye, *A Million and One Nights* (1926); Homer Croy, *How Motion Pictures are Made* (1918); Lescarboura, *Behind the Motion Picture Screen* (1919); Lindsay, *The Art of the Motion Picture* (1922); Minsterberg, *The Photoplay* (1916); Freeburg, *The Art of Photoplay Making* (1918); Freeburg, *Pictorial Beauty on the Screen* (1923); Seabury, *The Public and the Motion Picture Industry* (1926); Van Zile, *That Marvel—the Movie* (1923); *Film Year Book*, Film Daily, New York; P. Milne, *Motion Picture Directing* (1922); H. Carr, *How the Great Directors Work* (1925); C. B. DeMille, *The Story of the Films* (1927); D. Brown, *Cost Elements of a Motion Picture*, No. 17 of the *Transactions* of the Society of Motion Picture Engineers; J. R. Cameron, *Taking and Showing of Motion Pictures for the Amateur* (1927); M. J. Wrigley, *The Film: Its Use in Popular Education* (1922); G. and H. Bollman, *Motion Pictures For School and Community Needs* (1922); Ellis and Thornborough, *Motion Pictures in Education* (1923); Sir James Marchant, *The Cinema in Education* (1925); Oscar W. Neale, *Picture Study in the Grades* (1925); William H. Johnson, M.A., Ph.D., *Fundamentals in Visual Instruction* (1927); *Picture Values in Education* (1928); T. E. Finegan, "An Experiment in the Development of Classroom Films," *The General Science Quarterly* (1928); *The Educational Screen* (1922 *seq.*), the only magazine in the field of visual instruction.

MOTION PICTURE THEATRE. The growth of the motion picture theatre is almost as remarkable as the development of the motion picture itself. From the "store-show" with its primitive "movies" of the early days, to the palatial buildings which house the costly film productions of to-day is indeed a far cry. Yet the progress of the motion picture theatre, as an institution of ever expanding influence in community life, is no less remarkable. While its primary purpose is and must always be the entertainment of its patrons, the film theatre has become the gathering ground and often the well-spring of many important public movements and forms of civic expression. In the smaller communities especially, the theatre owner or manager is fast becoming a personage to whom, if any worthy cause calls for public discussion and thought, his fellow citizens look for co-operation and advice. The power of the screen has been said to transcend even that of the newspaper, of which, in its potentialities for public service, it has fittingly been called the complement. Its messages are delivered directly to an audience whose entire thoughts are then occupied by what is registered through the eye. The reaction, therefore, is necessarily immediate and the fullest understanding is obtained. This element of service has been considerably augmented by the introduction of sound pictures, now (1929) in a state of development, but with possibilities of a most pronounced character.

A Civic Centre.—The possibilities of the motion picture theatre as a centre from which the greatest amount of information may be distributed to the largest number of people in the shortest time were not fully recognized until the World War. The work done during and since this period for the Red Cross and kindred institutions is a matter of record. Gatherings of citizens were then furnished ready-made for speakers on behalf of the nations' problems, a service that could not have been secured in any other way with the same facility, and whose value would be hard to measure. But while this emergency may have attracted attention to the growing importance of the screen, during the ensuing years it has established itself as more than a medium for transmitting emergency messages. In its finest aspect the motion picture theatre has become an institution unique in its potential service. It may combine much that formerly lay exclusively in the domain of the church, the school or the newspaper. But in addition to these it has advantages that are distinctively its own in furthering local or national activities. The finest romances of history and fiction have been depicted for the entertainment of the world. Through the news-reels, slow motion pictures, nature studies, travel photoplays and the visualizing of scientific experiments, the people of every nation have been instructed and entertained. The humour of the screen, the comedy relief, so necessary to all well-balanced programs, has improved consistently. Finer wit finds its way to the screen, developing a better sense of humour. Viewing it still more broadly, it may reasonably be hoped that the motion picture theatre will be one of the ultimate factors in developing and establishing the international understanding and good will that all nations hope for but at times seem far from attaining. (R. F. W.)

MOTIVE, in psychology, a general term signifying any element of consciousness which prompts an agent to a decision (from Lat. *movere*, to move). The older psychology usually regarded motives as strictly analogous to mechanical forces exerting pressure or tension, and explained human action as necessarily determined by the resultant of various, possibly conflicting, motives. Contemporary psychological research tends to show with increasing clearness that we must recognize a power of decision in the self, and that the analogy of mechanical forces is inadequate to explain the facts. On this view motives will be regarded as solicitations to act in a certain direction, while the self decides by throwing its volitional weight on the side of the motive which it regards as preferable. The solicitations may come from the most diverse sources: they may be mere desires to avoid some pain or to gratify some appetite; or they may be of higher origin, such as the motive of patriotism, or the desire to advance knowledge. Purposes or ends are often termed motives. "Conflict of motives" means sometimes a conflict of purposes, when the agent has adopted two different lines of action and has difficulty in combining them; or it may mean a conflict of solicitations. It is better to call purposes or ends by those names when they have been definitely adopted by the agent: while they are still under deliberation the term "motive" may be used.

MOTLEY, JOHN LOTHROP (1814–1877), American historian, was born April 15, 1814, at Dorchester (now a part of Boston), Mass., and graduated at Harvard in 1831. He then studied at Göttingen and Berlin, becoming a friend of Bismarck at Göttingen, and after a period of European travel returned in 1834 to America, where he continued his legal studies. In 1837 he married Mary Benjamin, and in 1839 he published anonymously an unsuccessful novel entitled *Morton's Hope*. In 1841 he entered the diplomatic service as secretary of legation in Russia, but resigned his post within three months. Returning to America, he soon entered definitely upon a literary career. Besides contributing various historical and critical essays to the *North American Review*, he published in 1849, again anonymously, a second novel, entitled *Merry Mount, a Romance of the Massachusetts Colony*. About 1846 the project of writing a history of Holland had begun to take shape in his mind, and, after working in the United States, he spent five years at Dresden, Brussels and The Hague in investigation of the archives. *The Rise of the Dutch Republic* (1856) speedily passed through many editions, was translated into French, and also into Dutch, German and Russian. In 1860 Motley published the first two volumes of its continuation, *The United Netherlands*, which was brought down to the truce of 1609 by two additional volumes,

published in 1868. Partly as a result of his letters to the London *Times* on the causes of the Civil War, Motley was appointed U.S. minister to Austria in 1861, a position which he filled with success until his resignation in 1867. Two years later he was sent to represent his country in London, but shortly after was recalled by President Grant. After a visit to Holland he again took up his residence in England, where the *Life and Death of John Barneveld* appeared in two volumes in 1874. Ill-health and the death of his wife now began to interfere with his literary work, and he died at Frampton Court, near Dorchester, Dorsetshire, on May 29, 1877. The merits of Motley as an historian are undeniably great. He has told the story of a stirring period in the history of the world with full attention to the character of the actors and the vivid details of the action, showing as well a most commendable thoroughness in research.

The Netherlands edition of Motley's *Writings* appeared in 1900, and an excellent edition of his historical works was published 1903–04.

BIBLIOGRAPHY.—*See* the *Correspondence of John Lothrop Motley*, edited by G. W. Curtis (1889); O. W. Holmes, *John Lothrop Motley, a Memoir* (1879); M. D. Conway, *Biographical Introduction to The Rise of the Dutch Republic* (1896); *John Lothrop Motley and his Family: Further Letters and Records* (1910), edited by his daughter, Mrs. Susan St. John Mildmay; and the chapters on Prescott and Motley in J. S. Bassett, *The Middle Group of American Historians* (1917), and *The Cambridge History of American Literature* (1918).

MOTLEY, *i.e.*, of many colours, a term particularly used of the parti-coloured dress of the professional "fool" (*q.v.*) of the middle and later ages. The origin of the word is probably to be found in "mote" (O.E. *mot*), a particle of dust, hence a spot or patch.

MOTMOT, the Mexican name of a bird of the genus *Momotus*. The motmots form the family *Momotidae*, very nearly related to the *Todidae* (*see* TODY) of coraciiform birds, the nearest allies being rollers (*q.v.*) and kingfishers (*q.v.*). In outward appearance the motmots have an undoubted resemblance to bee-eaters, but, though beautiful birds, various shades of blue and green predominating in their plumage, they do not exhibit such decided and brilliant colours. The motmots are neotropical, extending from southern Mexico to Paraguay, with the majority of species in Central America. Their ordinary food is small reptiles and fruits, and insects caught on the wing. In adult birds the shaft of the median pair of tail rectrices is devoid of barbs for the space of about an inch a little above the extremity, so as to produce a spatulate appearance. This peculiarity is produced by the motmot itself nibbling off the barbs. Darwin was aware of this strange habit, and suggested that it was an illustration of sexual selection, the bird seeking to make itself more attractive.

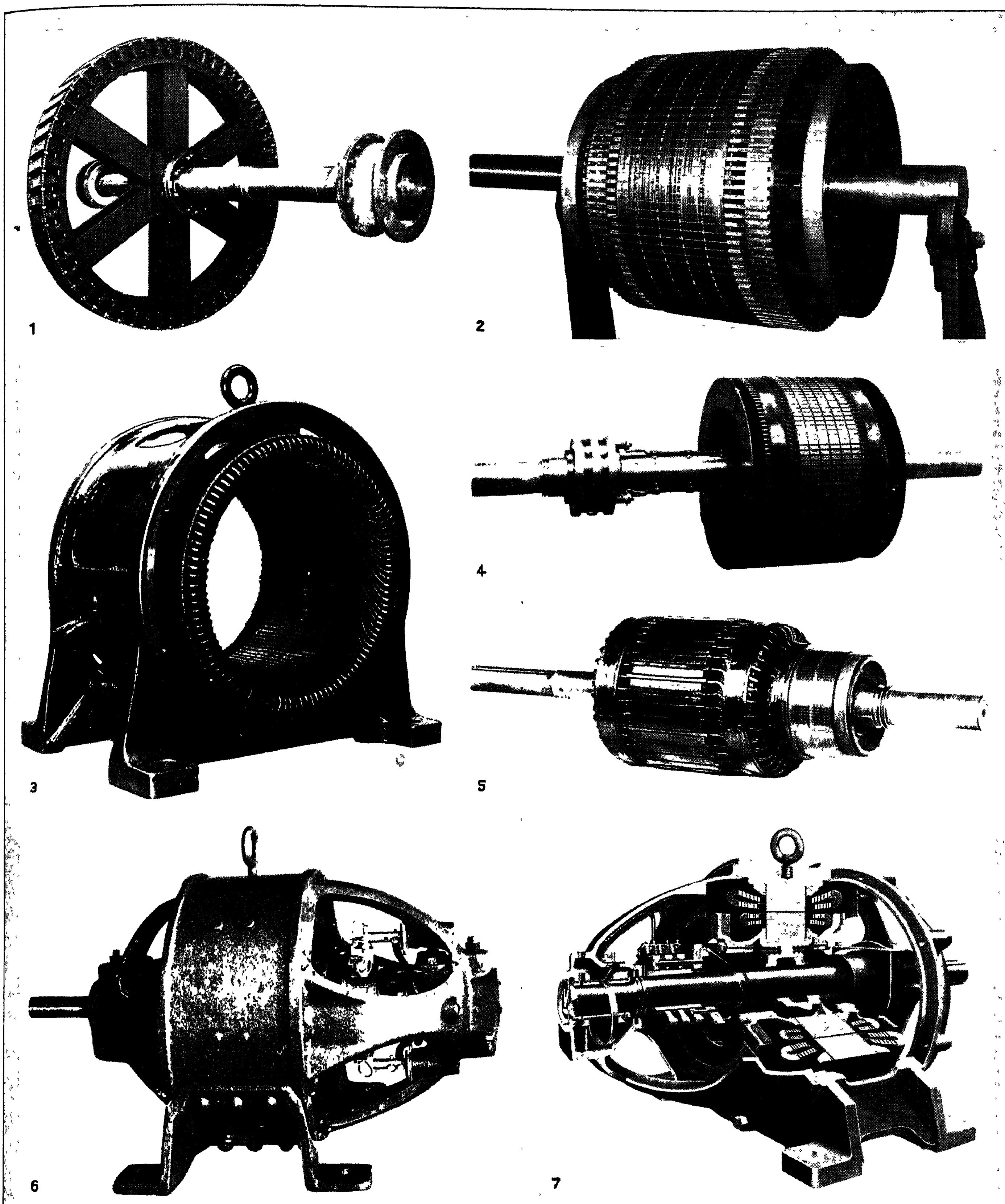
MOTOR, ELECTRIC. A machine for converting energy in the form of an electric current into mechanical work. This is accomplished through the use of two fundamental physical phenomena, the first, that an electric current passed through a wire surrounding an iron core causes a magnetic field to be set up in that core and, the second, that an electric current flowing through a wire situated in a magnetic field exerts a mechanical force on the wire tending to force it out of the magnetic field. Fundamentally, then, it may be said that an electric motor consists of four main elements, viz., (*a*) a mechanical structure which supports and protects the magnetic, electric and insulating members, and which transmits the mechanical force to the work; (*b*) a magnetic structure which carries the necessary magnetic flux or field; (*c*) one set of copper coils or windings for carrying the electric magnetizing current which sets up the magnetic field; (*d*) a second set of coils for carrying the electric working current which reacts on the magnetic field to produce torque.

GENERAL CLASSIFICATION

Electric motors are first classified with reference to the characteristics of the supply circuit from which electric energy is to be taken. There are two common forms in which electric energy is commercially distributed. These are *direct current* and *alternating current*. In the first of these forms the current is considered as flowing continuously in one direction around the circuit. The distribution of the current requires only two conductors. Ordinarily these two conductors are two copper wires, but in the case of street railway work a copper wire is used for one conductor and the earth or ground is used as the return side of the circuit. This arrangement avoids the necessity of carrying two trolley poles on the car. In the second form, or *alternating current*, the current is assumed as reversing its direction several times a second throughout the circuit and flowing alternately one way and the other. In the two most widely used systems of alternating current in use in the United States, the current reverses its direction or alternates 50 times per second and 120 times per second. Since two alternations are required to complete a cycle forward and back to the starting point, these two systems are known as 25 cycle systems and 60 cycle systems. This characteristic of alternating current energy is called *frequency*. Electric motors are, therefore, broadly classified as: (*a*) direct current motors and (*b*) alternating current motors. Direct current motors are further classified as: (1) shunt motors; (2) series motors; (3) compound motors; (4) compensated motors. Alternating current motors are classified as: (1) synchronous motors; (2) induction motors; (3) commutator motors. Induction motors are further classified as: (1) squirrel cage rotor motors; (2) phase wound rotor motors.

Structural Description.—In structural detail an electric motor consists of a stationary member and a rotating member, usually called respectively the field or stator and the armature or rotor, as shown in Plate, fig. 7. The stator is composed of (*a*) a *frame*, usually cylindrical, which serves as a mechanical support for the stationary magnetic structure and for the stator windings as shown in Plate, fig. 3. In machines of small and medium capacity, the frame also serves to support the brackets which carry the bearings in which turns the shaft or axle carrying the rotor parts. In direct current motors the frame forms part of the magnetic circuit; it may also support the brushes or carbon blocks which make contact with the rotating commutator and serve as means for introducing line current into the rotating coils on the armature as seen in Plate, fig. 6; (*b*) the stator magnetic structure consisting of individual or salient steel poles bolted to the frame in direct current motors and of a core built up in the axial direction of many thin sheet steel laminations in alternating current motors. These laminations have punched, in their inner periphery, bore slots or notches in which are placed the stator coils or field windings, as illustrated in Plate, fig. 7; (*c*) the field coils or stator windings which are electrically connected to the supply circuit and which conduct into the motor the electric current for magnetizing purposes. In alternating current motors the torque or working current is also taken into the stator windings, but in direct current motors the working current is taken into the armature or rotor through the stationary brushes and the rotating commutator. The rotating member, called the *armature* or *rotor*, shown in Plate, fig. 5, consists of (*a*) an axle or shaft which turns in the bearings and which serves to transmit the mechanical torque from the rotating magnetic core and windings to the pulley or gear or coupling, which is connected to the driven machine or work which is to be done. Mounted on the shaft and inside the bearings is (*b*) the rotating magnetic structure. In direct current motors and induction motors this consists of built-up thin sheets of steel laminations. These laminations have punched in their outer periphery slots in which are located the rotor coils. These laminations may be mounted directly on the shaft or carried through an intermediate member, usually of cast iron, called a spider. In the case of synchronous motors the rotor magnetic circuit consists of an annular steel rim to which are bolted salient radially projecting poles of solid or laminated steel seen in Plate, fig. 1; (*c*) the rotor windings of various forms situated in slots in direct current armatures and induction motor rotors as illustrated in Plate, fig. 5, fig. 2, fig. 4, and surrounding the complete pole in the case of synchronous motors; (*d*) the *commutator* in the case of direct current motors and alternating current commutator motors or *slip rings* in the case of phase wound rotor induction motors and synchronous motors. The function of the commutator and slip rings is described later.

Mechanical Modifications.—The construction just described applies to what are generally known as standard, open, horizontal



BY COURTESY OF THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY

VARIOUS TYPES OF ELECTRIC MOTORS

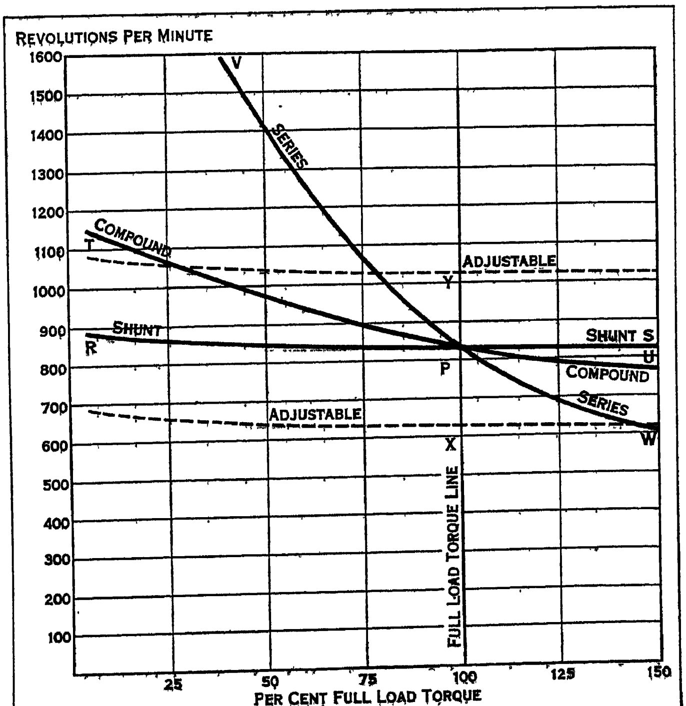
1. Rotating field of synchronous motor
2. Rotor of induction motor of the squirrel cage type. Straight bars of winding, and short circuiting rings form the squirrel cage
3. Completely wound stator of induction motor
4. Phase wound rotor for induction motor with collector rings on the left
5. Rotating member or armature for direct current motor. Commutator shown on the right
6. Direct current motor, industrial type, with open horizontal commutator and brushes seen through bracket opening
7. Cutaway view of wound rotor motor of induction type, showing all parts

motors. In order to take care of special conditions surrounding the work, it is sometimes necessary to make mechanical modifications, such as arranging motors with the shaft in a vertical plane instead of horizontal, or arranging for back gearing as a part of the motor, to secure comparatively low driving speeds. As a protection against mechanical dust or moisture or acid fumes, the openings in the frame and brackets are sometimes closed with covers. Such an impediment to the ventilation results in some reduction in the amount of power the motor can deliver without overheating, but this handicap is offset by the longer life of the winding and insulation and other parts susceptible to breakage or corrosion. In very special cases, as sometimes occurs in traction work, such combinations as the *twin* motor are worked out, in which two separate motors are mechanically connected through gears to one driving axle. Functionally, an electric motor, which converts electric energy into mechanical power, may be looked upon as the direct antithesis of an electric generator (*q.v.*) which develops electric energy by the application of mechanical power to a suitable structure. From this point of view, direct current machines and alternating current synchronous machines may be used reversibly as motors or generators, but alternating current induction motors, as described later, may not be reversed and used as alternating current generators, unless at the same time there are electrically connected in parallel with them suitable alternating current synchronous motors or generators.

Fundamental Mechanical Relations.—The electric motor, after converting electric energy into mechanical force, develops power by means of rotary motion. A consideration of this action involves the *torque* or turning effort and the revolutions per minute at which the torque is delivered. From fundamental physical relations, work is measured by the product of a force and the distance through which it acts, or W=Fs. Work is therefore expressed in foot pounds and may be considered as the work done in raising a weight against gravity. Mechanical energy is also measured in the same units. Further, power is the time rate of doing work and is expressed by dividing Work by Time, or $P=\frac{W}{t}$. The power of electric motors is usually expressed by a unit called a horsepower. This unit is the power required to lift a weight of 33,000 lb. through 1 ft. in 1 min., and the horsepower of a motor is calculated from the torque or turning effort at 1 ft. radius and the revolutions per minute by the formula:

$$\text{Horsepower} = \frac{\text{Torque}\times\text{revolutions per minute}\times 2\times 3{\cdot}14}{33{,}000}.$$

In this formula the torque is expressed as the pull exerted at the end of a lever arm or crank 1 ft. long, and the factors 2 and 3·14 are introduced in order to calculate the number of linear feet that this pull travels in one revolution. Multiplying by the r.p.m. and dividing by the equivalent of one horsepower gives the horsepower which the motor will develop. The simplest conception of torque is that the electric current creates two magnets, one in the stator and one in the rotor. In the case of direct current the stator magnet stands still and attracts to itself the rotor magnet, whose poles are not directly in line with it. At the first glance it would appear that the rotation produced by this attraction would be limited and that as soon as the south poles of the rotor were opposite the north poles of the stator rotation would cease. This would be the case if it were not for the action of the commutator and brushes, which introduce current successively into different coils on the rotor in such a way that as rapidly as a magnetic pole on the rotor is attracted to the nearest stator pole, the current is shifted into the next coil behind, with the result that the poles on the rotor are continually approaching the poles on the stator but never reaching them, since they are continually shifted back automatically by the action of the commutator. Structurally, the commutator consists of wedge-shaped copper bars built up to form a complete circular arch, as illustrated in Plate, fig. 5. These copper segments are separated and electrically insulated from one another by thin strips of mica, which permits attaching the ends of each rotor coil to separate commutator bars. The stationary carbon blocks or brushes make contact with the outer surface of the commutator bars, which, during the rotation, slide under them, and in this manner the current is always led into the proper coils to provide a continuous mechanical pull on the rotor, and this is the torque. As the mechanical work or load which the motor is called upon to do is increased or decreased within the normal rated torque of the motor, the torque developed and the speed at which the motor runs automatically adjust themselves until a stable running condition is reached. This variation in speed with changes in load is known as speed regulation. In the alternating current induction motor, the device of commutator and brushes is not used, but in their place advantage is taken of a principle discovered independently by Nikola Tesla and Galileo Ferraris in 1886. By this principle, if the windings of the stator of such a motor are supplied with polyphase alternating currents, a magnetic field of alternate north and south poles is set up in the stator iron core and this rotates in space independently of the mechanical rotor. This rotating magnetic field sets up or induces in the windings on the rotor electric currents, which in turn create magnetic poles in the rotor and, as a result, the rotor magnetic field is pulled around by the rotating stator field at a slightly lower speed than the rotation of the stator magnetic field. The r.p.m. of the stator field is obtained from the expression $\frac{\text{cycles}\times 120}{\text{number of poles}}$; *e.g.*, on a 4 pole, 60 cycle motor the r.p.m. of the rotating magnetic field would be $\frac{60\times 120}{4}=1{,}800$ r.p.m. The no load r.p.m. of the physical rotor is very close to this so-called synchronous speed, but the full load r.p.m. of the physical rotor drops a few per cent below this. In the alternating current synchronous motor, Plate, fig. 1, which is built like an a.c.



BY COURTESY OF THE WESTINGHOUSE ELECTRIC COMPANY

FIG. 1.—CURVES SHOWING THE VARIATION OF SPEED WITH LOAD OF VARIOUS TYPES OF DIRECT CURRENT MOTORS

generator, the magnetic field of the rotor is separately set up by direct current from an independent source. In this case the rotating magnetic field of the stator which is set up by polyphase alternating currents locks in magnetically with the rotor field and pulls it along synchronously. For this reason the no load and the full load speed of a synchronous motor are given by the expression: revolutions per minute $=\frac{\text{cycles}\times 120}{\text{number of poles}}$. The electric and magnetic relations in both direct current and alternating current motors and their theory and method of calculation are

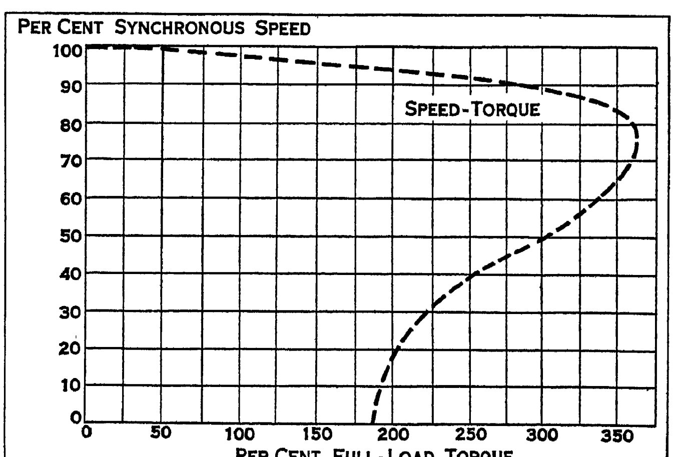
quite analogous to the same conditions in *electric generators* (*q.v.*).

Counter Electro Motive Force.—This is one fundamental principle to which special reference is here made as it is most useful in understanding the action of motors. Counter electro motive force is a back voltage generated by any motor all the time that it is operating as a motor and is of such a direction and such a value that it is directly opposed to and nearly equal to the voltage which is applied to the motor from the supply circuit. The slight margin between the applied line voltage and the generated back voltage (perhaps of the order of 3% to 5% of the line voltage) is just sufficient to send through the resistance of the windings a current which is automatically exactly sufficient to produce the torque required to drive the mechanical load. If the load increases the motor slows down a trifle and generates a little less back voltage, so that the difference between the line voltage and the back voltage is a little greater and hence an increased current flows in the motor, producing an increased torque to balance and carry the increased load. If the load decreases, the motor speeds up and less torque results.

SPEED-TORQUE CURVES AND CLASSIFICATION

In the application of electric motors to their work the characteristic to which the greatest attention must be paid is that of the variation of speed under load. A graph is drawn from standstill to the maximum speed which the motor attains, showing how the torque increases or decreases as the speed rises or falls. Such a graph or characteristic curve is called a *speed-torque* curve and illustrations are shown in figs. 1, 2, 3, 4. With reference to their speed-torque curves, motors are classified as follows: (*a*) constant speed; (*b*) varying speed; (*c*) adjustable speed; (*d*) multi-speed.

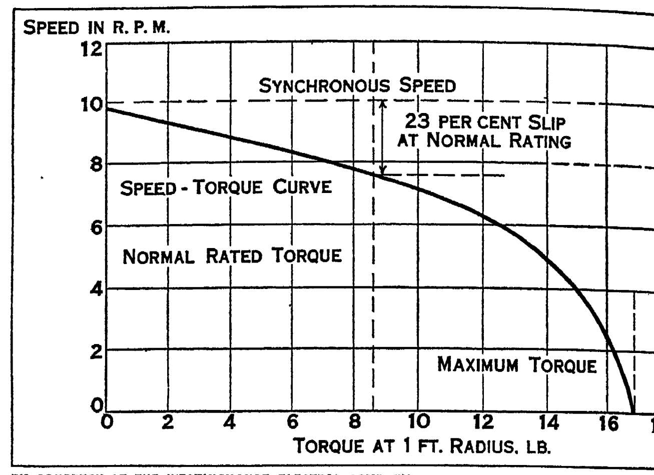
Constant speed motors run as nearly as possible to a fixed speed, regardless of change of load from no load to the maximum load which can be carried. A varying speed motor is one whose speed changes widely with load changes, in general running slowly under heavy loads and fast under light loads. Adjustable speed motors have the added possibility that by changing a rheostat or equivalent resistance control device the no load speed of a motor may be changed over a considerable range, but when once set for a given speed it will run practically at that same speed at any and all loads. Multi-speed motor is a term usually applied to alternating current motors, the connections to whose windings may be changed in such a manner as to change the number of magnetic poles and hence the speed of the motor. Like the adjustable speed motor, these motors, when connected for one speed, run practically constant at that speed, even under load changes.



BY COURTESY OF THE WESTINGHOUSE ELECTRIC COMPANY

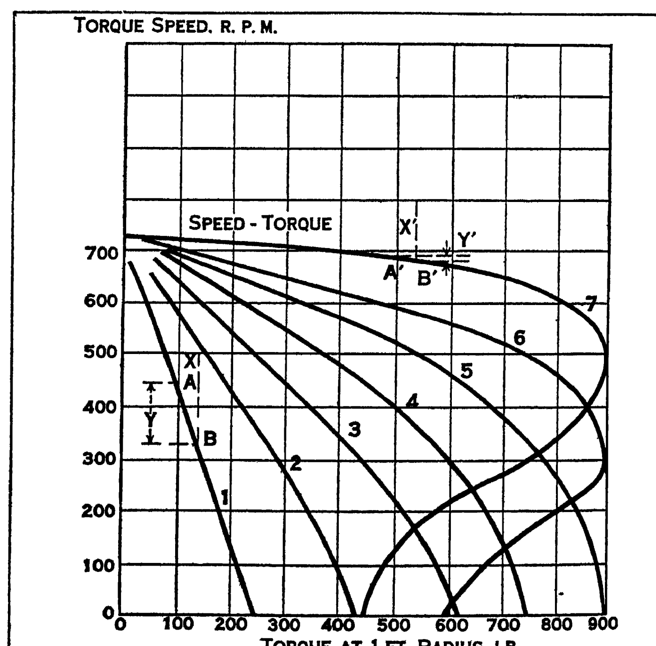
FIG. 2.—SPEED-TORQUE CURVE FOR INDUCTION MOTOR, WITH LOW-RESISTANCE SQUIRREL-CAGE ROTOR WINDING

Speed-torque Classification of Direct Current Motors.—The classification of direct current motors into shunt, series, compound and compensated has reference to the manner in which the magnetizing coils on the field magnets are wound. This is shown schematically in fig. 5. In the shunt motor the field coils consist of a relatively large number of turns of wire of relatively small cross section connected directly across the full line voltage as in *A*, fig. 5. It will be seen in this diagram that the field winding and the armature winding are in parallel across the supply voltage, or, using another expression, the field is *shunted* across the armature. In the series motor, whose connection is shown in *B*, fig. 5, the field coils are made up of a relatively small number of turns of relatively large cross section and the field coil is in series with the armature winding instead of being in parallel with it as in *A*. In the series motor the same current flows through the field coils that flows through the armature winding, and hence it is doubly effective, once in magnetizing the field and once in producing torque in the armature. For this reason the torque in a series motor is proportional to the square or second power of the current up to the point where the magnetic material of the motor is saturated with magnetic flux so that the field strength cannot be further proportionally increased. In the compound motor, whose connections are shown in *C*, fig. 5, the field poles are provided with a shunt coil and also with a series coil so that the motor partakes partly of the characteristics of a shunt motor and partly of a series motor. The compensated motor illustrated in *D*, fig. 5, is a special form of compound motor to which there is added a compensating



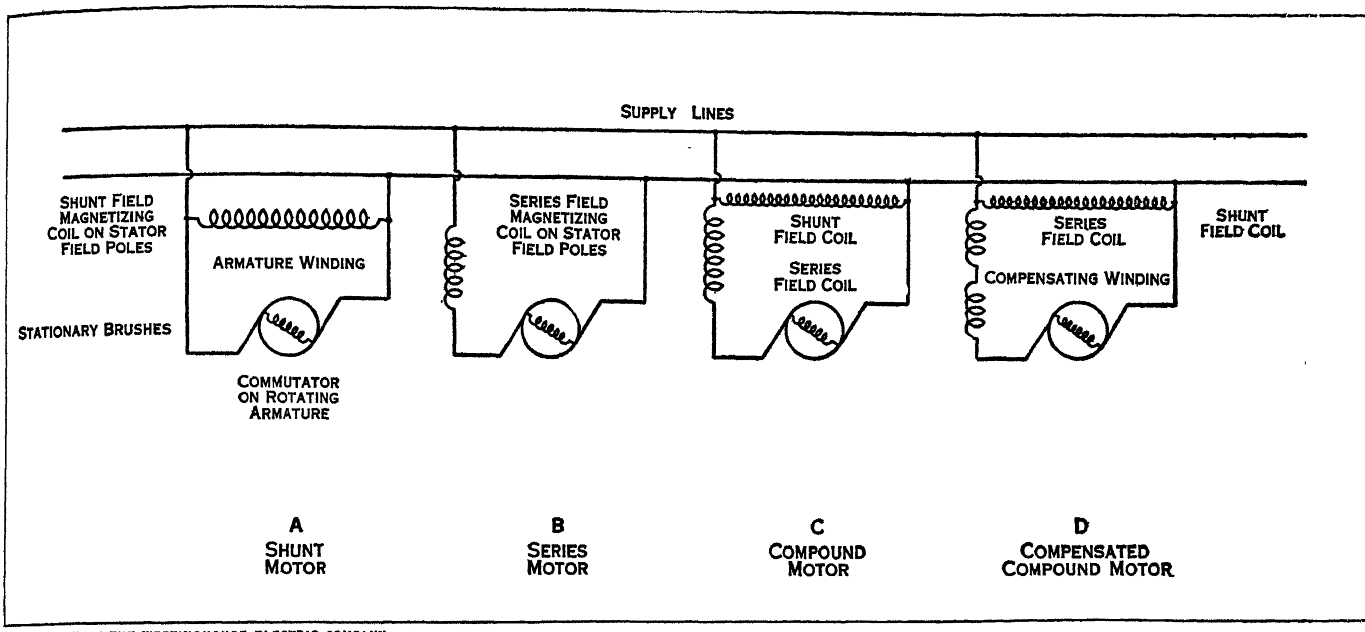
BY COURTESY OF THE WESTINGHOUSE ELECTRIC COMPANY

FIG. 3.—SPEED-TORQUE CURVE FOR INDUCTION MOTOR WITH HIGH RESISTANT SQUIRREL-CAGE WINDING



BY COURTESY OF THE WESTINGHOUSE ELECTRIC COMPANY

FIG. 4.—SPEED-TORQUE CURVES FOR INDUCTION MOTOR, WITH PHASE-WOUND ROTOR AND VARIOUS AMOUNTS OF EXTERNAL RESISTANCE

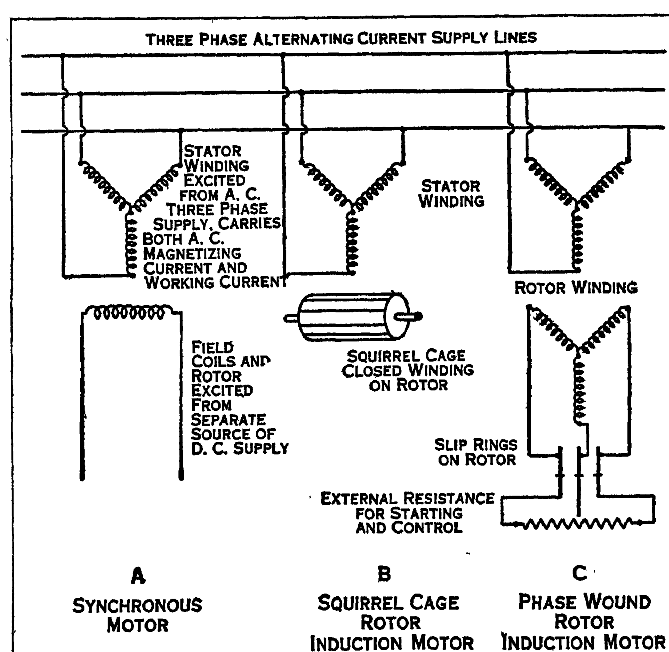


BY COURTESY OF THE WESTINGHOUSE ELECTRIC COMPANY

FIG. 5.—SCHEMATIC CONNECTION DIAGRAMS FOR DIRECT CURRENT MOTORS

winding in series with the armature winding which compensates for the magnetic effect on the field of the working currents flowing in the armature. This compensating winding is placed in slots in the faces of the poles. The compensating winding decreases the sparking which occurs to some extent on the commutator of all commutating motors, and also makes possible a very flat speed torque curve with almost no change in speed from no load to maximum overloads. The curves in fig. 1, illustrate the behaviour of the different classes of direct current motors when the load on the motor is varied. The load on the motor in per cent of full load torque is plotted horizontally and the revolutions per minute vertically. The same rated torque and the same full load r.p.m. has been chosen for three motors wound and connected respectively according to the schematic diagrams *A*, *B* and *C*, fig. 5. This full load point is shown as *P* in fig. 1 and the r.p.m. is 840. In the case of the shunt motor, the speed is seen to be fairly steady, varying from 880 r.p.m. at no load, point *R*, to 835 r.p.m. at 150% load, point *S*. The shunt motor is therefore classified as a constant speed motor. In the case of a compound wound motor, the speed regulation is much wider and the speed changes from 1,150 r.p.m. at no load, point *T*, to 770 r.p.m. at 150% load, point *V*. For this reason the compound motor is classed as a varying speed motor. In the case of the series motor, fig. 1, the change in speed with change in load is still greater, ranging from 1,600 r.p.m. at low load, point *V*, to 620 r.p.m. at 150% load, point *W*. If the load were removed entirely the speed would rise still higher than 1,600 and the motor possibly damage itself. It is therefore necessary on a series motor to make sure that some restraining load is provided at all times.

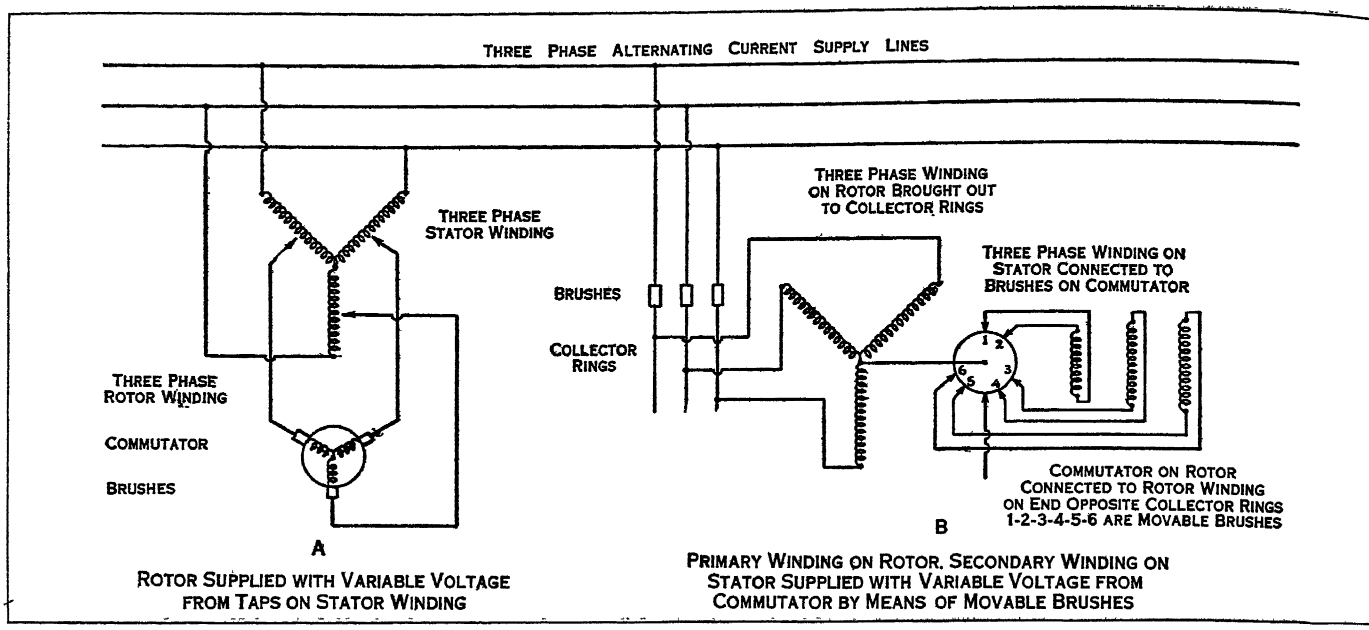
The case of the direct current adjustable-speed motor is illustrated by the dotted curves of fig. 1. This is shown to be a shunt motor provided with a rheostat in the shunt field, which permits the full load speed to be adjusted between a range of 640 r.p.m. and 1,040 r.p.m. When adjusted for one full load speed, the change in speed with changes in load is small, and is comparable, as shown by the two dotted curves, with the curve of the straight shunt motor. The speed-torque curve of a compound compensated motor can be varied in accordance with the desired application, but in general the motor is classified as a constant speed motor. The speed-torque curve would be similar to that of the shunt motor shown in fig. 1. Consideration of the curves in fig. 1 leads to the conclusion that where constant speed is required at all loads, a shunt or compound compensated motor would be used. As a matter of practice, nearly all modern shunt motors have a light series field coil to prevent the speed actually rising at heavy loads due to the demagnetizing effect of the armature current on the magnetic fields. Where heavy loads must be started and moved slowly and where lighter loads must be moved at higher speeds, a series motor is used or a very heavily compounded motor. Compound motors are used in general industrial work to drive tools such as punch presses and shears which are equipped with heavy flywheels. They are advantageous here for two reasons; first, because the starting duty is heavy, due to the



BY COURTESY OF THE WESTINGHOUSE ELECTRIC COMPANY

FIG. 6.—SCHEMATIC CONNECTION DIAGRAM FOR ALTERNATING CURRENT MOTORS OF THE SYNCHRONOUS AND INDUCTION TYPES

weight and inertia and, second, because their dropping speed curve as load comes on allows energy to be drawn from the flywheel to meet the sudden severe peak. After the peak load passes, the motor accelerates again and restores to the flywheel the borrowed energy. In the case of all direct current motors there is a direct relation between the speed and the supply voltage applied to the armature, as was inferred in the definition of counter electro-motive force. Advantage has sometimes been taken of this to secure varying or adjustable speed characteristics, either by placing an external resistance in series with the armature



BY COURTESY OF THE WESTINGHOUSE ELECTRIC COMPANY

FIG. 7.—SCHEMATIC CONNECTION DIAGRAMS FOR COMMUTATOR A.C. MOTORS

or by changing the supply voltage applied. The resistance method is objectionable because it wastes some power, but the variable voltage scheme is efficient and finds an important application in the control of large high-speed passenger elevators. As an additional desirable characteristic a direct current motor may be so controlled that it will act as a generator while the load is being brought to rest, and thus considerably lessens the duty and the wear on the mechanical brakes. This is particularly useful in the case of series and compound motors, as in the case of railway motors. This feature is called *dynamic braking*.

Table I. gives some typical applications for the different classes of direct-current motors.

motors on the main roll drives of steel mills and similar applications, a system has been worked out by using auxiliary machines of the commutator type which gives a true adjustable speed characteristic for the whole combination. This arrangement involves too much complication and expense to justify it in case of comparatively small units. Aside from this rather special application, the broad legitimate field of alternating current motors is in constant speed and varying speed applications. So great is the mechanical simplicity and ease of installation and maintenance of the squirrel-cage rotor induction motor that it is doing a major percentage of the world's work in general industrial applications where constant speed is required, coupled with comparatively infrequent starting duty.

TABLE I.—*Typical Application of Direct Current Motors*

Type of motor and control	Control speed	Adjustable speed	Varying speed
Straight shunt motor	Motor-generator sets Centrifugal pumps General purpose work		
Shunt motor with resistance in series with the armature			Fans or blowers
Shunt motor with field resistance control or variable voltage supply		General machine tool work Printing presses	
Compound motor			Screw downs on rolls Bending roll motors Cross head motors Punch presses Miscellaneous flywheel applications
Compound motor with variable voltage supply . . .			High-speed passenger elevator
Compound compensated motor	Continuous strap steel rolling Paper machine drives		Large reversing steel mill drives Mine hoists
Series motor			Railway work Crane work Industrial hoists

Speed Classification of Alternating Current Motors.—Many attempts have been made to develop an adjustable speed alternating current motor which would compare favourably with its direct current competitor, but up to the present time this cannot be said to have been accomplished. If it were readily feasible to vary the frequency of the alternating current supply this could be accomplished, but since such variation is attended with too much complication this field is practically monopolized by the direct current motor. In the case of very large induction

The typical constant speed alternating current motor is the *synchronous motor*, a diagram of which is shown in fig. 6, which, as has been explained, has an unvarying speed at all loads so long as the frequency of the alternating current supply remains constant. The synchronous motor in structural detail originally exactly duplicated an alternating current generator but as so designed had very little starting torque and could not be applied where compelled to start under load. Later an additional wind-

TABLE II.—*Typical Applications of Alternating Current Motors*

Type of motor and control	Constant speed	Adjustable speed	Varying speed
Synchronous	Motor-generator sets Synchronous condensers Centrifugal pumps Ice machines Air compressors		
Squirrel cage induction with low resistance rotor winding	Pumps Fans Positive blowers Line shaft drive Cement machinery Woodworking machinery Textile machinery Paper machinery General purpose work		
Squirrel cage induction with high resistance rotor winding			Laundry extractors Flywheel service (*a*) Punches (*b*) Shears Cranes and hoists Starting motors Valve motors
Phase wound rotor induction motor operated constant speed	Air compressors Ice machines Flour mills Belt conveyors Ship propulsion Locomotives Steel mill machinery		
Phase wound rotor operated varying speed			Hoists and winches cranes Elevators Flywheel motor generator sets Coal and ore unloaders Electric shovels
Commutator motors single phase			Electric locomotives Electric motor cars Domestic applications of small induction motors
Commutator motors polyphase		Textile applications Mine fans	
Phase wound rotor induction motor with auxiliary commutator machines		Main roll drives in steel mills Variable ratio frequency changer sets	

ing similar to that of a squirrel cage rotor induction motor was added to the rotor, and at the present time synchronous motors have sufficiently good starting characteristics to permit their use on many industrial applications formerly covered by induction motors. The speed-torque curve of a synchronous motor is a straight line at synchronous r.p.m. If loaded beyond the capacity of its torque to hold it in step the motor stops entirely and comes to rest. The synchronous motor has a very desirable characteristic from the standpoint of the supply system, in that it can be made to draw from the line a magnetizing current for its stator winding, which is said to be leading the supply voltage in time phase and which, therefore, compensates for the magnetizing current of induction motors on the same system, which current is said to be lagging. Expressed in a practical way, if a supply system is entirely loaded up with induction motors so that its generators cannot take on any more load, it may be possible to install additional synchronous motors and develop additional mechanical power without adding to the electrical load on the generator. So valuable is this characteristic that at times synchronous motors are run on a system without any mechanical load, merely to furnish this the so-called *leading current*. When so used, a synchronous motor is called a *synchronous condenser*.

The ***induction motor*** may be either a constant-speed or a varying speed motor as may be seen in fig. 6. In the squirrel cage rotor type, a constant speed motor has a comparatively low electrical resistance in the copper bars and short-circuiting rings of the rotor winding as shown in Neg. 105,482. If a varying speed characteristic is desired, the electrical resistance of the rotor winding is increased. The speed-torque curve for a constant speed squirrel cage rotor induction motor is shown in fig. 2. It will be noticed that the torque at start is about $1\frac{1}{2}$ times normal full load running torque and that as the motor speeds up the torque increases until maximum torque is reached and then decreases until the motor runs steadily at a torque corresponding to the load. Unlike the synchronous motor, which runs at all times at synchronous speed, or $\frac{\text{cycles} \times 120}{\text{number of magnetic poles}}$, it will be noted that the induction motor falls away slightly from synchronous speed and, at full load, runs, for example, at 3% to 5% below synchronous speed. This departure from synchronous speed is characteristic of the induction motor and is called *slip*. In the case of the varying speed squirrel cage rotor induction motor with high electrical resistance in its rotor winding the *slip* will be much greater, at rated full load torque and the speed torque curve will be typified by that of fig. 3. In this case it will be noted that maximum torque occurs at start and that the torque decreases as the speed increases. Also, that the *slip* at full load is 25% or much greater than in the case of the constant speed motor. Such a speed-torque curve is desirable where heavy loads are to be started, perhaps frequently. Moreover, the varying speed motor has the further desirable characteristic that the current required in starting is less. On the other hand, it is less efficient when running continuously by a percentage represented by the increased slip. The phase wound rotor induction motor has a coil

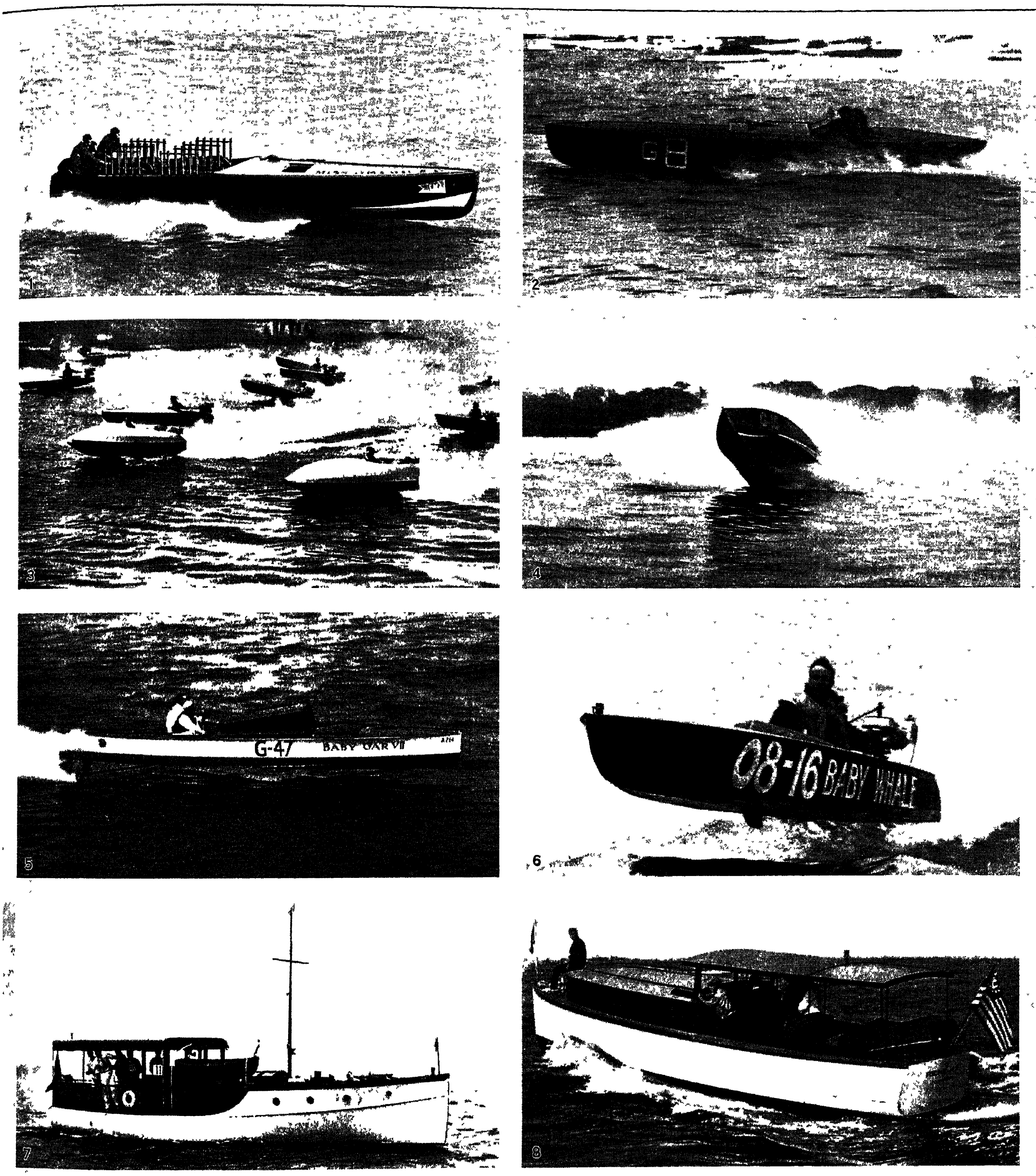
winding on the rotor of relatively low electrical resistance, and the terminals of the windings are brought out to collector rings on the shaft as shown in Plate I., fig. 7. Contact is made with these rings by means of carbon blocks or brushes, so that it is possible to insert or cut out resistance external to the motor and in series with the windings. In this manner a very flexible control is secured, since a number of different speed-torque curves can be obtained for the same motor, depending on the amount of this external resistance. This is shown by fig. 4 in which the speed torque curve 7 would be that with all resistance cut out of the circuit, and curves 1 to 6 inclusive those with varying amounts of external resistance. From this it might appear possible to get adjustable speed characteristics, but this is not the case for the reason that a change in load represented by X^1 on curve 7 produces a slight change in speed represented by Y^1 but the same change in load on X on curve 1 produces a considerable change in speed shown by Y. From this it appears that on curve 7 the motor could be rated as *constant speed* but on all other curves it would be *varying speed* and the motor is so applied. In connection with all induction motors, the torque developed varies as the square of the line voltage applied.

Alternating Current Commutator Motor.—The number of commutator motors used on alternating current is much smaller than other types as the problem of commutation is more difficult than with direct current. However, the demand for an alternating current motor which would be suitable for railway work resulted in various forms of single phase motors (requiring a single supply wire and trolley) having a speed-torque characteristic equivalent to that of a series direct current motor. The schematic diagrams for such motors are shown in fig. 6, *A, B* and *C*. These are known as series, repulsion and doubly-fed motors. A demand for a polyphase alternating current motor with adjustable speed characteristics resulted in several so-called "alternating current shunt motors." The schematic diagrams for two of these are shown in fig. 7, *A* and *B*. In *A* the brushes on the rotor are fed with current from taps taken off of the stator winding and hence at varying voltage. In *B* the rotor winding has collector rings at one end of the rotor and a commutator at the other. The supply line connection is made to the collector rings instead of to the stator winding. On the commutator are two sets of movable brushes. Opposite ends of the three separate phase windings on the stator are connected to corresponding pairs of brushes. Due to the shifting of the brushes, a changing voltage is impressed on the stator winding and speed adjustment results. These types of motors are expensive and complicated and are little used. Three general applications have been made of single-phase alternating current commutator-type motors. The first, as a means of getting better starting characteristics on a single phase industrial motor. Unlike a polyphase induction motor, a motor which is supplied from a single-phase supply line has no starting torque unless auxiliary windings or so-called phase splitting devices are used. However, a single-phase commutator motor of either the repulsion or series type has very good starting characteristics. Therefore it is the practice of several manufacturers to build a single-phase induction motor which has a rotor similar to the armature of a direct current motor. In addition, the rotor has a device actuated by centrifugal force which short circuits all the commutator bars after the rotor is up to speed and it then continues to run as an induction motor. This motor is referred to as *repulsion-start, induction-run motor*. The second application of alternating current commutator motors is in connection with heavy traction or the electrification of steam railroads. Here the motor has been used both as motive power for electric locomotives and in so-called motor cars. The third general application for alternating current commutator motors is as auxiliaries to large wound rotor induction motors where adjustable speed must be had and where the application of direct current is not feasible. This system has been applied to main roll drives in steel mills and to variable ratio frequency changers, where two alternating current supply systems are to be tied together for the exchange of power, but where there must be some flexibility allowed to each system in the maintenance of its exact frequency. Some typical applications of alternating current motors are shown in Table II. In comparing the uses of direct current motors with those of alternating current, it may be said that alternating current is more widely used but that certain classes of work can be handled more satisfactorily by direct current motors. Broadly, these are: industrial cranes, high-speed passenger elevators, adjustable speed machine tools, heavy steel mill reversing rolls and city street railway service. Aside from these applications, alternating current motors are preferred because the general distribution of energy by any other means than alternating current is practically prohibitive on account of cost.

BIBLIOGRAPHY.—B. F. Bailey, *The Induction Motor* (1911); J. H. Morecroft, *Continuous and Alternating Current Machinery* (New York, 1914); H. Mason, S. Sheldon and E. Housmann, *Dynamo-Electric Machinery; Its Construction, Design and Operation* (1914–15); Edward Blythe, "A *Textbook* on machine drawing for electrical engineers, forming an introductory treatise on the construction of electrical machinery and apparatus" (1920); R. R. Lawrence, *Principles of Alternating Current Machinery*, 2nd ed. (1920); A. S. Langsdorff, *Principles of Direct Current Machines*, 3rd ed. (1923); Erich Housmann, *Dynamo-Electric Machinery* (1924); Gordon Fox, *Principles of Electric Motors and Control* (1924); C. V. Christie, *Electrical Engineering; the Theory and Characteristics of Electrical Circuits and Machinery*, 3rd ed. (1925); F. A. Annett and A. C. Roe, *Connecting and Testing Direct Current Machines* (1925); J. L. Beaver, *Elements of Alternating Current and Alternating Current Apparatus* (1926); E. Arnold and J. L. La Cour, *Die Gleichstrommaschine; ihre Theorie, Untersuchung, Konstruktion, Berechung und Arbeitsweise* (Berlin, 1919–27); R. E. Brown, *Alternating Current Machinery* (1927); A. M. Dudley, *Induction Motor Practice* (1928).
(A. M. Du.)

MOTOR-BOAT, a small vessel propelled by a motor, especially by a petrol (gasolene) engine. Its history dates from 1885 when, it is believed, a launch was successfully propelled by an internal-combustion engine by J. J. R. Hulme of London. In 1886, in Germany, Daimler fitted a boat with one of his engines of 1 h.p. and carried 11 persons in it on a lake in Württemberg. Within a few years the Daimler Co. was turning out numerous motor-launches at Coventry. Relatively slow progress was made and the public generally did not, seemingly, become convinced of the reliability of motor craft. Hence the reliability trials which were organized by the Royal Automobile Club in 1904, and the cross-Channel race for motor-boats in the same summer, both of which were afforded much publicity, helped considerably to bring before the general public the possibilities of motor-boating as an enjoyable and safe pastime. It may be recorded as indicating the reliability of marine motors at that date that in the trials in question a 20 hours' test was included and 15 out of the 16 boats which were entered satisfactorily completed this arduous trial. Since 1904 steady progress has been made in the development of motor-boating, also in the design of motor-boats and engines suitable for their propulsion. With the increasing congestion, due to the very large number of cars on the roads in the thickly populated countries, it is evident that more and more people are taking to motor-boating, and there are definite indications that the pastime will become increasingly popular, particularly in view of the recent production of cheaper boats, of which details are to be given later. With these, the cost of motor-boating has been reduced to a figure less than that of motoring.

Construction of Motor Boats.—For the construction of pleasure motor-boats, wood is utilized almost exclusively, except for large yachts. Steel is heavier and more expensive than wood, but it is occasionally employed for certain special types of boat, also not infrequently in the tropics. Duralumin, an alloy of aluminium, has been adopted in Germany for cruisers and launches, where extreme lightness was required but it is unlikely to find any general application. A large number of different woods are used in the construction of boats. Mahogany, oak, pitch-pine and teak are commonly employed for planking, teak being specially good for boats built for service in the tropics, but it is expensive. The keel is usually of oak, pitch-pine, oregon pine, larch or American elm, and the stem and stern-post of English oak or larch. British oak is one of the best materials for boatbuilding, but for the planking or skin of a boat Honduras mahogany represents, perhaps, the finest timber. Pitch-pine is cheaper and has advantages for



BY COURTESY OF (1) CHRIS SMITH AND SONS BOAT COMPANY, (2-8) MORRIS ROSENFELD, COPR.

TYPES OF AMERICAN MOTOR-BOATS

1. "Miss America II.," which made 80.567 statute miles an hour in 1921. This record stood until "Miss America VII." made 92.838 in 1928
2. "Greenwich Folly," winner of the "Gold Cup" in 1926 and 1927. She is a 25 ft. displacement boat with a motor of 625 cu. in. cylinder capacity
3. Outboard racers at the start of a contest. The two boats in the foreground have streamlined decks
4. A "Gold Cup" racer just as she started to capsize
5. A high speed racer. These boats when driven fast in a choppy sea will often leap entirely clear of the water
6. The winner of the New York-Albany Race of 1928, a 12 ft. boat driven better than 25 knots by an outboard motor
7. A 41 ft. cruiser which has been successful in a number of long distance races for her type
8. Hundreds of these 34-footers have been built by one large manufacturer of standardized boats

boats intended for arduous service. Wood boats are either clench or carvel built. In the former system, the bottom of each plank distinctly overlaps the plank below, whilst in carvel construction, the adjoining planks are planed on their edges and butt together. The carvel method is by far the more common, as it has a better appearance and offers less resistance to the water. Most boats have single planking but two skins are not uncommonly employed, with canvas between. The inner and outer planks are usually arranged diagonally, or there is a horizontal outer skin and a diagonal inner planking. The two skins are fastened with nails, but another system is that in which the two skins of planking are sewn together by stitches of linen thread.

Types of Motor Boat.—Motor-boats may be divided roughly into two categories: displacement craft and hydroplanes. In the former, the same amount of water is displaced, no matter at what speed the boat travels. A hydroplane, on the other hand, when running at high speed raises itself partly out of the water, and the amount of water displaced is less than when at rest. The result is that the water resistance is reduced and higher speeds are possible than with displacement boats. The hydroplane principle is, however, seldom used except for racing craft and is, in fact, practically ineffective at speeds under about 15 or 16 knots. The famous coastal motor-boats used so successfully during the World War are examples of high-speed hydroplanes which virtually skim over the water, the bottom of the hull being built with a step, generally disposed near the centre. In some craft two or more steps are provided. The open launch is, perhaps, the most popular type of motor-boat. Referring first to inboard engined craft (outboard motor-boats will be dealt with later), this class is generally constructed in sizes from 16 ft. up to about 35 ft., and is equipped with engines varying from 6 h.p. to 30 h.p. The speed is usually moderate, but fast launches are now gaining favour, more particularly in America. Craft with speeds of 25 to 35 knots are standardized, one firm in the United States turning out more than 1,500 of these annually, whilst standard boats with a guaranteed speed of 55 knots are now produced. The tendency of builders of modern launches, both of the high speed and moderate speed classes, is to design them somewhat on automobile lines so far as the steering wheel, controls and electric starting equipment are concerned. A reason for this policy, apart from its general convenience, is that many of the purchasers are those with motoring experience. The 18 ft. Brooke runabout, which is fitted with a 10 h.p. engine, is a British example of the latest type of launch designed to meet the demands of such buyers.

Cabin Cruisers and Auxiliaries.—The cabin cruiser represents one of the most attractive types of motor craft. It is built in sizes of from 20 ft. in length upwards, with cabin accommodation and is usually constructed as a seaworthy boat capable of making good passages at sea under moderate or even rough conditions. Owing to the fact that a small increase in speed calls for greatly augmented engine power, and consequently, higher fuel consumption and capital cost, the average speed of cabin cruisers is from 8 to 10 knots. Thus, a vessel of from 25 ft. to 30 ft. in length usually has an engine of from 10 h.p. to 20 h.p. In England the average price of a 30 ft., 8 to 10 knot cruiser is about £500 to £750 according to equipment. In the United States, however, where petrol is relatively cheap, the large majority of cabin cruisers are constructed with much higher speeds than those in the United Kingdom, and express cruisers, vessels from 25 ft. to 50 ft. in length, having speeds of 20 to 25 knots, are very popular. As with all other classes of motor boats in the United States, cabin cruisers are, for the most part, built in quantities as standard productions. In England and, in fact, most other parts of the world, there is a larger proportion of boats built to individual requirements, but the tendency towards standardization becomes more marked every year.

The "auxiliary" is a type of motor-boat which appeals to the sailing man and is gradually replacing the pure sailing yacht. It is designed essentially for sailing but in it is installed an auxiliary motor; this is usually only of sufficient power to propel the yacht at a speed of about 6 knots. In small auxiliaries specially designed motors are provided, occupying very little space and scarcely detracting from the sailing qualities of the boat. The drive is taken through a clutch so that the propeller may revolve freely when the yacht is under way or, in some cases, a feathering propeller is used, the blades of which can be fixed in a vertical position when the yacht is under sail. Specially designed boats are built for use with outboard motors, that is to say, engines which, complete with propeller and propeller drive, together with the fuel tank, can be attached to the stern of the boat. These craft are constructed, either as hydroplanes or displacement boats, from 8 ft. to 16 ft. in length, and as speeds of over 30 m.p.h. can be attained with such craft equipped with outboard motors rated at 8 h.p., outboard motor-boat racing has become extremely popular in America, also in Great Britain and to a certain extent on the Continent. Outboard motor-boats have led to a wider field of popularity for motor-boating than was possible with inboard engined craft, since these launches with speeds of between 20 and 30 m.p.h. can be purchased for £100 or less.

Motor Boat Engines.—For the vast majority of motor-boats engines operating on petrol are used, similiar in general design to those fitted to motor-cars. A certain number of motor-boats built for service in Great Britain and in some other parts of the world are fitted with paraffin engines, but these are seldom used in America. For large yachts, engines known as semi-Diesel, Diesel or other types operating on cheap, heavy oil, are employed. The main difference between marine motors and those used for motor-cars is that the speed of the former is generally lower since, especially for moderate speed craft, it is inefficient to drive the propeller at more than 1,000 to 1,200 revolutions per minute. Otherwise, the differences between the marine and car engines are only in detail. The paraffin motor is also similar except that a vaporizer is utilized, this being heated by the exhaust gases so that the fuel may be effectively vaporized before admission to the cylinders of the engine. The compression pressure of the paraffin motor is, however, slightly lower than that of the petrol type and the output for given cylinder dimension is 10% less. The tendency, however, especially in America, is to increase the speed of marine motors, and engines operating at 1,600 to 2,000 r.p.m. are frequently fitted to the faster types of boat. Higher speeds mean smaller, lighter and cheaper engines, and these are the reasons for their adoption, even at the loss of a certain degree of propeller efficiency. In some boats, in order to improve propeller efficiency, fast-running engines are used in conjunction with reducing gears, so that the propeller turns at about one-half the speed of the engine. Petrol and paraffin engines, apart from outboard motors, are almost invariably built as four-cycle motors. The outboard engine, a type which has become extremely popular, consists of a horizontal engine driving a vertical shaft, at the bottom of which the propeller is driven through bevel gearing. It also incorporates the fuel tank and the whole unit can be clamped direct to the stern of the boat. It is started by turning the fly-wheel. The majority of modern outboard engines have two opposed cylinders and are of such weight that they may be conveniently carried by one man. For the most part they are built in three standard sizes, rated at approximately 2½, 4 and 8 h.p. respectively, the prices ranging from £25 to £70. When specially designed for high speed the actual power developed is considerably in excess of the rated output. They are suitable for attachment to dinghies and relatively heavy boats, whilst, as mentioned above, they are often fitted to specially-built racing hulls, thus forming high speed racing craft.

Most motor-boats are driven by means of a propeller coupled through the shaft to the engine. Where the depth of water is restricted, aerial propulsion is sometimes resorted to. This involves the employment of a propeller similar to that used on an aeroplane. It is mounted on a framework and is driven by a petrol engine through a chain or by other means. Hydraulic propulsion is also utilized in some instances with shallow draught boats, the engine in this case driving a pump through which the water is drawn. The propulsive efficiency is less than with a submerged propeller, but with the latest Hotchkiss system the difference is not large. (A. P. C.)

Outboard Motors.—The early small marine motors manu-

factured for installation in rowboats and canoes were miniature editions of larger plants and had all their complications of shafting, stuffing boxes, foundations, etc. For their use, the boat had to be especially built or adapted for them. Shifting a motor from one boat to another was a difficult task. In 1906, Ole Evinrude, of Milwaukee, Wis., began experimenting and in 1910 applied for a patent on a small, light, single-cylinder, internal combustion motor, which could be attached to the stern of a small boat and readily detached when desired.

The new machine rapidly grew in popular favour and others manufactured somewhat similar devices. These were all of the two-cycle type, some with two opposed cylinders. Most of them weighed about 40 lb. or less and developed from 1½ to 2½ horsepower. In 1928 the larger motors developed more than 35 h.p. and weighed nearly 150 pounds.

In 1924, the outboard motor was grudgingly granted a place on the schedules of some of the important regattas. They were used to drive boats of many models and sizes and the fastest speed was less than 9½ knots. In 1925, racing boats were especially designed for outboard motors, more powerful motors appeared, and speeds increased to 14½ knots. Thereafter each season saw power and speed going up, reaching 20·3 in 1926 and 29·1 in 1927.

The year 1928 saw remarkable strides in the popularity of the outboard motor, both in the United States and in Europe and also in Australia. Long distance racing was inaugurated in 1928, the first event being time trials between Albany and New York in which the winner ran the 115 nautical miles at an average speed of 25·4 knots. Other contests followed, some in open water, such as the race from Boston to New York, upwards of 250 m., of which a large proportion was at sea, and another on Lake Michigan, which was run under adverse weather conditions. The 202 m. from Peoria, Ill., to St. Louis, Mo., was covered at better than 33 knots. In shorter races over club courses, 2, 2½ or 3 m. to the lap, remarkable speeds were made that summer, culminating at Peoria, Ill., in September, where two boats did better than 40 m. an hour as the average of six runs each over a measured mile. "Spirit of Peoria" averaged 41·478 and "Cyclone" did 40·453 in these trials. Their motors were four-cylinder machines, the cylinders being in pairs and opposed. In October at the outboard championship race at Wilmington, N.C., records were made over the 4 miles. In class A, "Bumble Bee" did 25 m. per hour; in class B, she did 33·57; in class C, "Rubber Baby II." did 35·55; and in class D, "Orange Blossom" made 37·07.

In the Albany–New York outboard marathon, early in 1929, the winner, "Miss Eastern," averaged 37·4 m. per hour.

Motors are classed for racing by piston displacement, the classes being as follows: class A, under 14 cu.in.; B, 14 to 20; C, 20 to 30; D, 30 to 40; E, 40 to 50, etc., advancing by tens. The 1928 records in statute miles are: class A, 25 m. per hour; class B, 34·346; class C, 39·764; class D, 41·748; class E, 35·022. (C. H. Ha.)

MOTOR CAR, a self-propelled freight or passenger vehicle adapted to run and be steered on ordinary roads. Most motor vehicles are propelled by internal combustion engines, but some are driven by steam and some by electric motors although these are, for the most part, limited to commercial service. This article is divided into two parts: (1) general description of the development of the automobile with particular reference to conditions in the United States; and (2) a description of the motor car with particular reference to Europe.

In general, motor vehicles may be classified into three groups, according to the service they render. First, there are private passenger cars for transporting individuals, usually seven or fewer in number; second, commercial passenger vehicles for transporting a large number of persons; and third, commercial goods vehicles for transporting materials and goods. During the past 25 years in England, continental Europe, Dominion of Canada, and the United States, a wide variety of terms has been used to designate these three classes. The passenger car has been called "motor car," "motor vehicle," "automobile," "autocar," "auto," "car," "motor," etc. In 1928 "automobile" is the universal word in America, while elsewhere the term "car" is common. The commercial passenger vehicle has been known as "omnibus," "charabanc," "motor-bus," "coach," and "bus." While all these terms are used more or less generally, the last, "bus," is used extensively in the United States and Canada and also to no small extent in England and on the Continent. At the present time the "charabanc" is an open vehicle for conveying tourists about, employed in Europe. "Lorry" is now distinctly the English and "truck" distinctly the American name for the commercial goods vehicle. Coaches, omnibuses and buses, and lorries and trucks are treated elsewhere. This article deals only with motor cars, or automobiles.

HISTORY OF THE MOTOR CAR

It is difficult to assign definite dates for events in the progress of the automobile. Many men were working on the same problems in different places. This brief outline can point out only the trends and major developments. The self-propelled vehicle dates back to the middle of the 18th century. Credit for the first "road wagon" propelled by its own engine, is generally given to Nicholas Cugnot, a Frenchman, who about 1770 built a three-wheeled carriage, with a cumbersome steam power plant operating on the single front wheel. It is claimed that this steam carriage could run at the rate of 2½ m. per hour, but it had to stop every hundred feet or so to make steam. Cugnot's second vehicle, produced in 1771, is still preserved in the Conservatoire des Arts et Métiers, Paris. (Some histories of the automobile state that his first car is still preserved and not his second car.) During the latter half of the 18th century a few other attempts were made to build steam carriages, many of which were not capable of operating under their own power. The next century, however, saw a number of steam vehicles put to practical use in transporting passengers. Among these early experimenters were: Oliver Evans in America, making a car in 1787; Trevithick, England (1801); Gordon, England (1824); James, England (1824); Gurney, England (1828); James, America (1829); Summers and Ogle, England (1831); Hancock, England (1824–36); Church, England (1832); Maceroni and Squires, England (1834); Dudgeon, America (1857); and Butler, England (1883). Gurney put three steam coaches into operation on a route near London covering about 3,644 miles. Around the same time Walter Hancock built the first of nine steam carriages that were to operate on a route regularly.

Starting about 1831, the English parliament enacted laws which practically eliminated the steam coaches from the roads. Among these might be mentioned the Red Flag Law, which required that a man precede the horseless carriage, carrying a red flag by day and a red lantern by night. In addition, the toll roads and bridges raised the charges for the steam carriages until they could no longer operate at a profit. As a result, there was little development of the horseless carriages in England until after 1896, then the restrictive law was repealed. In Germany and France interest turned toward the internal combustion engine to replace the cumbersome power plant of these early steam vehicles. In 1885–86 Gottlieb Daimler (Germany), patented his high speed internal combustion engine, which is generally credited with revolutionizing automotive transportation Nevertheless, there is some disagreement among historians on this point. Some state that in 1875 Siegfried Narkus (Austria) built a four-wheeled vehicle powered by an internal combustion engine. Benz (Germany), in 1885, produced a tricycle with an internal combustion engine. Credit is commonly given to Krebs for the first petrol or gasoline automobile incorporating many of the essential features of the modern car. In 1894 he designed the Panhard car with a vertical engine under a bonnet or hood, at the front, and a modern type chassis. The car also had the common type of sliding gear transmission operated by the right hand, clutch and brake pedals, and a foot accelerator.

About 1896 or 1897 considerable work was carried on in Germany, France, England and the United States on the development of vehicles driven by internal combustion engines. These cars varied greatly in detailed design; some had the same general arrangement as the Panhard, while others were patterned on the

familiar horse-drawn carriages which they were expected to supplant. The motor car is not the product of a single inventor nor even of men within a single century. Among the European pioneers there were: Daimler, Benz, Maybach, Krebs, Panhard, Levassor, Royce, Serpollet, De Dion, Bouton, Gibbon and Roots; and among the American pioneers were Duryea, Olds, Haynes, Winton, Ford, King, Maxwell, Apperson, Riker, Clarke, Stanley, White and Franklin. These automobiles were produced, of course, in very small numbers because of the limited manufacturing facilities and of the small consumer demand.

In 1903 the Association of Licensed Automobile Manufacturers was formed in America to grant licences to manufacture motor cars under the Selden patent (U.S. patent No. 549,160, Nov. 5, 1895), and for eight years was a powerful force in the development of the new industry. By limiting licences to concerns which were held to be "good and reliable," the association doubtless protected both the automobile industry and its customers from unscrupulous exploitation, and stabilized somewhat the general conditions of production and market competition. The National Automobile Chamber of Commerce was organized in 1913 to succeed the association (strictly speaking, the National Automobile Chamber of Commerce succeeded the Automobile Board of Trade, which succeeded the Association of Licensed Automobile Manufacturers). Among its activities was the "cross-licence" agreement whereby any member might use the patents held by any other member, without paying a royalty. While never adhered to quite universally, this agreement still (1928) holds for patents issued previous to 1925. At that time the life of the agreement ran out; and it was not renewed mostly on account of the commercial aspect of large private developments.

Until 1909–12 the automotive industry was, in general, chiefly concerned with developing a product that at least would operate. Some cars, of course, were marketed in this period; these in essential details were nearly as satisfactory as cars designed in recent years. During the experimental period, cars of every description were produced with alternatively chain, bevel gear or friction drive; bar, tiller or wheel steering; planetary or sliding gear transmissions; and with the number of cylinders ranging from one to eight, with a few twelves and sixteens. The prejudice against a new and radical invention, poor road conditions, the comparatively high original cost, the cost of maintenance and the general unreliability of the cars, all tended to retard rapid introduction of motor vehicles. The sporting phase of the automobile was recognized long before it was commonly appreciated that the automobile provides a thoroughly reliable, economical, comfortable and rapid means of individual transportation.

After 1909–12 the production of sufficient cars for a growing demand and marketing and distributing facilities became of great importance. Problems of time payments and the extensive purchasing of cars on an instalment payment basis, trade in used cars, dealer organization and advertising have been demanding the attention of manufacturers, in addition to problems of quantity production and engineering. During this period also the internal combustion engine has almost entirely superseded both steam and electric motors for propelling automobiles. The electric vehicle is confined, for the most part, to use for short distances, over improved roads. The expansion and growth of the motor car has, in a large measure, proceeded abreast with the building of good roads, development of alloy steels and improvement of rubber. The need for rapid and reliable individual, or private, transport has existed for a long time; and when the automobile was recognized as fulfilling that need, its adoption was rapid not only in Europe and America, but in late years, all over the world.

Year	Production	Registration	Year	Production	Registration
1895 .	4	4	1912 .	356,000	902,600
1896 .	25	16	1913 .	461,500	1,194,262
1897 .	100	90	1914 .	543,679	1,625,739
1898 .	1,000	800	1915 .	895,930	2,309,666
1899 .	2,500	3,200	1916 .	1,525,578	3,297,996
1900 .	5,000	8,000	1917 .	1,745,792	4,657,340
1901 .	7,000	14,800	1918 .	943,436	5,621,617
1902 .	9,000	23,000	1919 .	1,657,652	6,771,074
1903 .	11,235	32,920	1920 .	1,905,560	8,225,859
1904 .	22,419	54,590	1921 .	1,529,165	9,346,195
1905 .	24,550	77,400	1922 .	2,397,827	10,864,128
1906 .	33,500	105,900	1923 .	3,780,358	13,479,608
1907 .	43,300	140,300	1924 .	3,327,770	15,460,649
1908 .	63,500	194,400	1925 .	3,904,566	17,512,638
1909 .	127,731	305,950	1926 .	3,984,018	19,237,171
1910 .	181,000	458,500	1927 .	3,093,428	20,219,224
1911 .	199,319	619,500	1928 .	4,024,590	21,379,125

(U.S. National Automobile Chamber of Commerce, *Facts and Figures*, 1929 ed.) Figures 1921–28 include Canadian production. In 1927 the Canadian production was 146,870 cars.

The table in the first column shows the yearly production and registration of passenger cars in the United States.

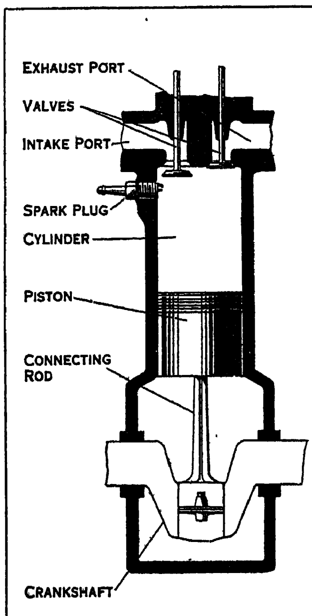
The figures for the United States for 1927 represent 85% of the production and 75% of the registration of the world, for in that year 3,650,000 cars were built in total for all countries and 29,639,000 were in operation. The following table shows the relation of population to motor car registration (based on passenger vehicles) in various countries in 1927:

	Persons per car in 1927
Australia (white population)	19·7
Canada	12·9
France	69·1
Germany	313·0
Great Britain*	63·9
Italy	495·8
New Zealand (white population) . . .	13·3
South Africa (white population) . . .	21·4
United States	7·0

(*Motor Industry of Great Britain*, 1927 ed., published by the Society of Motor Manufacturers and Traders Association.)

THE AUTOMOBILE ENGINE

The automobile engine transforms the chemical energy of a mixture of air and fuel (petrol or gasolene) into mechanical energy which can do work, *i.e.*, move the car. The engine is often also called the power plant. Essentially the engine consists of: (1) an enclosed cylinder in which a gaseous mixture of air and fuel is burned; (2) a piston which moves back and forth in the cylinder; (3) a connecting rod which links the piston to a crankshaft; and (4) a crankshaft which changes the reciprocating motion of the piston into rotary motion. This is shown in fig. 1. Other parts necessary for the operation of the engine are: (1) A carburettor for mixing air and fuel, with an intake pipe to conduct the mixture up to the inlet valve; (2) inlet valve, which, upon being opened, admits the mixture into the cylinder, and upon being closed, prevents this charge from escaping; (3) a spark-plug, which ignites the charge at the proper time; and (4) an exhaust valve, which opens to allow free exit to the charge after it has delivered part of its energy to the engine. Practically all automobile engines operate on what is called the four-stroke cycle. The stroke refers to the travel of the piston in the cylinder, from top to bottom for one stroke, and back again for another stroke. Four strokes complete one cycle.



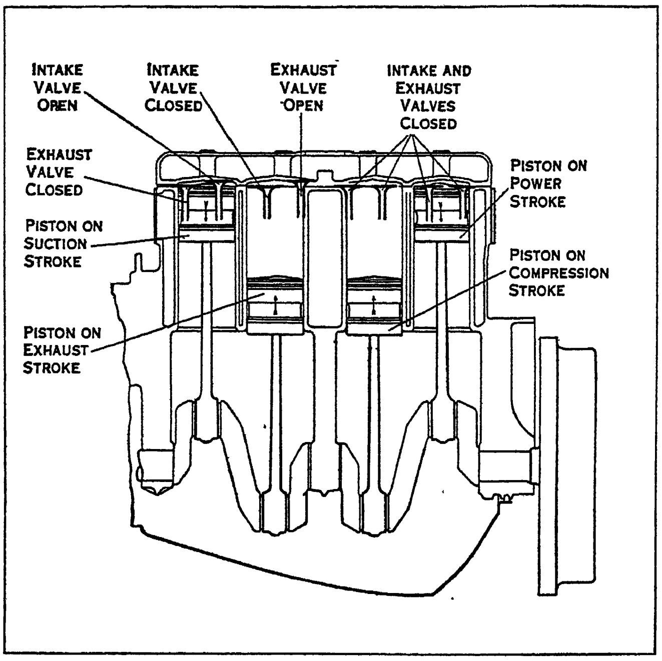
BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 1.—DIAGRAM OF SIMPLEX ENGINES

The following events take place in the engine during one cycle:

(1) *Intake stroke:* The inlet valve is open. The piston travels down the cylinder, and, acting like a pump, draws in a charge of

air and fuel through the inlet valve. Strictly speaking, atmospheric pressure forces the mixture of air and fuel into the cylinder to fill up the space left vacant and partially evacuated by the receding piston. (2) *Compression stroke:* The valves are both closed. The cylinder is full of the air-fuel mixture. The piston travels up the cylinder, and compresses this mixture into a very small space at the top of the cylinder. Shortly before the piston reaches the upper end of its travel on the compression stroke, ignition occurs. Due to the fact that an appreciable time is required for the charge to burn, the timing of the spark is required to be somewhat in advance of the top centre position of the piston to produce maximum turning effort on the crankshaft. (3) *Expansion stroke or power stroke:* The valves are still closed. The air-fuel gaseous mixture has been ignited and burned. During the burning high temperatures have been produced. High temperature is accompanied by a substantial increase in pressure, reaching about 400 lb. per square inch. The pressure of the burned gases forces the piston downward. (4) *Exhaust stroke:* The exhaust valve is open. The piston travels upward, and forces the burned gases out through the exhaust valve. This fourth stroke completes the four-stroke cycle, and the next stroke starts a new cycle. This is shown in fig. 2.



BY COURTESY OF THE NATIONAL AUTOMOBILE CHAMBER OF COMMERCE

FIG. 2.—FOUR-CYCLE ENGINE CUT AWAY

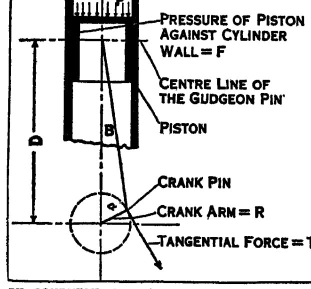
In addition to this four-stroke cycle, there is another plan of engine operation, called the two-stroke cycle. The effective distinction between the two lies in the fact that in the former, one out of *four* is an expansion, or power stroke, whereas in the latter, one out of *two* is a power stroke. At first thought, this distinction seems advantageous for two-stroke cycle engines, but many problems arise in the actual design and construction of such an engine, which, up to 1928, have outweighed automobile advantages. (*See* INTERNAL COMBUSTION ENGINES.) Usually the two-stroke cycle engine has no valves, but has ports in the wall of the cylinder near the bottom. The piston uncovers these ports on the lower portion of its travel. A new charge of gas and fuel, which has been previously compressed in an auxiliary chamber, rushes through one port and forces the spent gases out from the cylinder through the other port. The piston compresses the new charge, ignition and expansion take place, and the piston travels down ready for a new charge. Considerable inventive effort has been applied to gas turbines, rotary engines, and numerous other types of power plant. In actual construction and operation, however, the advantages are more apparent than real, and none has progressed beyond the experimental stage.

Cylinders.—The cylinder, as the name implies, is a cylindrical cavity with one end closed and one end fitted with a movable piston. The closed end, which is called the "combustion chamber," differs in shape in different engines. There is, in fact, a definite relation between the engine performance and the shape of the combustion chamber, which must be determined specially for each engine type. Apart from the combustion chamber, the principal features of cylinders are their number, size and arrangement. One, two and three cylinder engines have dropped largely into disuse in modern automobiles because of the great variation in turning effort due to the comparatively infrequent power strokes. Also, such engines usually require large fly-wheels, a fact which results in heavy, sluggish engines. Even the four-cylinder engine is less in demand than hitherto, because the trend of public desire is ever toward smoother engines. The present six-cylinder engines are considered very smooth, but engines of eight and even more cylinders are in use and can be made still smoother but only at additional cost and complication.

The size of the cylinder is determined by its diameter, or "bore," and by the portion of its length which is swept by the top of the piston, and which is called the "stroke." The "displacement" is an expression of the volume swept by the piston from the top to the bottom of the stroke, and equals $\frac{(\text{Bore})^2 \times \pi \times \text{stroke}}{4}$. The total displacement is the sum of the displacements of all the cylinders. The "compression ratio" is an expression of the relation of the volume of the gas when it is fully expanded to the volume of the gas when it is fully compressed. The compression ratio equals $\frac{V+D}{V}$, where V=volume of the combustion chamber for one cylinder, and D=displacement for the same cylinder.

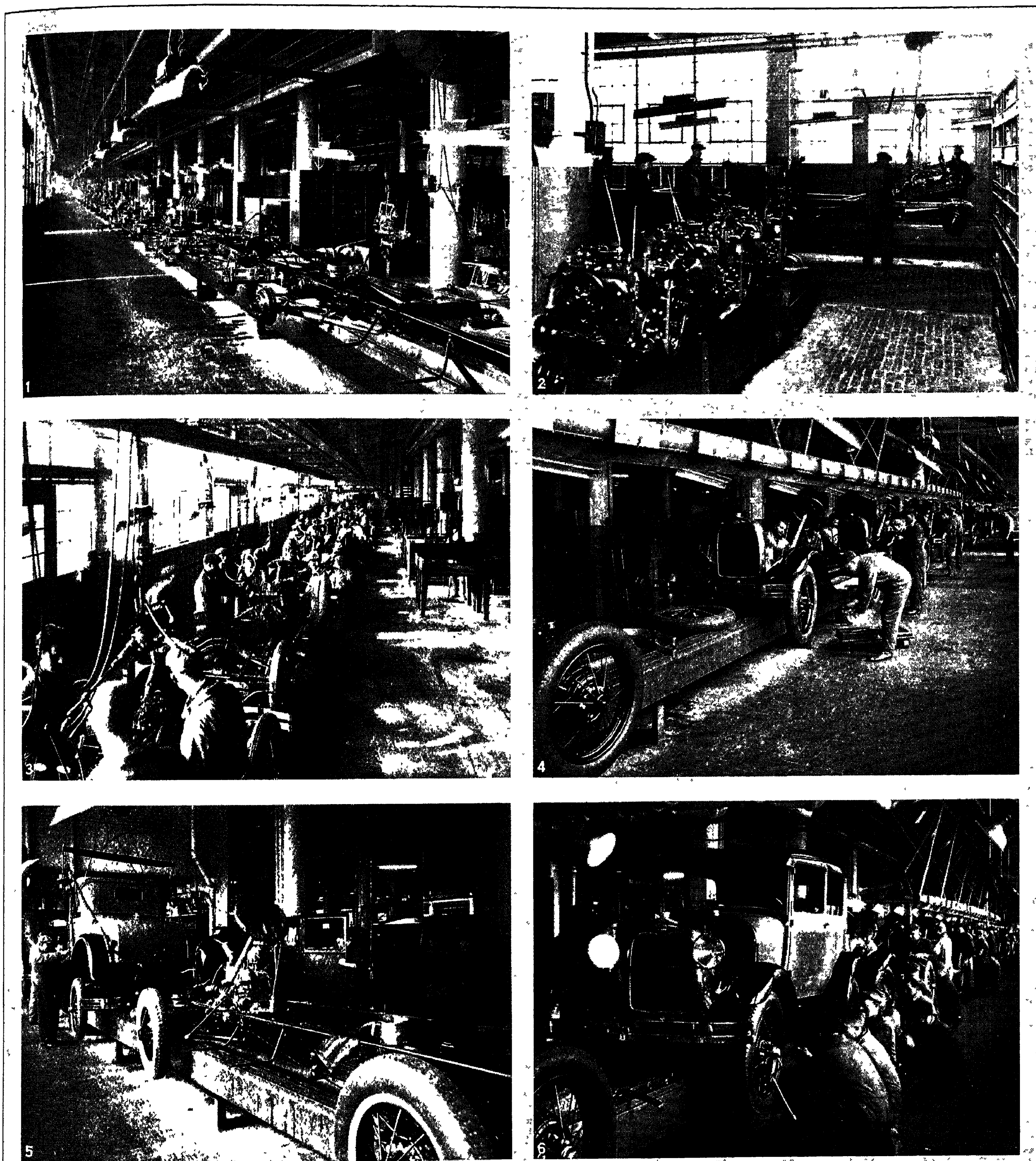
These dimensions, volumes and ratio are of very considerable importance in engine design, although it is impossible to assign to them any absolute value in terms of resulting performance. The power an engine is capable of producing depends on many factors—combustion chamber design, number of cylinders, displacement and compression ratio, speed of the crankshaft, weight of the reciprocating parts (pistons, connecting rods, etc.), valve size, valve timing and a large number of other factors. Each factor is built into an engine design with all the others in mind to accomplish a definite range of performance and service. The arrangement of the cylinders, at the present time, is limited to three types—"in line," **V**, and horizontal opposed. All fours and sixes have their cylinders "in line," *i.e.*, vertical and one behind another from the front to the back. Eights and twelves may have their cylinders in line or disposed like a **V**. In the latter type the angle between the two banks of cylinders is usually either 90° or 60°.

Piston and Connecting Rod.—The piston transmits the gas pressure to the crankshaft where it is available as torque. The side pressure of the piston against the cylinder is the torque reaction. Technically, the torque and torque reaction are best demonstrated by the analysis shown in fig. 3. Due to the inertia of the reciprocating parts, an inertia torque, and an inertia torque reaction are also set up in the same manner as that of the torque and torque reaction shown in fig. 3. The piston is directly exposed to the heat of combustion and unlike the cylinders cannot be directly water cooled. It must be well lubricated because the side pressure of all the pistons applied to the cylinder walls will produce a rotative effect at least equal to that present at the crankshaft. In a high speed engine or one with very heavy pistons it may be considerably more. The problem in piston design is to use as little metal as possible, and to use that metal to the greatest advantage in conducting the heat to the piston rings and to the



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 3.—DIAGRAM SHOWING THE THEORY OF TORQUE REACTION

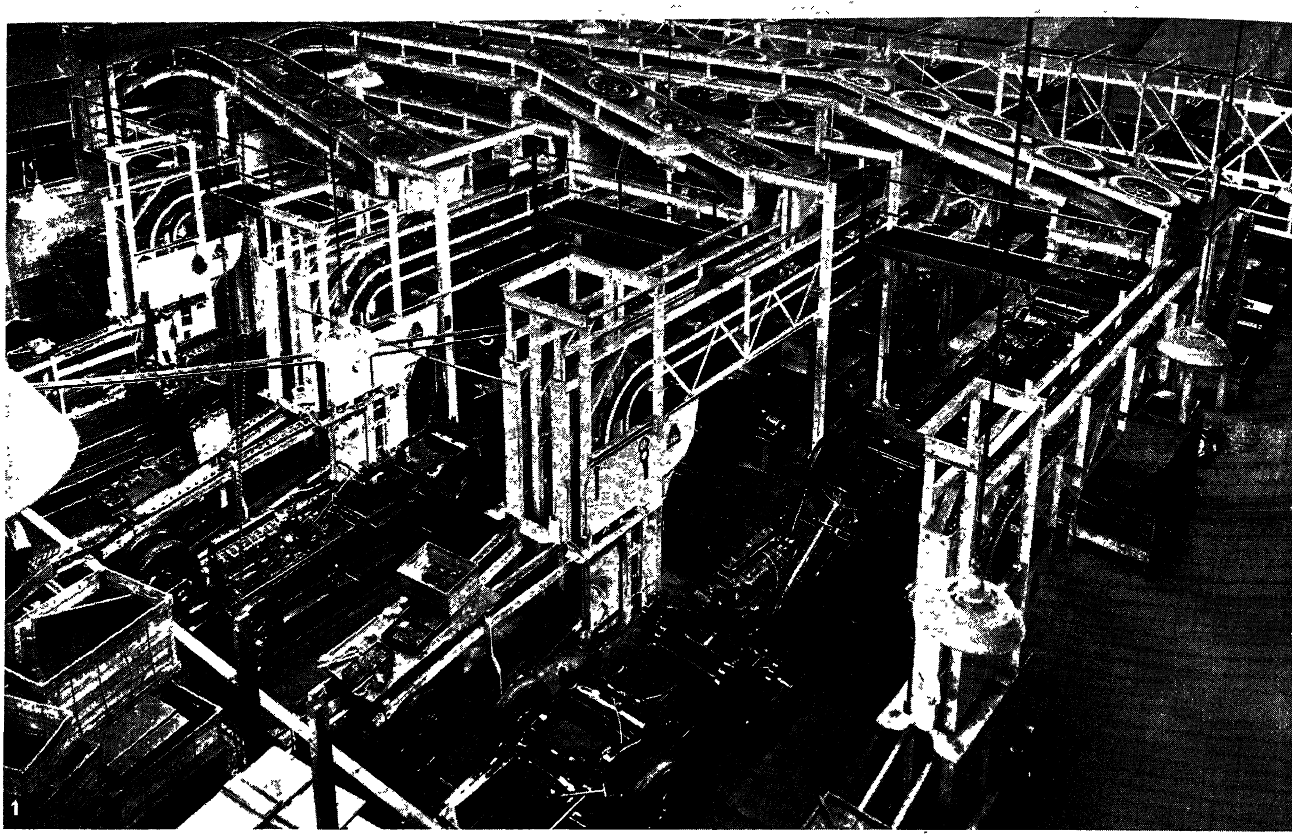


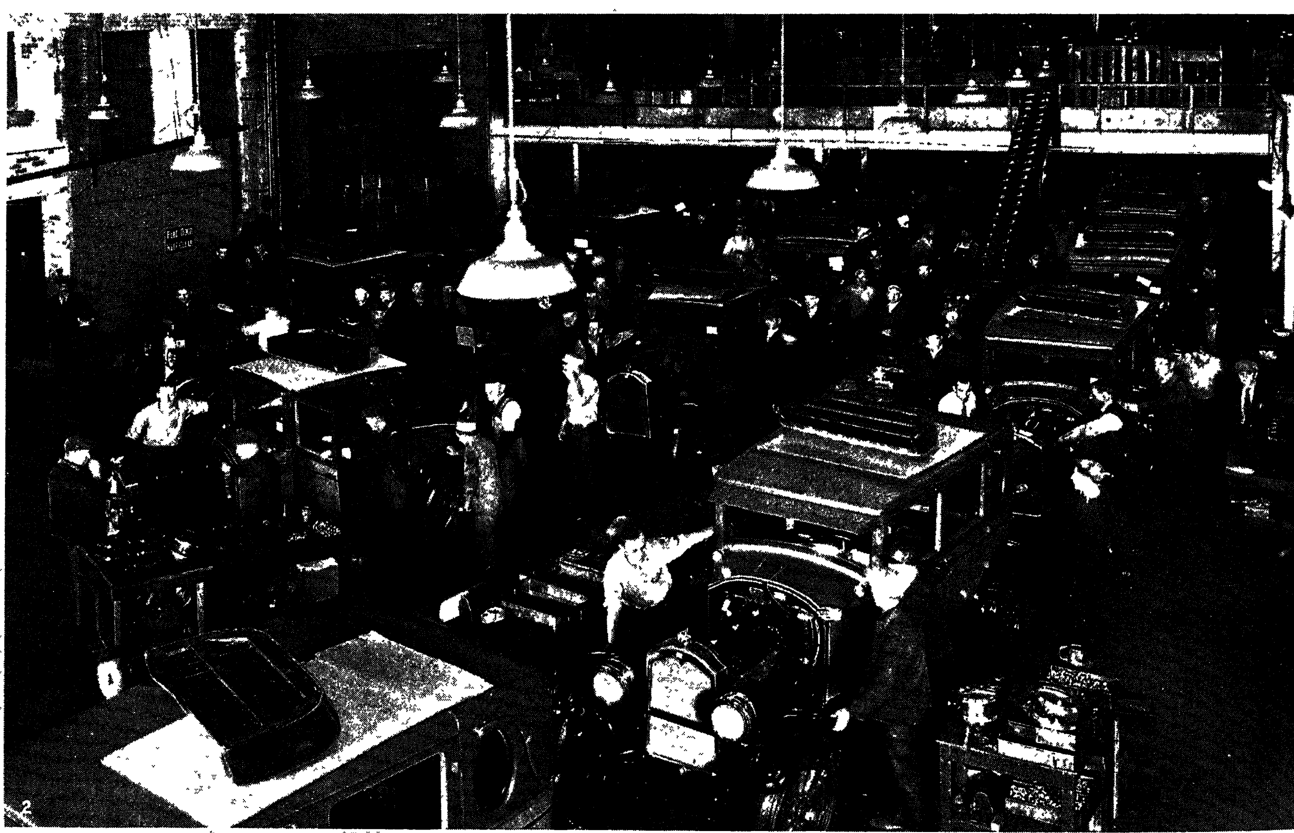
BY COURTESY OF THE FORD MOTOR COMPANY

MAIN ASSEMBLY LINE OF LARGE MOTOR CAR FACTORY SHOWING SIX STAGES IN THE PROCESS

1. Early stage of assembly line showing motor car frames with rear axles and differential installed. Rear bumpers are mounted here
2. Motors being placed in position (right background) where motor conveyor line (left) meets general assembly line. The motors are ready to operate, having been tested beforehand on running blocks
3. Completing chassis along assembly line. Steering mechanism is being installed by workmen in foreground at left
4. Complete chassis including wheels to which running boards and mud guards are being added, preparatory to attachment of body and top
5. Bodies being attached to chassis. Overhead conveyor from right brings body to position above completed chassis (foreground)
6. Completed car receiving final inspection before leaving assembly line by its own power. Headlight lighted for inspection of wiring system. Workman at right is tightening lugs on wheels. At left can be seen inspector testing engine connections; inside the car an inspector is testing door fittings and dash connections, after which he will start the engine and drive the car to storage. Entire process of car assembly is completed within ¾ hour

MOTOR CAR





BY COURTESY OF THE BUICK MOTOR COMPANY

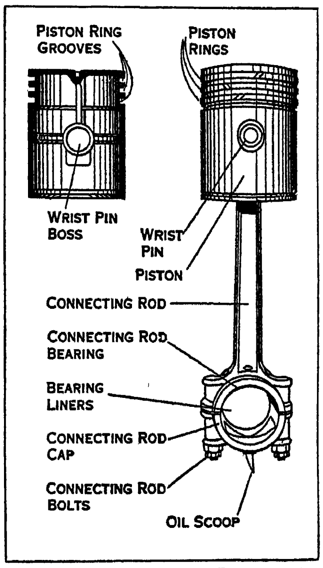
MOTOR CARS IN PROCESS OF PRODUCTION IN ASSEMBLY LINE AND TESTING ROOM

1. View of unified assembly line in a large motor car plant. Overhead are the conveyors, three in number, which deliver the wheels by gravity to the belt conveyors, on their way to the assembly lines below. Each wheel is retarded while passing through the conveyor belt from the gravity overhead conveyors to the assembling racks on the floor

2. View of testing room at the end of the assembly line. Engine hood and front seat of each car are removed for ready inspection. Benches in foreground have spare parts and testing apparatus for use in each stage of the testing process

piston skirt or bearing surface. Then it will pass through the cylinder walls and be carried away by the cooling water. In a well-designed piston, such as that shown in fig. 4, the temperature of the entire piston head will be uniform and well below the point at which roughness would be caused under severe operating conditions.

The connecting rod links the piston to the crankshaft. The upper, or "small," end is connected to the piston by means of a pin, variously called "piston pin," "wrist pin," and "gudgeon pin." The lower, or "big," end is connected to the crankshaft by means of that part of the shaft called the crankpin. Since the connecting rod is a rapidly moving part, it is made as light as is consistent with rigidity and durability. Although some manufacturers use an aluminium alloy, most use steel.

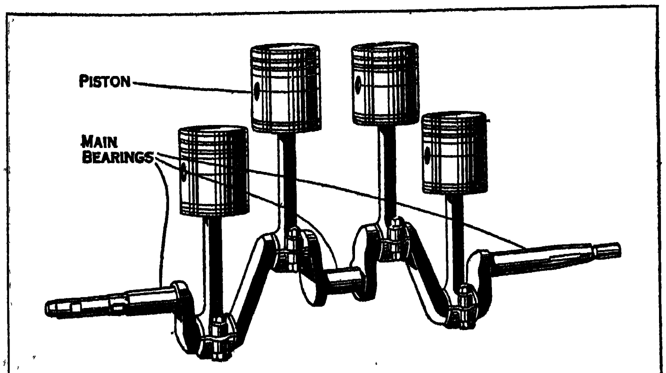


BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 4.—PISTONS

Crankshaft.—The crankshaft of an engine is the means for converting the straight line motion of the piston into rotary motion. It is a shaft which runs in bearings at the open or lower ends of the engine cylinders, and has portions of its length bent into **U** shaped cranks. The portions of the shaft which are concentric with its centre line are called journals; the eccentric portions, crankpins. These may be seen clearly in the illustration, fig. 5, which shows a crankshaft for an engine having four cylinders in line. The journal runs in bearings supported in the engine crankcase. The crankshaft is connected to one end of the connecting rod and the piston is connected to the other, and as the piston reciprocates in the cylinder the crankshaft revolves. When the cylinders are arranged in line, there is one crankpin for each cylinder; when they are arranged in a **V**, two cylinders share one crank. In aeronautical, but not automobile, practice, as many as 9 or 11 cylinders may operate on a single crank.

The bearings in which a crankshaft runs are named "main bearings." Practice in respect to the number of cranks for each main bearing varies from the use of four cranks between adjacent



BY COURTESY OF GENERAL MOTORS CORPORATION

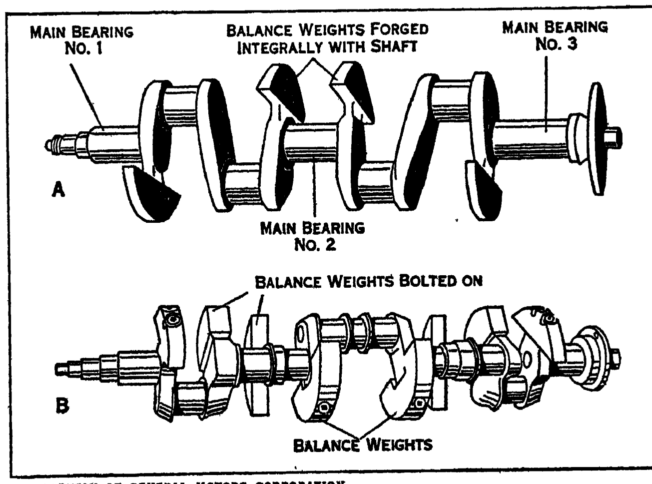
FIG. 5.—PISTON ASSEMBLY

main bearings to the use of alternate cranks and main bearings. Generally, the larger the individual cylinder, the fewer is the number of cranks between adjacent main bearings. Engines with a single crank between journals will have one more main bearing than they have cranks. The following table shows all possible arrangements of cranks and main bearings, the most common being marked by an asterisk.

Number of Main Bearings

Type of engine	4 cranks between main bearings	3 cranks between main bearings	2 cranks between main bearings	1 crank between main bearings
1 cylinder	..	..	..	2
2 cylinder	..	..	2	3
4 cylinder vertical or 8 cylinder **V**	2	..	3*	5
6 cylinder vertical or 12 cylinder **V**	..	3*	4*	7*
8 cylinder vertical	3	..	5*	9*

Balance and Vibration.—Automobile engines of the present day are run at such a high speed that dynamic forces become as great as, if not greater than, the forces due to the gas pressures. Centrifugal force on the cranks of a crankshaft becomes of prime importance, since any small lack of balance causes severe vibration at high speeds. Shafts are approximately balanced statically in all conventional engines by virtue of the cylinder arrangements, since there are cranks equally spaced at all angles; but practically all crankshafts have to be balanced dynamically (a running balance) to correct for unbalanced disposition of the material in the rough forging. Often, in high speed engines, counterweights are attached opposite the cranks, so that



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 6.—CRANKSHAFT

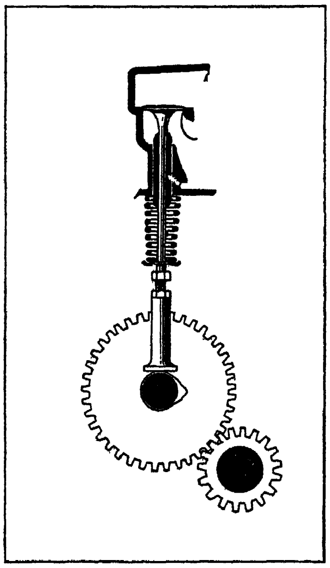
their centrifugal force tends to counteract that of the cranks, which otherwise would cause the engine to vibrate. The use of such weights greatly reduces the load on these bearings and lessens engine vibration. Fig. 6 shows two types of counterbalanced crankshafts.

Another species of vibration, torsional vibration, makes itself felt in long engines, especially if there are six or more cylinders in line, and if the crankshaft is comparatively flexible. The impulses, particularly of the front cylinders, tend to wind up the crankshaft, which, of course, springs back when the force is relieved. Due to its elasticity and inertia, the shaft does not come to rest immediately, but vibrates, winding and unwinding, about the fly-wheel, which, because of its inertia, does not change its speed of rotation to any appreciable extent. When the torsional impulses have the same frequency as the natural period of the crankshaft, or a multiple of this natural period, the vibration becomes very severe, and steps must be taken to reduce or counteract it if smoothness is desired. On some cars this is done by the use of a small fly-wheel attached at the front end of the shaft by a slipping clutch; when the shaft winds up, or vibrates, slippage occurs at the clutch, permitting relative motion between the shaft and fly-wheel. In this way energy supplied to the crankshaft by the vibration-exciting forces is converted into heat. On other cars an inertia weight is mounted on the crankshaft through springs. The inertia weight counteracts the torsional vibration of the shaft by vibrating out of phase with it.

A single cylinder develops power on only one stroke out of four, and in order to function it must be driven for the other three strokes. A heavy wheel, or *fly-wheel,* usually of cast iron, is attached to the crankshaft, and its momentum causes the shaft

to continue revolving through the idle strokes. As the number of cylinders increases, the overlapping of these power strokes makes it possible to decrease materially the size of the fly-wheel. A heavy fly-wheel decreases the accelerating ability of the car, especially in the lower gears, while a very light fly-wheel is likely to transmit the fluctuations in engine speed to the transmission and there set up gear noises. The final size of the fly-wheel is, therefore, a compromise between these two limits.

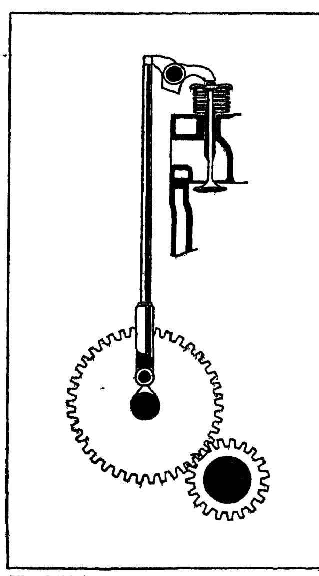
Valve Mechanism.—Engines are described with reference to the arrangement of the valves for admission of the air-fuel charge and for the expulsion of the burned gases. The L head (fig. 7) has the valves extending in an approximately vertical direction downward from the combustion chamber to the valve tappet (an intermediate member which is actuated directly by the valve camshaft). The *valve-in-head* engine (fig. 8) has its valves extending upward from the combustion chamber. This results in a very good combustion chamber form and in simple direct passages for the inlet and exhaust gases. If the camshaft is in the lower position, as in the L head, long push-rods are required to actuate rocker arms which, in turn, operate the valves. Occasionally, the camshaft is located above the engine, and operates directly on a tappet which is attached to the valve stem. This arrangement requires elaborate gearing and introduces lubrication problems. The F head is a combination of the two types mentioned, one valve per cylinder (usually the exhaust valve) being located as in the L head type and the other located as in the valve-in-head type. In the T head, one or two valves are located on each side of the cylinder. In another type, the valves extend horizontally outward from the combustion chamber.



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 7.—L HEAD TYPE MECHANISM

Each of these types of valve arrangement has inherent advantages which account for its use in any particular engine. Each has also certain disadvantages. Various factors which must be taken into consideration in valve design are volumetric efficiency, combustion chamber design and resulting smoothness of combustion, weight of reciprocating parts, cost and complexity, lubrication, quietness and adjustment. These types of valve are all classified as "poppet valves"; there is still another type called "sleeve valves."



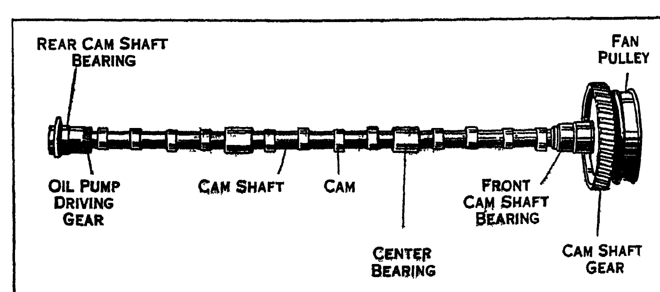
BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 8.—VALVE-IN-HEAD OPERATING MECHANISM

The "sleeve valve" engine has its cylinder made larger than the piston. Two thin-walled sleeves lie between the cylinder and the piston. The two sleeves are reciprocated through connecting rods by a small eccentric shaft which, like a camshaft, rotates at one-half engine speed. The two sleeves reciprocate in a manner with respect to each other such that two ports, cut in their walls in certain positions, will register together and also with two ports provided in the cylinder wall. The ports are timed to register in such a way that two sets of ports will function as inlet, and two sets as exhaust, valves. Sleeve valve engines have attained fairly wide use in several makes of automobiles, both European and American, and in some makes of commercial vehicles. The single sleeve is another type of sleeve valve engine which, up to the present time, has had limited use. In order to accomplish the proper register of ports, the single sleeve has an oscillating circular motion in addition to the reciprocating vertical motion. Ever since the beginning of the automobile, a great deal of inventive effort has been spent on unconventional types of valve, viz., rotary, piston, disc and others, but these have either been proved impractical or have not shown sufficient gains to justify their use.

Valves.—All poppet valves have the same general form. A circular flange, called the head, is joined to a stem by an easy curve. The valve seat is formed on the outer edge of the head, on the same side as the stem, and is usually bevelled at a 45° or 60° angle to the stem, although in a few cases it is made flat (or at 90° to the stem). The valve is very carefully ground or lapped in its place on the valve seat to ensure against gas leakage from the combustion chamber when the valve is closed. The valve is opened by the camshaft to permit gas flow and is closed by a compression spring which transmits pressure through a spring seat or washer fitted to the end of the valve stem. Both the inlet and exhaust valves are directly exposed to the heat of combustion. The inlet valve is cooled quite well by the incoming mixture during the inlet stroke. The exhaust valve must operate under what probably is the most severe condition that exists in the engine. It can be cooled only by the loss of heat into the cylinder wall through the valve seat, and the valve stem guides. Although exceptionally good heat-resisting alloy steels have been developed for valves, nevertheless, valves must be very carefully designed, for otherwise the most carefully prepared valve seat will not last.

Camshaft and Timing Gears or Chains.—The valve operation is controlled by the camshaft (fig. 9), which is rotated by the crankshaft, either by means of gears or through a chain and sprocket wheels, at one-half the crankshaft speed. A fixed relationship of the camshaft with the crankshaft must be maintained in order that the valves may be opened and closed in a fixed time-relation with the various events in the cylinder. This is done by using datum points. The datum point on the crankshaft is marked on the fly-wheel and registers the uppermost position of some specific piston. The datum for the camshaft is usually marked on the gear or sprocket, and registers with the crankshaft datum point. On nearly all modern engines an individual cam is provided on the camshaft for each valve. Between the valve stem and the cam there is a valve lifter, or tappet, one end of which rides on the cam, and the other end of which abuts on the valve stem. In the overhead valve engine, there are other intermediary parts—a push-rod and a rocker arm.



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 9.—CAMSHAFT

The cam is so shaped that at some point located within a very limited range, the valve lifter will push the valve off its seat slowly enough not to cause violent impact between the parts of the valve mechanism. This "opening" point on the cam profile must be located for each cam in a very definite position with respect to the datum point on the camshaft. The remainder of the cam profile is designed to raise the valve to its maximum lift and then permit it to be lowered by the spring so that it will close without violent impact between the valve and the valve seat at a point also closely limited. Only about one-quarter of the

cam profile lifts the valve directly. The rest of it acts as a means of controlling the action of the valve spring. Since this condition exists, cam design and valve spring design are so interrelated that they can be said to constitute a single problem.

Cooling System.—The internal combustion engine is a heat engine in which power is developed by converting the heat energy generated through the combustion of the fuel into mechanical energy. Therefore it would seem wasteful to have a cooling system for dissipating a portion of the heat of combustion; however, in order to control the temperature of the combustion chamber to prevent pre-ignition, warping of the valves, loss of power through lower volumetric efficiency, excessive piston expansion and rapid breakdown of the lubricating oil film, especially on the cylinder walls and pistons, it is necessary to dissipate approximately 33% to 40% of the total heat of combustion of the fuel through the cooling system. In all types of cooling systems the heat is dissipated to the surrounding air by radiation or conduction.

In the water-cooled system which is commonly used for automobile engines the cylinder walls, combustion chamber and valve seats are surrounded by a water jacket generally cast integral with the cylinder block and head. The heat absorbed by the water is dissipated to the air through a radiator at the front of the car. The radiator consists of a large number of tubes or cells through which the cooling water flows. Cooling fins are also provided for more efficiently conducting the heat from the water passages to the air. In most cases a fan mounted at the front of the engine provides circulation of air through the radiator during idling and at low car speeds. At high car speeds the forward motion of the car forces sufficient air through the radiator to provide proper cooling. The cooling water may be circulated through the engine passages and through the radiator by thermo-syphon action or may be circulated much more rapidly by means of a pump, usually of the centrifugal type, mounted on the engine. The water-cooled system is, in the final analysis, an air-cooled system, the water acting only as a means for transferring the heat from the engine to the radiator where it is dissipated directly to the air.

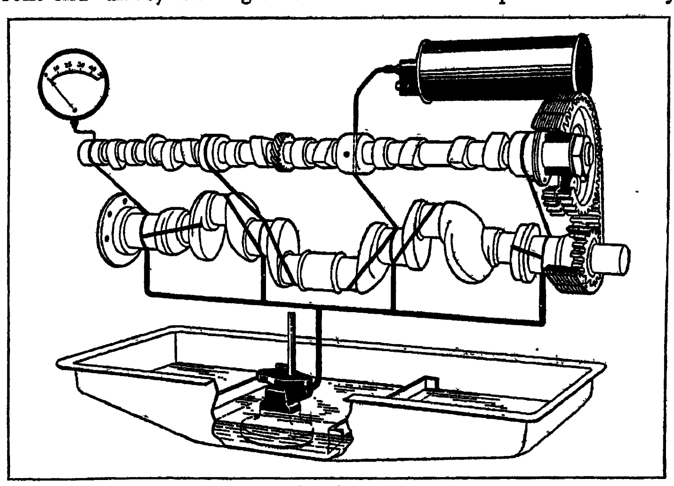
In the air-cooled system the radiator, in the form of copper, steel or cast iron cooling fins, is mounted directly on or cast integral with the cylinder block and cylinder head. In air-cooled automobile engines the cooling fins are generally surrounded by a conduit which provides a closed passage through which the cooling air is drawn over the cylinders by a fan mounted either at the front of the engine or on the fly-wheel. In air-cooled aeroplane engines the propeller blast plays directly upon the cooling fins. Cooling systems employing steam, oil and other media, and evaporative cooling systems making use of the latent heat of vaporization have been used but have not been widely adopted.

During the winter months, with atmospheric temperatures below freezing, an "anti-freeze" solution must be employed in the water-cooled system. Solutions of alcohol, glycerine and ethylene glycol are generally used. In order to heat quickly a cold engine to the proper operating temperature, a thermostatically controlled valve is sometimes located in the water line discharging from the engine to the radiator. With cold water in the cylinder heads the valve remains closed, either blocking the flow of water from the engine or passing it around the radiator. After the water heats up the valve opens, maintaining the water in the jackets automatically at a fixed temperature. Thermostatically operated radiator shutters are also sometimes employed to shorten the warming up period and to assist in maintaining constant operating conditions.

Lubrication System.—The purpose of lubrication is to reduce friction and wear, decrease noise and carry away heat. The most important surfaces of the engine to be lubricated are the frictional surfaces of the pistons, cylinder walls, main and camshaft bearings, connecting rod bearings, wrist pins, timing gears or chains and the valve mechanism. The lubrication of each part is provided for either by delivering the oil through tubes or passages directly to the part to be lubricated, or by depending on lubricant splashed by, or thrown off from, rotating parts. The commonly used lubricants are fluid oils, semi-fluid oils and semi-solids, such as greases. These may be animal, vegetable or mineral oils, but for automobile lubrication, oils derived from petroleum are most generally used because of their suitability and abundance. Oils used for engine lubrication for ordinary driving conditions have a viscosity of 100 to 210 Redwood, or 120 to 250 Saybolt seconds at 130° F. Heavier oils are used for high speed and high temperature operation, and lighter oils for extreme cold weather operation, to permit easy starting.

In the simplest method of lubrication, and one often employed on earlier cars, the lower ends of the connecting rods dipped into oil contained in the crankcase, splashing it to all the bearing surfaces, such as the pistons, cylinder walls, main and camshaft bearings, and camshaft drive. The connecting rods were sometimes drilled so that the force of their impact with the oil would force oil to the bearing surfaces. Difficulty was often encountered with this system due to changes of oil level with oil consumption and with changes of the angle of the car when ascending or descending hills, or on rough roads. These difficulties soon led to the provision of splash troughs under each connecting rod, and a pump or other device to keep each trough constantly overflowing. In this way the engine was rendered less dependent on the quantity of oil in the crankcase for correct lubrication. The model T Ford car furnishes an example of this system.

On many engines, lubrication by the "pressure" system has been provided for the most important bearing surfaces, particularly the main and connecting rod bearings. In these engines usually no splash troughs are provided; an oil pump of the piston or gear type, usually the latter, forces oil under pressure to the main bearings, and sometimes to the camshaft bearings, and, in an overhead valve engine, to the rocker arms. The crankshaft is drilled to conduct oil from the main bearings to the connecting rod bearings. Suitable oil grooves in the bearings allow the oil to flow from the stationary main bearings to the rotating crankshaft. In a few engines an oil line is fastened to the side of the connecting rods, or else the rods are drilled, to convey oil to the wrist pins and cylinder walls. Usually, however, cylinder wall lubrication depends on the oil which is thrown off from the connecting rod bearings by centrifugal force, and which forms a heavy mist within the crankcase. This mist also lubricates the camshaft bearings and cams, valve tappets and front-end drive, although some of these are provided for by



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 10.—PRESSURE LUBRICATION SYSTEM

direct oil pressure. Fig. 10 shows a typical pressure system.

Other parts of the automobile to be lubricated are the transmission, differential, wheel bearings, steering gear, springs and chassis bearings. The transmission and differential require oils of viscosity of 68 to 165 Redwood, or 80 to 200 Saybolt seconds at 210° F, except when semi-fluid greases are used. The chassis bearings may be lubricated with either grease or oil. All these systems try to provide a lubricant of some kind between all moving parts. Automobiles must operate under widely different climatic conditions and at different speeds. Most of the lubrica-

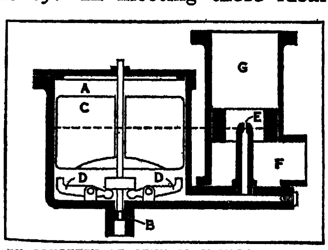
tion problems originate in the difficulty of providing a system that will deliver to all parts the proper amount of lubricant under these different conditions.

CARBURETION AND MANIFOLDING

The engine, properly lubricated and cooled, produces power by converting the chemical energy stored in the fuel into mechanical energy. A system of carburetion and manifolding functions in supplying the proper mixture of air and fuel, which is the source of the engine's power. Carburetion is the art of mixing or blending a liquid fuel with a certain amount of air to form the combustible mixture necessary to meet the required demand. Normally, this is done by a mechanical device known as a carburettor. From the outlet of the carburettor this combustible mixture is carried through an intake pipe or conduit, commonly known as a manifold, to the various cylinders. The carburettor and manifold, together with any other device used in conveying the mixture to the cylinders, make up the induction system of the internal combustion engine. The functions of an induction system are: metering, distribution, acceleration, and starting.

Types of Carburettor.—Three types of carburettors have been employed for internal combustion engines: (1) surface carburettors; (2) wick carburettors and (3) jet carburettors. In the surface carburettor the air passing over the surface or bubbling up through the liquid fuel carried along with it sufficient vapours to make a combustible mixture. This type of carburettor was unsatisfactory as it tended to remove only the lighter fractions of the fuel, leaving the heavier ones. To eliminate this condition the wick carburettor was developed, which also presented a larger surface of fuel to the air stream. Both the surface and wick carburettors have long since passed from the commercial field. A diagrammatic sketch of the simple jet carburettor is shown in fig. 11. Butler is credited with having originated this type of carburettor, although it was first extensively used by Maybach in connection with light oil engines. A nearly constant fuel level is maintained in the fuel bowl *A* by means of the float *C*, which acting through the levers *D* permits fuel to enter through the valve at *B*. The suction stroke of the engine causes air to enter at *F*, pass through the restricted throat in which the fuel jet *E* is located and into the cylinders through the passageway *G*. The restricted throat causes a drop in pressure at that point, and the higher pressure on the fuel chamber *A* causes fuel to flow through the jet *E*. This liquid fuel is picked up by the air stream and forms a combustible mixture.

An ideal carburettor would have the following characteristics: (1) it would correctly proportion fuel to speed and load; (2) compensate for temperature changes; (3) proportion suitable accelerating mixtures; and (4) have low resistance to air flow, to maintain high volumetric efficiency. In meeting these ideal characteristics the simple jet carburettors have been changed until they are now very complex structures. Modern carburettors can be divided into two classes; plain tube and air valve, dependent upon the method of proportioning fuel. The plain tube is similar to the simple jet carburettor in the respect that it depends upon a restricted throat or venturi to proportion correctly the fuel throughout the major portion of its range. The air valve carburettor uses the spring-loaded air valve for the same purpose.



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 11.—SIMPLE JET CARBURETION

With the development of automobile engines where operation is necessary over a wide variation of speeds and loads, it was found that numerous additions to the simple carburettor were necessary to obtain satisfactory performance. These changes included the use of auxiliary jets at idle and low part throttle engine speeds, a metering pin which varies the size of the fuel jet, and a fuel well which supplies the necessary enrichment for acceleration. Next came the development of the economizer, which provides rich mixtures for maximum power at full throttle and leaner mixture for maximum economy at part throttle. This is accomplished in one of three ways: (1) by reducing the effective pressure on the fuel jet at part throttle, a method which becomes inoperative at full throttle; (2) by the use of an auxiliary jet which cuts in at full throttle; or (3) by changing the jet size by means of a tapered or offset metering pin. The last important development in carburettors has been the use of an accelerating pump. These pumps are operated by the throttle and provide positive enrichment during the accelerating period.

Manifolds.—As the air fuel mixture leaves the carburettor, it passes into the manifold. An ideal manifold would have the following characteristics: (1) be free from puddling; (2) have low resistance to maintain high volumetric efficiency; and (3) distribute the unvaporized and unatomized liquid fuel evenly to the cylinders. Depressions in the manifold, which permit puddles of raw fuel to collect, may entirely destroy the performance of a carburettor in correctly proportioning fuel to the engine demand. Also puddles may, upon sudden acceleration, be drawn into the engine, causing poor operation. The resistance of a manifold is controlled largely by its size and the character of the necessary bends. While large manifolds are desirable to maintain high volumetric efficiencies, they also reduce the velocities, permitting more puddling. Thus, a compromise must always be effected between these two points.

Present-day petrol includes as many as possible of the crude oil fractions. Thus the end points are being continually changed as new cracking processes and other developments warrant, until now a large portion of petrol fuel can be evaporated only by the use of external heat. This necessitates the use of hot air or hot spots to vaporize a sufficient portion of the fuel to secure adequate distribution. The use of a hot spot is the most desirable way of obtaining good distribution. The liquid fuel in the manifold tends to collect on the walls and absorb heat from the hot spot. This film of fuel also acts as an insulator for the air, keeping the heat away from it and maintaining high volumetric efficiency. Perfect distribution can be obtained only by having all the fuel in a finely atomized or vaporized state. To do this, however, the heat added would greatly decrease the volumetric efficiency. Thus, a compromise must always be effected between the hot spot size and volumetric efficiency.

Superchargers.—To increase the power output for a given-sized engine, superchargers are sometimes resorted to. By this means a greater weight of air-fuel mixture is forced into the cylinders than would be the case with simple induction. The supercharger is a pump capable of handling large volumes of air at comparatively low pressure difference, say about 6 lb., and is located either between the carburettor and the engine or else between the carburettor and the air intake. The supercharger finds its widest application in racing-car practice, where the cylinder size is limited and maximum power must be obtained. A few cars in Europe are equipped with superchargers, but in America superchargers on passenger cars are seldom seen. (*See* SUPERCHARGERS.)

FUEL

Gunpowder was the fuel used in what is thought to have been the first internal-combustion engine. Christian Huygens, a Dutch experimenter, has been credited with trying out that idea about the year 1680; but, for good reasons, his example was not followed in later and more successful engines. Gas was burned as fuel in the first useful internal-combustion engine, built by Lenoir in 1860. Volatile liquids began to be used for internal-combustion engines about 1890, and from the very outset liquid fuels were employed almost exclusively as sources of energy for the automobile engine. Petrol from petroleum has always made up the bulk of automobile fuel. Other liquids, such as benzol and alcohol, and even paraffin, or kerosene and other fuel oils, have also been used, but only in a small portion of the whole. Each American motor car uses, on the average, about 450 gal. of petrol a year; but trucks and buses, which represent less than 15% of all the cars in service, account for nearly one-half of

the consumption. The average passenger car uses only 250 to 300 gal. a year.

Essential Properties.—There are three essential properties that a satisfactory automobile fuel must have: (1) it must contain a large amount of energy; (2) it must be volatile enough to vaporize quickly; (3) it must be reasonably free from tendency to detonate or "knock" in engines. In respect to the first essential property, high content of energy, it is fortunate that petrol made from petroleum contains the largest amount of potential energy per pound of any ordinary liquid that is known. How large this content of energy really is may be seen from the following comparison of the amount of heat produced by burning a pound of petrol with that of some high explosives, which latter are ordinarily thought of as representing energy in its most concentrated form. The figures given are approximate heating values in British thermal units, per pound: petrol 19,000; T.N.T. 6,500; nitroglycerine 3,200; dynamite (No. 1) 2,500; black powder 1,250. The heating value of benzol (benzene) is 17,500 b.th.u. per pound, and that of alcohol (95% ethyl alcohol) is 11,000 b.th.u. per pound. The principal reason why high explosives appear to be so low with respect to petrol in the above comparison is that they contain both a fuel and the oxygen necessary to burn the fuel; but, in the case of petrol, the weight taken is that of the fuel alone. It is for this reason, that a liquid must be vaporized before it can be burned, that a suitable degree of volatility becomes the second essential property of an automobile fuel. A portion of every liquid that makes a satisfactory automobile fuel must vaporize easily enough to make it possible to start an engine in cold weather, and all of it must vaporize readily enough to make the engine run smoothly after it gets under way. The volatility characteristics of a motor fuel are usually measured by distilling 100 cu.cm. of it under carefully regulated conditions (American Society for Testing Materials, Method D 86, 1927).

Knocking.—Freedom from the known tendency to detonate or knock in engines, the third essential property of an automobile fuel, is important for two reasons. The first reason is that the knock, which is the metallic "ping" that smites the ear of the driver sometimes when he is "crowding" his engine in traffic, or when his car is labouring up a hill trying to make it "in high," or top gear, is very unpleasant. The second reason is that a knocking fuel places a definite limitation upon the power and the economy of an engine. If it is to be powerful and efficient, the automobile engine must tightly compress the mixture of air and gasolene in its cylinders, for it is only in that way that maximum expansion can be obtained, and it is the expansion of the burned gases in its cylinders that imparts power to the piston. So the higher the compression ratio of an engine can be made, the greater is its power and the lower its fuel consumption. The actual compression that can be employed in practice however is limited by the tendency of the available fuel to knock, for the knock gets worse and worse the higher the compression is made, and soon a point is reached at which the knock becomes violent enough to cut down power, so that any further increases in compression results in a loss instead of in a gain.

The knocking properties of the average automobile petrol as sold in the United States in 1926 were such that the compression ratios of automobile engines varied from 4:1 up to about 5:1, depending upon the size and the design of the engine. As a result of much research upon detonation in automobile engines, compression ratios are now being increased (1) because automobile fuels are treated to improve their anti-knocking characteristics, and (2) because improvements in engines themselves make them freer from detonation on any given fuel. Four ways have been found of decreasing the knocking tendencies of automobile fuels; viz., (1) adding to the fuel very small amounts of extremely effective materials for preventing knock, such as lead tetraethyl and iron carbonyl; (2) adding to the basic fuel a percentage of another fuel which is comparatively free from tendency to knock. Blends of benzol and petrol and of alcohol and petrol are the most familiar examples of automobile fuels of this second class. Petrols produced in this way usually have good anti-knock qualities; (3) "cracking" heavy petroleum oils into petrol by means of heat, *i.e.*, breaking the large molecules of a heavy oil into smaller and lighter ones (*see* PETROLEUM); (4) selecting crude oils which by nature yield petrol of good anti-knock properties. Petrol obtained from some of the California petroleums, for instance, is much freer from knock than that produced from Pennsylvania petroleum.

Conversion of Heat into Energy Driving the Wheels.—The manner in which the automobile engine converts into motion the heat produced by the burning of fuel in its cylinders is briefly as follows: The gas in the cylinders of the automobile engine, just as everything else in the world, is composed of multitudes of minute particles or molecules. Every one of these molecules is in rapid motion. The hotter a molecule is the faster it moves, and the colder it is, the slower it travels. All of this is the basis of the kinetic theory of heat (*see* KINETIC THEORY OF MATTER), which states that the motion of the tiny particles of which matter is made is dependent on their temperature. The automobile engine first draws into its cylinders a mixture of fuel and air, which is done simply by a downward stroke of the piston away from an open intake valve. That breathed-in vapour consists of billions upon billions of tiny molecules racing about. Next, the piston is pushed up, thereby crowding or compressing the swarming molecules of fuel and air ahead of it into a much smaller space. The result is that several minute particles now batter against the piston top, as they speed about, for each one that did so before; and so the piston feels a much greater push or pressure against it than at the beginning of the compression stroke. At this point a hot electric spark sets fire to the compressed and highly inflammable mixture of fuel and air, and the whole burns very quickly, releasing an extremely large amount of energy in the form of heat. This increases the heat of the mixture, and the motion of those crowded and swarming molecules in the cylinder is speeded up to a terrific velocity. In their violent agitation they beat against the piston top until they thrust it down. The piston, by pushing downward, turns the crankshaft, the crankshaft operates through the clutch and the transmission to turn the driveshaft; and the driveshaft rotates the gears in the differential, the differential gears turn the rear axle, and the axle drives the wheels that roll the car along the road. It is thus that motion of molecules is converted into movement of the automobile. The function of the fuel is to speed up the molecular motion.

ELECTRICAL SYSTEM

The carburetion and manifolding system delivers the proper mixture of fuel and air to the engine. There the chemical energy is converted into mechanical energy through the process of combustion. The ignition system functions in starting this very process by igniting the combustible mixture in the cylinder.

Spark-plugs.—The spark-plug provides ignition of the charge. It consists of an electrically insulated rod surrounded by a shell which screws into a cylinder. Projecting into the cylinder is a pair of short wires, one an extension of the central rod and the other attached to the shell, and between the pair there is a short gap (·02 to ·04 in.) across which the spark passes. These two wires are the electrodes. The electrodes are made of a heat-resisting metal alloy. The outer shell is usually made of steel, threaded on the outside to permit screwing it in place in the cylinder. The insulator, which surrounds the central electrode, is either some ceramic material or mica, and is selected to withstand high temperatures, resist mechanical strains, and to possess high insulating properties. This last requirement is very important for electric current must jump nowhere except across the spark gap. The insulating material must also be a relatively good heat conductor, and proportioned in size and shape to permit the dissipation of heat into the shell. By this means the temperature of the insulator and electrode is kept down to a point where the material itself will not be injured, and is kept below the point where it might cause ignition of the charge at the wrong time. Nevertheless, it is just as necessary to maintain the temperature

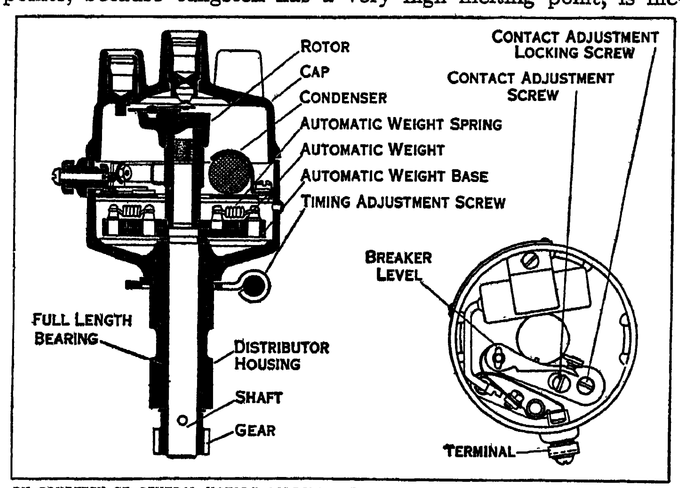
of the insulator sufficiently high to burn any liquid oil or fuel from its surface in order to prevent electrical leakage across the surface. The spark-plug has practically supplanted earlier types of ignition devices, such as hot tubes and make-and-break spark mechanisms, although the latter is still used to some extent in stationary engines.

Ignition System.—In order for the spark to jump the spark gap, a high voltage is necessary. This is obtained either from a magneto or a battery ignition system.

Magneto.—Magneto ignition is used on many European cars and on many aeroplanes where the additional weight of a storage battery is sometimes undesirable. The magneto is fundamentally an electric generator using permanent magnets for the field, and equipped with an integral transformer for the purpose of increasing the voltage to a value high enough to jump the gap in the spark-plug. Either the coils in which the currents are generated may rotate between the stationary field magnets, or the field magnets may rotate within the stationary coils. At the proper time the current which is induced in the primary coils by the relative rotation of the field magnets and the coils is interrupted by means of a circuit-breaker mechanism operated by a cam. A sudden flux change then occurs which induces a current flow in the secondary windings of the magneto, of sufficiently high voltage to jump the gap of the spark-plug in series with this secondary winding. A distributor built integrally with the magneto distributes the secondary current to the various cylinders in the proper order. (*See* also High Tension Magneto.)

Battery Ignition System.—The mechanism of a battery ignition system appears different in form from the magneto, but functions in a very similar way. The engine drives an electric generator. The electric energy generated is either used immediately in the electrical system of the car or is stored in a battery, or accumulator. The ignition system draws on the low voltage battery for an electric current, which passes through an interrupter and through the low voltage winding of a transformer, or coil. Current is induced in the high voltage winding of the same coil and passes through a distributor, and thence through the spark-plug electrodes, jumping the spark gap.

Interrupter or Breaker.—The interrupter is a switch that is periodically opened and closed in synchronism with the vents in the engine cylinder. It is usually equipped with tungsten contact points, because tungsten has a very high melting point, is mechanically hard, resists corrosion to a high degree and is comparatively inexpensive. Formerly platinum was used almost exclusively. A small condenser of about 0·2 microfarads capacity is connected across the contact points to reduce arcing and pitting and also to increase the sharpness of the current break and the intensity of the spark.



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 12.—DISTRIBUTOR

Coil.—The ignition coil consists of an iron core, a primary winding and a secondary winding. The core is a bunch of iron wires or thin strips. The primary low voltage winding consists of comparatively few turns of comparatively large wire, wound around the core. The purpose of the primary winding is to build up a magnetic flux through and around the core. The secondary or high voltage winding consists of a large number of turns of fine wire, also wound around the core. When the interrupter or breaker is closed, the low voltage electric current flows through the primary winding of the ignition coil and sets up a magnetic flux in and around the core. When next the interrupter is opened, the low voltage electric circuit is opened and the current stops flowing through the primary winding. The magnetic flux which had been set up in and around the iron core now immediately collapses. This collapse of the magnetic flux induces a voltage in the secondary winding, causing a current to jump the gap in the spark-plug. Several thousand volts are required to cause a spark to jump across the gap in the spark-plug, whereas the battery voltage is usually 6 or 12 volts. The voltage in the primary winding of the coil is therefore 6 or 12 volts, but the voltage induced in the secondary winding of the coil is many thousands of volts. The coil functions increase the voltage available in the battery to the voltage required by the spark-plug, although at the same time the process results in a reduction of the current.

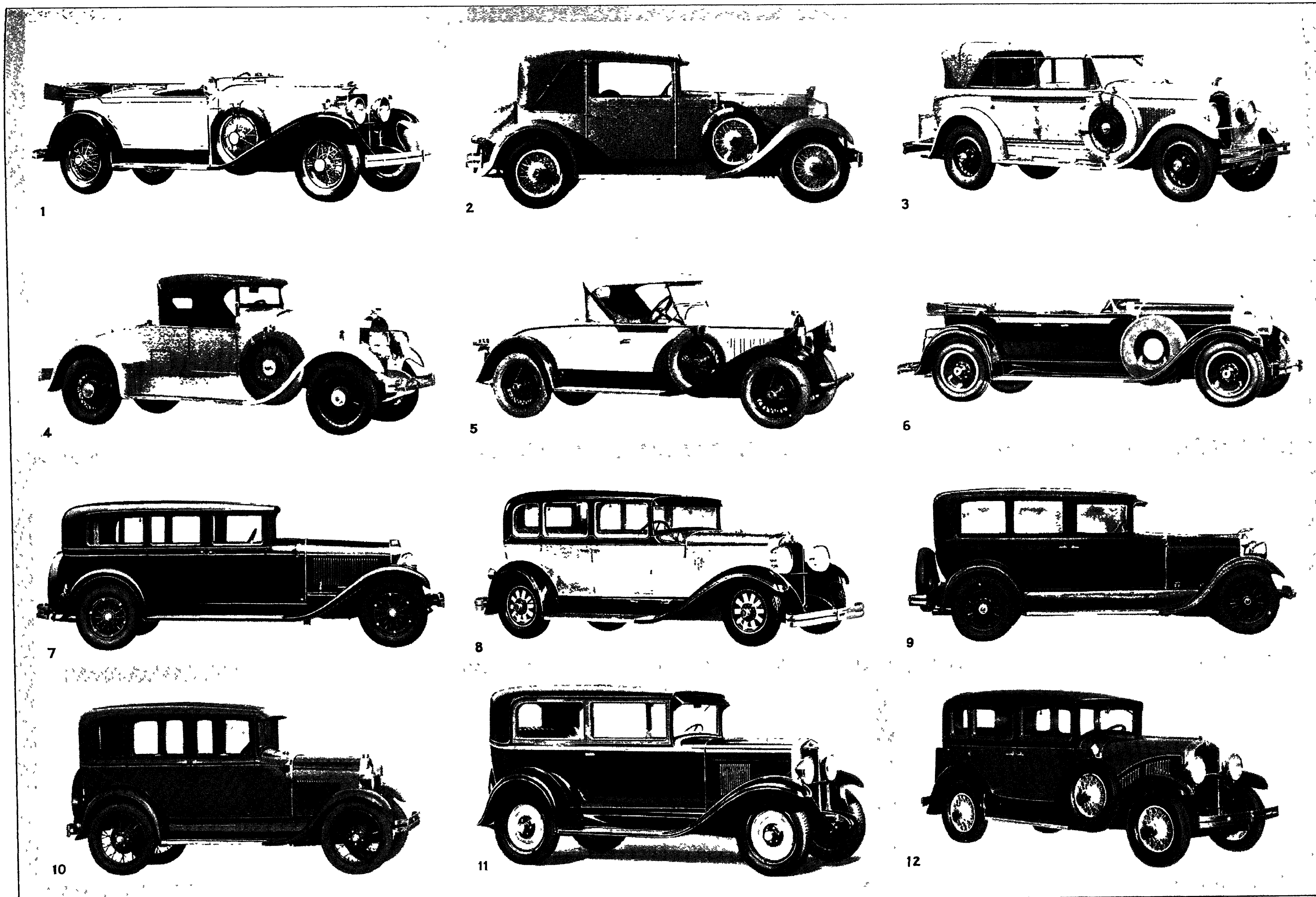
Distributor.—The distributor rotates and distributes the secondary current from the coil to the spark-plugs at the proper time and in the proper sequence. A typical distributor is shown in fig. 12. The case is usually made of some moulded insulation material such as bakelite, resistive to the action of moisture, heat, acids and oils.

Timing.—Shortly before the piston reaches the upper end of its travel on the compression stroke, ignition occurs. Due to the fact that an appreciable time is required for the charge to burn, the timing of the spark to produce maximum turning effort on the crankshaft is required to be somewhat in advance of the top centre position of the piston. This advance varies with speed. In general, less spark advance is required at low speeds and more at high speeds. Automatic governors are commonly provided inside the distributor housing to adjust the advance to approximate engine requirements at all speeds. In addition to this automatic advance, suitable controls are usually provided to enable the driver to advance or retard the spark.

Generators and Storage Batteries.—The purpose of the electric generator (*q.v.*) is to transform mechanical energy from the engine to electrical energy which is used in the various electric units of the car, either directly or reserved for later use by means of the electric storage battery, or accumulator. The conventional generator is an ordinary direct current two- or four-pole unit equipped with a shunt field. In case of the two-pole generator it is common practice to mount a third brush adjustably in a position between the two other brushes so that when the speed and load on the generator increase and the field shifts, the third brush will collect a diminishing current supply for the field. In this manner the battery charging rate may be kept at a high value at low speeds and be prevented from rising to abnormal values at high speeds.

Starting Motor.—The function of a starting motor is to set the moving parts of an engine in motion at sufficient speed until the engine starts operating under its own power. Engine cranking speeds of above 35 r.p.m. are usually required for successful starting in cold weather. Starting motors are generally of the six-volt series-wound type. They are equipped with a special coupling which permits the engagement of a small gear on a shaft extension of the motor with a ring gear either cut on or attached to the fly-wheel. This gear reduction makes possible a starting motor speed 10 or 12 times as great as the engine speed during cranking, with a consequent multiplication of torque. Starting motors are designed with a low internal resistance in order to utilize to full advantage the energy contained in the storage battery.

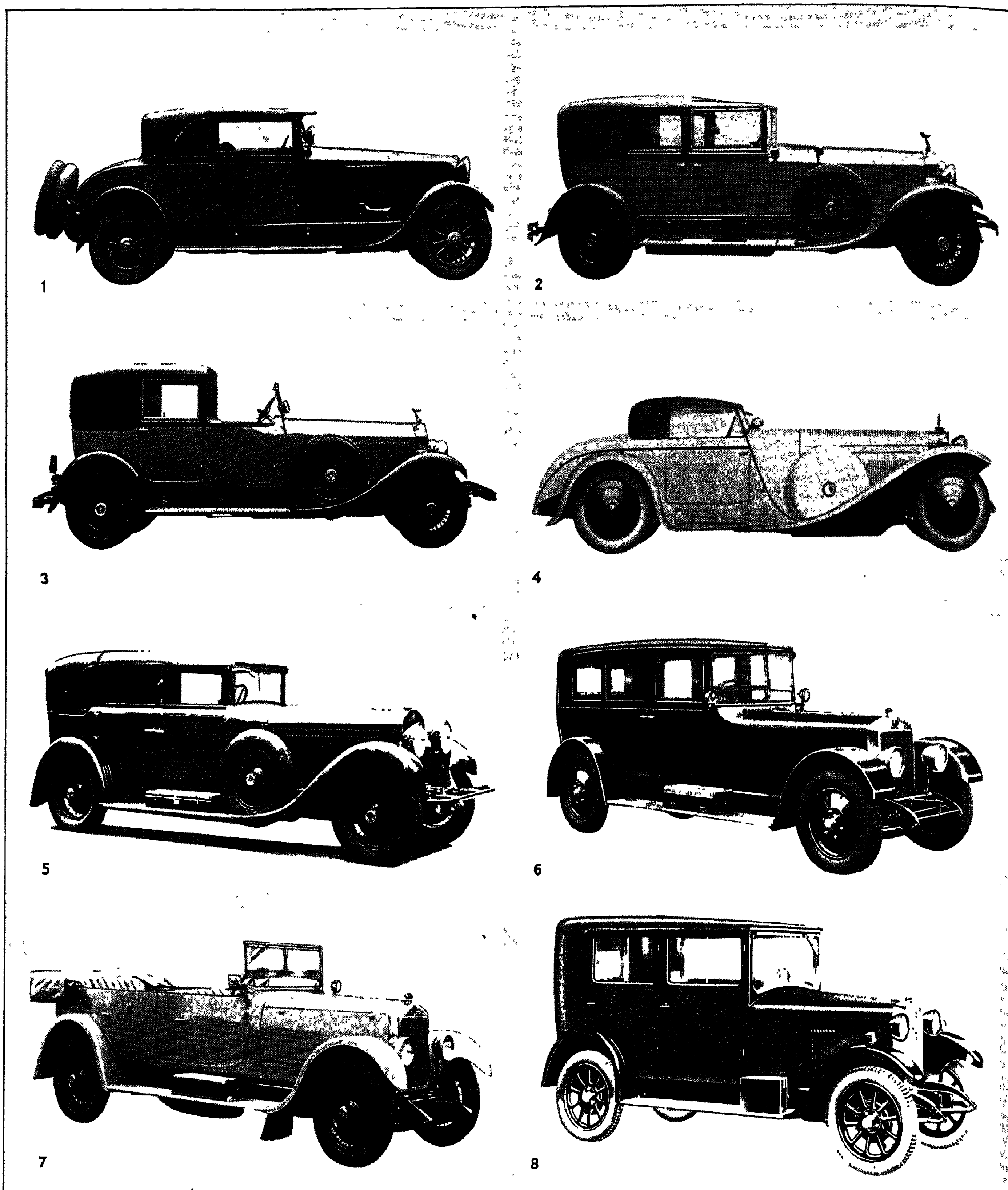
There are a number of different types of engagement couplings. The automatic coupling is of the inertia type. The small gear is mounted on the armature shaft through a steep spiral thread. The rotational inertia of the gear prevents it from turning when the motor armature begins to rotate, and it is therefore moved toward the fly-wheel ring gear. The teeth are so chamfered both



BY COURTESY OF (1) GENERAL MOTORS, (2) THE STUTZ MOTOR CAR COMPANY, (3, 12) THE REO MOTOR CAR COMPANY, (4) THE FRANKLIN AUTOMOBILE COMPANY, (5) THE PIERCE-ARROW MOTOR CAR COMPANY, (6) THE PACKARD MOTOR CAR COMPANY, (7) THE F B STEARNS COMPANY, (8) THE NASH MOTORS COMPANY, (9, 10) THE FORD MOTOR COMPANY, (11) THE CHEVROLET MOTOR COMPANY

AMERICAN MOTOR CARS, OPEN AND CLOSED MODELS, OF RECENT DESIGN

1. Sport phaeton. 2. Four-passenger landau. 3. Cabriolet. 4. Roadster. 5. Runabout. 6. Phaeton. 7. Limousine. 8. Four-door Sedan. 9. Limousine. 10. Town Sedan. 11. Coach. 12. Sport Sedan.

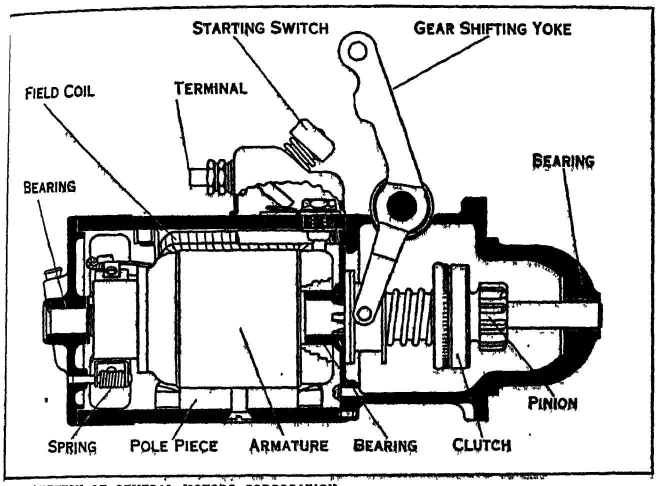


BY COURTESY OF (1) RENAULT SELLING BRANCH, INC., (3) HENRY BINDER, PARIS, (4) THE MERCEDES-BENZ COMPANY, INC., (5) ISOTTA-FRASCHINI, (6, 7) THE LANCHESTER MOTOR CAR, LTD., (8) ROVER CAR COMPANY

EUROPEAN MOTOR CARS OF MODERN DESIGN

1. Four-passenger coupé, 40–140 h.p. **2.** Barker Sedan de Ville on Rolls-Royce chassis. **3.** "Faux cabriolet" or fixed head cabriolet designed by Henry Binder, Paris. **4.** Racing car designed by the Mercedes engineers. **5.** Coach-work on an Italian limousine. **6.** 40h.p. six-cylinder limousine of English make. **7.** English 21 h.p. five-passenger touring car. **8.** 10–25 h.p. car, of English make, a small enclosed car having narrow gauge or tread

n the pinion gear and on the ring gear that engagement is quite ositive. When the engine starts under its own power, its speed creases and the small gear on the armature shaft rotates faster an the shaft. This action screws the gear out of mesh with e fly-wheel and thereby prevents injury to the starting motor rough excessive speed. In the other type of coupling the pinion forced against the ring gear by means of a foot lever and held



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 13.—SECTIONAL VIEW OF STARTING MOTOR

lightly in place by means of a spring. Further motion of the foot lever compresses this spring until the lever closes the starting motor switch. The pinion then revolves slightly until engagement is effected and cranking of the motor follows. An over-running clutch disengages the starting motor when the engine starts. Fig. 13 shows a typical starting motor.

Lighting.—Automobile head-lighting practices differ very materially in the different countries. These differences arise chiefly from the fact that no system of head-lighting has yet been developed which satisfactorily meets all of the requirements of the various driving conditions. In localities where roads are straight and traffic is light, cars may be operated at relatively high speeds, and drivers will be interested primarily in seeing obstructions, turns, etc., far down the road. In other localities where the roads twist and turn and traffic is heavy, much lower speeds will prevail. Here drivers do not need to see nearly as far ahead but require more light to either side to illuminate roadsides and ditches and to show the way around turns. Some satisfactory means is also needed to pass other cars safely and without dangerous glare. Where cars are driven from one part of the country to another and encounter a wide range of driving conditions, the head-lighting system adopted for general use must take the form of a compromise designed to provide for reasonable safety and comfort under all conditions of driving.

In the United States, where the traffic problem has been difficult for some years, head-lighting has received a large amount of attention. The trend of development has been influenced to a considerable extent by the recommendations of technical societies and by the laws in the various States. These systems of head-lighting in general use require that the beam be adjusted in such a manner as not to permit the high intensity rays to rise above the level of the head-lamps under ordinary conditions of operation. A small amount of light is required above the head-lamp level to reveal overhanging obstructions and objects, the lighter coloured or bulkier parts of which are above the level of the lamps, but this part of the light should be closely limited so that it will not dazzle approaching drivers to a dangerous extent. In the United States head-lamps are designed to produce a beam which has the form of a horizontal band of light when projected on a vertical surface. The top of this beam is aimed at or slightly below the horizontal. The highest intensity is near the top of the beam where it is needed to reveal objects several hundred feet ahead. This high intensity section extends to both sides sufficiently to light the road well ahead of the car in rounding turns. A relatively small amount of light is needed in the immediate foreground and well to both sides to show up inequalities in the road surface, roadsides and ditches.

On smooth, level roads, head-lamps adjusted in this manner are fairly satisfactory. Drivers may pass each other at relatively high speeds without dimming and in comparative safety. Unfortunately, however, all roads are not smooth and level. The angular difference between the eyes of an approaching driver 100 ft. ahead and objects which one must see on and above the road is so very small that it does not require a great change of gradient to lift the blinding part of the beam into the other driver's eyes. Car springing is another source of trouble. On rough roads the action of the springs raises and lowers the beam so as to direct a series of flashes into the eyes of an approaching driver. Also, in cars having both front and rear seats, loading must be considered. When the rear seat is loaded, the beams may be raised as much as 2 ft. at a distance of 100 ft. ahead. For this reason it has been customary to aim the beams with the car loaded. This, of course, interferes seriously with the range of visibility ahead when the rear seat is empty. The tendency toward lower drivers' seats, softer springs and balloon tires in the United States and elsewhere, has aggravated these troubles.

Because of these inherent deficiencies in fixed-beam head-lamps, dual-beam head-lamps have come into general use during the past few years. The double-filament incandescent lamp is used in practically all dual-beam head-lamps supplied on American cars. By switching from one filament to the other the driver may raise or lower the beam at will. The upper beam should be aimed up to the horizontal to illuminate objects far down the road. The lower beam is tilted downward about two degrees. This avoids dangerous glare under ordinary conditions of driving. The beam projects a high intensity on the road to a distance of about 100 ft. ahead of the car, which is desirable for passing other cars with glaring head-lights. This beam may be used continuously with safety in the city where street lights illuminate objects several hundred feet ahead. The lower beam is also very satisfactory for continuous use in traffic where the road is illuminated by the headlights on other cars.

MOTOR CAR OPERATION TERMINOLOGY

In the development and testing of automobile equipment certain engineering terms are used that are frequently misunderstood and misinterpreted. (*See* INTERNAL COMBUSTION ENGINES.) These terms are: mean effective pressure, work, torque, power, thermal efficiency, mechanical efficiency and volumetric efficiency.

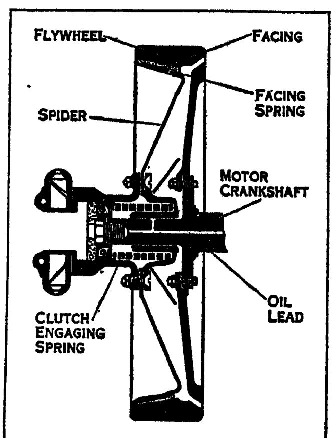
Pressure is generally used in referring to the force of the gases on the piston, and the force between two bearing surfaces. It is commonly measured in pounds per square inch. For some purposes it is convenient to refer to a theoretical average pressure such that, if it acted on the piston throughout the expansion stroke, would produce the same amount of work as the actual varying pressure. This theoretical pressure is known as the *mean effective pressure* (m.e.p.). *Work* denotes the transfer of energy from one place to another. It is defined as a product: of force and distance. The engineering measures of work are the foot-pound and inch-pound; *i.e.*, force in pounds multiplied by distance, in feet or inches, through which the body, on which the force is applied, moves. From a scientific point of view no work is done unless the force applied to a body moves the body. In other words, no energy is transferred unless there is movement of the body into which we are trying to put the energy. *Torque* is merely a technical name for twist. It is different from work in that it does not take into consideration the distance through which a force acts. Torque might also be defined as a special case of linear force where the force is so placed with respect to the body as to produce only rotary motion of the body. Its measures are the pound-foot and the pound-inch. At the speed of maximum power the torque is only about two-thirds or three-fourths as great as its maximum at a lower speed, generally 800–1,600 r.p.m. American automobile engines develop from 90 pound-feet of torque to over 350 pound-feet.

Power.—Power may be defined as the rate of doing work.

The common measure of power is the horse-power, which may be defined as the rate of doing work which is equal to 550 foot-pounds in one second or 33,000 foot-pounds in one minute. Another way of saying this is: the rate energy is transferred so many foot-pounds per second or per minute, or so many horse-power. Power (rotary motion) must consider force, distance and time, which is expressed for convenience as torque (force) and revolutions per minute (distance and time). If the torque of an engine should remain constant, the power developed would be twice as great at double the speed. The power of an engine is commonly measured on a dynamometer (*q.v.*), which in some cases is a special electric generator with certain arrangements to permit measuring the torque developed at the crankshaft. This torque, combined with the speed of the engine, gives a measure of the power available for doing work, which is called the *brake horse-power* (b.h.p.). The b.h.p. of an engine increases with speed up to a certain speed, above which it decreases. For American cars this speed varies from 2,000 r.p.m. to over 3,600 r.p.m., the majority being about 2,800 r.p.m. The maximum b.h.p. developed by these engines varies from about 35 to over 120.

Brake horse-power is sometimes confused with the horse-power rating often used for taxation purposes. Various countries use a formula based on the physical dimensions of the engine to determine a theoretical horse-power figure for computing the tax. In the United States and Great Britain the same formula is used (called the N.A.C.C. formula for the U.S., and the R.A.C. formula for Great Britain) based on the diameter and number of cylinders: h.p. $= \frac{D^2N}{2\cdot 5}$ when D is the diameter of the cylinder in inches, and N is the number of cylinders. This formula gives a figure which is from one-half to one-fourth of actual b.h.p. developed by modern engines. Another formula is: h.p. $= \frac{D^2NS}{10}$ where S equals the length of the stroke. This formula is used in some parts of the United States.

Efficiency.—*Thermal efficiency* is the ratio of the work output of the engine, expressed in terms of heat, to the total amount of heat in the fuel used to secure that amount of work. A normal engine has a thermal efficiency of from 15 to 22% at full load. (*See* MOTOR CAR: *Fuels and Combustion;* INTERNAL COMBUSTION ENGINES.) *Mechanical efficiency* is the ratio of work output of the engine to the work developed within the engine cylinders. The difference is accounted for by the friction and pumping losses within the engine itself. Of the various friction losses, the piston friction is the largest. Considerable work is also expended in pumping the gases into and out of the cylinders, particularly at part throttle. Automobile engines vary from 75 to 93% mechanical efficiency at full load.

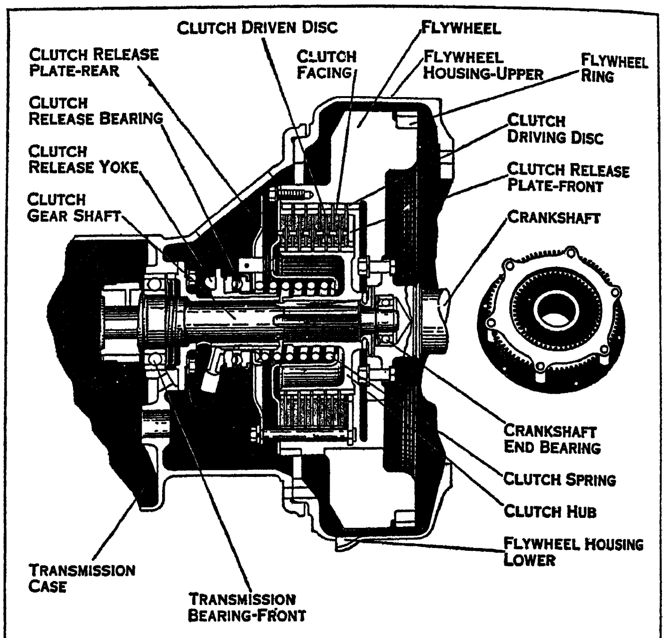


BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 14.—CONE CLUTCH

To decrease the friction losses in an engine, bearing materials with low-friction properties have been developed, and also more thorough lubrication of moving parts has decreased friction to as low a figure as seems feasible with present design of engines. The pressures developed at the bearing surfaces have necessitated certain minimum limits for bearing sizes, with due regard for durability. While the bearing friction losses for a given size of engine have been decreased but little, the mechanical efficiency in many cases has been increased by increasing the power output of the engine without a corresponding increase of friction. (*See* section, *Metals in the Motor Car.*) *Volumetric efficiency* is the ratio between the volume of air drawn into the engine for each two revolutions (one cycle), and the engine displacement, or volume of the cylinders swept by the pistons.

Loss of Energy.—In the operation of an automobile, more power is required to bring the vehicle up to any predetermined speed than to keep it moving at that speed (except the maximum speed of the automobile). The difference between the power of the engine at any speed and the power required to drive the automobile at a speed corresponding to this engine speed on level roads, represents the power available for acceleration and hill climbing. To increase this difference, for starting purposes and on other occasions when greater power is needed, the change gears in the transmission are used. (*See* section, *Transmissions.*) Nearly all cars have their rear axle gear ratio so chosen that the engine will develop very nearly its maximum power at approximately 75% of the maximum speed of the car when in direct drive. Then the maximum hill-climbing ability or the maximum accelerating ability will come at the speed of maximum torque, or for most American cars, about 20 to 25 m. per hour.



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 15.—MULTIPLE DISC CLUTCH

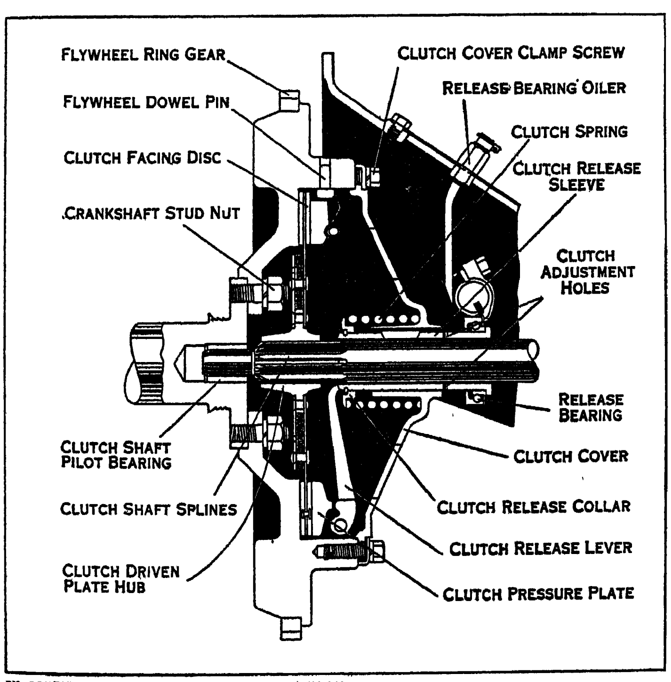
The power required to drive an automobile on a level road is utilized to overcome two resistances to motion—rolling or friction resistance, and air resistance. The rolling resistance is caused by friction in the transmission, universal joints, differential, rear wheel and front wheel bearings, and also of the tires on the road. The air resistance is caused by the pressure of air against the front of the car and the partial vacuum behind it, and by the friction of the air as it passes over the various surfaces. The rolling resistance is more or less constant, regardless of the speed, while the air resistance increases as the square of the speed. In other words, at 60 m.p.h. the air resistance is four times as great as it is at 30 m.p.h. At low speeds, say 15 to 20 m.p.h., the air resistance forms the smaller part of the total, say about a quarter, while at higher speeds, the air resistance increases very rapidly, so that at 60 m.p.h. it accounts for two-thirds or more of the total resistance.

TRANSMISSION

The engine, with its lubrication and cooling, and the carburetion and ignition systems, function as a unit to produce power, and are commonly known as the power plant. In addition, a mechanism is necessary to transmit the power produced by the power plant to the wheels of the vehicle in order that they, rotating, may push the car along the road. This mechanism is the transmission, and it consists of several units: (1) the clutch, (2) the gear-set, gear-box or transmission, (3) the propeller shaft and universal joint,

(4) final drive, differential, rear axle.

Clutch.—The clutch enables the operator to connect or disconnect at will the engine and the mechanism used for transmitting the motive power to the driving wheels. The clutch is disengaged when one desires to stop the vehicle without stopping the engine, or when it is necessary to change the ratio of the gear in the transmission. Of the many forms of clutches that have been used, the three types—the cone, fig. 14, multiple disc, fig. 15, and single plate, fig. 16,—have been used more than any others. The cone clutch is made up of a short portion of a cone with an included angle of about 12° to 15°, and is usually faced with leather or asbestos fabric. Provision is made so that this cone can be moved axially in and out of contact with a corresponding conical surface in the engine fly-wheel. A spring or springs are employed to keep the clutch engaged with the fly-wheel when it is not held out of engagement by the operator. The multiple disc clutch is made up of a plurality of plates or rings, half of which, called the driving discs, are connected by splines to the fly-wheel, the other half being similarly connected to the main drive shaft of the transmission. Sufficient spring pressure is provided so that the friction between the driving and driven disc surfaces will transmit the full power of the engine without slipping. The single plate clutch, on account of its simplicity and ease of manufacture, has largely superseded all other forms. This clutch is made up of a single plate which is keyed to the transmission main drive gear shaft and is usually spring-clamped between a flat surface on the fly-wheel and a pressure plate arranged so that it is also driven by the fly-wheel. The required pressure to prevent slipping is provided, either by a plurality of springs at the back of the pressure plate,



BY COURTESY OF GENERAL MOTORS CORPORATION

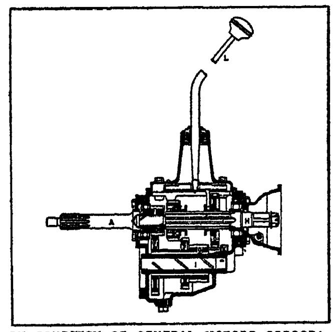
FIG. 16.—SINGLE PLATE CLUTCH

or a single spring multiplied by levers fulcrumed in the fly-wheel or pressure plate, and acting against the other members.

General Requirements for Transmission.—"Best car performance" requires a power plant capable of driving the road wheels to the verge of slipping during acceleration and at maximum car speed. An internal combustion engine could be built powerful enough to approach these conditions; such an engine would have a slipping clutch, a properly selected rear axle ratio, and it would drive the wheels directly. Considerations of weight, space limitations, cost, economy of operation, and sometimes excessive taxation, however, prohibit the use of such a large power plant, making it necessary to use a smaller engine.

An internal-combustion engine delivers its maximum power at a definite engine speed. Therefore, for best performance it is desirable to maintain this definite engine speed constant regardless of car speed. For normal driving conditions on level roads, however, the power required is less than the maximum power supplied by the engine, and for this condition it is desirable to run the engine at a much lower speed in order to give economy of operation. To fulfill these two conditions—maximum power and economy—it is necessary to incorporate between the engine and the road wheels a device which will permit a change of the ratio of engine speed to car speed. This is called the transmission. An ideal transmission would fulfill the above two conditions completely, but at present mechanical difficulties, cost, size, weight and complicated operation, make such an ideal transmission impracticable. In actual practice, therefore, transmissions are a compromise between the ideal and the limiting factors.

Gear-set, Gear-box, (Gear) Transmission.—The most common type of transmission is called gear-set, gear-box, or gear transmission, and comprises a housing or case with shafts and bearings to carry the necessary gears, usually of the spur gear type. In the greater number of transmissions the gears are so arranged that by proper selection either three or four ratios of engine speed to car speed for forward driving, and one ratio for reverse driving, may be obtained. A typical three-speed forward and reverse transmission is shown in sectional view in fig. 17, in which *a* is the driving shaft and clutch member, *h* is the driven or spline shaft, *i* is the countershaft, *b* and *e* are constant mesh gears. The shaft *i* is stationary and gears *e, f* and *g*, fixed together, rotate on shaft *i*, whenever the clutch is engaged and the engine running. To engage the low gear, the shifter lever *l* is moved so that gears *g* and *d* are brought into mesh. The torque is then transmitted from gear *b* to gear *e* and through gears *g* and *d* to the spline shaft and universal joints to rear axles and road wheels. When in low gear, the engine revolutions are from 10 to 15 times the revolutions of the road wheels, a condition which causes the vehicle to move forward slowly, but with considerable force, as is required when starting, climbing a steep hill or pulling through sand or mud. To engage second, or intermediate gear, the gear shifter handle is moved so that gears *c* and *f* become engaged. When in second gear, the engine makes from 7 to 12 revolutions to 1 revolution of the road wheels, a condition which causes the vehicle to move faster than when using low gear, but with less force. To engage direct gear, the internal clutch teeth in *c* engage the external clutch teeth on *b*, and the torque is transmitted directly to the main spline shaft and on through to the road wheels. When in direct, or high, gear, the engine makes 3 to 5 revolutions to 1 revolution of the road wheels, a condition which gives high speed and best economy. To reverse the vehicle, sliding gear *d* is moved into engagement with idler gear *k*. Torque is then transmitted from shaft *i* to the idler gear *k* and from *k* to gear *d*, which drives shaft *h* in a reverse direction.



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 17.—SECTIONAL VIEW OF THREE-SPEED FORWARD AND REVERSE TRANSMISSION

Planetary Transmission.—This transmission was extensively used early in the automobile industry, but due to its complication, particularly when more than one reduction ratio is desired, and subsequent cost, it has been practically abandoned. It receives its name from the fact that an end view is similar to a solar system having a sun gear and a series of planet gears rotating about it. The two most simple types consist of direct, low and reverse speeds, one type being made up of all external gears and the other made up of external gears and one internal gear. By selecting various numbers of gear teeth any ratio can be obtained from 2 to 1 up, within practical limits. Several reduction ratios can be built into the same unit by the addition of more combinations of gears.

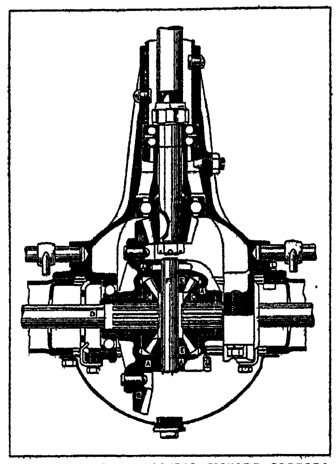
Infinitely Variable Transmissions.—An infinitely varia transmission provides a continuous range of transmission rati

within selected limits. Thus any transmission ratio most suitable for a particular driving condition may be selected, giving best car performance for a predetermined engine size. Moreover, noise, time loss and effort experienced when shifting gears in an ordinary transmission are eliminated and adaptability for automatic control is increased. These advantages were recognized early, but complexity, weight, cost and low efficiency have limited the use of such transmissions to a small field where performance and smoothness are paramount and the objectionable features are of secondary importance, as for instance in American motor-bus and rail-car operation. Friction drive was among those first utilized. Early types used a belt and two conical pulleys. Friction discs using wood, leather or fabrics on the driving surfaces, or metal to metal contact, have been tried on small cars with limited success. Variable throw mechanisms oscillating intermittent members which in turn drive through devices simulating ratchets are used in the De Lavaud transmission. The intermittent action of the several individual members combine in a continuous driving effort. Other transmissions use the inertia reaction of weights oscillated by a constant throw mechanism, the inertia reaction driving through ratchets or similar devices.

Hydraulic transmissions use an engine-driven pump, delivering an arbitrarily variable amount of fluid to an hydraulic motor operating the driving wheels. In electric transmissions an engine-driven generator supplies current to electric driving motors. In some arrangements the structural parts of generator and motor have been combined to reduce weight and cost. Electric transmissions are widely used in American motor-buses and on a few trucks. By combining an infinitely variable transmission with an epicyclic gear, part of the torque may be transmitted through gears, thus reducing weight and costs of the variable mechanism and increasing efficiency. Besides this, two ratios may be obtained at which the variable mechanism does not perform any relative motion. In general, the control of transmission ratio may be inherently automatic, governor operated, manual, or a combination of these. Automatic control may be based on engine or vehicle speed, road torque requirements or combinations thereof. Only a few passenger cars at present use any of these forms of infinitely variable transmission, because when cost, weight, size, complication and general reliability are considered, the manually operated sliding gear transmission is more practical than any infinitely variable type so far developed. At the present time the electric transmission used on American motor-buses is generally not considered suitable for passenger cars.

Propeller Shaft and Universal Joints.—The shaft which transmits the power from the gear-box to the rear axle is called the propeller shaft. Since the rear axle in the usual design of car moves up and down with the wheels relative to the car itself, it is necessary that this shaft incorporate some means to allow the shaft to assume varying angularities and revolve at the same time. This is done by means of universal joints. There are two general types of propeller shafts, depending upon the manner in which the rear axle is attached to the car. In the torque tube drive, the rear axle housing is extended in the form of a tube surrounding the propeller shaft, and this tube is flexibly attached to the rear of the gear-box or to some point on the frame adjacent thereto, so that the rear axle, in moving up and down, rotates about this joint. In this case only one universal joint placed coaxially with the point of attachment of the torque tube is required. In the so-called "Hotchkiss" drive, the rear axle is fastened rigidly to the springs, and moves up and down without rotating about the wheel axis, in which case it is necessary to have two universal joints, one at each end of the shaft, and a sliding connection to allow the shaft to change its length to allow for movement of the rear axle about a centre not coaxial with either joint. Some cars have a beam or "radius rod" which performs the function of locating the rear axle, in which case two joints are invariably employed.

Universal joints are used to transmit torque from one shaft to another through an angle. Where loads and speeds are high, this angle must be small, not over 6 to 8°, although for light work angles of up to 30° are practical. Many types of universal joints are used, but the most common are the mechanical "Cardan" joint and the flexible type. The former consists essentially of two forked members, one on each of the two intersecting shafts, so disposed that a pin between the two "prongs" of each fork will pass through the point of intersection of the shafts. The two pins form a rigid cross which transmits the torque from one fork to the other regardless of their relative angle. The flexible type of universal joint consists essentially of two similar forks with a ring of flexible material, usually a rubberized fabric between them, and the relative movement of the two forks is taken up in the flexing of the ring.



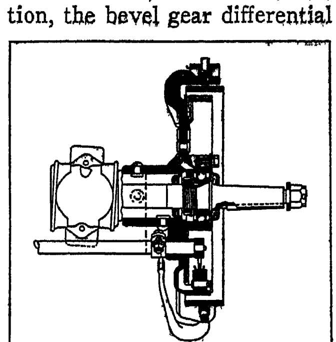
BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 18.—SPIRAL BEVEL GEAR, REAR AXLE ASSEMBLY

Rear Axle and Final Drive.—When the axis of the power plant is disposed longitudinally, the final transmission has to provide a right-angle drive combined with the necessary reduction of rotational speed; this may be effected in various ways, of which at the present time the bevel gear and the worm drive are principally adopted. The bevel gears used at present are mostly of the spiral bevel type, the straight bevel being almost obsolete for passenger vehicles. The torque is transmitted from the propeller shaft to the final drive and from the final drive to the main shafts, and is equalized between the shafts by means of the differential.

Worm Drive.—The worm drive is used quite extensively and has made progress in the United States, several makers having adopted this drive for passenger car use in recent years. The chief advantages are quietness of operation, permanence of adjustment and freedom from vibration. This construction with underslung worm also permits considerable lowering of the chassis.

Axle Differential.—The axle differential divides equally between the driving wheels the effort supplied by the engine and at the same time allows one wheel to overrun the other when turning corners. The most common method of doing this is by means of a combination of bevel gears. Spur gears, worm gears and different combinations of pawls and ratchets have been employed at various times, but because of its low cost and satisfactory operation, the bevel gear differential is most generally used.



BY COURTESY OF GENERAL MOTORS CORPORATION

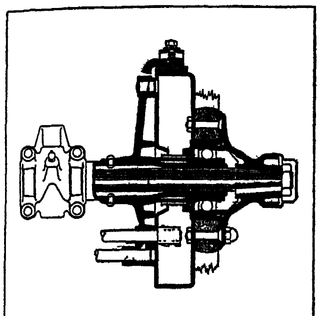
FIG. 19.—REAR AXLE, SEMI-FLOATING TYPE

The bevel gear differential may be described in the following manner (*see* fig. 18): The gears are carried in a differential case A which has fastened to it the driven final drive gear B. Two bevel side gears C and C' are placed opposite each other and attached one to each axle drive shaft D and D', and are free to rotate in the case. Two (or more) equally spaced bevel pinion gears E and E', also free to rotate, are carried by means of a stub-shaft F fastened in the case and meshed with the side gears C and C'. The turning effort is transmitted to the case A and stub-shaft F, and in turn to the pinion gears E and E', which divide it between the two side gears C and C' in the manner of a simple beam loaded in the centre and restrained at each end. The only serious disadvantage of the bevel and spur gear type appears when one rear wheel loses traction; *i.e.*, starts to slip as in deep sand or mud; the wheel without traction will spin and the other will stand still, giving no motion to the vehicle. This can be overcome by introducing internal friction or locks, but in most

cases the disadvantages of these methods outweigh the advantages.

Rear Axles.—The three types of rear axles are classified according to the shaft construction, as the semi-floating, the three-quarter floating and the full-floating.

Semi-Floating.—In the semi-floating type of rear axle the axle shaft is supported on two bearings, one at the outer end of the housing and one at the differential end, and the wheel is keyed rigidly to the shaft, which in addition to transmitting the driving effort sustains the weight of the car and resists all external thrusts, such as are due to skidding or to turning corners (*see* fig. 19).



BY COURTESY OF GENERAL MOTORS CORPORATION

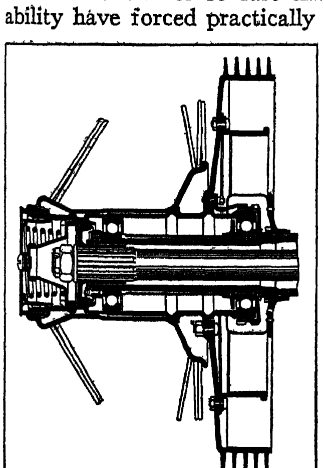
FIG. 20.—THREE-QUARTER FLOATING AXLE

Three-Quarter Floating.—In the three-quarter floating type of rear axle the inner end of the axle shaft is supported in the same manner as in the case of the semi-floating axle. The outer bearing, however, supports the wheel, which in turn is rigidly keyed to the outer end of the axle shaft. In this type of axle the car weight is carried by the housing, but the side thrusts due to skidding and to turning corners, in addition to the transmission of the driving effort, are still carried by the axle shafts (*see* fig. 20).

Full-Floating.—In the full-floating type of rear axle the wheels are carried by double bearings on the axle housing, which, therefore takes all stresses except that of the driving effort. The wheel is not keyed rigidly to the axle shaft but is driven through splines by means of a splined flange on the axle shaft (*see* fig. 21).

THE CHASSIS

Brakes.—The brakes are called upon to perform two duties, one of which is to bring the car to rest or to decrease its speed, and the other to hold the car in its place while unattended. These two functions are ordinarily performed by two separate braking systems, the former function by a foot pedal operated system, called the "service" brake, and the other by a hand-operated brake, called the "parking" or "emergency" brake. The modern car moves so fast that the demands for rapid stopping ability have forced practically every make of motor car to have a separate brake for each of the four wheels, and a modern motor car can stop from a speed of 60 m. per hour in 200 ft. or less (the distance depending on the condition of the road and the tires). Maximum deceleration rates generally are about 18 to 20 ft. per sec., but depend to a large extent on the condition of the road surface and the tires.

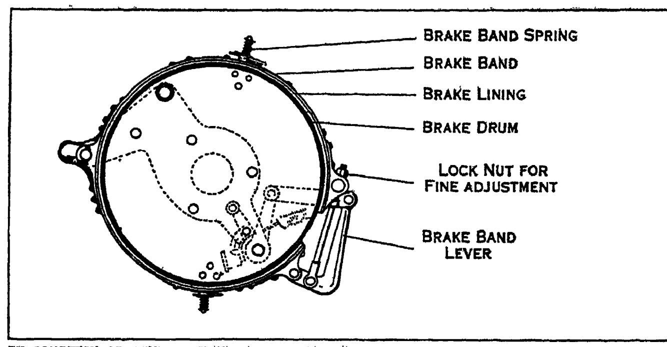


BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 21.—FULL FLOATING AXLE

Brakes may be divided roughly into two classes—the external contracting and the internal expanding brakes. Fig. 22 shows the external type, and fig. 23 shows the internal type. The former type consists of a band attached to the stationary part of the axle, and acting on the outer surface of a drum attached to the wheel. The internal expanding brake uses a similar drum, the inner surface of which is gripped by two or more shoes which are forced outward by the driver through a suitable mechanism connected to the brake pedal or lever; in some installations a flexible band is used, which is forced outward against the drum by separating its ends.

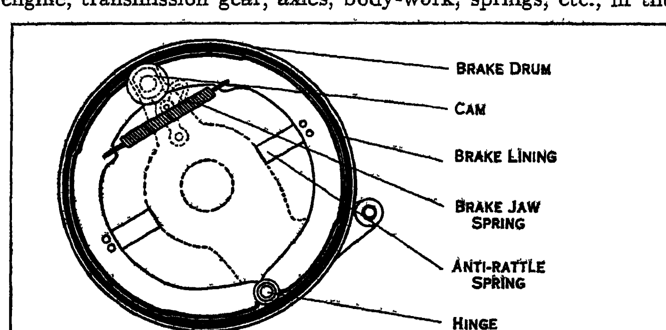
Two general methods of operating the brakes are commonly used—mechanical and hydraulic. In the mechanical systems motion of the brake pedal is transferred to the brakes at the wheels by means of rods or cables, with suitable shafts and levers to compensate for the motion of the wheels relative to the frame and sometimes to equalize pressure between the different brakes. In the hydraulic system, used on some cars for the service brakes, motion of the brake pedal applies the brakes through an oil pipe to each wheel. A master cylinder and piston is actuated by the pedal, and the oil displaced from this cylinder is forced through a system of conduits to each wheel, where it actuates the pistons in such a way as to apply the brakes. A mixture of glycerine and alcohol is commonly used for the liquid; this mixture changes in viscosity but slightly with change of temperature, and freezes far below any usual operating temperature of the car. Suitable means are provided to refill automatically or manually the liquid lost from the system. A brake is often fitted to the drive shaft which acts on the rear wheels through the driving mechanism. Since the retarding forces are in general more severe than the driving forces, use of this brake involves a certain amount of extra wear and tear on the driving gear, and for this reason it is most often used only as a parking brake. The shoes or bands which press against the brake drum are ordinarily faced with some material having a high value of friction. This is ordinarily made of woven asbestos, which is treated with various materials to act as a binder and to secure desirable friction characteristics.



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 22.—EXTERNAL BRAKE

Frame, Front Axle and Steering Gear.—The desirability of making the mechanism of the car independent of the style of passenger accommodation was apparent as soon as motor cars were made in any considerable numbers. Accordingly, the frame, which forms the backbone of the car, has become practically universal, and to it are fastened all of the car's principal components. It is the function of the frame to keep these components, the engine, transmission gear, axles, body-work, springs, etc., in their proper relative positions. The type of frame which has become practically standard, consists of two longitudinal beams, usually pressed-steel channel sections, with cross members spanning between them at intervals. Brackets are provided for the mounting of the various parts of the car. The frame with the mechanical parts of the car assembled upon it is called the chassis. Due to inequalities of road surface there is considerable tendency to distort the frame, which places strains upon the mechanism and body-work; so it is important that both longitudinal and cross members be of stout construction to avoid bending and twisting.



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 23.—INTERNAL BRAKE

The side members are almost always of pressed steel and are from 4 to 8 in. in depth, of material from $\frac{1}{8}$ to $\frac{3}{16}$ in. in thickness. The cross members may be of almost any section, but are most commonly either channel or tubular. Departures from this type of construction, which are very few, use wooden frames, combine the functions of body and frame, or substitute tubular longitudinal members.

The front axle supports the front end of the car as its name implies. It is a steel beam, usually of I or tubular section, which joins the front wheels of the vehicle; and is ordinarily attached to the frame of the vehicle through springs. These springs prevent the irregularities and shocks from the road being transmitted to the car and passengers. Instead of turning with respect to the vehicle, as in the case of the horse-drawn carriage, the axle of the motor car is always fixed in attitude and direction, and the vehicle is steered by moving the wheels about pivots vertically disposed at the ends of the axle. On some motor cars the front axle is omitted, and each wheel is independently attached to the car frame.

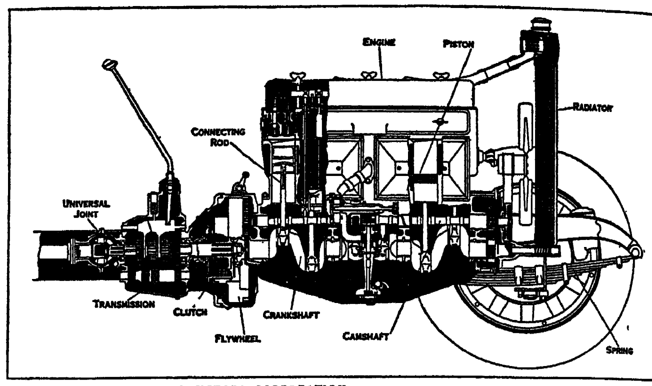
The car is steered with a hand wheel which is connected to the steering pivots by means of gears and linkages. The steering gear, as this system is called, may be any one of quite numerous forms of construction. The rotation of the hand wheel is communicated to a horizontal shaft at the base of the hand wheel, or steering column, through a worm gear, screw or cam mechanism. A lever at the end of this horizontal shaft transmits the turning motion, through an intervening link, to a pivot on which a front road wheel is mounted. The other front wheel is also mounted on a similar pivot and the two pivots are linked together by means of a cross rod so that the two front wheels move simultaneously, keeping their proper relative position.

Springs and Riding Quality.—Laminated leaf springs have been almost universally used on motor vehicles for the chassis suspension system. The semi-elliptic type is the one in most general use, being found on about 97% of all the makes of cars now in production. Many of these use the Hotchkiss drive in which the spring transmits the driving force and resists the braking torque, thus eliminating the torque tube required when other types of springs are used. When the Hotchkiss drive is used, the springs are often designed to be nearly straight under average load so that the driving force is directed along the spring.

The springs are usually mounted on the axle, being attached thereto by means of spring plates and U bolts. In the designs using semi-elliptic springs, the front end is usually attached to the frame by means of a pin joint and the rear end by means of a swinging shackle which allows for the change in length as the spring is straightened under load. The cantilever type, used on many "luxury" cars, is merely an inverted semi-elliptic spring having the centre attached to the frame by means of a trunnion bearing and the front end attached to the frame by means of a swinging shackle, the free end resting upon the axle with a pin joint. In order to eliminate the lubrication required by these pin joints, other types of mountings using rubber extensively are being experimented with and a few of these are now in use. Originally, the leaf springs were made of plain carbon steel. The ends of the leaves were tapered and had various shapes designed to prevent localized stresses.

In manufacture, the leaves are usually formed to the same inside curvature, thus causing a space between each pair of leaves as they are placed together. This space, termed "pull," causes the leaves to remain together even though the spring rebounds to its free position after deflection. It has been the practice sometimes to give the tips a little extra curvature, called "nip," which increases the friction between the leaves. This extra inter-leaf friction was for the purpose of rapidly damping the spring vibrations, thus preventing excessive rebound. It has the one disadvantage, however, of making the springs stiff to small vibrations which has of late been considered undesirable. The recent trend has been to decrease the inter-leaf friction and mount some auxiliary type of damping device, a shock absorber, to prevent the rapid upward acceleration but not to add compressive resistance to the spring. These devices are of many different designs but are basically of two types; mechanical friction and hydraulic friction.

The design of a laminated leaf spring is too complicated to be taken up in detail. It is often the custom merely to specify the length between the eyes, the width of the spring, the number of pounds required to deflect the spring one inch and the load to be carried in a certain position, leaving the rest of the dimensions to be determined by the spring maker. The basic formulae for designing leaf springs will be found in most engineers' handbooks, but the permissible departures therefrom, based upon results obtained by experiment and practice, may best be determined by the specialists engaged in spring manufacture. The flexibility of the springs is indicated by the "rate," that is, the number of pounds required to deflect the spring one inch. The "normal load," which is the portion of the weight of the car and passengers which is carried by the spring, divided by the "rate," gives the number of inches of initial deflection. This initial deflection determines the periodicity of vibration which may be roughly determined by the formula: $V=\sqrt{\frac{35300}{D}}$ when D is the initial deflection in inches.



BY COURTESY OF GENERAL MOTORS CORPORATION

FIG. 24.—PARTIAL SECTION FRONT END OF CHASSIS

It has been found that the rear springs must have a periodicity of vibration below 90 per minute in order to have satisfactory riding characteristics. It is evident that if the front end of the car has the same or a multiple of the same frequency of vibration as the rear end, resonance will exist between the front and rear and the car will "pitch" or "gallop" badly. It is, therefore, necessary to have the periodicity of the front end of some higher frequency other than double that of the rear. Thus it will be understood that the riding quality of a car is determined by the loading characteristics rather than by some particular type of spring. The increased number of miles of improved highways has brought the question of riding quality more and more to the attention of the designers, who have found the use of springs of a greater degree of flexibility plus the addition of some controlling device necessary to meet this demand. Fig 24 shows the front portion of a complete chassis.

Accessories.—The air to the carburettor, fuel and lubricating oil supply of an engine must be kept free from sharp particles of dust and other foreign matter, to prevent excessive wear of the moving parts or the plugging of the oil or fuel lines. To do this petrol filters, oil filters and air cleaners are used. Air cleaners also reduce the amount of carbon deposit in the combustion chamber, as much of this deposit is composed of road dust. Air cleaners are made in the centrifugal, inertia, screen and liquid types. To indicate the operating conditions to the driver, oil pressure gauges, ammeters, petrol gauges and speedometers are mounted on the dash. The four main types of speedometers are air friction, air blower, centrifugal and magnetic, the latter being by far the most common. As automobiles have become more numerous, theft prevention has become a problem of increasing importance. Numerous types of locks operating on the steering gear, transmission, throttle, intake manifold, ignition coil, ignition distributor, breaker or clutch are in use. A lock may operate on two or more parts of a car to give increased protection. The mod-

ern automobile is fitted with many accessories to make it more attractive and convenient. These may include bumpers, windshield wipers, rear view mirrors, radiator ornaments, cigar lighters, vanity cases, ventilators, heaters, etc.

Metals in the Motor Car.—A wide variety of metals is used in the various component parts of the automobile. Members subjected to greatest stress are in the power-transmitting train, such as connecting rods, gears, propeller shafts and rear axle shafts. In some vehicles, it is necessary that some of these members have over 200,000 lb. per sq.in. elastic limit and 250,000 lb. per sq.in. tensile strength. Most of the parts of an automobile made of steel have, as their primary function, resistance to distortion under load and ability to transmit considerable power without failure. Grey cast or malleable iron is used for castings of intricate and complicated shapes. Cast iron is used for cylinder blocks because of its resistance to wear and low friction. Malleable castings are used in certain places where shock is encountered, to insure against abrupt failure.

Copper is used, on account of its high electrical conductivity, in the electrical equipment, including lighting, ignition and starting motor circuits. It is also used for gaskets, which are washers of various shapes and sizes consisting of a soft material such as asbestos sandwiched between metal sheets. Brass and bronze are used as castings or rolled sheets. These metals are used as bearing materials to reduce friction between moving parts. Low unit weight is an important advantage of aluminium. Because of the comparatively high cost, its use is confined in most cars to pistons where its high thermal conductivity and low weight contribute to the efficient performance of the engine. In the more expensive cars, the weight of the engine is reduced by the use of aluminium crankcase and transmission housings. Aluminium alloys are also used for body fittings, and by some manufacturers for radiator shells, on account of their resistance to corrosion.

Nickel is used for the electrodes of the spark-plug. The high melting point, electrical and thermal conductivity, as well as resistance to corrosion, are the properties which cause its selection for this service. It is also plated on radiator shells, lamp rims, etc., as a protective coating and for appearance, and in some cars the radiator shell is made entirely of this metal. Tungsten is used as contact points in the ignition circuit where the spark is timed to synchronize with the position of the piston. The resistance of tungsten to corrosion and to the pitting which results from the electric spark is its principal recommendation. In the high tension magneto (*q.v.*) platinum points are generally used for the contact breaker.

Zinc base alloys are used for die castings for the economical manufacture of small complicated shapes, provided very little strain is applied. Zinc is used as a protective coating on bolts and wheel rims. Cadmium is also used as a protective coating on certain parts. Chromium is plated on surfaces to resist wear, tarnishing and corrosion. It is frequently plated over nickel on such decorative parts as radiator shells and lamp rims. Silver is commonly used to plate head-light reflectors, because of its efficiency in reflecting light and its ability to take a high polish. Occasionally other metals with a lower reflecting efficiency are used because they are less likely to tarnish. Tin base alloys are used for the engine bearings. They provide a surface that permits the crankshaft to turn with a minimum of friction. Lead castings are used for battery plates. Their function is to enter into a reversible chemical reaction which alternately stores and supplies electrical energy for lighting and starting circuits.

PRODUCTION

The development of mass production of automobiles since the beginning of this century, especially since the beginning of the World War, has been remarkable and far-reaching, its influence being felt in almost every other line of manufacturing. This development has been due very largely to necessity, because in the early days of the industry, when 10,000 cars a year was a big output, buildings were not designed to embody any specially helpful feature, nor were they large enough to handle the increased volume under the old methods, where one workman did many operations, and the work moved slowly and at irregular intervals until it was finished. Among the pioneer companies which have been forced by the growth of their business to construct additional buildings and reorganize old ones the principle of progressive production has been carried out to a fine degree. These buildings are laid out so that all parts and sub-assemblies move forward to the main or final assembly line with the least amount of duplicated travel possible. The phenomenal growth of the industry has presented the problems of inventory and material handling. If material on hand and in process were handled to-day by the old methods, the inventory would be prohibitive and the production slowed down beyond belief.

The development of material handling within the plant has undergone many improvements. The following items show the evolution of these methods: (1) four-wheel truck; (2) hand-lift truck, with movable rack; (3) electric or gas truck, with movable rack or trailer; (4) mechanical and gravity conveyor. While all of these methods are still in use for some phases of material handling, the last is being more and more used wherever the situation warrants. The use of the improved methods has relieved congestion, speeded up production and reduced inventory. The use of motor trucks for transporting materials between buildings is being superseded in many cases by conveyors. Distance alone is no barrier, for in certain cases conveyors a mile long are in use. Some companies operate their own fleets of motor trucks on regular schedule from supplier to their own plant, in preference to relying on the railroads. In this connection it is becoming common practice to provide large loading docks to facilitate the loading and unloading of trucks, just as it is customary to provide loading platforms for railway trucks. (*See* CONVEYORS IN MASS PRODUCTION.) In many cases where the manufacturer is a quantity producer, he makes all the various "units" going into the whole assembly, except those which are highly specialized, requiring an enormous amount of floor space and capital as well, such as electrical equipment or tires. From this, then, it will be seen that the automobile manufacturer makes grey iron, aluminium, brass, and in some cases malleable castings, die castings, forgings, sheet-metal stampings and glass; and does all kinds of plating, enamelling, painting and machining and assembling. In addition, he has tool, die and pattern shops for making and maintaining tool equipment.

It has become customary among many of the larger companies to bring out about every 12 months what are known as new models. These are either an entirely new series or the old series changed to embody the latest improvements and refinements. The development of the new line starts months before it is scheduled for manufacture. Experimental cars are built and tested through thousands of miles and as far as possible under all of the conditions to be experienced by the future owner. Each series frequently consists of as many as 15 or 20 models differing from each other in chassis or power plant or body. Each model may be built with a choice of several styles of wheels and many different body colours, all of which further complicate the problem of quantity production at low cost.

When the series is finally approved, the problem of the big producer is how to finish the run on the old series and begin on the new with the least possible break or loss of time in between. This requires consideration of all the following subjects: Bill of material or list of every part in each model; designing and making of new tools, dies, patterns, etc.; ordering and installation of new or special machines; relocation of old machines and equipment, if necessary to facilitate production of the new parts; routing of each part by operations; running ahead on parts to be discarded to give opportunity to try out new equipment; (*a*) time required for each operation and for moving from department to department or building to building; (*b*) number of cars scheduled per day; (*c*) number of days float or quantity needed to keep the parts moving steadily from raw state to finished car; (*d*) amount required ahead of primary operation as a protection against unforeseen delays in transportation; (*e*) time required for supplier to make shipment; (*f*) time required in transit. Then: Time—*a* plus *e* plus *f* equals number of days that material must be ordered

in advance of shipment of automobile. Material—*b* times *c*, plus *d*, equals amount of material required in the plant at all times, *c* only varying inversely with a change of capacity.

To start a series in production on scheduled time and to keep production running smoothly requires an experienced organization, the skeleton of which follows:

Management	Engineering	Development
		Testing
	Purchasing	Buyers
		Traffic
		Stores
	Manufacturing	Production
		Efficiency
		Factory

While refinements and improvements have been steadily incorporated for years in all parts of the car, this development has led to many economies in methods, especially during the last ten years.

Processes Characteristic of Modern Practice. *Heat Treating.*—Twenty years ago little was known about this subject, whereas to-day steels are treated for strength and wearing properties in a highly scientific manner, thus providing against breakdowns and ensuring a longer life for the car. There has been a great change from the old "batch" type of furnace to the present-day continuous furnace, at one end of which the operator loads the constantly moving conveyor with forgings. Forgings travel through the annealing furnace, through a quench, then through a drawing furnace without any labour. This principle is applied to pre-heating furnaces in the forge shop, where billets are loaded at one end and travel to the outlet, gradually acquiring the forging heat. In these cases time, labour and fuel are saved.

Plating.—The first automobiles were equipped with brass head-lamps. Along with the development of the electric lighting system for automobiles, nickel plating came into use on lamps and other outside trimmings. Later, radiators called for nickel plating, which necessitated enlarging of this department in the factory and putting it on a progressive basis. Recently, chromium for plating automobile parts such as radiators and lamps has been used by some manufacturers. This plating is not as easily scratched as nickel, and will not rust or tarnish. The plating of rims, usually galvanizing over a copper strip, has not changed much except in method of handling the work. Rims can now come from the forming rolls and sizing machines to conveyors which conduct them through tanks to inspection without manual labour.

Painting.—Painting as applied to automobile bodies has undergone a great many changes. At the beginning of the century bodies were made entirely of wood, and were painted by hand with a brush, pushed around on trucks by hand, and stood up on end to dry after each coat was applied. A good paint job required approximately 24 major operations and 14 drying periods ranging from six to 24 hours, the whole taking about 21 days from start to finish. With the introduction of steel body panels, drying ovens could be used which speeded up the time of drying. With the flow system of applying varnish together with conveyors, more time and much labour were saved. Within the last few years the use of the quick-drying cellulose finishes and spray guns has still further speeded up the work and reduced the labour cost, until bodies can be finish-painted in regular course in four days, or in 48 hours if necessary. Aside from the saving in labour and floor space required for storage, the saving in inventory has been tremendous. Enamelling of wings, or fenders, and other sheet-metal parts presents another advancement even in the last few years. For many years these parts were dipped by hand in the bath, hung up to drain, transferred to a truck and pushed into a drying oven, which had to be brought up to the proper heat after being loaded. After baking, the oven had to be opened and the parts cooled off before preparing for the next coat. To-day the preparation of the parts is about the same, but they are now hung on a constantly moving conveyor, run alternately through several baths and baking ovens, inspected and conveyed direct to the car assembly line. Here again is a big saving in labour, material, fuel, floor space and inventory.

Foundries.—Only in comparatively recent years have foundries been operated on a strictly progressive basis, and the transition from hand labour to machine and conveyor has kept pace with improved methods in other branches. Machines are now used for ramming cores and moulds; sand is mixed and conveyed to moulding machines mechanically; moulds are made, cores set, castings poured, cooled and shaken out while in motion. Cupolas are charged mechanically. Here again is a great saving.

Machine Shops.—Modern machines have reduced labour, speeded up production and reduced inventory. Not only have the modern machines made closer limits possible with the resultant reduction in scrap losses, but in some cases have made it possible to incorporate improvements and refinements otherwise impossible on an economical quantity production basis. Some machines typical from a production standpoint are multiple drills, for drilling 100 holes in all sides of a casting such as a crankcase at one time, and the revolving planes on which castings are loaded and unloaded while in motion. Centreless grinders are used considerably to speed up the grinding of certain parts. Special machines are used to balance crankshafts, fly-wheels and other rotating parts.

Stamping Plant.—With the change from all-wood bodies to framed bodies panelled in sheet-metal, the stamping plants took on a big increase in work. Many parts formerly made of forgings or malleable castings are now made of stampings, reducing cost and weight. (*See* Motor Car Body.)

Assembling.—It is in all branches of assembling that the progress made in the industry is most striking. Whether it be a motor, axle, transmission or entire car, the assembling is done on a steadily moving conveyor, all parts being fed to this conveyor at the exact place and time needed. The routing and scheduling of the individual parts and sub-assemblies through the various plants or departments to arrive at the final assembly line on time and at the required rate is a nice problem in synchronization, as some of the primary operations must start weeks ahead.

Service.—Provision of repair parts for the owner has been given a great deal of attention for years, not only as to requirements but as to interchangeability. It is the aim of every manufacturer to have a part on hand when the owner wants it. The rapidly increasing number of cars in use and the constant changing of models has complicated the matter, but for those who have studied the question for years each year gives better data as to the life of various parts of the car. In this way the manufacturer can estimate closely what parts will be required for replacements, and plan production accordingly.

The Modern Road Testing.—In order to determine successfully the way in which an automobile will function in the hands of the average owner, motor car manufacturers have made a practice of conducting tests over a wide variety of road conditions, and recording data as accurately as possible on the performance over thousands of miles. Such tests must be carried on, as it is not possible to duplicate exactly tremendously varying road conditions, even with the most elaborate laboratory equipment. It is not possible in a laboratory to reproduce the violent stresses to which a car is subjected in driving over frozen, rutted roads. Road testing naturally follows the detailed development work of the component parts of an automobile and provides a means of checking the final design to determine the characteristics of comfort, performance, economy, reliability and durability. When such tests are conducted on the public highways, many variables must be taken into consideration, such as weather, condition of roads, traffic and legal regulations. As a result, delays frequently occur, and often the tests are a source of danger to other users of the highways. All of these factors have some effect upon the accuracy of the tests and the speed with which the information may be obtained. Consequently, manufacturers have utilized such facilities as may be available where carefully controlled tests may be made.

In past years racing provided a very good means for such tests, but in more recent times, due to arbitrary rules set up by the governing organizations for racing, it is hardly feasible from the economic point of view for manufacturers to take this means for

checking the performance of their cars. Several American motor car companies, in order to provide standardized conditions for tests, have installed private testing grounds containing a wide variety of roads where many conditions can be maintained constant and so designed that motor cars may be operated day and night at all times of the year. Such a road system includes highways where sustained high speed may be maintained with safety, concrete hills with accurately laid gradients, level stretches to insure elimination of error in critical engineering tests,—in fact, a duplicate of nearly every type of road found among the public highways. Other manufacturers have utilized only the high-speed track. One company in Italy has gone so far as to incorporate this track on the roof of its factory building. Under such standardized conditions, cars may be tested and the results compared from day to day and year to year with reasonable accuracy.

The private testing ground offers many advantages over the public highways, in that traffic conditions can be controlled definitely and the information obtained on the tests is more quickly available to the designers. Even though the test car travels 1,000 m. or more a day, in the event of failure of any part, it is still only a few minutes away from the shop and the engineer. Again, such a testing ground as a part of the automobile manufacturer's facilities permits the establishment of definite standards of performance, comfort, economy, reliability, etc. It permits the manufacturer to operate his experimental design simultaneously and under the same conditions with any other cars with which he wishes to compare for speed, acceleration, braking, riding qualities, or anything else of importance to the customer. Thus the designer is able to set up a continually improving set of specifications based upon the hitherto intangible operating differences between various cars.

Research in the Automobile Industry.—In the early years there were comparatively few efforts at systematized research, although those few efforts which were carried on by early automobile engineers quite merited the title of research. Conditions have changed, however. Developments garnered from every day necessities and simple observations will not answer now. The world has become quite technical and complex—so much so that the automobile industry cannot hope to maintain its position without the assistance that science can render. The acquisition, development and application of new knowledge is necessary for continuous growth. Groups of trained and well-educated men are brought together, properly housed and furnished with adequate equipment, and are set to work on the major problems of an industry. Men of initiative are sought, and they work tirelessly in a definite place on a single problem, until success comes. (*See* RESEARCH, INDUSTRIAL.)

Investigations leading to the discovery of fundamental facts come under the jurisdiction of the research laboratory. Research points the way to new products; it steadily improves the existing product; research makes money and saves money for the automobile manufacturer. Many research laboratories, proving grounds, etc., have sprung up in the automobile industry—some of them employing 300 to 400 highly trained specialists; chemists, electrical and metallurgical engineers, mechanical experts dealing with engines and chassis design, strength of materials, thermodynamic principles, new metallurgical developments, etc. Other research organizations exist also for the intensive study of marketing, sales and service problems, for research is not confined to materials and mechanical questions alone. (C. F. KE.)

EUROPE

Up to 1900 the development of the motor car was mainly due to continental engineers. After the abolition of legislative restrictions in Great Britain in 1896, many British engineers, scientists and inventors realized the industrial possibilites of the motor car, and the names of Lanchester, Royce, Napier, Thornycroft, Dugald Clerk and many others became famous during this period. Modern European cars generally conform to a certain arrangement of component parts dictated by experience. The radiator is mounted at the front end of the frame, with the engine immediately behind it. The engine is covered by the bonnet which merges into the body, this occupying practically the whole length of the frame behind the bonnet. At the rear of the engine is a clutch connecting the engine with a gear-box from which the driving effort of the engine is transmitted to the rear axle through universally jointed shafts. Two axles are used, front and rear, the former allowing for the angular movement of the front wheels necessary for steering, the latter being so constructed that the rear wheels can revolve at different speeds when rounding bends in the road. Brakes are fitted to each wheel. The driver, in his seat, sees in front of him the steering wheel with levers mounted thereon to control the ignition and the throttle, and an instrument board which carries the switch, speedometer, clock and other accessories. At his side are the change speed and hand brake levers; at his feet are the accelerator pedal which enables him to vary the speed of the car by controlling the throttle opening, the clutch pedal which disconnects the engine from the transmission, and the brake pedal which applies the brakes to all four wheels. In bare outline such is the disposition of the units of the modern car.

Body-work and Equipment.—Few points are more carefully studied in modern motor car design than the lines, curves and colouring of the body as viewed from outside, and the disposition of the seats, internal lighting arrangements, colour and quality of the fabric or leather used in upholstering. The radiator and bonnet have always been characteristic features of various makes, and these are made to conform to artistic requirements without losing their essential character. The necessary large difference in width between the body and the bonnet necessitates a merging of these two by the scuttle, which is between the rear end of the bonnet and the wind-screen. This encloses the pedals and other controls. In small cars it often carries the petrol tank, which is, in larger cars, carried at the rear end of the frame, the petrol being delivered to the engine by a suction device. Body-work is constructed in a variety of types and with many artistic variations, the style and quality depending largely upon the price at which a car is sold. There is a distinct line of difference between cars which are intended to be owner-driven and those built to be chauffeur-driven.

For bodies constructed in large quantities steel pressings are largely employed, but a wooden framework panelled with aluminium is also used to a considerable extent. Of quite a different character is the Weymann body in which the wooden frame is so jointed as to be to some extent flexible, and is covered with padded fabric. This and other similar types have been evolved to safeguard the body from racking effects caused by twisting of the chassis frame on rough roads. (*See* MOTOR CAR BODY.)

Popular Types of European Car.—Owing partly to systems of taxation based on horse-power rating formulae which, in turn, depend upon the cylinder dimensions of the engine, European designers have tended to concentrate upon the use of small engines made to develop considerable power by various expedients, so that it is quite common for a European car to develop two and a half to three times its rated power. The size of the engine is therefore better expressed by stating its capacity; *i.e.*, the volume swept by the pistons, which can be given in cubic centimetres or litres. In 1928 the most popular type of European car was one equipped with a four-cylinder engine rated at about 12 h.p. with a capacity of between 1,500 and 2,000 cubic centimetres. Another important four-cylinder type is the baby car rated at about 8 horse-power. In the case of the larger cars manufacturers have turned their attention more and more to six-cylinder and eight-cylinder engines with a view to obtaining greater smoothness and flexibility; a type which has grown in importance is the six-cylinder car of moderate price rated at from 14 h.p. to 20 h.p., with a capacity of from $1\frac{1}{2}$ to $2\frac{1}{2}$ litres. Apart from these varieties there is the large and powerful high-priced car, with a rating of 40 h.p. or more, and with 8 or even 12 cylinders, and the sports model in which performance ranks first in importance, followed by appearance, and with comfort as a poor third.

The following are typical brief specifications of the medium-powered six-cylinder car, baby four-cylinder car and the large

high-priced car, the examples taken being the 14 to 45 h.p. Talbot, the 7 h.p. Austin and the Daimler "double-six."

Medium-powered Six-cylinder Car.—Engine: bore 61 mm., stroke 95 mm., capacity 1,666 cu.cm., rating 13·8 h.p. overhead valves, push-rod operated. Transmission: single-disc clutch, four-forward speed gear-box, enclosed propellor shaft, spiral-bevel final drive. Gear ratios (forward) 23·19, 13·45, 9·66 and 5·875 to 1 (reverse), 17·39 to 1. Brakes: pedal-operated four-wheel brakes; hand lever controls rear brakes; suspension: front, semi-elliptic springs; rear, quarter-elliptic springs; four shock absorbers; petrol system: 14 gal. rear tank, feeding through vacuum tank or dash; dimensions: wheel-base 10 ft., track 4 ft., 7½ inch.

Diminutive Four-cylinder Car.—Engine: bore 56 mm., stroke 76 mm.; capacity 747·5 cu.cm.; rating 7·8 h.p.; side by side valves; transmission: single-plate clutch, three-forward speed gear-box, enclosed propellor shaft, spiral-bevel final drive; gear ratios (forward) 16·9 and 4·9 to 1 (reverse), 21 to 1; brakes: hand-operated front brakes, foot-operated rear brakes; suspension: front-transverse semi-elliptic spring; rear two-quarter elliptic springs; frictional shock absorbers combined with radius rods; petrol system: 4 gal. scuttle tank, feeding by gravity; dimensions: wheel-base 6 ft. 3 in.; track 3 ft. 4 inch.

Large Twelve-cylinder Car.—Engine: bore 81·5 mm.; stroke 114 mm.; capacity 7,135 cu.cm., rating 49·4 h.p.; double-sleeve valves; transmission: plate clutch, four-forward speed gear-box, open propeller shaft, worm-and-wheel final drive; gear ratios (forward) 15·8, 10·15, 7·6 and 4·86 to 1; reverse 15·8 to 1; brakes: pedal-operated four-wheel brakes; hand lever controls transmission brake; suspension: four semi-elliptic springs and shock absorbers; petrol system: 24 gal. rear tank feeding through vacuum tank on dash; dimensions: wheel-base 13 ft. 7 in.; track 5 feet.

Racing Cars.—Many sporting events take place annually for which a number of prominent European manufacturers build highly specialized types of car. These differ markedly from the ordinary kind of chassis sold to the public, but in their design a great deal of data is obtained which is of considerable value in improving the performance of the private car. In a racing engine everything except reliability is sacrificed to power output, and very often a supercharger is employed to pump the mixture of petrol and air into the cylinders. Needless to say, the chassis is stripped of every unnecessary component, and is also specially constructed with a view to making the car as light as possible. Most record-breaking attempts and races are run under regulations which severely curtail the size of the engine permissible, so that small 1,500 cu.cm. racing cars have been developed capable of 150 m. per hour. Distinct from these is the 200 m. per hour type of record-breaking car, of large size and weight, which is usually propelled by one or more aero-engines.

Methods of Car Production.—In Great Britain and on the Continent, there are a few manufacturing concerns employing quantity-production methods similar to those used in America, although on a smaller scale, such as Morris, Austin, Citroën, Renault and Fiat. Additionally, there are very many makers producing cars in strictly limited numbers who stimulate the development and adoption of new ideas; a small output enables them to change designs more readily than the larger concerns and so to keep ahead in technical improvements. Their prosperity depends upon the fact that there is always a certain number of European buyers wanting a car differing from the mass-produced types. Some of these smaller firms specialize in racing and sports cars, while others build large, powerful and expensive chassis. In a typical British quantity-production factory arranged to turn out approximately 1,000 cars per week, the chassis, or mechanical part, is assembled upon a slowly moving conveyor, frames being placed on the track at one end and gradually fitted with springs, axles, power units, etc., as they move along. Running at right-angles to this assembly line are a number of sub-assembly lines, each feeding a component to the appropriate point. On each sub-assembly line will be grouped the necessary plant and fitters for the making and building of the component concerned. The end of the chassis assembly line is arranged to meet the terminus of a similar line on which the bodies are built up, each completed body being then lifted with tackle and dropped on to a chassis to which it is bolted down. In the making of both the chassis and body of a car produced in quantities, standardization is essential and a close control of dimensions must be ensured both by careful planning of the machine tools and fixtures and by elaborate systems of inspection on the sub-assembly lines. The complete car is given a short-road test and engines are run-in and tested independently before being fitted to the chassis. Similar methods are in vogue at the factories of Citroën and Fiat on the Continent.

During 1926 the principal European car-producing countries built the following numbers of cars:—Great Britain, 158,699; France, 150,000 (approximate figure); Germany, 37,000; Italy, 50,000 (approximate figure); Belgium, 5,000; Czechoslovakia, 6,000; Austria, 3,960. (*See* also MOTOR VEHICLES, COMMERCIAL; MOTOR CYCLES; MOTORING; MOTOR VEHICLE INSURANCE; INTERNAL COMBUSTION ENGINE and the section of this article: *Motor Car Body Design.*)

BIBLIOGRAPHY.—Historical: *The Automobile,* translated from the book of Gerard Lavigne by Paul N. Hasluck (1904); H. L. Barber, *Story of the Automobile* (Chicago, 1917); W. H. Berry, editor, *Modern Motor Car Practice* (1921); F. A. Talbot, *Romance of the Automobile Industry* and *Motor Cars and Their Story* (1912). Elementary handbooks: *The Motor Manual* (annual); F. J. Kean, *The Petrol Engine* (1918); *Autocar Handbook* (11th ed. 1926). A. Graham Clark, *Textbook of Motorcar Engineering* (1911–17); R. W. A. Brewer, *Motorcar Constructor* (1912–28); and P. M. Heldt, *The Gasoline Automobile* (1924). General data and statistics are dealt with in *The Motorcar Index* (annual); *Dyke's Automobile and Gasoline Engine* (14th ed., 1925); and *The Motorist's Year Book. See* also *Automobile Shop Practice; The Motor; The Autocar; The Light Car and Cyclecar; The Automobile Engineer; Automotive Industries; Proceedings of the Institute of Automotive Engineers;* and the *Society of Automotive Engineers' Journal and Transactions.* (L. H. P.)

MOTOR CAR BODY DESIGN

This subject, which deals with aesthetic considerations in relation to motor car body design, is treated comprehensively below and also under a following section, *United States.*

DESIGN

In automobile design, the artistic or aesthetic side of the designer's craft is subservient, *i.e.,* there is no true place for decorative art as such in the modern automobile. The body designer can only exercise his powers within well-defined limits; he is bound by certain factors as to proportions, measurements, etc., with which few liberties can be taken. The designer's province as an artist is to give character to the ensemble and by well-chosen lines and treatment to suggest such attributes as power, comfort and speed, and to emphasize and not to destroy the feeling of structural unity.

Early Errors.—Automobile designers have much for which to thank the earlier carriage builders, without whose example and traditions they would have been unable to make such rapid progress. Nevertheless, they erred in the past in copying features of horse-drawn vehicles, instead of going deeper into the origin of such features and forming a true appreciation of the new problems which the change in the manner of locomotion involved.

In the single brougham, or coupé, we require firstly a seat for two, carried on an axle by a pair of springs. The axle position is determined by the need for bringing the springs beneath the seat part of the vehicle and not under the vehicle; convenience of access demands this, the brougham is not a vehicle for the young and athletic and the access is one of the governing factors in design. Next we have to assign a position for the front axle; this, on the established system of horse-drawn vehicles, requires to be mounted on a perch bolt and turn-table with room to swing well over on the lock; thus, the position of the perch bolt, or pivot pin, in front of the body of the vehicle is determined. Also, in order not to require too high an arch over the wheel when on the lock, the front wheel is made of smaller diameter than the rear wheel, where no such conditions apply. Now, having drawn the position of the turn-table and the arch, we have ready-made the position for the driving seat; the footboard and dashboard follow

as a necessary sequence. The vehicle is to be a closed vehicle which determines approximately the height and size of the body. The back panel, of course, is sloped to follow the general position of the passenger's back and the squab. The door position admits of no alternative. Now the ingenuity of the engineer or constructor is needed. The vehicle has very little strength; if loaded it would collapse. To give the necessary strength a frame reinforced by steel members is provided under the door and continued from arch to dumb iron. It is here that the designer's art comes into play. Apart from his knowledge of construction, his rôle is to give unity and character to the design. There are no redundant lines or ornaments, the treatment is severe and is simplicity itself, but such simplicity was only achieved after centuries of experience. There is one point in particular which calls for attention, viz., the bringing forward of the line of the front door post to form, as it were, a "cusp" and so disguise what otherwise is liable to be unsightly, the junction of the visible part of the frame with the body proper.

When the automobile designer first endeavoured to design a coupé, instead of analyzing the origin of the horse-drawn coupé or brougham and learning its lesson, viz., that no lines or features of design which are foreign to the necessities of the case can live, he took the side of the horse-drawn coupé and, as it were, plastered it on to his chassis, or body drawing, just as we see sham columns plastered on to the walls of buildings in certain examples of bad architecture. The problem of the designer of that period was in not knowing what to do with his door post line when he had finished with it. The result of experience has since decided that door post lines and other vertical lines require to be eliminated or subordinated entirely to the lines denoting horizontal structure. This is one of the most important principles that has been established in the art of automobile body design: the dominance of the horizontal line. After the event it is easy to understand how inevitable this should be. The whole character of speed, which is the "breath of life" of the automobile, is consistent with the horizontal line and the horizontal partitioning of the design. Vertical lines and vertical sub-divisions are lost and meaningless in rapid motion; they belong to and are only consistent with things stationary or slow moving. The horizontal line in itself suggests speed. The arrow, the javelin,—length in the direction of motion—give instantly the suggestion of speed.

Returning again to the horse-drawn vehicle, here the need for weather protection, which is imperative in the automobile, was far less pressing, and in the introduction of doors in the early automobile (where such would not have existed in an equivalent horse-drawn vehicle) judgment was warped by traditions of the old carriage builder's idea of elegance in lightness of line and design. This resulted in these doors being at first made low with pretty curves and decorative mouldings. Instead of the automobile designer boldly proceeding on the firm basis of utility and then allowing his artistic sense to harmonize his lines with his purpose, he put the cart before the horse and endeavoured to allow what he thought was artistic feeling to interfere with his freedom of choice. Early attempts to establish a horizontal waist line were hampered by the dread of giving a heavy or clumsy appearance. This was due to regarding the design as static, something suitable to stand in a glass case, and not as a vehicle travelling along the road at 40 or more miles an hour. The straight and uncompromising waist line of a modern car would have been reached many years earlier if nobody had worried about the appearance of a car at all, and, paradoxical as it may seem, the result would have been the attainment of beauty far sooner.

Structural Unity.—One of the results of modern design has been, as already stated, to present the car to the eye as a structural unit. The blending of the body and bonnet characteristic of the modern car may be cited as an example of this tendency. There is an appearance of strength and power about a machine whose lines suggest structural unity that does not exist otherwise and cannot otherwise be suggested to the mind.

Before a considered judgment can be formed on the score of artistic merit, whatever the subject may be, the artistic sense requires education; there is no realm in which preconceived ideas are more prone to be the subject of prejudice than that of the arts. Some go as far as to assert that merit in art is merely a matter of taste. It is not altogether easy to combat such a statement; there is, however, one sound reply, viz., the general tendency of the evolution of the individual. Among those who take an interest in any art, progress in taste goes with experience. Thus we make the public—the interested public—the final and ultimate judge. It is the general direction in which the public appreciation tends, not the verdict of the majority at any moment nor the pendulous swing of fashion, that decides the reality and soundness of the advance made in all that pertains to appearance and in the art of the designer which contributes to same.

Decoration.—There are certain factors that enter into the design and appearance of the automobile which require separate consideration and discussion. Some cars exhibit a lavish display of nickel plate work, revealing a practice that is almost universally condemned. Nevertheless, tradition permits us to brighten up the otherwise dull appearance by means of showy lamps, and a conspicuous radiator-frame and crown. A car with no bright metal work rarely satisfies the eye, and, although possibly this may not always be so, it is probably justified. The hunger for some such decorative embellishment may be a survival of the fact that the well turned out horse-vehicle, the glossy coated chestnuts or bays, and the well-polished harness-fittings and lamps must have their counterpart in the power-driven vehicle. The justification or condemnation of this view, time alone will determine, but there is one fact that quite early impressed itself, viz., that any accessories, such as lamps, horns, etc., must either be made quite inconspicuous or must be developed as a definitely striking feature or ornament.

Colour.—Another much debated question is that of body colours. Comparatively few appreciate the reasons for avoiding brilliant or violent colours. We know that in the days of the horse-drawn vehicle such colours were "bad form," and with few exceptions, such as the coach yellow used on stage coaches and vehicles of a sporting character, any well turned out equipage was finished in a dark colour, such as a deep lake, a dark blue or green, or even black. The underlying factor, and the principal reason for this exclusive use of non-committal colours, was the need for avoiding a clash with ladies' dresses, and perhaps in the 18th century with the colours worn by men also. Another factor, however, which cannot be ignored is of visibility. In entering a thoroughfare out of a side road, for example, especially in the dusk, the driver has to concentrate his main attention on approaching traffic, and it has been the experience of many drivers that in doing so he has failed to see a car approaching in the other direction, *i.e.*, in the line of traffic which he is about to join. Especially does this apply when the colour is of a uniformly sombre hue; this question of visibility arises in other road experiences. Consequently there is a demand for tints and colours which, while not liable to clash with the costume colours of the passengers, are sufficiently conspicuous to give good visibility. Such colours as the various shades of grey, light russet, biscuit-colour, pale coach yellow, etc., are coming to be accepted as consistent with good form, even in automobiles of the most exclusive class. (F. W. LA.)

UNITED STATES

The first automobile bodies were open bodies, consisting of a front and rear seat, each seat being designed to accommodate two persons, and were upholstered in leather. The rear seat was generally entered through a small door in the middle of the back. In 1902, side rear doors were added, displacing the middle back door, but there were not as yet doors for the front compartment. Such doors did not come into use until 1910–12. It was not until 1910 that bodies were equipped with windshields as standard equipment, although these could be purchased as special equipment. The first windshields were made with wood frames. Cars with tops as standard equipment had appeared in 1907–08. These were merely carriage tops, the folding top, which could be lowered or raised with comparative rapidity, coming into use in 1910.

Until about 1910, very few cars were equipped with closed bodies; the open body—touring car or roadster—represented practically the entire automobile production. Makers of closed bodies

still clung to the traditions of the horse-and-carriage days; bodies were built to individual patterns and almost entirely by hand. In 1910, an important body manufacturer obtained an order from a quality car manufacturer for 500 closed bodies. The body manufacturer had begun to apply chassis methods of standardization and volume production to the manufacture of both open and closed bodies, and had thus brought about more economical body manufacture. The entire automobile industry watched the experiment with close interest. Many doubted whether closed bodies so produced would be successful. Many more doubted if sufficient demand existed for 500 closed cars. However, the closed cars were successful from the owner's viewpoint and from that of the manufacturer, who the next year increased his order. These closed cars, driven not only in the large cities of America but in many of the smaller centres, proved the practicability of the closed automobile. They marked the definite beginning of a turning to the closed car.

THE CLOSED CAR

The progress of the closed car in the motor world, in proportion to the number of open cars produced, was at first, however, very slow. This is explained by the fact that the cost of the closed car was, in earlier years, far in excess of the cost of the open car, for two main reasons: (1) the closed cars were produced in small quantities; (2) the material and labour for the closed car were more expensive. The art of building closed cars developed slowly; costs were reduced only gradually. Furthermore, car manufacturers as a whole did not encourage the closed car sale. They looked upon the closed car as an impediment to production and a potential cause of complaint. The first closed cars were flimsy structures which rattled and creaked even when a car was travelling over the smoothest city pavements, and were decidedly impracticable on unpaved roads. For many years, in fact, the closed car was looked upon as a rich man's toy, the public referring to them as "show-cases." They were seldom driven outside the city and very few were found even in the largest centres.

One of the chief reasons for the lack of practical service in the closed automobile bodies of earlier years was the fact that they were inadequately engineered. The most important defect was insufficient bracing. Gradually, however, the internal design of closed bodies was improved. Body engineers provided far greater strength and rigidity without increasing the weight. Even as late as 1917, however, open bodies constituted the bulk of motor car body production, but at this time observers of the trend of the automotive industry began to predict that the closed car would eventually come into general use. In compactness and in strength, the closed bodies of this period left much to be desired, although improvements were being made with notable rapidity. By 1920, fundamental structure had been vastly improved, but the closed car was still, in some degrees, "a show-case on wheels." The roof was high and the contours lacked gracefulness. Efforts were being successfully made to lower the closed car. As this was accomplished, the lines of the closed car became more sweeping, more harmonious. The body, instead of appearing to be mounted on the chassis, seemed to become integral with the chassis. Windows became oblong rather than square and all lines, including the fender lines, brought the car, apparently even more than actually, closer to the ground. One of the chief difficulties which was overcome in lowering the motor car was the rear axle.

With the improvements and decreased cost of closed cars, they came into wider use. The National Automobile Chamber of Commerce of the United States supplies the following figures showing the percentage of closed cars manufactured, as compared with total motor car production, by its members from 1922 to 1927, inclusive, these figures including all excepting the Ford Motor Car company: 1922, 37·2; 1923, 36·8; 1924, 47·6; 1925, 69; 1926, 82·6; 1927, 85·5. Closed bodies are built so strongly to-day that a car can be driven over the most uneven roads consistently without developing weaknesses or unpleasant noises, provided ordinary servicing is not disregarded. It is largely because of the economies achieved in motor car closed body production that the automobile is a relatively great monetary value. The cost of closed car body manufacture has continuously been decreased and the public has benefited from these economies.

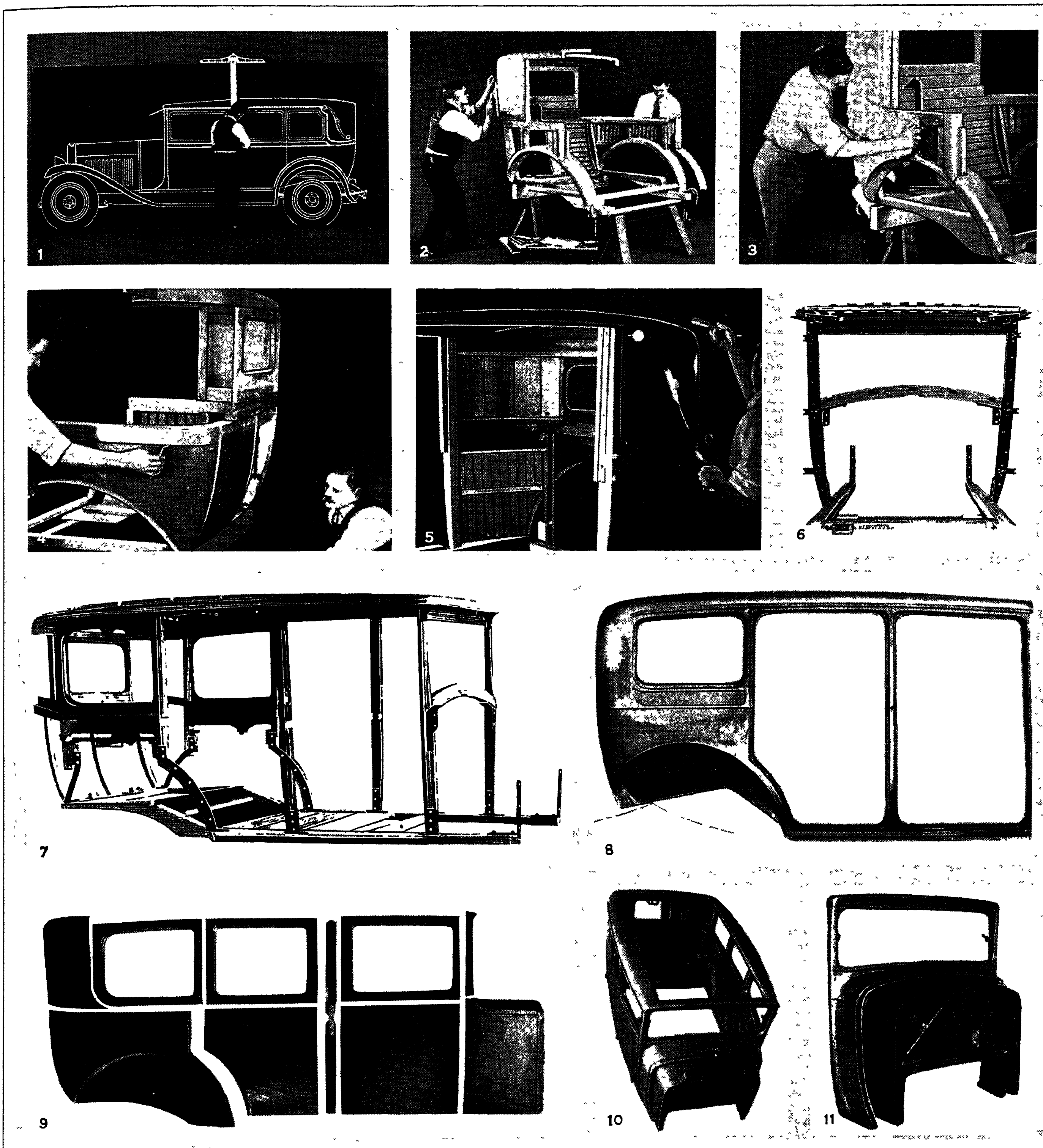
Planning a Body.—Changes are necessary in body lines, in hardware, in style of upholstery, to meet the constantly shifting taste of the public. The public fancy is caught, perhaps, by some change in the motor car lines. A general trend in body and chassis manufacturing is the result. The public is always demanding that which is new and different. Designers and engineers are constantly working to keep ahead of that demand. Before an automobile is ready for production, several steps are necessary. The first of these is transferring, from the mind of the designer to a blackboard, a full size picture of the car. Throughout many previous months he has kept in mind trends in public taste and new chassis developments which may require changes in the body. He has discussed with many executives the new body to be produced. Some of these executives are representative of the public, in that they translate to the designer the opinions of dealers who have, in turn, arrived at these opinions through many conversations with their salesmen and with the public. He also discusses the new body and its requirements with men who know body production—who advise him upon the practicability of the changes.

In designing a body, the designer must observe a great many details. He must always leave a certain number of inches between the seats and the roof for head room. He must allow a certain amount of leg room for front seat and rear seat passengers. The seats, because of the cushions, must be a certain minimum depth, width and length. The doors also must have fixed measurements from which he cannot depart. Comfort and convenience of the eventual owners of the new car require that he conform to these measurements with undeviating exactitude. It is the employment of these fixed measurements in such a way as to create a pleasing, harmonious, beautifully proportioned body, which constitutes one of the chief problems of the master designer. In most instances, of course, his work is based upon the body designs of the year before—for automobile manufacturers generally adhere to the policy of gradual, rather than rapid and radical change.

After the car is drawn on the blackboard, a wooden frame of the new model is set up. This is constructed with painstaking attention to the precise measurements of the drawn model. The framework is then filled out with modellers' clay—the same kind of clay which sculptors use in the modelling of statues. Just as the clay model of the sculptor is later reproduced by workmen in marble or in brass, so the clay model of the new body is to be reproduced in wood and steel by the thousands of craftsmen with machinery which permits quantity production. The clay model is created with the utmost care. A few necessary mechanical parts are employed, such as steering wheel and post, springs and traction wheels, lights and upholstery, but all else in wood and clay. This model is precise in its measurements. It is, to the eye, the complete body itself, with interior lights, hardware and all other fitments installed. After the clay has dried the entire model is painted. It reveals exactly how the new body will look. Expert designers view it with scrutinizing eyes, considering and weighing every detail in an effort to improve it, if possible.

The new body is then created from the engineering viewpoint. It is yet but a model—it must be worked out with respect to stresses and strains, so that it may withstand the daily service required throughout the long life of the car. Furthermore, it must be engineered with full consideration for practical production and every detail of its construction specified—dimensions, materials, etc.

Bracing.—One of the structural body details which must be worked out with painstaking care is the bracing of the different parts of the body. Quality bodies have a heavy iron brace between the front pillar and the top cross-bar; also a machine bolt from the top rail to the pillar, which is a double strength unit to prevent the body from becoming loose and squeaking at this point. Between the front pillar and the dash, where three heavy braces are employed on each side, the body is bolted down to the frame in front, directly back of the motor. Each upright pillar is heavily braced at the bottom also, to insure rigidity. Furthermore, steel plates, set in with wood screws, are installed on the wheel housings.



BY COURTESY OF (1-7, 9) THE FISHER BODY CORPORATION, (8, 10, 11) THE EDW. G. BUDD MANUFACTURING CO.

STEPS IN THE DESIGN AND CONSTRUCTION OF MODERN MOTOR CAR BODIES

1. Motor car design traced on blackboard, scale, or full size
2. Craftsmen building up wood-and-plaster model of closed car tonneau
3. Modellers' clay being applied to the framework of an automobile body model
4. Smoothing the surface of a body model to obtain the exact form of the car
5. Painting the waterproof top of a cabriolet or collapsible top model
6. View of front framework showing windshield and dashboard frame, of wood and steel construction, with slatted top support. View shows the method of attaching upright members of frame to the chassis
7. Completed framework of automobile body showing the wooden outlines or frames and the metal braces joining them. Side window frames in rear seat have been attached
8. Side frame of two-door sedan stamped from one piece of sheet steel
9. Pressed steel parts which fit into and around the framework shown in fig. 7. These include the outlines of windows, doors, panels and braces of the closed car body. The present tendency is toward the use of large pieces of sheet metal for this purpose, to minimize the use of rivets and bolts
10. Overhead view of assembled all-steel body "in-white" before the top, upholstery or paint has been applied
11. Cowl, dashboard and windshield framework of pressed steel. The box or inside space of the cowl contains the instruments and controls for regulating the electrical and oiling systems and the mileage meter and other devices

These plates are the anchors for the fenders.

BIBLIOGRAPHY.—British Aluminium Company, *Body Building in Aluminium* (1926); British Engineering Standards Association, *Schedule of Sheet Steels for Automobiles* (1924); H. J. Butler, *Motor Bodywork; the Design and Construction of Private, Commercial and Passenger Types* (1924); C. T. B. Donkin, *Elements of Motor Vehicle Design; a Textbook for Students and Draughtsmen* (1926); F. X. Morio, *Automobile Pattern Drafting; a Concise Course of Instruction in laying out Complete Patterns for Hoods, Cowls, Bodies*, etc. (1922); James Shepherd, *Motor-body Building* (1923); C. W. Terry, *Practical Motor Body Building. A Practical Treatise on the Various Branches of Motor Body Construction, for Coachbuilders, Draughtsmen, Designers, Students and Others* (1921). (H. J. C. H.)

MASS PRODUCTION OF BODIES

In America the concentration of automobile production in a few factories soon eliminated the small workshops scattered throughout the country and resulted in the development of large body-building units either within the plant of the chassis manufacturer or nearby. Piece by piece, the wooden side panels were replaced by steel or aluminum panels in order to secure better and more durable painting, until finally the entire body was covered by pieces of sheet steel. About 1912 this sheet steel was first drawn into large units. These parts were attached to an inner wood frame and were simply a skin superimposed on the body itself to receive the finishing coats. Many manufacturers still use this outer steel shell over an inner wooden frame.

Steel Body.—About 1915 what is known as the "steel body" was developed. In this design the same outer shell was flanged inwardly at the top and bottom edges and around the door openings and was reinforced on the inside by certain metal members riveted or welded to the outer shell. The wooden posts, sills and braces were omitted. These two types of construction were used in the manufacture of what are known as open or touring car bodies, the solid framework extending up about 10 or 12 in., above the level of the seats. In each case, the body was a distinct member from the chassis, having its floor integral with the sides, and fastened to the chassis frame by means of bolts. Up until about 1920 a very great proportion of automobiles carried such a body. Protection from the weather was by means of fabric tops which were, in most cases, collapsible and by means of removable side curtains.

In the years immediately after the World War, there came a demand for greater comfort on the part of the buyer of moderate means and there were developed closed types of bodies which could be manufactured by the American method of production at reasonable costs. Within the last few years this closed type of body has almost entirely superseded the open type. The demand for very great quantities of bodies at moderate cost has necessitated the development of ingenious methods of manufacture to reduce the cost. (*See* MASS PRODUCTION.)

In the case of the wood bodies, this reduction of cost has been brought about by cutting the framing to dimension stock where the timber is grown, building the bodies by progressive manufacture; by having each operation done on an individual tool by an especially skilled operator; with the assembling, fitting, upholstering and painting on conveyor lines as the body is moved by the successive operators. (*See* CONVEYORS IN MASS PRODUCTION.) This need for reduced costs and weight and the elimination of squeaks and rattles has resulted in the development of the all-steel closed body on a very large scale in the United States. In 1928 one-half of the automobile bodies manufactured are substantially entirely of metal.

One of the latest and most interesting developments has been the sill-less type of body. In this body, the entire side is made of one piece of steel with the door openings formed in. The entire front: hood, dash, windshield opening, front edge of roof, is formed of one sheet of steel. The entire back, from the bottom to the roof, is made of a single sheet of steel. This body has no floor. The seats are placed on the chassis frame and the sides of the body are mounted directly on the chassis frame—the body serving as a cover for the passengers only.

Upholstery.—In the wooden frame body, the upholstery is attached to the body after it has been built, by skilled operatives, using tacks to hold the material in place and covering the line of tacks by means of lace or gimp. This requires a high degree of skill on the part of the operative, takes a great deal of time and is expensive. In the steel body there has been developed what is known as removable upholstery.

Painting.—The use of varnishes has been almost entirely superseded by the use of cellulose coatings. This is commonly applied by means of pneumatic sprays, several coats being applied as the body moves along the conveyor lines. The coats can be applied one after the other at intervals of 15 to 30 minutes. In the interim, from one spray to another, the bodies pass through ovens where the drying is hastened and the lacquer is somewhat hardened before receiving the succeeding coat. After the several coats have been applied they are polished by vigorous rubbing on the part of the operative. (E. G. BU.)

MOTOR CAR ENGINES: THEIR OPERATION AND CARE. An internal combustion engine is one in which the fuel is burned directly inside the machine which converts the heat energy into work. Practically all motor cars use this kind of engine, the fuel being petrol (gasolene). The engine consists of a number of cylinders. In each cylinder a piston slides up and down. A rod connects each piston to a special shaft, which runs lengthwise of the engine. This is the crankshaft, which carries the flywheel. When the pistons are pushed down, they rotate the crankshaft and this turns the flywheel. In engines having a heavy flywheel, it is here that the power of the engine is stored, and from here the clutch and transmission take it to the rear wheels, which drive the car.

The easiest way to understand how an engine works is to keep in mind only one cylinder. For the engine to run and do work, certain things must take place over and over again in a regular order. The fuel must be sucked in, it must be compressed and exploded; the resulting gases expand, owing to the heat generated, and thus do work, and after expansion they must be removed. These steps make up what is known as a cycle; in the modern engine it takes four strokes of the piston to make up one cycle. During this time the crankshaft will have made two complete revolutions. This type of engine is said to operate on a four-stroke cycle. The four strokes of the piston are named according to what they accomplish. The first is the suction, the second the compression, the third the power, and the fourth the exhaust stroke.

At the start of the suction stroke, the piston is at the top of the cylinder. It moves downward and the inlet valve opens. This sucks in the charge of gases from the carburettor. The compression stroke starts when the inlet valve closes and the piston is moving upward. The mixture is ignited while under pressure by a high tension electric spark, which is produced across the points of the sparking plug, either by means of a battery and coil (*see* INDUCTION COIL), as in American cars, or by a high tension magneto (*q.v.*), as in British cars. The power stroke begins with a downward thrust of the piston. The burning of the gases gives off heat, which causes expansion. Pressure is thus exerted on the piston, forcing it downward as far as it will go. This completes the power stroke. The last movement of the piston is the exhaust stroke. The exhaust valve opens toward the end of the power stroke and most of the burnt gases rush out. The piston moves upward, pushing the remaining gases out of the cylinder. The four-stroke cycle is now complete. (*See* INTERNAL COMBUSTION ENGINES for more extended treatment.)

Fuel and Carburation.—In order to be utilized by the engine, the petrol (gasolene) must first be atomized by the carburettor (*q.v.*), which introduces into the intake manifold a fine spray of petrol which is mixed thoroughly with the incoming air (generally pre-heated to encourage the evaporation of the fuel droplets). This mixture is sucked into a combustion chamber, where a spark ignites it at the top of the compression stroke. The more intimate the mixture, the faster it burns. It is also the duty of the carburettor to admit the correct amount of air needed to burn the fuel. This is important, for if too much air is present the mixture will be too lean, resulting in a lack of power. The most common fault, however, is the use of a mixture that is too

rich, *i.e.,* one containing so much fuel that there is not enough air present to burn it all. This happens when the choke valve (which cuts off the supply of air to the carburettor) is used too freely. To get the most power out of the engine, a mixture of about 12 to 1 is needed. Most cars on the road are run with a mixture of about 10 to 1, and are sadly in need of carburettor adjustment. Practically all exhaust gases are dangerous as they contain about 7% of carbon monoxide, which is exceedingly poisonous. The engine therefore should not run in a closed garage.

Starting.—Occasionally, owing to the improper functioning or failure of a particular part of the mechanism, the engine will not start. There are then three main lines of investigation to follow:—(1) Is there petrol (gasolene) in the tank and is it being supplied to the carburettor? (2) Is the ignition system in order and producing sparks at the sparking plug? (3) Is the compression poor because of pitted or leaking valves, blown-out gaskets or imperfectly fitting pistons and piston rings? If there is fuel at the carburettor, a good spark and good compression, and yet the engine does not start, it may be that the carburettor is delivering to the engine an air-fuel mixture so rich that it will not fire. If the trouble is due to too rich a mixture push the choke back a little, and the engine will run more smoothly. If, however, during acceleration and warming up the engine "pops back" then the trouble may be that the mixture is too lean. The choke should be pulled out until the spitting stops. Then as soon as the engine is warm, push the choke clear in; the engine will run more efficiently and crankcase dilution will be reduced. If uneven firing persists, the carburettor should be given proper adjustment by a competent carburettor mechanic. More engine trouble results from unwise adjustments of the carburettor than from any other single cause.

Electrical System.—The battery is quickly run down if the car is used a great deal at night, when most of the current generated is consumed by the lights, or if many short runs have been made, which gives a battery no time to build up after frequent use of the starter. When the starter turns the engine over slowly and with much difficulty, it is wise to start the motor with the hand crank, as the starting motor takes a heavy current. In American cars in which coil ignition is employed, when the battery is badly run down, the voltage drop is so great that the battery cannot at the same time actuate the ignition system; when a magneto is fitted, as in European cars, the rate of revolution may be insufficient to produce a spark. The battery should be kept clean and the terminals covered with vaseline to prevent corrosion. The cells should be tested regularly and enough distilled water put in to cover the insulators slightly. If the car is laid up, the battery should be removed and kept charged. (*See* ACCUMULATORS.) The ammeter, usually fitted on the dash-board, indicates whether the battery is being charged or discharged. When the lighting, dynamo and ignition switches are turned off, the ammeter should register zero.

Poor performance, excessive consumption of fuel, and misfiring are often caused by dirty, damaged or unevenly adjusted sparking plugs. The sparking plug insulator should be well cleaned. It is well to use the plug recommended by the manufacturer of the car, and to change plugs at stated mileage intervals, since deterioration of porcelain insulators may cause leakage of current, resulting in a weak spark. To discover a defective plug, short-circuit each plug one after another by holding screw-driver or hammer so as to touch the metal or terminal of the spark plug and the metal of the cylinder at the same time. If, when any one plug is short-circuited, no difference is noted in the running of the engine, that particular spark plug may be at fault. Other defects in ignition causing engine trouble are the following:—switch not on; fuse burnt out; disconnected wire on switch, ammeter or battery; and spark retarded or advanced too far. In the case of coil ignition, the coil may be defective or the resistance burnt out, or the contact breaker points may be dirty, pitted or burnt. Where a magneto is used the following may be the source of the trouble:—dirty magneto contact breaker points, contact breaker sticking, gap incorrect, or condenser short-circuiting. (*See* MAGNETO.)

Cooling.—Two systems of cooling motor car engines are used: (1) by air and (2) by water. The cooling of an engine by air depends on the surface exposed, on the temperature of the air and on its volume. To give a large surface for radiation, fins are provided on the cylinders. Most motor car engines are cooled by water which circulates through jackets around the cylinders. After it takes up heat from the engine it passes to the radiator where it is cooled by air. In some cases the draught is aided by a fan. In the two commonest types of cooling systems (*a*) a pump provides forced circulation of the water or (*b*) the principle of the thermosyphon is employed. (*a*) The pump is geared to the engine so that when the engine is running the water must circulate. Even if the radiator is not full the pump will operate and, except in the case where only a very small amount of water is present, overheating will be prevented. In cold weather, the circulation of the water is at the same rate as in hot weather since it depends only on the speed of the engine. As a result, the engine on cold days will not reach a high enough temperature to operate efficiently. To aid in overcoming this condition, a thermostat (*q.v.*) is sometimes used to control the amount of water which is circulated by the pump; the use of the thermostat is not advisable when the circulation is promoted by means of the thermosyphon. (*b*) In the case of the thermosyphon, the hot water from the cylinder jacket passes from the top of the jacket to the top of the radiator where it cools and, becoming denser, falls to the bottom; in the meantime previously cooled water from the bottom of the radiator has passed back to the bottom of the cylinder jacket.

Freezing of the water in the cooling system may cause leaks in the radiator, and may crack the engine block. Methanol, formerly known as wood alcohol, denatured alcohol, glycerine and ethylene glycol are often mixed with the water in the radiator to lower its freezing point. Of these liquids, however, the first two are easily lost by evaporation. A radiator shutter, or winter front, may be used to limit the amount of air which the fan pulls through the radiator, thus aiding in keeping the engine warm in cold weather. Evaporative cooling, used with many stationary farm engines, has not as yet been used on the road, except experimentally.

Lubrication.—A problem that confronts every motorist is dilution, the thinning of the oil in the crankcase. Prolonged use of the choke, particularly in cold weather, is a large factor in causing dilution. Any excess of fuel that is drawn into the cylinders may become mixed with the oil in the crankcase. The lower temperature at which the engines usually operate during the winter also causes dilution. The condition may continue until the amount of dilution of the oil becomes constant, because some of the diluent may evaporate when the oil gets hot, as, for example, during a long trip. A large amount of water is formed by the combustion of the gasolene, and it sometimes finds its way into the crankcase, because of the low operating temperature. Excessive dilution will result in rapid wear of the cylinder walls and bearings, as the oil film on the bearings will not be thick enough to prevent actual contact between the metal surfaces. It should be noted, however, that in cold weather a slight amount of dilution may protect the motor during the warming-up period, for if the oil is extremely thick it might not flow to the bearings. For this reason a cold engine should not be raced to warm it up quickly. Failure to observe this precaution often results in the scoring of the cylinder walls and pistons. The manufacturers' directions should be followed in regard to the proper interval for changing the oil in the crankcase. Before adding the new oil it is inadvisable to use kerosene to wash out the crankcase, because such a procedure would dilute the oil before it is used.

It is the duty of a lubricating system to keep a thin film of clean suitable oil between all metal surfaces which move against each other. Lack of oil will cause friction and abrasion; particles of dirt in the oil will scratch the surfaces and destroy the precise fitting of parts. The film forms only after the engine has been running for a short time, and for this reason the motor should never be raced on starting. There are several different ways of lubricating the engine. In all systems a supply of oil is held in the

bottom of the crankcase. The oil is conducted to the various bearing surfaces by either splashing, pumping under pressure, or by a combination of both systems. The oil gauge is the nerve centre of the engine. If the gauge shows no pressure, it is dangerous to drive the machine farther. If the gauge indicates very low pressure, there is good reason to believe that the oil is flowing through the bearings too rapidly. This may mean that the oil is too thin and diluted, or that the bearings are too loose. If the gauge fluctuates, this symptom of distress signifies that there is probably not enough oil in the system, that the system is choked or that the pump is in need of repair. In any case, irregularities in the operation of the gauge should be taken as the forerunner of trouble and should be investigated immediately. The following are a few rules for the lubrication of a motor car engine:—(1) Keep the crankcase filled to the proper level with oil of the grade recommended by a good oil company. Do not fill beyond the proper level, as this will make the engine sluggish, and in some cases cause sticking of the valves. (2) Change the oil at regular intervals to ensure longer life to the engine. (3) When driving, watch the oil gauge for possible failure in the lubricating system. (4) Keep the engine clean and inspect the air, fuel and oil cleaners regularly. (5) When the engine is old and bearings and piston fits are loose do not expect heavier oil to correct these defects. Have the motor repaired. (6) Do not race a cold engine. (7) Use an oil that will flow freely in winter weather. (8) Do not drive a new machine fast or allow it to overheat. One quart of light oil per 10 gal. of gasolene, poured directly into the fuel tank, may help a great deal during the first few hundred miles of driving. (9) Do not wait until you hear a squeak before lubricating the engine. A squeak means a dry or dirty bearing.

Carbon Deposits in the Engine.—In the process of lubrication, some of the oil, in the form of spray, gets past the piston rings in the cylinders and enters the combustion chamber. This oil causes carbon deposits. The so-called asphalt base (naphthene) oils have been found to leave the least carbon in the engine. As carbon accumulates it makes itself known by loss of power and knocking of the engine, especially on a hard pull, as in climbing a hill. The carbon on the inside of the chamber, on top of the piston and sometimes below the piston, keeps the heat in the combustion space, causing the knocking. Sometimes the carbon itself gets so hot that it burns or glows, exploding the charge of fuel before the proper time. This produces the pre-ignition knock which involves a great loss of power. Sometimes pieces of carbon get between a valve and the valve seat, holding the valve open. When the exhaust valve is thus held open, the flame of the explosion can pass completely around it, burning or warping the valve.

The best way to remove carbon is to take off the cylinder head of the engine and scrape out the deposit. The valves should be ground while the head is off and the gaps on the spark plugs reset. Before replacing the head every particle of loose carbon or grinding compound should be removed to avoid scratching the cylinder walls, and a new gasket put in between the head and cylinder block. Carbon troubles may be minimized in the following ways:—(1) by using an oil of low carbon-depositing tendency; (2) by operating the engine on a lean air-fuel mixture; (3) by running the engine at a sufficiently high operating temperature and giving it a little real work once in a while; (4) by use of an efficient air cleaner; (5) by use of anti-knock fuels when necessary; (6) by keeping the engines in such mechanical condition that oil consumption is not excessive. (W. A. Ha.)

MOTORCYCLES. Although the motorcycle did not become popular in any country until 1911–12, the first examples of it were seen in France and Germany about 1885. In 1907, the first of a series of famous motorcycle road races, the International Tourist Trophy races, was held in the Isle of Man. The importance of winning this race urged designers to improve their machines, as regards both speed and reliability, and from then until 1914, the first year of the World War, the production of motorcycles increased by leaps and bounds. The necessity for the manufacture of war materials, and the difficulty of obtaining petrol then reduced the combatant countries' production of motorcycles to a minimum, but in America an increasing number of machines were made. There was a tremendous demand for motorcycles in the years 1919–20, but British manufacturers, disorganized by war work, were unable to meet it. In 1919 America sold 1,481 motorcycles to Great Britain, and in 1920, 4,277. The numbers then dropped until, in 1926, they reached the low figure of 75, whereas in the same year 48,391 motorcycles were exported by Great Britain and 628,955 were registered for use in that country. Great Britain is by far the largest producer of motorcycles, the output for 1926 being approximately 120,000. Germany comes second with about half this number, America third with some 45,000, and France fourth with 25,000. The figures taken are for the years 1925–26. Italy, Belgium, Austria, Switzerland and Sweden complete the list of the chief manufacturing countries, although many other countries assemble machines.

Stages in Improvements.—The advance in the motorcycle's utility can be marked by three distinct steps. The first was the discovery that the best position for the engine was in the centre of the frame, rather nearer the front wheel than the back, and the adoption of this fixing; the second was the advent of electrical ignition; and the third was the use of efficient chain transmission through a change-speed gear-box. Many other improvements, such as those relating to carburization, frame design, etc., were effected, but the three mentioned above were outstanding in the resultant popularity of the motorcycle. There was no definite position in which one might expect to find the 19th century motorcycle's engine. On some machines it was carried in front of the steering head and drove the front wheel; on others it was attached to the down tube from the steering head, being either in front of or behind it; the seat pillar tube, again, sometimes carried it, whilst on a few machines the power unit was built up into the back wheel or placed immediately above it. In all except the first position mentioned the power was transmitted to the rear wheel. Early in the present century it became acknowledged that the most suitable position for the engine was low down in the frame, just in front of the pedalling gear. In most cases the crank-case of the engine was bolted into the frame, and thus formed part of it, but on a few machines and notably the American "Indian" the down tube from the steering head was continued below the engine. This pattern was known as a loop frame, and although it was little in evidence for many years it is to be found in an improved form on many modern machines.

The problem of ignition of the petrol vapour was one which had puzzled designers from the earliest days of the internal combustion engine. The first form of ignition consisted of a tube protruding from the cylinder, the rider having to heat its external end by means of a Bunsen burner using petrol fuel, before the engine could be started. Towards the end of the nineteenth century, this system, which was known as "tube ignition," was replaced by electrical ignition, composed of a battery, coil, contact breaker and sparking plug. The first electrical system was greatly in advance of tube ignition, but in its early form it was by no means trouble-free, and it was not until the advent in 1903–04 of the magneto, an instrument which generated current when it was rotated, that the motorcycle became a practicable means of transport. Until then the machine as a whole was extremely unreliable, and the rider could never be sure of concluding a run under the power of his own engine. Even when the magneto had marked a reasonable degree of reliability, the motorcycle was still suitable for young and active men only, owing to the inadequacy of its transmission system.

The Advent of Variable Gears.—When the pedal cycle with a three-speed hub-gear, and the motor car with a three or four-speed gear-box were in common use, the motorcycle was still devoid of change-speed gears, and was driven by a single belt. There were, of course, exceptions, one of which was the two-speed chain-driven P. & M., first produced in 1902. Engine power on the earliest machines was transferred to the front or back wheel by means of a twisted leather belt. This soon proved inadequate for the increasing power of new engines, and "V" sec-

tion belts were employed, the angle formed by the two driving surfaces being 28°. These "V" belts were built up either of leather or of rubber surrounding a fabric core. Leather belts were harsh and wore the driving pulleys quickly and rubber belts slipped badly when they became wet. The failings of both were thus very marked, and since they connected the engine direct to the back wheel, the former could not run unless the motorcycle also were in motion. This meant that the only way to start the machine was for the rider to push it at a speed of 6–8 miles per hour and to jump on as soon as the engine fired, an athletic procedure which could only be indulged in by a small section of the community. To understand the motorcycle's lack of development in this respect, it is necessary to consider the type of engine used. This was in most cases a four-stroke of either single or twin-cylinder pattern. (*See* INTERNAL COMBUSTION ENGINE.) As the power impulses of the engines were too harsh to be transmitted to the rear wheel by chain or other such appliance, it was necessary to have a driving element capable of absorbing the shock of the explosions, and a belt, which provided a certain amount of elasticity, proved the easiest solution of the difficulty. With the single belt, an unpleasant but inevitable component, the only place to fit change-speed gears was the hub of the rear wheel. Various two- and three-speed hub gears were made during the early part of the 20th century, each of these incorporating a clutch, a slipping device for allowing the power of the engine to be applied gradually to the rear wheel, so that the machine would start under its own power. Hub gears, however, proved to be very unsuitable, since their internal parts could not be made large enough to withstand the strain. Designers, therefore, applied themselves to the production of counter-shaft gear-boxes—so called because the gear wheels work on more than one shaft, as opposed to epicyclic gears which employ a common shaft —usually placed just behind the engine. With a few exceptions, the early counter-shaft gear-box was driven by a chain from the engine, an ordinary "V" belt connecting it to the rear wheel. This type of transmission was much in favour in 1914, when the outbreak of war stopped further experiments in motorcycles. Belt trouble was still existent, but, since the belt ran in larger pulleys than was the case with a single-belt drive, it was not so marked. Shortly after the war, however, machines with all-chain drive became almost universal, a device to absorb the shock of the engine being fitted on the engine shaft, in the gear-box or in the rear wheel. This type of transmission or one which replaces the primary chain by gear-wheels, together with many other improvements, has made the modern motorcycle a most efficient piece of engineering and suitable for riders of either sex. It can be ridden by anyone who is in possession of normal physical and mental powers, and it is a cheap form of mechanical transport.

Types and Sizes of Engines Used.—As has already been mentioned, most motorcycles employ single- or twin-cylinder engines. This rule may be said to apply to machines all over the world, except in the U.S.A. where a few four-cylinder motorcycles are made. Apart from this small number of cylinders, most motorcycle and motor car engines are similar in general design (*see* INTERNAL COMBUSTION ENGINE), and are of the four-stroke type. Many motorcycles, however, are fitted with a type of engine little used for cars, the two-stroke. The two-stroke engine fires on every revolution, instead of every alternate revolution as does the four-stroke, and its power impulse is thus more smooth. It is extremely simple and reliable, in that it has only three moving parts, but it has certain defects, and it does not develop more power than the four-stroke. The earliest two-stroke to be placed on the British market was the twin-cylinder water-cooled Scott (1909), the first air-cooled two-stroke being the Levis which made its appearance a year later. Races and reliability trials have done much to improve the motorcycle, and the modern machine has a low centre of gravity, a smooth running and relatively well-silenced engine, large pneumatic tyres, a three-speed gear-box with a handle-bar controlled clutch, a kick-starter and all-chain drive, efficient internal expanding brakes, a well-sprung saddle and front forks, and mudguards which give a moderate degree of protection. Electric lighting sets came into general use in 1927, and almost any machine can be obtained with one at a small extra charge.

Motorcycles are made in all sizes from about 1·5 to 12 h.p., and a machine of 3·5 h.p. or more is capable of taking a side-car. The side-car is attached to the left side of the machine in Great Britain, and to the right side in the United States, according to the rule of the road of the country in which the outfit is being used. In most countries, however, there is no law prohibiting the fitment of the side-car on what is considered locally to be the wrong side. Horse-power is reckoned on the capacity of the engine; *i.e.,* the volume swept by the piston or pistons, in cubic centimetres, 100 c.c. being considered equal to one horse-power. Thus an engine with a capacity of 350 c.c. is stated to have a horse-power of 3·5, and so on. Some manufacturers, however, cling to horse-power denominations based on an old and inaccurate rating. In America the most favoured type of motorcycle is the large twin- or four-cylinder machine of 10–12 h.p., for either solo or side-car use, but in Great Britain and most European countries solo machines of above 5 h.p. are not widely used, the larger sizes generally being employed with side-cars. Machines of from 1·5 to 2·5 h.p. are very popular in Europe or wherever the roads are moderately smooth, since they are light and easily handled, but in districts where roads are poorly constructed the larger sizes are usually chosen.

British Racing Successes.—At the beginning of 1928, the majority of racing successes stood to Britain's credit. Every international tourist trophy race except one (the 1911 5 h.p. class, in which an American "Indian" was successful) had been won by a British motorcycle, and in most continental grand prix races when British motorcycles were present they had proved themselves to be infinitely superior to their competitors. As an indication of the increase of speeds in recent years it is interesting to note that whereas the first tourist trophy race (1907) was won at 38 miles per hour, the 1927 race, on a larger and more difficult course, was won at 68 miles per hour. Most of the world's records for high speeds are held by British machines.

The following is a list of record speeds over a distance of one kilometre, up to the end of 1927.

Solo motor cycles: 2·5 h.p. 89·96 m.p.h.; 3·5 h.p. 102·99 m.p.h.; 5 h.p. 114·02 m.p.h.; 10 h.p. 121·41 m.p.h.

Side-car machines: 6 h.p. 99·07 m.p.h.; 10 h.p., 104·12 m.p.h.

The 5 h.p. solo and 6 h.p. side-car records are held by Belgian motorcycles, the remainder of the records standing to the credit of Great Britain.

BIBLIOGRAPHY.—Shepherd, *Motor Cycle Overhauling* (1920); Wyatt, *Motor Cycling* (1925); Brown, *The Complete Motor Cyclist* (1925); *Two-Stroke Motor Cycles* (1925); *Motor Cycles and How to Manage Them* (1925); *Tracing Motor Cycle Troubles* (1926); *Hints and Tips for Motor Cyclists* (1927); *The Petrol Engine* (1927); *Motor Cycling Manual* (1927); Harwood, *Speed and How to Obtain It* (1927). (G. S. D.)

UNITED STATES

The modern American motorcycle is constructed according to the service for which it is intended. The light type consists usually of a single cylinder, four-cycle engine with a chain transmission and weighs from 225 to 275 pounds. This motorcycle, intended for solo use only, is a very economical means of transportation. The motors are usually of 21 cu.in. capacity and will develop from 8 to 12 h.p., according to type; they operate regularly on a gasolene consumption of one gallon per 80 to 100 m. and up to a speed of 55 m. per hour. There has also been developed a medium-weight type for solo use. This has either chain or gear and chain transmission. The motor of the two cylinder type is from 37 to 45 cu.in. and will develop as high as 16 horse-power. This motorcycle will run at speeds up to 70 m. an hour and has a gasolene consumption of one gallon per 60 to 80 miles. The heavy type of motorcycle is used in police and commercial work, for pleasure, both solo and with side-car, and has also found a useful place in the army.

For police work the motorcycle becomes indispensable. The enormous increase of the use of the motor car, greatly encouraged by improved roads, has diversified police use in many ways. In

many States police bodies have been organized and equipped with motorcycles as a ready means of performing their duties. Their work consists of the regular police work and the prevention of reckless and careless driving. In the city, the motorcycle police officer, in addition to enforcing the driving and traffic laws, is able to respond with great quickness to emergency calls. The motorcycle as a necessity to the mounted officer is universally recognized and provides a mount which has capabilities beyond any other that is available for enforcing speed laws and regulation of traffic.

In the army, the motorcycle has proved its worth as a means of rapid communication in rough country and for its ability to thread its way through congested traffic such as occurs when large bodies of men and supplies are moved from place to place. Many thousands of motorcycles were used in the World War. When the army organization tables were recast some time after the war, motorcycles were provided for various units. The motorcycle is still being used for pleasure, but not to the extent that it formerly was. Its appeal lies to the young man between 18 and 25 and forms a rapid means of transportation and exhilarating sport. The motorcycle production in the United States reached its peak in 1913, and in that year a total of 70,000 motorcycles were made. The production for the last three years, up to 1928, has been 45,000 annually. There are six companies manufacturing motorcycles in the United States at the present time. (W. S. H.)

Motorcycle Racing in the United States.—The first real fast time established in the United States was made by the late Albert Champion, who covered a mile on a track in 1 min. 10⅘ sec. in 1902. Oscar Hedstrom, designer of a motorcycle and bicycle bearing his name, rode a mile on the Florida sands on an Indian machine he designed, in 1 min. 3⅕ sec.

Real competition came after the formation in 1903 of the Federation of American Motorcyclists, an association organized for the purpose of furthering the interests of the motorcyclists and the control of motorcycle competition. Almost at once race meets were promoted throughout the country with the then well-known Jake DeRosier, Walter Goerke, Frank Hart John U. Constant, Ben Swenson, Glen H. Curtiss, J. I. Brandenburg, Stanley Kellogg and many others.

With the advent of racing on a large scale the manufacturers built special racing machines to insure the name of their product being among the first three in the summaries. Speeds began to increase and trials for a "mile-a-minute" were made. Racing was held on dirt or horse-racing tracks, in the earlier days. Then, about 1911–13, came the board tracks, or the so-called motordromes and a circuit of such tracks, generally from ¼ to ⅓ m., sometimes ½ m., was established. But this form of motorcycle racing was soon abandoned due to the number of fatalities. Racing then went back to the horse tracks and later to the automobile speedways, of a mile or so. What racing is being done to-day is held either on horse tracks or on the automobile speedways. Most motorcycle competition work is confined to hill climbs, racing having been dropped by a number of factories. The control of racing is now handled by the American Motorcycle Association.

The A.M.A. records show that Jim Davis, at Beverly Hills Speedway, Los Angeles, Cal., did a mile in 32·43 sec. in 1922. Three years later at Laurel, Md., his time for 5 m. was 2 min. 41⅗ sec. Joe Petrali at Laurel did 10 m. in 5 min. 23⅘ sec.; 25 m. in 14 min. 8⅗ sec. and 100 m. in 59 min. 47⅕ sec., or better than a mile a minute for the entire distance. Records by R. Hepburn on a dirt course at Dodge City, Kan., in 1921, stand at 2 hr., 17 min. 54 sec. for 200 m. and 3 hr. 30 min. and 3 sec. for the 300 miles.

Record beach performances at Daytona Beach in 1920 stand as follows: 1 kilometre by Gene Walker in 19·32 sec. or 115·79 m. per hour; 1 m. by Gene Walker in 31·53 sec. or 114·17 m. per hour. (W. A. Ba.)

MOTORING. The increase in the popularity of private motoring is one of the most remarkable developments of modern times. Assuming that there were 1,300,000 motor-cars and motorcycles in use in Great Britain in May 1928, the total value at even £100 apiece—a very reasonable estimate—would have amounted to 130 millions sterling. If these 1,300,000 vehicles covered 5,000 miles a year, or on the average say 100 miles a week, it would work out that 6,500,000,000 miles are covered in a year by motorists in Great Britain alone, or about 70 times the distance of the sun from the earth! In 1897 less than twenty people, all of them enthusiasts, daily execrated by the public at large, possessed a private motor vehicle. But the private owner can no longer be regarded as using a car for pleasure only. Every day use for every day purposes is now the usual work of a privately owned car. Prior to the World War, motoring was to some extent confined to well-to-do people, whereas to-day the majority of motorists are people of quite moderate or even very limited means. People possess and use cars to-day not so much because they want to as because they must do so. In short, the question is not so much whether a person can afford a motor car as whether he can afford to be without one.

Causes of Rapid Growth.—Apart from the great demands of business, the very rapid recent growth of motoring has been due to factors which may be enumerated as follows:—(1) Cheap prices for really good cars; (2) the adoption of the hire purchase or "purchase out of income" system; (3) improvement in the quality of both mechanism and tyres, resulting in reduced maintenance charges; (4) improved engine efficiency resulting in reduced fuel consumption and lowered running costs.

Dealing with the factors categorically we find:—(1) Owing to the very large increase in wages subsequent to the World War, and the corresponding increase in the cost of all manufactured articles, it became necessary to study and apply scientific methods of production to a much greater extent than had previously been considered necessary, for it is a well-known fact that when labour is both cheap and plentiful there is less incentive than when wages are high to pay attention to this matter. Hence since the war it has come about that partly at least owing to much higher wages prevailing the introduction of more scientific methods of production has revolutionized many industries, to their great advantage, and this change has been particularly evident in the motor manufacturing and affiliated trades.

(2) The introduction of the hire purchase system in regard to motor-cars has resulted in large numbers of persons joining the ranks of motorists who would not have done so had it not been for this convenient method of extended credit. The economic pros and cons of the system need not be considered here. It is sufficient to say that the hire purchase of pianos, furniture, houses, etc., has been in existence for many years and that it has certainly been responsible more recently for an enormous increase in the number of motor vehicles in use. There are, in fact, thousands and thousands of young professional and business men to-day to whom the motor-car or cycle has become literally a necessity and the hire purchase system has provided them with an easy means of obtaining their equipment.

(3) Just in the same way as increased demand and larger output, as the result of scientific production, have enabled prices to be reduced, so improvements both in design and equipment have similarly resulted. Wheels, tyres, transmission gears, brakes and electric equipment are all more efficient, while lubrication, which was at one time not only a dirty business but also little understood by the average owner, has now been arranged so as to render it practically automatic and fool-proof. Tyres give much longer mileages than previously, which may be attributed partly to the improvement in the quality of the tyres, and to a very large extent also, to the improvement in the quality of road surfaces. Gears have longer lives because in the first place they are better designed, and, in the second place, because the steel from which they are made has been greatly improved in quality.

(4) The improvement in engine efficiency has been particularly marked. Efficiency in this respect means the amount of power derived from the engine which is transmitted to the road surface, in relation to the power put into the engine in the form of petrol or other fuel. A modern engine of good class will give on a gallon of petrol double the mileage which an engine of similar dimensions would have given only a few years ago.

CARS IN GREAT BRITAIN

The following special table shows the number of private cars in use from 1911 to 1927 together with the annual percentage increase and number of persons per car in Great Britain. Previous to 1911 the various types of motor vehicles in use had not been classified.

Great Britain: Proportion of Private Cars in Use to Total Population: 1911–1927

Year	Private cars in use	Population per car	Annual increase or decrease of cars in use, per cent
1911	47,000	862·8	..
1912	57,000	717·5	+ 21·3
1913	68,000	602·0	+ 19·3
1914	85,000	486·1	+ 25·0
1915	90,000	463·5	+ 5·8
1916	92,000	435·5	+ 2·2
1917	71,000	555·5	− 22·8
1918	50,000	780·3	− 29·5
1919	71,000	547·1	+ 42·0
1920	122,000	318·8	+ 71·9
1921	250,000	168·3	+105·0
1922	315,000	135·6	+ 26·0
1923	384,000	112·1	+ 21·9
1924	474,000	91·3	+ 23·4
1925	580,000	75·1	+ 22·3
1926	686,000	63·9	+ 18·2
1927	727,000	..	..

The figure 63·9 persons per private car given in the foregoing table for Great Britain in 1926 compares as follows with other principal motor using countries.

	No. of persons per private car
United States	6·0
Canada	12·9
New Zealand*	13·3
Australia*	19·7
South Africa*	21·4
Great Britain	63·9
France	69·1
Germany	313·0
Italy	495·8

*White population only.

Classification by H.P.—A return issued by the Ministry of Transport showing the number of vehicles bearing current licences during the quarter ending Sept. 30, 1927 shows the classification in respect of horse power. The table given in the next column is not up-to-date, but it is the latest available, and is very interesting as showing the degree of popularity of each. (*See* also MOTOR CYCLES.)

Great Britain—Analysis of Total Number of Mechanically-propelled Private Motor Cars and Cycles for Which Licences Were Current at Any Time during the Quarter Ended Sept. 30, 1927.

Description	1927	1926
A.—Cars taxed on horse power		
Electrically Propelled	48	540
Other Motor Vehicles:		
1–6 H.P.	388	573
7 ,,	14,079	11,146
8 ,,	54,668	35,431
9 ,,	45,886	43,668
10 ,,	45,468	41,062
11 ,,	72,682	66,156
12 ,,	203,834	174,641
13 ,,	42,894	27,322
14 ,,	96,922	76,564
15 ,,	14,592	10,718
16 ,,	41,557	40,974
17 ,,	4,374	3,390
18 ,,	19,024	13,749
19 ,,	13,505	15,223
20 ,,	11,856	10,852
21 ,,	12,537	11,789
22 ,,	12,778	13,053
23 ,,	37,711	45,437
24 ,,	12,843	10,467
25 ,,	2,318	2,378
26 ,,	3,333	4,208
27 ,,	906	870
28 ,,	5,480	6,217
29 ,,	206	256
30 ,,	4,372	4,360
31 ,,	4,109	4,559
32 ,,	366	367
33 ,,	183	463
34 ,,	206	171
35 ,,	883	774
36 ,,	472	501
37 ,,	265	216
38 ,,	450	334
39 ,,	635	764
40 ,,	85	114
41 ,,	18	17
42 ,,	21	32
43 ,,	14	13
44 ,,	906	624
45 ,,	656	678
46 ,,	5	8
47 ,,	4	1
48 ,,	23	14
49 ,,	2,923	3,123
50 ,, and over	125	96
Total, cars taxed on horse power	786,610	683,913
B.—Motor Cycles		
(1) *Bicycles.*		
Weight unladen:—		
Not exceeding 200 lb.	242,717	247,720
Exceeding 200 lb.	427,819	378,643
†Total	670,536	626,363
†*Including bicycles used for drawing a trailer or sidecar.*	205,450	201,042
(2) *Tricycles*	10,874	10,608
Total, motor cycles	681,410	636,971

Freedom of Residence.—There is yet another matter having a very important bearing on the continually increasing use of the motor car, namely the greater freedom which it affords as regards choice of residence. First, the motor car appealed as a means whereby the town dweller could get out into the country, especially at week-ends, for both pleasure and health. Any train journey involves starting at a fixed time, with tedious waiting sometimes for train connections, and, in the case of the family man, the accompanying anxiety and worry of tired and peevish children and nervous strain on all concerned. These contingencies in connection with "a day in the country" or a week-end were sufficiently serious to weigh heavily with most so that more often than not it was judged preferable to stay at home rather than face such trials. With the coming of the motor car all this was entirely changed. That which was formerly a serious undertaking has now become an unalloyed pleasure. Those who make their journeys by car instead of by train gain thereby greater freedom, reduced cost and, very often, reduced expenditure of time also. Further, the average town dweller is no longer tied down for residence to the close neighbourhood of his business, with the probable incidentals of high rents and rates. He can now go further afield—to the country which, until then, had been to him more of a legend than a real fact. The migration thus set up is still in progress, and in England is evidenced by what is known, and also deplored, as the "ribbon" development along our highways, otherwise the tendency of houses to stretch out unduly along the frontages of the main roads. From a health point of view there is good in this new development, but control is needed to preserve the amenities of the countryside. And if care is not

exercised by the highway authorities main trunk roads will become long drawn out suburbs instead of high speed roadways and much of the expected advantage will be lost.

LAWS AND REGULATIONS

The laws and regulations governing the use of motor-cars are of various kinds.

Driving Licences.—In Great Britain, before driving a car or a motor cycle a licence must be obtained from the county council or borough council, the fee for which is 5/–. In the Irish Free State it is 10/–. Councils have no power to refuse a licence except under a magistrate's order, in consequence of a conviction for a road offence, suspending or declaring an applicant incapable of holding a licence. The licence must be renewed each year and it must be produced on demand by a police officer. If a licence is lost a duplicate may be obtained for 1/–. A driving licence is obtainable by anyone above the age of seventeen or, for a motor cycle, above the age of fourteen.

Registration.—Before a car or motor cycle may be used on the road it must be registered with a county council or borough council. The council at the same time assigns an identification number. A number plate, of a size and with letters and numbers prescribed by regulations, must be carried at the front and at the back of the car. Motor cycles may carry plates of half size and the front plate may be lettered on both sides and carried so as to be read from either side.

For the purpose of registration, the registration authority requires the following information:—(1) the present registration mark and number, if any; (2) type of body; (3) colour of body and wheels; (4) name of maker, type of car, chassis and engine numbers; (5) year of manufacture, if possible; (6) number and diameter of cylinders.

On registration the owner of each vehicle is provided with a registration book, which—

(1) must be handed on any change of ownership to the transferee, who on receipt must send it to the local council (Minister of Transport Regulations, 1924) which must also be notified by the former owner.

(2) must be produced on reasonable notice, though it need not be carried in the car.

The position of the licence card, in the case of motor cycles, in a conspicuous position on the near side of the vehicle in front of the driving seat; in the case of a motor cycle with sidecar, on the near side of the handlebar of the cycle or the near side of the combination in front of the driving seat; in the case of all other vehicles (except when placed on or adjacent to the windscreen), on the near side of the vehicle facing toward the near side and not less than 2 ft. 6 in. nor more than 6 ft. 6 in. from the ground level.

In the case of a vehicle fitted with a front glass windscreen, the licence may be carried facing forwards on the near side lower corner of the glass, so as to be clearly visible from in front at all times during daylight.

Full particulars concerning the issue of licences for motor cars are contained in the Road Vehicles (Registration and Licensing) Regulations, 1924.

Motor Car Licence.—The taxes payable in respect of these are as follows:—in respect of private and other "horsepower taxed" cars, not exceeding 6 h.p., or those electrically propelled, £6 per annum; in respect of those exceeding 6 h.p. £1 per annum for each unit or part of a unit of horse power.

The Royal Automobile Club formula, which has also been adopted by the British Government for the purpose of motor taxation, *i.e.*, for the determination of horse power, is $D^2 \times N \div 2\cdot5$, in which D=diameter of cylinder in inches and N=the number of cylinders. For millimetre dimensions the formula is:—$D^2 \times N \div 1{,}613$. The formula does not take into consideration the question of stroke.

A licence may be taken out for a motor car or any mechanically propelled vehicle, for one quarter of the year only beginning on Jan. 1, March 25, July 1 or Oct. 1, the duty in this case being $27\frac{1}{2}\%$ of the full annual value.

A licence may also be taken out for shorter periods but the licence in these cases must expire on the last day of the quarter, the duties payable being—(1) Full quarter duty if over two months; (2) Two-thirds of quarter duty if over one month to run; (3) One-third duty if under one month to run.

Warning Signals and Lamps.—A bell or other instrument of warning must be carried on every motor vehicle, by which the driver may give audible and sufficient warning of the approach or position of the car.

By the Road Transport Lighting Act 1927, which came into operation on April 22, 1928 the lighting requirements prescribed are two lamps showing a white light to the front and one lamp showing a red light to the rear. Motor bicycles are also required to carry a white front light and a red rear one and pedal bicycles and tricycles a white light in front and either a red lamp or red reflector behind.

The hours of darkness or periods during which vehicles must be lighted are defined as being the time between one hour after sunset and one hour before sunrise in "summer time" and, for the remainder of the year, the time between half-an-hour after sunset and half-an-hour before sunrise.

Speed and Noise.—The regulation (1928) with regard to speed is a limit of twenty miles per hour. The driver of a motor vehicle may, however, be prosecuted for reckless driving even if proceeding at a lower speed. The Minister of Transport has power further to reduce the speed limit to 10 miles per hour in special places, such places being indicated by notice boards. It hardly needs adding that the 20 mile speed limit is more honored in the breach than the observance.

The driver of a motor car must not wilfully disregard the direction of a police constable in uniform, to stop, or to proceed, or to keep a particular line of traffic. This is the general law under the Public Health Act 1925 (Section 74).

A motor car must have two independent brakes in good working order, so that the application of either shall cause two of its wheels on the same axle to be prevented from revolving. In cars with less than four wheels, "two wheels" means "one wheel."

A motor car must be so constructed that when stationary, the action of the machinery may be stopped so far as is necessary to prevent noise. Further, a car must be so constructed that it will not make sufficient noise to cause a nuisance when passing along the highway. By the Cut-out Order 1912, it is forbidden that any motor car or motor cycle shall be permitted to use a cut-out or any other device which will allow the exhaust gases from the engine to escape into the atmosphere without first passing through a silencer or expansion chamber, suitable and sufficient to reduce the noise which would otherwise be caused as far as may reasonably be practicable.

Insurance and Accidents.—Though there is no law requiring insurance, it is a most important matter, particularly that with regard to what are called third party risks, otherwise injuries caused to others. It must also be remembered that the owner of a car, giving a lift to a friend, is liable for any injury which his friend may sustain, owing to his careless driving. The insurance policy should cover this risk.

As was to be expected, the advent and rapid increase of motor traffic, has led to a very large increase in the number of road accidents. The measures which are being taken to reduce the number include systematic road improvements (widening, straightening out or easing of dangerous bends and so on), the education of both pedestrians and drivers on "Safety First" lines by the National Safety First Council and, in addition, continued improvement in the control mechanism of vehicles.

The table on p. 908 gives the statistics of all recorded road accidents in Great Britain from 1918 to 1927.

In the face of these alarming figures it is comforting to realize that in 1927 the number of accidents, fatal and non-fatal, declined in proportion to total population, vehicles used and miles run. But the education not only of the motor vehicle driver but also of the pedestrian in the principles of "Safety First" must proceed much farther if a really substantial and satisfactory reduction in the number of accidents is to be effected.

(M. OF B.)

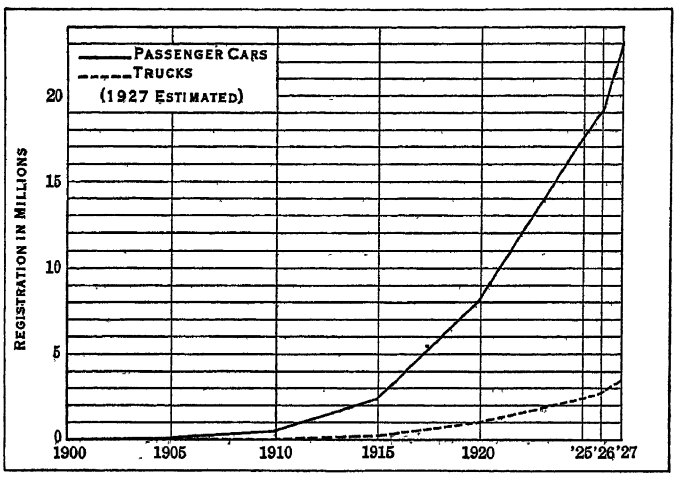
Road Accidents in Great Britain, 1918–27

	Fatal	Non-fatal	Total
1918 . . .	2,094	34,591	36,685
1919 . . .	2,488	47,262	49,750
1920 . . .	2,704	53,734	56,438
1921 . . .	2,678	59,943	62,621
1922 . . .	2,768	67,429	70,197
1923 . . .	2,979	80,121	83,101
1924 . . .	3,631	94,584	98,215
1925 . . .	3,971	111,502	115,473
1926 . . .	4,803	119,484	124,287
1927 . . .	5,195	128,748	133,943

UNITED STATES

A general impression of the present status of motoring in the United States may be obtained from the chart of motor vehicle registrations since 1900.

The inference is that there is one automobile for every six persons in the United States, and at first glance the chart seems to show that there is a great amount of pleasure touring. It raises also the question of how this volume of motor travel can be supported. But as a matter of fact, touring for pleasure is secondary, and there are only one or two clubs in the United States which approximate the service given by the Royal Automobile Club of Great Britain and the Automobile Association. The basis of motoring in the United States has always been the need for transportation, especially in rural communities. From the beginning the most numerous purchasers have been the farmers. The demand for rapid communication in rural regions is clearly indicated by the accompanying table:



GRAPH OF INCREASE IN REGISTRATION SINCE 1900

Distribution of Registration in Rural and Other Communities

(Figures as of December 31, 1926, by courtesy of R. L. Polk Company)

	Per cent		Per cent
Towns under 1,000 including rural . .	28·1	Towns 25,000 to 50,000	6·4
Towns 1,000 to 2,500	11·3	Towns 50,000 to 100,000	6·0
Towns 2,500 to 5,000	8·3	Towns 100,000 to 500,000	11·7
Towns 5,000 to 10,000	7·9	Towns 500,000 and over	11·4
Towns 10,000 to 25,000	8·9	Total	100·0

It is not strictly accurate to state that every sixth person in the United States owns a motor car. Of the 23,000,000 motor vehicles in the United States, 20,000,000 are passenger automobiles. At least 1,500,000 are owned by corporations for the corporate purposes of selling, building inspection and purely commercial ends. It is further true that there are approximately 3,000,000 families in the United States who own more than one automobile. Hence the actual number of families owning motor cars in the United States may not total more than 15,000,000.

It is to be noted that 56% of the automobiles are registered in communities having less than 10,000 population and it is significant that the bureau of public roads is a part of the U.S. department of agriculture. The demand for better highways continues to come from rural regions. The congestion of traffic—mostly motor driven—in the large cities is, to some extent, strictly urban, but various traffic counts have indicated that much, if not most, of it originates in the country districts, for the cities are the market places for the farmer and in many cases they lie athwart the State highway. The bureau of public roads is continually working with the various State Governments to develop a network of highways connecting every community in the United States of 5,000 population or more. Nearly half of the work has been finished, and when completed, this system will comprise about 200,000 m. of well paved roads.

Another side of motoring in the United States is the practice of travelling to and from business by motor car, which has led to a very considerable extension of suburban territory. The motor vehicle registration on Long Island, a suburban region adjacent to New York city, has increased fourfold since 1918. In cities of less than 200,000 population, this method of travelling to work is quite usual. Most of the factories in Detroit and in the outlying sections of other large cities, maintain large spaces where the cars of their employés may be parked during working hours. The worker using an automobile is able to live where land is cheap, and thereby save more than his motor transportation costs.

Touring for Recreation.—In the past few years there has been an increase in recreation touring. Motor camps in the United States number (1928) about 5,000. In addition to this there are thousands of tourist lodges which will accommodate persons for as little as 50 cents per night. These low prices have made touring possible for those who could not afford to stop at regular hotels, and although there were only 29,000 cars registered at the national parks in 1916, by 1920 the number had grown to 406,000 cars. In 1926 15,489,000 motorists visited the national forests. The place of the automobile as a general carrier of the public is indicated by these figures since there were but 1,600,000 visitors to these playgrounds who arrived by other means than car.

Accidents.—Motor travel increased with great rapidity in the period following the World War, and resulted in a great increase in the number of fatalities as is indicated by the following:

Motor Fatalities, 1917–26

Year	Automobile fatalities	Motor vehicle registration	Fatalities per 100,000 registration	Year	Automobile fatalities	Motor vehicle registration	Fatalities per 100,000 registration
1917	9,097	5,104,321	178	1922	13,676	12,238,375	112
1918	9,457	6,146,617	154	1923	16,452	15,092,177	109
1919	9,825	7,565,446	130	1924	17,566	17,593,677	100
1920	11,074	9,231,941	119	1925	19,828	19,954,347	100
1921	12,370	10,463,295	118	1926	20,819	22,001,393	95

The annual total of fatal accidents is still rising, although 14 States and 28 cities in 1926 made a reduction in their total fatalities and it is expected that the 1927 records will indicate still further progress in this direction. As it is, the rate per 100,000 is being steadily reduced. Opinion varies as to the best ways of reducing the accident rate but experience on specific highways indicates that improving the design of the road is very effective; *e.g.*, the Bronx river parkway, on the outskirts of New York city, which has carried as many as 35,000 vehicles on a holiday without an accident. On this road grade separations provide that intersecting highways pass above or underneath the parkway and opposing lines of travel are, for the most part, separated by a strip of landscaping. Furthermore, it is interesting that psychologically roadways which are well "landscaped" have the better safety records. Equally broad roads flanked by shops, signboards and similar distractions are not as safe.

Traffic Codes.—The national Government is co-operating with various national associations to simplify and unify the many different State and city motor vehicle codes. Most of the public schools include safety education in their curricula. "Stop" and "Go" signals are widely distributed. (J. C. L.)

MOTOR RACING. The first motor car competition of any kind, which was not actually a race, though it had some of the

characteristics of one, consisted of a trial from Paris to Rouen and back in 1894. Though only 26 cars competed, the fact that 102 were entered says much for the enthusiasm of the moment. The first prize was divided equally between a Panhard and a Peugeot car. It was after this that racing really began as a serious business. The route generally lay between two big towns along the ordinary highways, a limited number of police afforded meagre protection, dust-laying compound was not used and other traffic was sometimes allowed to stray on the road in the path of the cars. From the driver's point of view this increased the difficulties. It was impossible to practise over the roads and obtain full knowledge of the curves and corners. To pass another car, it was first essential to drive through a blinding dust-cloud, and there was always the possibility of a number of people being in the road round any curve. Moreover, each driver fought alone for his own car; there was no team organization, no organized national rivalry. Of such character were the Paris-Bordeaux, Paris-Berlin and Paris-Vienna races.

The Gordon Bennett Race.—This race, for a trophy presented by James Gordon Bennett, was a different affair. In this a team of three cars represented their country, and it was country against country, not car against car. Also, every part of each machine down to the smallest detail had to be manufactured in the country which it represented. The first two Gordon Bennett races were run as part of other longer competitions. Before the third could be staged a disaster changed the whole organization of racing. The Paris-Madrid, in 1903, was run in the old way over badly guarded main roads in the presence of enormous crowds with cars, which had ceased to be stripped and specially prepared touring cars, and had become very fast racing machines. The terrible series of accidents which occurred because the crowd invaded the road made the French Government stop the race at Bordeaux, and from that time onwards races have been run on a triangular circuit, palisaded on all sides, closely guarded by police and troops, and with a specially prepared road surface. The third Gordon Bennett race in Ireland was the first of this type. In the earlier races, also, big towns were neutralized, the cars going through slowly and resuming racing on the further side, a method adopted in Ireland for the last time.

The Grand Prix.—In 1906 there was another great change. The enormous number of manufacturers engaged in the trade in France resulted in a protest against the Gordon Bennett, as France could only be represented at the most by three types of car. Accordingly, the Grand Prix was organized from 1906 to 1908; in that race the various makes of cars competed against each other, though the national rivalry was maintained; all the cars from one country had to be the same colour, namely, British, green; French, blue; German, white; and Italian, red. These races were extraordinarily popular and were hard-fought battles. In 1909, 1910 and 1911 there was no race, while 1914 put an end to the next series, the last race being notable because the Mercédès firm introduced an efficient system of team control, involving both strategy and tactics.

Post-war Racing.—After the World War Grand Prix racing was resumed in 1921, but it was shorn of much of its former glory, the number of cars entered being greatly reduced, and the last really great race of the series occurred in 1924. Thereafter, the number of competing teams dwindled and practically every year one particular team had such a superiority that the others were in a hopeless position. This led to a resumption of the original type of racing, a 24 hours' race being organized first at Le Mans in 1923, in which the cars had to carry full equipment, namely, lamps, screen, hood and bodies of touring type. This race, which proved a great success, was followed in 1927 by a six hours' race of the same character on the Brooklands track in England. In 1928 the R.A.C. revived the Tourist Trophy Race for fully-equipped sports cars by organizing an event on the Ards circuit, near Belfast; this resulted in a magnificent contest between a great number of different sizes of cars, in which Kaye Don won with a Lea-Francis at 64·06 m.p.h.

Racing Records.—Races to establish records are always run under the same rules. The cars are stripped racing machines built for speed only, and the results are in two categories, the first termed "world's" records, in which the size of engine does not matter, and the second called international class records, in which the cars are grouped according to the size of engine. Records in one class have nothing to do with records in the other.

In America a car with an engine capacity of 91½ cu.in. under American rules has averaged in the same manner 164 m.p.h., and, to give another example of the speed attained by these small cars, which are about the equivalent of the 12 h.p. car of everyday use, the hour in the European class for engines of similar size stands at 115·56 m.p.h. Appended are the results of some of the more important races:—

Date	Drivers	Car	Speed m.p.h.
200-Mile Race			
1921	H. O. D. Segrave	Talbot-Darracq.	88·82
1922	K. Lee Guinness	Talbot-Darracq.	88·06
1923	C. M. Harvey	Alvis	93·29
1924	K. Lee Guinness	Darracq.	102·27
1925	H. O. D. Segrave	Darracq.	78·89
1926	H. O. D. Segrave	Talbot	75·66
1927	M. Campbell	Bugatti	76·62
1928	M. Campbell	Delage	78.34
Italian Grand Prix			
1922	Bordino	Fiat	86·89
1923	Salamano	Fiat	91·0
1924	Ascari	Alfa-Romeo	98·7
1925	Brilli Peri	Alfa-Romeo	94·76
1926	Charavel	Bugatti	85·87
1927	Benoist	Delage	90·04
1928	Chiron	Bugatti	99.35
Indianapolis 500-Mile Race			
1919	H. Wilcox	Peugeot	88·06
1920	G. Chevrolet	Monroe	88·50
1921	T. Milton	Frontenac	89·62
1922	J. Murphy	Murphy Special	94·48
1923	T. Milton	H.C.S.	90·95
1924	J. Boyer	Duesenberg	98·24
1925	P. de Paolo	Duesenberg	101·13
1926	F. Lockhart	Miller	95·885
1927	G. Souders	Duesenberg	97·544
1928	L. Mayer	Miller	99·68

(S. C. H. D.)

THE UNITED STATES

From less than 30 m. to 231·362 m. per hour shows the strides made by the automobile since the advent of competition among

Le Mans 24-Hour Race

	Drivers	Car	Miles	M.p.h.
1923 Distance	Lagache and Leonard	Chenard-Walcker	1,372·5	57·1
1924 Distance	Duff and Clement	Bentley	1,290·75	53·75
1925 Distance	De Courcelles and Rossignol	Lorraine-Dietrich	1,388·1	57·83
1925 Rudge cup	Senechal and Loqueheux	Chenard-Walcker	1,126·7	46·84
1925 Rudge cup	Glaszmann and de Zuniga	Chenard-Walcker	1,169·6	48·72
1926 Distance	Bloch and Rossignol	Lorraine-Dietrich	1,585·99	66·08
1926 Rudge cup	Minoia and Foresti	O.M.	1,446·4	60·26
1927 Distance	Benjafield and Davis	Bentley	1,472·6	61·36
1927 Rudge cup	Casse and Rousseau	Salmson	1,244	51·8
1927 St. Didier cup	De Victor and Hasley	Salmson	1,254·8	52·3
1928 Distance	Barnato and Rubin	Bentley	1,658·6	69·1
1928 Rudge Cup	Casse and Rousseau	Salmson	1,372·2	57·17

drivers of steam or motor-propelled cars. The races of the earlier days were confined to the small horse-powered car, while the 100 m. an hour cars of to-day make up the entries. Ray Keech, driving a Triplex special, built by a Philadelphian, on April 22, 1928, established an average of 207·552 m. an hour over a one-mile measured course at Daytona Beach, Fla., the highest automobile speed record until March 11, 1929, when H. O. D. Segrave broke the world's record by making an average of 231·362 m. an hour on the same course, in a British-built car.

Automobile racing in the United States is governed by the American Automobile Association. There are races not sanctioned by this association; but records in these so-called "outlaw" races are not recognized by the governing body. In the earlier days of automobile races a number of bicycle-racing men branched out as automobile speed drivers. Among them were Barney Oldfield, one of the pioneers at dirt track racing; Earl Kiser, known as the "Dayton Dumpling" in cycle-racing circles; and somewhat later Ralph De Palma, Frank Galvin, Carl Limberg, Joe Downey and others of equal note. Soon after the first automobile races, which were held on beaches and dirt tracks, there came the road classics such as the Vanderbilt Cup race, the Grand Prix race and the Savannah Grand Prix race. All of these are but history, and the Indianapolis Speedway race, started in 1911 and run every year since with the exception of 1917 and 1918, is the one classic left. The first race was won by Ray Harroun, who averaged 74·59 m. an hour. Then in turn came Dawson, 1912, with 78·7 m.; Gioux, 1913, 96·92; Thomas, 1914, 82·47; De Palma, 1915, 89·94; Resta, 1916, 82·26; Wilcox, 1919, 86·96; Chevrolet, 1920, 88½; Milton, 1921, 89·62; Jimmy Murphy, 1922, 94·48; Milton, again in 1923, 90·95; Corum and Boyer, 1924, 98·28; Peter De Paolo, 1925, making the fastest average, 101·13; Frank Lockhart, 1926, 95·8; George Souders, 1927, 97·54 and Lou Meyer, 1928, 99·482.

Records for automobile racing, as compiled by the Contest Board of the American Automobile Association are classified as: speedway records, 91½ cu.in. displacement, and 122 cu.in. and 1 m. dirt track records. The fastest speedway qualifying record for 1½ m. was held by the late Frank Lockhart made at Atlantic City, on May 7, 1927, when he did a lap of 1½ m. in 36.66 sec., an average of 147·729 m. per hour. Lockhart also had the best dirt-track qualifying mark, which he made at Cleveland on Sept. 26, 1927, doing the mile in 38·94 sec., an average of 92·46 m. an hour. The speedway records for standard distances, 5–500 m., are:—

Speedway—91·5 cu.in. Displacement

Miles	Date	Driver	Time	Miles per hour	Track
5	May 7, 1927	Lockhart	2:14·77	133·560	Atlantic City
10	” ” ”	”	4:25·37	135·659	” ”
25	Nov. 11, 1926	”	11:19·73	132·405	Charlotte, N.C.
50	May 7, 1927	Lewis	22:53·25	131·075	Atlantic City
100	” ” ”	Keech	45:31·30	131·802	” ”
150	” ” ”	”	1:08:09·10	132·058	” ”
200	” ” ”	Lewis	1:32:15·97	130·058	” ”
250	March 6, 1927	Duray	2:00:16·60	124·712	Los Angeles
300	May 30, 1927	Gleason	2:54:21·49	103·236	Indianapolis
350	” ” ”	”	3:25:51·86	102·009	”
400	” ” ”	Gulatta	3:57:39·15	100·988	”
500	” ” ”	Meyer	5:01:33·75	99·482	”

Speedway—122 cu.in. Displacement

Miles	Driver	Time	Miles per hour	Track
5	Hill	2:10·50	137·931	Los Angeles
10	Duray	4:24·60	136·054	” ”
25	McDonogh	10:58·90	137·426	Atlantic City
50	”	22:04·59	135·890	” ”
100	Lewis	44:52·40	133·709	Los Angeles
150	Devore	1:07:82·41	133·716	Atlantic City
200	McDonogh	1:30:39·11	132·375	” ”
250	”	1:51:53·03	134·068	” ”
300	Hartz	2:14:14·18	134·091	” ”
350	Lewis	3:27:23·84	101·25	Indianapolis
400	”	3:56:30·19	101·16	”
500	De Paolo	4:56:39·46	101·13	”

One Mile Circular Dirt Tracks.—All standard distance records on dirt tracks are credited to Frank Lockhart, who was killed on the beach at Daytona, Fla., while attempting to establish a new speed mark. His marks, made at the Cleveland, O., track were:

Miles	Time	Miles per hour	Miles	Time	Miles per hour
1	41·95	85·816	10	7:00·71	86·569
2	1:23·53	86·196	25	17:42·42	84·712
3	2:05·43	86·104	50	35:55·72	83·499
4	2:46·55	86·465	75	54:25·72	82·677
5	3:28·12	86·488	100	1:14:14·50	80·817

(W. A. Ba.)

TRACK RACING

The first racing track to be built was that at Brooklands, near London, completed in 1907. Though road racing was already popular on the European continent, there were no facilities for this type of racing in England, and consequently the development of English motor cars was behind that of the Continental cars, which benefited by the tests carried out at comparatively high speeds. Locke-King, therefore, built the track at Brooklands, Surrey, primarily to enable manufacturers to investigate problems in the design of the ordinary touring car by means of intensive high-speed tests.

The ordinary touring car owes its reliability to the experience gained comparatively quickly on a track, where the conditions of fast travelling reproduce approximately the fatigue which results from prolonged use at ordinary speeds. In order to encourage manufacturers to use racing tracks for these tests, records were kept of the various distances covered in the short times by different classes of car. This promoted competition between the manufacturers, and led to the development of track racing as a sport which attracted the general public.

The second track to be built was that at Indianapolis (1911). This, in common with other tracks that have since been constructed in America, is used for racing only. In contrast with Brooklands, where there are several race meetings every year, besides manufacturers' trials, at Indianapolis there is one annual race meeting, which, however, is attended by a vast number of people from all parts of the United States, the competitors being representatives of the various racing centres. The necessity for racing tracks on the Continent was not felt until after the World War, and the first of these, the Linas-Montlhéry track, near Paris, was opened in 1924, and was followed by several others, notably the Monza track, near Milan, and one at San Sebastian in Spain.

There are two main classes of racing, viz., the long distance race, in which high speed and reliability are the chief points to be considered; and the short races, in which the interest is concentrated on a close finish. The former type is more general on the Continent, and in this case road racing is frequently combined with track racing. However, it is interesting to the general public only in the form of international competitions and when comparison is being made between well known types of machine; and on the whole, the short race is the more popular, particularly when handicaps are arranged in order to result in a close finish.

In form, a racing track is usually annular, the bends being banked, steeply at the outside edge and more gradually towards the inner edge of the track. This permits of the curves being negotiated at high speeds without the risk of skidding or overturning. At Brooklands the banking is designed so that a car travelling in the middle can round a bend at 60 m.p.h. without steering; at the top, or outside, of the bends speeds of over 100 m.p.h. are permissible without steering. The Montlhéry and San Sebastian tracks are more steeply banked than that at Brooklands, and hence higher speeds are attained, the highest speed records being established at Montlhéry. The Monza track is not as steeply banked as Brooklands, and in Italy the interest is centred on road racing, as is the case in Germany.

The advantage of road racing is that it shows up acceleration and braking efficiency, as well as pure engine reliability. On this account there are private road sections connected with the Monza

and Montlhèry tracks. At Brooklands, road races have been simulated by the placing on the track of obstructions.

Whereas, at most places, speed, irrespective of the size of the machine, alone has been considered, at Brooklands class racing has always been strongly encouraged. The cars are divided into various classes, originally according to the cylinder bore, but now according to the cylinder capacity. In 1925, the International Association adopted this policy. It is of interest to note that at Brooklands in 1907, when motoring was in its infancy, Edge, in a Napier, covered 70·07 m. in one hour, and 20 years later, Marchant, in a Voisin, covered 128·35 m. in the same time.

MOTOR-SHIP: *see* SHIPBUILDING.

MOTOR TRANSPORT, COMMERCIAL. The following article deals with the economics of commercial motor transport, with special reference to Great Britain. For a complete discussion of this subject, including engineering design and operation in the United States, *see* MOTOR VEHICLES, COMMERCIAL.

Commercial motor vehicles may be divided broadly into two groups, namely, vehicles for the transportation of goods and passenger vehicles. Dealing first with passenger vehicles, irrespective of the carrying capacity of the vehicles, all the vehicles licensed for the purpose of carrying passengers are known as "hackney carriages." The first motor vehicles of this description to ply for hire in England were motor buses and cabs. Neither class developed very rapidly. The chassis of the early days was not sufficiently strong to stand up to the exacting conditions of regular passenger services and the expenses of running and maintenance were greater than the revenue which was derived by way of fares. Up till about the year 1910 the balance sheets of the various companies showed anything but promising results. Only those with large financial resources were able to survive the transition stages. Until the beginning of the century there had been no experience in this form of traffic to guide either management or design. Until 1914, though the number of hackney carriages was increasing steadily, they were both crude and uncomfortable.

The public service passenger vehicle became an essential in the life of Great Britain about the year 1920. Until then, War Department vehicles were being sold at exceedingly low prices and thousands were converted into passenger vehicles—a purpose for which they were entirely unsuited. Thus it was that though the motor hackney was rapidly replacing the horse drawn hackney, the radius it served round its centre of operation was not greatly in excess of the practical horse radius.

About this time (1920) there were introduced from the United States, light, fast pneumatic-tyred passenger vehicles designed to carry from 14 to 20 passengers with a degree of comfort superior to anything previously experienced and with this example before them British manufacturers almost immediately changed their policy, beginning to manufacture special passenger chassis instead of chassis to serve for the transport of either passengers or goods. With the introduction of such chassis, longer services became practical propositions, until, in 1928, there are very few villages, having reasonable road access, not served with regular passenger services, varying, of course, in degrees of quality and frequency. Thus the number of hackneys alone increased from 31,899 in 1911 to 95,752 in 1927.

On Jan. 1, 1927, the tax on passenger vehicles was considerably increased, which had the effect of checking the growth, but, on the other hand, the improvement of both vehicles and roads had the effect of increasing the earning power of such vehicles, a result furthered by the steady increase in the number of villages and districts remote from railway services which acquired a residential character, the residents being able to rely upon the organized public passenger services to take them either to and from the nearest railway station or direct to their places of business. Long distance motor services have also become established, as for instance between London and Bristol and Exeter; London and Liverpool; London and Newcastle-on-Tyne; or in other cases connecting the more important provincial centres. The vehicles used on these long distance services carry from 20 to 25 passengers in the utmost comfort upon pneumatic tyres and can average speeds of from 20 to 30 miles per hour.

Motor Transport of Goods.—The development of motor traffic for the transportation of goods has been somewhat different from that of passenger transportation, in that the heavier loads were the earlier to show an economic advantage. In this respect the steam wagon led the van. On selected routes and, given the requisite amount of freight, one steam wagon of five tons carrying capacity, could, and did, replace as many as twenty horses. On the other hand, for local delivery work, involving a considerable number of calls, the motor, for many years, showed no advantage in the matter of cost, as compared with horse transportation.

But, notwithstanding the somewhat heavier cost of motor vehicles for goods transport, it was soon appreciated that it had an advertisement value to the tradesman and that larger areas could be served than would otherwise have been possible without the aid of branch depots. The brewing and milling trades were the first to adopt the new transport, as they had continuity of employment and distribution over wide areas, which at the same time did not involve a large number of deliveries. In the initial stages the heavy motors replaced horse transport only; but generally, as their construction and working became better understood, they encroached on what the railways had hitherto regarded as their unassailable monopoly.

Until the year 1907, commercial motor transport was almost entirely effected by the agency of the steam wagon. The internal-combustion-engined vehicle had made some progress for passenger carrying, but, for the transport of heavy loads, it was at first somewhat unreliable as well as expensive in the matter of maintenance. The turn of the tide may be said to have dated from the Royal Automobile Club trials, held in 1907. In these trials close on one hundred vehicles took part. The trials were by no means severe and a fair percentage of vehicles got through satisfactorily. In consequence a moderate demand resulted for goods carrying vehicles of the heavy type. Apart from steam wagons, those vehicles which acquitted themselves creditably, were of from 20 cwt. to 25 cwt. capacity. Lighter vehicles did not do so well and so, for some few years, they were not regarded favourably by the retail tradesman, for whose service they were primarily intended. But the seed was sown and in due course the number of converts to the newer kind of transport steadily increased. The tradesman, whether wholesale, retail or manufacturing, found that from the advertising point of view alone the more enterprising policy was a sound one. As he, as well as the vehicle manufacturers, came to understand the requirements of the new kind of transport better, the radius of action increased and so though the actual costs of motor transport were undoubtedly heavy, comparatively considered, yet the increase in business resulting more than justified the extra cost.

Motor transport, however, is not an easy business to make successful in itself. The rates chargeable for carriage have been determined, on the one hand, by the rates charged by rail and on the other hand, by what would be the cost to a firm owning its own motors. At the same time the carrying contractor's chances of custom are limited, as they depend upon the patronage of firms either not having sufficient work to justify the purchase of their own vehicles or who hire only in cases of emergency. Organized parcels delivery and specialized transport come under a different category, but even their success depends upon the most skilful organization and management.

Hence commercial motor transport is largely in the hands of firms transporting their own goods, and in these cases there is certainly no question as to its economic advantages. It is indeed hardly going too far to say that in the case of many such firms their success is due mainly to the motor vehicle. This applies, more particularly, to the food catering industry, to the furnishing trades, and in relation to market garden produce having to be conveyed from centres near large towns. Whether the railways if they undertake road goods transport on a large scale will be more successful than individual firms remains to be seen.

Economic Radius.—Experience seems to show that, for goods transport by motor, economic efficiency begins at a radius of

about 1½ miles from the central depot. Within this radius horse delivery or electrical vehicles are the cheaper. The maximum economic radius of action on the other hand is not nearly so easily defined depending as it does on tonnage and rates obtainable. Long distance journeys are becoming more usual, but the majority of journeys are those permitting the vehicle to return to its depot each evening. This, provided there are no intermediate deliveries to be made, permits a daily run of about 150 miles. The number of commercial motor vehicles in Great Britain increased from 25,000 in 1911 to 283,000 in 1927, these figures being exclusive of road locomotives and tractors, the total number of which was, in 1927, 4,759.

Running Costs of Motor Vehicles.—The tables below give the approximate running costs of motor vehicles. The following is a brief explanation:—

(1) *Standing Charges.*—The items included under this heading are those which are incurred whether the vehicles are in use or not. Drivers' wages are included. Depreciation is estimated at 20% per annum.

(2) *Running Costs.*—These are the costs incurred whilst the vehicle is actually in motion. A vehicle on local delivery work costs more to run than one engaged on a clear out-and-home run.

(3) *Cost per Journey.*—All owners should know how many days per annum they may expect their vehicles to work; so, by dividing the annual standing charges by the estimated number of working days per annum, the daily standing charges are easily ascertained. Next, by multiplying the running costs per mile by the number of miles representing the journey and adding the resultant to the daily standing charge the cost per journey is readily arrived at.

STEAM VEHICLES

Capacity of vehicle	*3 tons	10–12 tons, 6 wheelers
	£	£ s.
Cost of vehicle	680	950
Interest on capital	35	47 10
Depreciation at 20%	136	190
Insurance	24	24
Rent (nominal)	25	25
Wages (driver and mate)	345	356
Tax	48	66
Total standing charges in £'s	613	708
	d.	d.
Tyres	1.44	2.16
Fuel	1.35	2.70
Oil and grease	.50	.80
Repairs	2.00	3.50
Running costs per mile in pence	5.29	9.16

*The tendency (1929) is to make steam wagons of 6–7 tons or of 10–12 tons capacity.

ELECTRIC VEHICLES

Capacity of vehicle	2 tons	5 tons
	£ s.	£ s.
Chassis price	350	500
Battery price	182	260
Interest on capital at 5%	26 10	38
Chassis depreciation (10 yr.)	35	50
Insurance	12 10	12 10
Rent	30	30
Driver	160	180
Repairs and cleaning	48 10	58 10
Tax	13	27
Total standing charges	325 10	396 0
	d.	d.
Battery depreciation at 20,000 miles life	2.13	3.12
Tyres at 14,000 miles life	.7	1.16
Energy at 2d. per unit per mile	2.0	3.75
Oil, etc.	.1	.1
Running costs per mile in pence	4.93	8.57

PETROL VEHICLES

	Pneumatic tyres				Solid tyres	
Capacity of vehicle	10 cwt	25 cwt.	2 tons	4 tons	5 tons	10–12 tons, 6 wheelers
	£	£ s.	£	£	£	£ s.
Chassis prices	200	350	500	800	900	1,250
Interest on capital at 5%	10	17 10	25	40	45	62 10
Depreciation at 20%	40	70	100	160	180	250
Insurance	22	22	24	24	24	26 10
Rent (nominal)	25	30	30	30	30	35
Driver	145	171	171	187	187	203
*Tax	10	26	26	54	54	66
Standing charges per annum in £'s	252	336 10	376	495	520	643
	d.	d.	d.	d.	d.	d.
Tyres	.65	.75	1.00	1.50	1.25	1.65
Petrol	.50	.85	1.00	1.65	1.75	3.00
Oil, grease, waste, etc.	.07	.10	.20	.30	.40	.50
Repairs	1.00	1.25	2.00	2.50	2.50	3.25
Running costs per mile in pence	2.22	2.95	4.20	5.95	5.90	8.40

*Hackney carriages are taxed on seating capacity; the figures above refer to goods carrying vehicles only. (M. OF B.)

MOTOR TRANSPORT, MILITARY. Transport by motor vehicles has profoundly modified the art of war. The use of it enables a commander, despite the unwieldiness of modern armies, to achieve surprise effects which give him victory. In the following account, illustrated by practical examples taken from the use of motor vehicles during the operations of the Allied Armies on the French front, there will be discussed the general principles underlying (1) transport of troops, (2) transport of *matériel* and (3) intensive traffic on roads.

I. TRANSPORT OF TROOPS

The Vehicle.—Troops have sometimes been carried in ordinary touring cars. During the battle of the Marne (Sept. 9, 1914), at the moment when the French Army of Gen. Maunoury was massing outside Paris, there were grouped together all available taxicabs to take direct to the front half the infantry of a division which, arriving by rail from the Vosges, was detraining in the stations of the northern suburbs of Paris. This method can only be employed in exceptional cases, because the car or taxicab has so small a carrying power, requiring one driver for every three or four combatants carried, while such vehicles for the most part differ in speed. On the other hand, such motor vehicles as are designed to convey a larger number of passengers in peacetime, *e.g.*, motor-omnibuses or *chars-à-bancs*, are eminently serviceable. Another vehicle is the common motor-lorry (or truck, as Americans call it). It is necessary to adapt it, *i.e.*, to place in it movable benches, which can be very rapidly installed when it is necessary to carry men, and can be removed without difficulty when it is necessary to carry *matériel*. A lorry, according to its capacity, can carry from 16 to 25 men with their arms and equipment. During the World War not only were units of infantry transported but also artillery formations; likewise, in some exceptional cases, cavalry with their horses. When horses are to be carried the body of the lorry must be as large and the bottom as low as possible, to make the loading more easy, and the ceiling must be high enough to prevent the horses being injured by striking their heads. The horses may be placed either lengthwise or crosswise. But they should be close to one another, to save them from bumping; and there should be no difficulty of access to their heads, in order that they may eat and drink on the road. These precautions taken, it has been found that horses travel as well by motor-lorry as in a railway wagon.

Organization of Lorries.—Lorries move grouped in formations of varying importance, but two essential conditions must be observed: efficient control and effective maintenance. The basic

unit, the smallest formation to be placed under the orders of an officer, may consist of 15 to 30 vehicles. The officer who commands this unit is the veritable sheep-dog of his troop of lorries; he must himself have a touring car so as to enable him to follow his lorries when they are on the move, and above all when they are formed into a large column. The officer himself should not drive, but be able to keep his attention free and to jump quickly from his car and speak to his drivers. Next above the basic unit, the "section," is placed the "company" or the "group," normally comprising three or four sections. The commander of the group or company is no longer the sheep-dog of his lorries; he is the shepherd. It is he who guides them in their itineraries, places them in billets and allots them to their work. The second point in an organization is to ensure effective maintenance. Automobiles require constant care on a long journey, *e.g.,* 200 kilometres. Some will have breakdowns, some even fall out; and if the workshop is to move with the group, it must be on lorries, and have a stock of tools and spare parts.

As soon as large transport movements have to be carried out, higher control above the group must be organized. To move the infantry of a division in war required 12 groups. Placed in a column on the road, this would make a file 36kilo. in length, a reasonable distance for each group being 3 kilometres. This mass would be formless and incapable of manoeuvring unless vivified by organization. It is a common saying that the action of a commander ought to be limited to directing four immediate subordinates and no more. Experience of large demands on transport during the War shows, however, that six groups could be united under one control, if the commander in charge was supported by a fully qualified staff. Such was the composition of the grouping in the French Army; such or something very near it was the composition of the "Bus Park" of the British Army. The grouping of six groups had a capacity for 6,000 infantry; the automobile service of the French Army comprised 25 groupings in 1918.

Organization of Troop Transports.—Let it be supposed that a grouping is ordered to carry out the transport of 6,000 infantry, to take them up in their billeting area, and to bring them to the field of battle some 100kilo. from billets. To accomplish this mission efficiently the staff must first fix the embarkation-points, *i.e.,* the points at which the infantry will be loaded into lorries. In order that this operation may be carried out quickly loading must take place at a number of points simultaneously; to embark one battalion (1,000 men) into a group (80 lorries) requires from 20 to 30 minutes. When the commander of an automobile grouping has prepared the organization of his embarkation-points, he must come to an agreement with the infantry headquarters concerned as to the time and place of embarkation of each battalion. The work which devolves upon the command of the lorry grouping in the disembarkation of the troops is generally similar to the above; but there is an additional difficulty, caused by uncertainty as to the exact points of disembarkation, which often depend on the military situation at the moment. Nevertheless, the procedure must be arranged as early as possible, in close touch with the higher staff which has to fix the disembarkation zone; and an understanding must be arrived at with headquarters as to the probable alternatives, between which a decision will be made later, when the lorries are quite near to the arrival zone. The itinerary between the two zones must be reconnoitred and marked out. The "route officer," with his own staff, marks the itinerary by posting up placards (and, for night work, hanging lanterns) bearing the distinguishing mark of the grouping and an arrow indicating the direction of the march and the route to take. Further, the commander of a grouping must organize the movement of his service lorries, supply lorries, workshop lorries, etc.

Transport of Complete Divisions.—An interesting example occurs when, together with the infantry of a division, it is necessary to transport all or part of their artillery with its horses. With horse-drawn artillery it may be a very serious matter for a general not to be able to bring up to the battlefield, in support of his infantry, the artillery who are accustomed to manoeuvre with him. It is thus very desirable to be able to transport artillery with horses. The loading of guns and limbers on lorries does not present any special difficulty; it is sufficient to have fixed rules for putting the *matériel* in place, and these are similar to the loading-rules for the same *matériel* on railway wagons.

II. TRANSPORT OF MATÉRIEL

Lorries are not specialized for the transport of *matériel.* The same type is employed as for troops, and therefore the organization is similar. A lorry-group capable of moving a battalion of infantry can alternatively move 100 tons of *matériel.* Experience in the World War has shown that, during the periods of active operations, a division requires an average of 200 tons per day in foodstuffs and ammunition. This is equally true in the case of defensive areas, as at Verdun; in offensive actions of the type of the Somme battles in 1916; or those of July, August and September 1918, on the Marne. Two groups are therefore required for the supply of a division, subject to the distance from the railway being, at farthest, within a radius of 40 kilometres. Four groups are necessary if the division is 70kilo. from a railway. An average of 3 hours must be reckoned for loading at the stations; with allowance for difficulties arising amid intensive operations, 7 or 8 hours are taken up on the journey and 2 hours in unloading. This gives about 13 hours for work, and leaves 11 hours per day for the maintenance of *matériel,* feeding and rest. If the traffic operations are to be continued for a number of days, more than this cannot be demanded of the personnel or of the *matériel* without risking excessive wastage. On the day after a journey with loads the vehicles return empty, and on the day after that they recommence the journey loaded. As 200 tons a day are required for a division there must be a double set of two groups, with a total capacity of 400 tons.

Non-Specialization of Matériel.—At a general mobilization like that at the opening of the World War, the resources available for transport are necessarily limited not only by financial conditions, but by the number of vehicles in existence in the country capable of being requisitioned, and by the maximum production of the manufacturing firms. On the other hand, there is no limit to the requirements in lorries, because no general thinks he has a large enough stock of transport at those critical times when every addition means an increase in his power of manoeuvre. During the 20 days which intervened between May 27 and June 15, 1918, the lorries of the French Army had to transport about 800,000 tons of foodstuffs and munitions, in order to ensure the supplies of those armies which were making headway against the German attack. And yet, during this same period, the French Headquarters Staff had transported by automobile the infantry of 63 divisions. It was necessary also to make numerous evacuations of public records, civil populations, hospitals and engineer parks. This wonderful effort was only possible because in the French Army the principle of non-specialization was adopted. Every lorry was controlled by the motor transport service of the armies, and was utilized by it for any form of transport needed. No vehicle was specially or permanently attached to this or that higher or lower formation. When a higher formation, such as a division, had need of transport, the automobile service arranged the transport, but as soon as it was finished the lorries employed on this service returned and were available for other transport services. In short, the lorry capital never remained unproductive.

The Use and Duties of Depots.—The reasons for avoiding the wastage of lorries apply likewise to avoid wastage of movement. The carrying-out of "detail" transport is the principal cause of low efficiency. In the battle of Verdun, March 1916, the supply of munitions was taken by rail to Bar-le-Duc and to Baudonvilliers. Trains of munitions arrived daily at these two stations to supply the artillery of the 10 divisions deployed around Verdun, some 60kilo. from the stations. If, to supply each of these divisions, there had been allotted a motor formation, which could come to load up at the stations and go as far as the batteries, bringing munitions, the efficiency would have been mediocre and uncertain. An accident at a depot, an interrupted road, an advance or a check at the front, would set back the whole time-table of the formation, and one would have seen them arriving in the station

for loading their lorries in twos and threes in disorder, and at different hours. There can never be efficiency unless there is regularity of movement. It is never possible to have regularity unless the traffic of the back areas, which can be regular, is definitely separated from the traffic of the front areas, which is always uncertain. This separation can be effected by the creation of depôts depending on the lines-of-communication authorities, and supplied by them where the formations from the front areas come to refill exactly as they would refill from the railway if there were stations at these fronts.

III. INTENSIVE TRAFFIC ON THE ROADS

The Route Gardée.—For the organized employment of automobiles on the roads, like that of railway trains, the essential condition is to be master of the road. If all and sundry are permitted to put columns of troops or vehicles on a road, it is useless to attempt to carry out important movements. It is an absolute rule, based on experience, that it is not possible to launch a big transport movement involving several hundreds of lorries without being absolutely certain of the complete freedom of the road during the whole time that the movement will last. Hence the organization of the *routes gardées,* with their personnel of guards and their traffic orders.

A *route gardée* is not necessarily reserved exclusively for automobiles. But in every case there must be a responsible authority, having power to give orders and have them carried out. In the French Army, during the War, this authority was a motor regulating staff (C.R.A.). In the British Army, the control of traffic in France was part of the duties of the Provost Marshal's staff (P.M.). The organization of the route, on a railway model, is based on the block system. The route is divided into a series of districts, each of which is under the direction of a district chief, having assistants for supervision. The district chief is in constant touch by telephone with the neighbouring districts, and with the office of the C.R.A.; he knows all the movements which affect his district, and also keeps a record of all movements which occur there and all the incidents of the traffic. Thus at the office of the C.R.A. it is always known what the state of the traffic is on every *route gardée,* and the necessary arrangements for launching an important movement can be made in a short time.

The length and the importance of the districts on a *route gardée* depend, obviously, on special difficulties to be overcome, *e.g.,* the number of adjacent routes, localities traversed, narrow passages, etc. Between Bar-le-Duc and Verdun there were six "districts" varying in length from 5 to 10 kilometres. It is quite unnecessary to control in this permanent fashion a route over which there is not continuous traffic. Whenever such a road is needed, for the time being, for an intensive transport operation, it is sufficient to occupy it immediately and transform it into a *route gardée*. This requirement leads to the C.R.A. (or any corresponding organization) being given a territorial zone of operation. In each zone it is the immediate business of the C.R.A. concerned to guard any portion of the road over which the transport will be moving. For this purpose the C.R.A. had at its disposal specially organized personnel, which may be fairly accurately designated "mobile districts," and which, being in the habit of operating in this way and supplied with the means of rapid installation, can, in two or three hours, make themselves masters of the traffic on whatever part of the road is entrusted to them.

Maximum Efficiency Over a Road System.—When one is master of "circulation" throughout a given region, one is free to aim at maximum efficiency. Formerly, when the staff proposed to carry masses of troops to a theatre of operations it traced the greatest number of parallel and serviceable roads which led to the zone of action decided on, and there was thrown on each of these roads a column of all arms scientifically echeloned in depth. Thus it was that Napoleon moved from the Rhine to the Main in 1805; thus, also, Moltke moved from the Sarre to the Moselle in 1870. When this system is applied to present-day conditions the efficiency of the road system is low, because the increase of speed due to the automobile is not turned to account. All modern armies have motor tractor-drawn heavy and light artillery and possess the means of transporting the bulk of their infantry by motor-lorry. In consequence, in co-ordination with the movements made by railway, the movements by road ought to be organized in the form of special itineraries, on each of which move columns of elements that are homogeneous from the point of view of speed. Thus combination of movements can be worked out in which much time is saved, as compared with the old methods.

The existence of regulating commissions in charge of zones of movement, and masters of the traffic, considerably eased the French problem. But the regulating commissions must have control not only of automobile traffic, but of all traffic; in their zones no movements must occur without their having received notice and taken the necessary measures to facilitate the execution of the movements in question. They must be able to arrest all false movements in good time. And they must be in close touch, so as to form a complete network, covering the whole area over which it may be necessary to move any column. It was by the functioning of an organization of this nature that the French Army was able to make its concentrations of considerable numbers of troops at very short notice in March, May and July 1918.

Strategic Transport by Road.—As the automobile has brought on the road again the tourist who had deserted it since the middle of the 19th century, so transport by motor lorry has brought into use again strategic movements by road. And, for the production of surprise effect, by adding the roads to the railways, it has been possible to put to full use all available means of communication. The air alone has not been utilized; but in the future it may be employed for the quick transport of combatants.

Combined Use of Railway and Motors.—In the majority of cases, use is made of railways and roads in combination. The end to be attained is always a rapid move of powerful forces; the staff should therefore make use simultaneously, and as efficiently as possible, of every means of transport which it possesses. One must never lose sight of the fact that the efficiency of the railway is much superior to that of the road; a train of 50 wagons is equivalent to 150 lorries. At a speed of 30kilo. an hour, and with four departures an hour, one has four trains in a length of 30kilo., or the equivalent of 600 lorries. We have seen that 600 lorries form on the road a length of 20 to 25 kilometres. Railway and road have, therefore, very nearly the same output. But the lorries, going 15kilo. an hour are only half as quick. Further, at the end of 100kilo. it is necessary for the lorries to stop in order to rest the drivers, for, save in exceptional cases, relief crews are out of the question. The weak point in transport by rail really lies in the necessity of having stations for embarking and for disembarking. Save in quite exceptional cases it is an absolute technical necessity to load and unload in stations, and, even so, only in those where there are sidings sufficient to take the military trains so as to leave free the main line during the times of embarking and disembarking. Without this precaution all the traffic will be blocked. Further, when it is a question of loading *matériel* it is necessary to place it on the platforms. While special platforms or docks are indispensable on the railway, it is always easy, on the road, to find or organize quickly loading-places for lorries.

Big movements by railway can be made only from a zone A to a zone B, if the two zones A and B are equally rich in loading-places. But—apart from those points which come into the initial concentration scheme, and on which, therefore, work can be done in peace—it is impossible to ensure, in the large movements which military operations may necessitate at any given moment, that the beginning and the end of rail transport shall take place in zones that are rich in loading-places. On the other hand, it is generally possible to find, within a radius of 50 to 100kilo. in the zones A and B under consideration, one or more regions rich in loading-places. The normal combination consists, therefore, in utilizing motor transport to prolong railway transport, and to carry the troops or *matériel* (1) from their stationary zone to the places of embarkation, and (2) from their places of disembarkation to the zone of operations. The relatively short movements (50 to 100 kilo.) it requires are those in which the efficiency of the lorry is at its greatest. And between the two zones of loading thus actually used, the efficiency of the railway will equally be a maximum.

Naturally, other combinations are also practicable; for example, that by which, on Nov. 20–21, 1917, three French divisions were to be carried from Meaux and Château-Thierry to Péronne; the infantry, with their machine-guns and cooking-carts, being conveyed in motor lorries, and the artillery by train. The object of these movements, very quickly ordered on Nov. 19, was to reinforce the successful British attack in front of Cambrai with the first use of tanks in mass. While the embarkation of the artillery was proceeding at railway stations in proximity to the divisional billets on the Marne, the C.R.A. of Meaux and Château-Thierry loaded up on 3,000 lorries the infantry, etc., of the three divisions.

There are many details which complicate considerably the task of the transport officials; such as the question of food supply for the troops during their transportation and at their disembarkation, and the question of moving troops simultaneously with the building-up of the munitions dumps which they will require. One last remark should be made: transportation by automobile and by railway, which, we have seen, supplement one another happily in regard to distance, is equally satisfactory in regard to time. Large movements by railway require concentration of *matériel*, often difficult to achieve; and, in the case of moves decided on in a hurry, the possibility of motor transport on a large scale assumes very great importance, since it takes four or five days for the railway to show its full powers.

Conclusion.—The experience of the War shows the rôle which transport by motors is called upon to sustain becoming more and more important. The Allied Armies, together, placed on the French front about 20,000 motor vehicles in October 1914; four years later the number exceeded 200,000. At the time of the Armistice the inter-Allied transport reserve, the creation of which had just been decided on, was of a size to transport simultaneously 10 divisions of infantry complete, with all their means of fighting, machine-guns and artillery included. This was a fighting mass of more than 100,000 men, which the Higher Command was able to pick up at short notice and carry at the speed of 100kilo. a day to any point where it was required. As regards the transport of *matériel* at the end of the War, it had become possible—independently of resources just mentioned—to keep supplied with food and munitions 40 divisions at a distance of 100kilo. from the railways.

BIBLIOGRAPHY.—A. M. Bartson, *The Motor-bus in War* (1916); R. Bürner, *Der Kraftwagen im Felde* (1917); I. F. Marcosson, *The Business of War* (1918); H. Carré, *Taxis de la Marne, Sept. 1914* (1921). *See* also WORLD WAR: *Bibliography*. (J. E. A. D.)

CROSS-COUNTRY TRANSPORT

Until comparatively recently the evolution of the cross-country mechanical vehicle has depended in the main on the initiative of the military authorities, though some agricultural tractors were developed before the World War, notably in the United States. American tractors were in fact adopted in the war as the standard tractor for heavy artillery in the British Army. At present, in many parts of the world where roads are poor or non-existent, and colonization and development are proceeding, there is an increasing realization of the value of cross-country mechanical transport vehicles. This is leading to an increasing demand for them, and will ultimately simplify the military problem, in that types of vehicles better suited to military employment will come into greater commercial production. Certain features of recent technical developments leading to increased cross-country ability, on the part of load-carrying vehicles, are not inconsistent with improved performance on good roads.

"Wheel" and "Track" Vehicles.—The earliest serious attempts to use self-propelled vehicles in war occurred during the South African War. In order to overcome natural obstacles of the ground, rough surfaces and boulders on the one hand, and softness of surface or sub-soil on the other, very large wheels were employed, as great as seven feet in diameter and two feet in tyre width, each wheel weighing as much as two tons. Some early lorries were also equipped with armour and armament. It was found that owing to their great weight, none of these machines were of much use except on hard smooth surfaces, and on the most moderate gradients.

After that war efforts were directed both in England and in the United States to obtain the beneficial effect of the very large wheel without its disadvantages. These efforts led to the development of what is now known as the "track," or "track-laying" machine. The idea that a vehicle should run on wheels on an endless road or track which it laid for itself was not new, the first invention of the kind, as far as can be ascertained, being that of R. L. Edgeworth in 1770. There were many ingenious inventions in the first half of the 19th century—the most practical results being achieved by James Boydell. His patent of 1846 and the tractor he produced are described with many others in *The Economy of Steam on Common Roads*, by C. F. T. Young, C.E. (1860).

Between 1903 and 1914 many important developments took place of which an interesting account may be found in two papers by L. A. Legros, originally published in *Engineering*. Some notable landmarks were, in the United States the Lombard track (1904), the Holt track known as the "Caterpillar" (1905), the Strait climbing chain-track (1912), in Great Britain the Diplock and "Pedrail," and the Roberts track (1904–08). Appreciation of the track-laying principle led to a considerable commercial adoption in the United States, where the need for powerful haulage in connection with lumbering, etc., was keenly felt. Internal-combustion engines were used on almost all of the vehicles incorporating these tracks. In England efforts were practically confined to developing machines suitable for military use, although both Roberts and Diplock proposed schemes for transporting heavy loads across country. (*See* Pl. I., 1, 2.)

Early in the World War track-laying machines driven by internal-combustion engines were adopted, firstly as tractors for the haulage of heavy guns, and secondly as a means of transporting into battle both men and their weapons under cover of armour protection. The latter type of machine, the tank (*q.v.*), was perhaps the most startling production of the war, and had a profound effect both on the issue of the campaign, and on the subsequent evolution of machines for cross-country travel.

Physical Factors Affecting Cross-country Travel.—A brief review of factors and conditions to be considered in connection with the design and performance of both wheeled and track vehicles intended for cross-country work follows:

Condition of ground. The three main factors affecting the degree of ease with which a load may be moved over the ground are: (*a*) the contour; (*b*) the hardness or softness; and (*c*) the nature of the material composing the ground—*i.e.*, whether it is slippery or not on the surface, and whether it is strongly bound together within, or will disintegrate or slide within itself when a force is applied to it acting in a plane parallel to the surface.

The tractive effort of a self-propelled vehicle is the force it exerts, through the medium of its driving wheels or track, against the ground, and by virtue of which it is able to progress.

Adhesion. Two things are necessary in order that the tractive effort exerted by wheel or track may make the vehicle progress:—(*a*) there must be sufficient grip between the wheel or track and the ground to prevent slip between them; (*b*) the ground itself must be firm enough to resist the tractive effort exerted upon it without sliding or disintegrating within itself. The greater the area of ground upon which a given tractive effort is exerted the less the tendency of the ground to fail.

Rolling Resistance. The rolling resistance of a vehicle is measured by the tractive effort required to keep it moving at constant speed on the level. It is thus a measure of resistance to movement due to the nature and inequalities of the ground and to the internal mechanical friction of the transmission gear, wheel bearings, track mechanism, etc. As far as the effect of the ground on rolling resistance is concerned it will be well to consider the behaviour of a wheel under different ground conditions. The amount by which a wheel sinks into the ground has a profound effect on rolling resistance. With a hard wheel rolling on a smooth and hard surface, the resistance is very small. But if the ground be soft, and the wheel sinks into it, the resistance may reach very high figures such as 600lb. for every ton of wheel weight. When a wheel sinks into soft ground it has, in order to advance, either

to push the ground away in front of it, or else to climb the slope it has made in front of itself by the act of sinking. A practical maximum of ground resistance is reached for any particular vehicle when either the greatest tractive effort of which the vehicle is capable or the adhesion between driving wheel and ground is insufficient to overcome the rolling resistance, and progression ceases. If there is a gradient as well, then a less degree of rolling resistance will suffice to arrest progress.

Thus the primary endeavour in designing a vehicle for cross-country work where soft and weak or friable ground may have to be traversed, is to secure a large area of contact between driving wheels or tracks and the ground. This has the effect of (*a*) reducing pressure between wheel and ground and thereby reducing sinkage and resistance to progression; (*b*) enabling weak ground to sustain a greater tractive effort, because the effort is spread over more ground. It is clear, therefore, that, if a vehicle has driving wheels which are large enough in diameter and wide enough for a given gross weight, then it can negotiate almost any obstacle. Unfortunately, considerations of weight, structure, visibility, etc., limit the size of wheel which is practicable. Cross-country vehicles are tending, therefore, to develop along two main lines:—(*a*) The incorporation of an increased number of driving wheels, of moderate diameter, together with the equipment of all wheels, whether idle or driving, with wide tyres having a flexible periphery, as in the case of soft pneumatic tyres. (*b*) The incorporation of endless tracks which provide a large area of ground contact and a firm road on which the wheels carrying the vehicle can run.

The Development of Wheeled Vehicles for Load-carrying.—A vast number of lorries (trucks) was used by the various belligerents in the World War. In the main, these lorries were heavy and of one type, having four wheels, of which the two rearmost were the drivers, the wheels being shod with tyres of solid india-rubber and in some cases even with steel tyres. The vehicles were themselves heavy and carried a useful load of from three to five tons. Thus they exerted a high pressure on the ground—as great as 180 lb.sq.inch. As a result, these lorries were found to be quite unsuitable for use on any surfaces but fair hard roads. They were allocated, in the main, to the more rearward transport services, but were enabled, owing to the multiplicity of the roads already existing in Western Europe, and the most strenuous efforts and lavish expenditure of man power on road maintenance and construction, to execute intensive services well forward in the battle zones, such as the entire transport of ammunition and supplies to the heavy artillery.

Certain lorries, all four wheels of which were driving wheels, had been produced before the war. Although these machines also had narrow and hard tyres it was clear that the distribution of the drive vastly increased the power of traction and the ability to travel across country. Such four-wheeled drive machines were used extensively for pulling guns. In Italy, Salonika, Africa and the Near East it was found that lighter vehicles, carrying light loads, and shod with pneumatic tyres could maintain services on poor mountain roads, and on roadless country and desert, where the heavier solid-tyred vehicles were quite unable to operate. Vehicles of this type were the Ford (7 cwt.), Fiat (1 ton), and Crossley (15 cwt).

The British War Office took very definite steps to profit by this lesson. In 1923 a specification was produced for a light lorry to carry a useful load of 1½ tons, having a high power/weight ratio; it was shod with large size pneumatic tyres on its four wheels, the two rearmost of which were driving wheels. A cash subsidy was offered to owners of approved vehicles, and a substantial reserve was built up in a few years. These army-type lorries exercised a considerable influence on subsequent commercial developments—particularly with regard to the adoption of the pneumatic tyre for load-carrying lorries. The improved cross-country performance of this type of lorry led to a decision to mechanize the supply, transport and baggage services of the division. There remained the problem of the mechanization of first line transport.

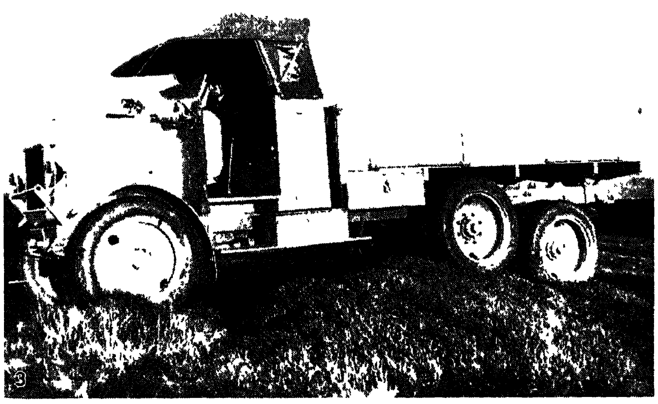
Efforts were next directed to the development of a type of vehicle having the following main features:—(1) Lower intensity of pressure on the ground; (2) Increased useful load capacity; (3) High speed; (4) Higher ratio of tractive effort to gross weight; (5) Great powers of adhesion to make use of the tractive effort available; (6) Increased flexibility in construction, giving ability to traverse rough ground without setting up undue stresses in the chassis; (7) Reasonable first cost; (8) Economy in running and maintenance; (9) Attractiveness to the commercial user at home, as well as in the dominions and colonies; (10) Ease of handling; (11) Ability to cross country without making the ground traversed more difficult for following vehicles. It was clear that the solution lay in providing more driving wheels per vehicle. Experiments with vehicles having three axles and four driving wheels had been made in the United States and in France, culminating in the successful trans-Saharan journeys of the light Renault six-wheelers in 1923–24. In the light of prolonged tests it became clear that such six-wheeled vehicles, in addition to ability to travel across country, were also admirable road vehicles, being fast, safe, smooth running, and economical, and as reliable as four-wheelers. Until quite recently it has, not without reason, become the custom to expect that any advance in the power of vehicles to move across country could only be obtained at the cost of a proportional decrease in efficiency for use on good roads. The importance of the unique quality of the modern multi-wheeled vehicle which causes it to be effective and economical in operation on both good and bad "going" is self-evident. Subsequent steps taken by the British War Office have resulted in the six-wheeled vehicle being produced by seven or eight of the leading manufacturers of British commercial vehicles, and in its adoption on a considerable scale, in Government and commercial service both at home and in the dominions and colonies where the characteristics of this type of machine are proving of particular value. Six-wheeled vehicles of the same general type are also in standard production in the United States, France, Germany, Belgium and Czechoslovakia.

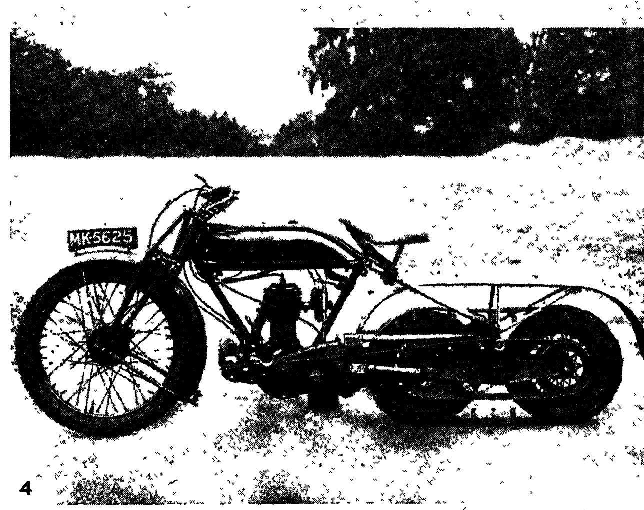
There are several methods of suspension of the four driving wheels under the load. The aim is to ensure that, within certain limits, the driving wheels are free to exert their tractive effort uniformly, and to follow the rise and fall of the ground contour without disturbing unduly the distribution of weight over the wheels, and whilst causing a minimum of movement and distortion of the main frame of the vehicle.

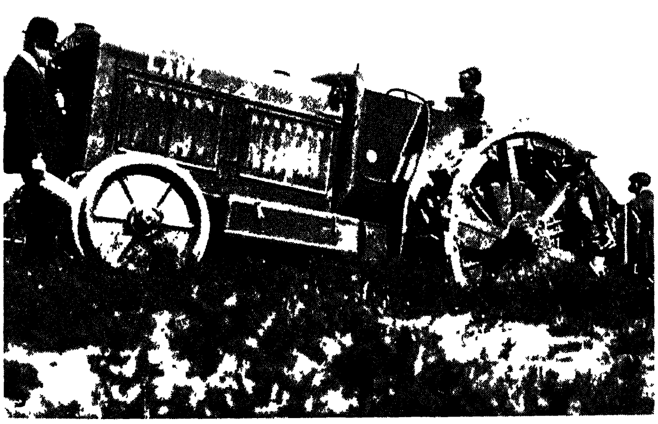
Twin pneumatic tyres having special treads designed to secure the maximum adhesion on muddy ground, may be used in conjunction with an easily detachable "overall non-skid chain" in order to give greater supporting area and adhesion on soft, weak and slippery ground. (*See* Plate I., 3, 6.)

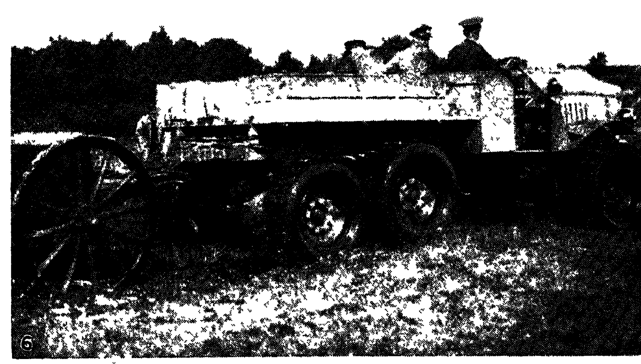
The great tractive effort which can usefully be employed on such a vehicle calls for abnormally great reduction in the lower gears, while small reductions are required in the higher gears to enable high speeds to be employed on good surfaces. A wide range of gears may be obtained by the introduction of a subsidiary two speed-gear behind the main three- or four-speed gearbox. The main gearbox and power unit may then be of quite normal pattern as used in normal four-wheeled lorries. The good performance of these six-wheeled lorries across country, coupled with the fact that they are cheap to make and to operate, and therefore attractive to commercial users, makes possible the mechanization of the first line transport of fighting units. Because the vehicles are fast and can reach their units quickly without long occupation of road space, and can, when necessary, divert from the road, it is found practicable to relieve the infantryman and cavalryman on the march of some of the weight of equipment and kit which they have hitherto had to carry.

Since the South African War, when steam traction engines were used to haul trucks, various attempts have been made to produce four-wheeled internal-combustion vehicles, having two large rear driving wheels tyred either with steel or solid rubber, which should be capable of operating across country. The Italian Fiat Model 20 tractor used for artillery haulage during the World War may be cited as a typical example of this class of vehicle. Other makes used during the World War were the Foster-Daimler (Britain), the Lanz and the Benz (Germany).





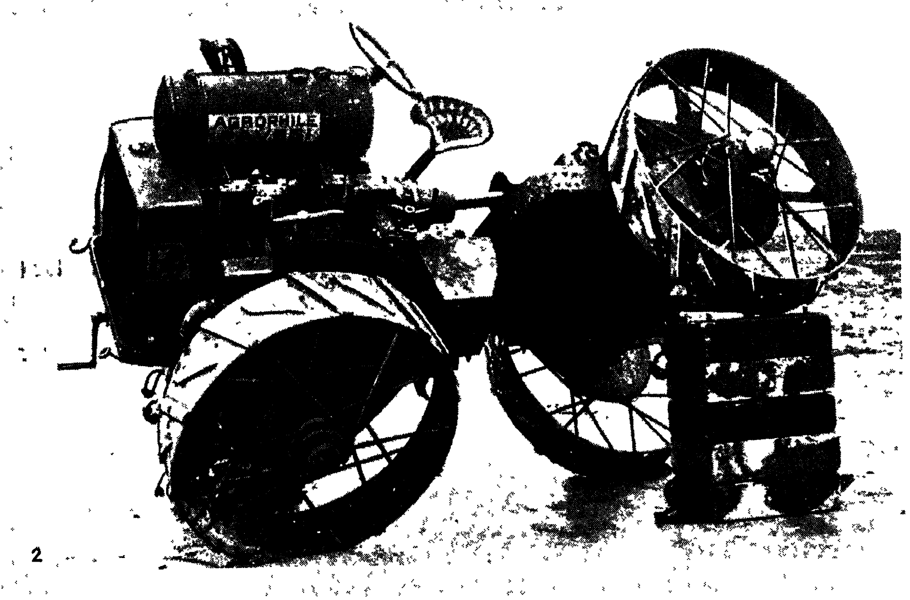




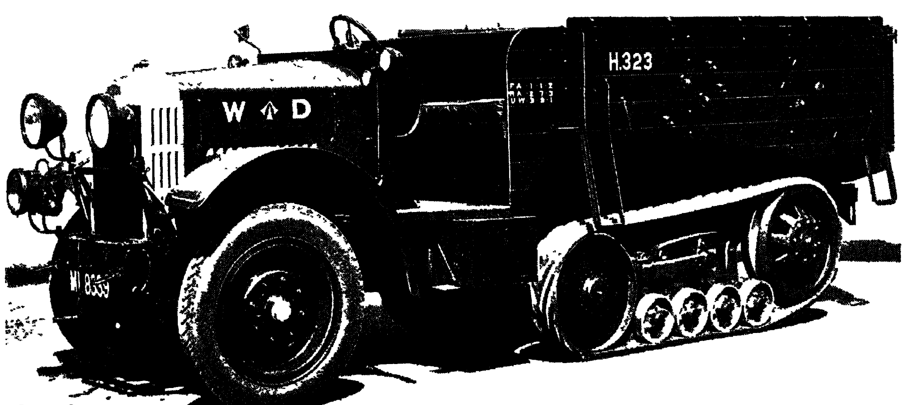
BY COURTESY OF (2) RUSTON AND HORNSBY, LTD, (4) THE INSTITUTE OF AUTOMOBILE ENGINEERS FROM "PROCEEDINGS"

1. Hornsby heavy chain-track tractor, paraffin engine, 1904–8. The shape of the track in contact with the ground resembles that of the rim of a wheel of very great diameter. This machine was a fore-runner of the Tank and other modern whole-track vehicles
2. Hornsby light chain-track tractor, petrol engine, 1907. The inventor, Mr. Roberts, is in the foreground
3. Modern 6 wheeled lorry. The four wheels at the back all drive and are fitted with pneumatic tyres. They are also free, within limits, to follow the contour of uneven ground without causing any distortion of springs or chassis frame
4. Experimental motor cycle incorporating two articulated driving wheels. Here again the object in view is to improve driving adhesion by getting a greater driving area in contact with the ground. The band fitted to run over the two driving wheels gives extra support on very soft ground, and is easily detachable
5. Typical heavy petrol tractor, 1914–18. It has large driving wheels with steel tyres, and adjustable spuds to improve the driving grip on soft ground
6. Modern 6-wheel-drive tractor, having 6-cylinder petrol engine, six forward gears, pneumatic tyres, detachable driving chains, and a power-driven winding gear. Such a vehicle has a greater driving area on the ground and is much lighter than a tractor as in fig. 5 employing only two large driving wheels

1



2



3

BY COURTESY OF (1) "MOTOR TRANSPORT," (2) L. A. LEGROS, M. I. MECH. E., FROM "TRACTION ACROSS COUNTRY" ("THE ENGINEER"—1924)

1. Modern six-wheeled motor car with four driving wheels, designed for travel across soft and rough country. The "overall" chain shown in use is detachable, and is only used to give increased support

3. Half track lorry. The track is a rubber and canvas band and is driven, by friction, by the rearmost wheel. On certain vehicles of similar type the track band is positively driven, engaging with teeth formed on the leading wheel of the track assembly

In general, this type of vehicle is a failure for cross-country work, as it is impossible to make the wheel large, wide and light enough to avoid sinkage and loss of adhesion. The most elaborate devices in the form of adjustable or detachable spuds, girdles, and diggers have been employed to prevent slippage of the driving wheels. Such devices often defeat their own object, and may have the effect of causing the driving wheels to "dig in" more swiftly on soft ground. At the best, they cause such severe damage to the ground traversed as to destroy it, and thus deny passage to following vehicles. Furthermore, such girdles, spuds, or diggers can only be used at very low speeds. (*See* Plate I., 5.)

Reference has already been made to the advantage of driving on all four wheels of a four-wheeled vehicle. As described in his book, *A new System of Heavy Goods Transport on Common Roads,* B. J. Diplock patented, in 1893, a design for a four-wheel-drive steam tractor. Many tractors of this type, and driven by internal-combustion engines, were developed during the World War, examples being the F.W.D. (United States) as used for the heavy artillery of the British army in the war, the Latil and the Panhard (France), the Mercédès-Daimler and Erhardt (Germany). The most successful was, perhaps, the Mercédès-Daimler, on account of its larger wheels and its excellent general proportions and design. These vehicles were all successful in varying degrees, but could not be said to be true cross-country machines. Some had solid rubber and others steel wheels, and several were equipped with powerful engine-driven winding gears with which they could extricate themselves when bogged on soft ground. All of them were heavy

After the war the British War Office tested two-wheel-drive and four-wheel-drive tractors of British, American, French, German and Italian origin, but none of them were found truly effective for cross-country work. It was considered, however, that a lighter four-wheel-drive tractor having the largest size of pneumatic tyres, and incorporating a wide range of gears, giving high road speeds, and a big tractive effort at low vehicle speed, as well as a powerful engine-driven winding gear, might be of service. It was estimated that it would haul 10 tons on average roads and four to six tons across country where the conditions were not too severe. A specification was prepared which resulted in the production of the Thornycroft so-called "Hathi" (Elephant) tractor. It has proved to be a fast, powerful and economical tractor, effective for cross-country conditions of many kinds. But when soft sand or slippery and boggy ground are met even this vehicle, with its moderate axle weight and large pneumatic tyres, is found to sink in unduly and lose adhesion. As a result of this experience such a tractor has been converted into a six-wheeler by the addition of a third driving axle. Several manufacturers in Great Britain are giving attention to the production of six-wheel-drive machines. (*See* Plate I., 6.)

A review of modern wheel vehicles would be incomplete without reference to the Pavesi articulated machine, produced in Italy. Reference has already been made to the importance of articulation on cross-country vehicles—that is, the property by virtue of which the wheels are free to follow the contour of the ground without undue disturbance of wheel-loads and without causing undue movement and twisting of the vehicle as a whole. The Pavesi tractor is almost completely articulated. The vehicle is made in two rigid portions joined together by a "wasp waist." Within certain limits the two portions of the vehicle are free to pivot both in the horizontal plane in order to steer, and about the longitudinal axis of the vehicle, in order to enable the wheels to rise and fall relatively to each other and so follow, freely, the contour of the ground. It is easy to see the great degree of articulation provided. All four wheels, which are of large size, are "drivers," the power being taken from the engine and gear-box on the front half of the machine, through a universally jointed propeller shaft to the rear half of the vehicle. The vehicle in its present state of development is not adapted for fast work on the road; it is not a dual-purpose vehicle. (*See* Plate II., 2.)

Motor-cycles are used to a considerable extent in military service. The conventional motor-cycle having two wheels, of which only one is driving, and having little ground clearance, is not useful across country. It suffers from lack of adhesion to drive, sinkage on soft ground, and fouling at the "belly" on relatively small obstacles. A machine is being developed experimentally in an endeavour to overcome these disadvantages. The machine has tyres of large section and low air pressure, the two small wheels are both "drivers" and are mounted in a manner to provide some articulation, and enable them to follow the contour of the ground. (*See* Plate I., 4.)

"Track" Vehicles.—The necessity for great ground area contact both for supporting and driving a cross-country vehicle has been noted. Early attempts to achieve this end by means of very large wheels led to the development of the endless track, or track-laying machine. It became clear, during the World War, that only by utilizing long and wide tracks was it possible to transport the great weight of the armoured fighting tank. By the use of tracks the average pressure on the ground was kept low, *e.g.,* 12 lb. sq. inch. The shape of the effective portion of the track protected other parts of the tank from coming into contact with the ground. The tracks also provided the adhesion necessary to enable a great tractive effort to be employed. Tracks are of the following kinds:—

(*a*) *Metal tracks* (articulating). These consist of a series of rigid metal shoe-and-link units jointed together. The drive is by a sprocket which meshes with teeth on the inside of the track. The track usually presents an almost continuous surface to the ground, and therefore the intensity of pressure exerted may be made very low. In order to make the track bear uniformly on the ground, and in order to "spring" the vehicle, its weight is supported by a series of small wheels running on the inside of the track, and these accommodate themselves to the contour of the track lying on the ground by means of spring and/or compensating lever mechanism introduced between them and the chassis. The tracks are also sometimes permitted some degree of articulation in the horizontal plane to facilitate, or achieve, steering by enabling the track to lay a curved road on the ground. But the life of such metal tracks is short, especially when driven at high speeds and on hard roads. (*See* Plate II., 3.)

(*b*) *Flexible band tracks.* These are made of canvas and rubber, sometimes with metal reinforcement. The drive is by friction, the track being formed with a Vee-shaped portion which engages with a Vee-groove on the driving wheel. The suspension of the vehicle on the track has been described above. Such tracks are quieter than the metal track.

Adjustment of the centres of the main track wheels must be made simple, as it is not easy to maintain correct tension to ensure driving grip between the pulley and the track band. The life of these tracks also is not long, and the mechanism is somewhat costly.

In order to obviate slip between driving wheel and band, experiments are in hand to try and secure positive instead of friction drive. (*See* Plate II., 4.)

(*c*) *Girder track* (*or truss wheel*). This is a metal track, but the joints between adjacent shoe units are formed so as to limit the maximum radius to which the track will conform.

The pivoting inwards is not limited and the track runs around two wheels only.

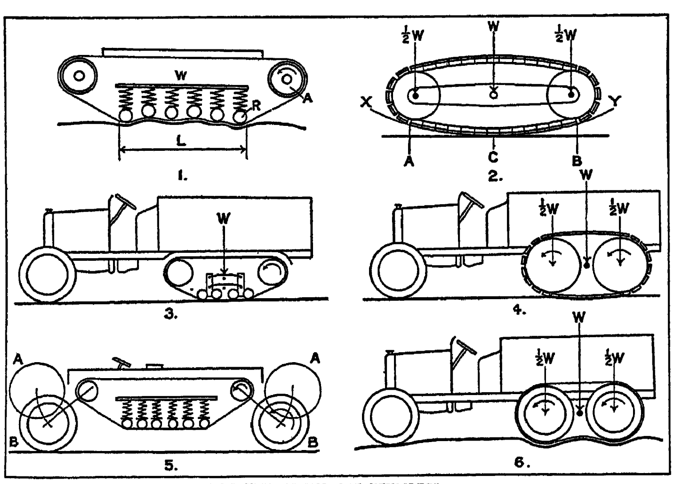
The lower portion of the track, being prevented from accommodating itself to the contour of the ground, forms a short arc of a circle of very great diameter, providing the effective low rolling resistance of a very large wheel. It is difficult to make the track strong enough to support, on hard ground, the weight of the load on each end of what is, in effect, a rigid girder.

(*d*) *W.D. type overall chain.* This device is a compromise between the track and the ordinary non-skid chain used on wheeled vehicles. It has been developed to enable the six-wheeler to cope with very soft and slippery ground. The chain is used over an ordinary twin pneumatic tyre equipment, and the drive is obtained only by virtue of the weight of the driving wheels on the shoes. Vehicles can run at 15 to 20 miles per hour with the chains fitted, and the chains make little noise. The shoes can be of small or large area according to the nature and supporting power of the ground to be negotiated. The chains are compara-

tively light and cheap to produce or replace. The pair of chains can be fitted to a vehicle in a few minutes. The diagrams in fig. 1 show:

(1) Whole-track vehicle—such as heavy fighting machines, gun tractors or carriers, etc.—articulating metal track—weight "W" distributed over small wheels R—drive by sprocket A—usually steering is achieved by relieving the drive on the inside track, and the vehicle slews around pivoting on the length L of the inside track. (For illustrations of whole-track vehicles, *see* TANKS.) (3) Half-track vehicle—having either metal or rubber articulating tracks instead of rear driving wheels. The front steering wheels are usually not driven. (5) Wheel-cum-track—this type is being experimented with by both French and British armies. Means are provided whereby the wheel axles can be raised or lowered—when the wheels are at A the vehicle runs on tracks (metal articulating), when at B the track is off the ground and the vehicle runs on the wheels. (2) Girder-track—the portion of the track from A to B—is a rigid girder due to the locking joints. On hard ground the stresses in the joints when the track is touching at C only, and ½W is applied at A and B are clearly high. A C B is a small arc of the imaginary large wheel X C Y. (4) The possible application of the girder-track to the six-wheeler. (6) Six-wheeler with "overall" chain.

Probable Lines of Development of Military Cross-country Vehicles.—It has been demonstrated, by trials specially arranged to test the relative capabilities of all types of modern vehicles to negotiate difficult conditions of cross-country "going," that:—(*a*) the long whole-track machine is essential for tasks where wide trenches, high banks, and soft bog have to be negotiated without delay, and where great gross moving weight is involved; (*b*) whole-track vehicles are able to tow heavier loads over soft ground than either half-track or wheeled vehicles; (*c*) for carriage of moderate loads there is little to choose between six-wheeled and half-track vehicles in regard to cross-country performance, while the former are at a great advantage on good roads, and in regard to cost of provision and upkeep. It seems probable, therefore, that, until they reach a much higher pitch of mechanical perfection, the use of tracks will be confined



FROM MAJOR C. H. KUHNE, "MILITARY TRANSPORT VEHICLES"

SIX SYSTEMS OF OBTAINING LARGE AREA OF GROUND CONTACT FOR CROSS-COUNTRY VEHICLES

1. Whole track, metal (articulating). 2. Girder track (or truss wheel). 3. Half track, metal or rubber (articulating). 4. Girder track applied to 6-wheeler. 5. Wheel-cum-track. 6. Six-wheeler with overall chain

to the minimum number of special military vehicles considered essential on mobilization, and that dependence must be placed on multi-wheeled vehicles for the great bulk of army transport.

A survey of military transport in various countries indicates certain general lines of development. Tanks or "chars d'assaut," whether large or small, will be whole-track machines. Gun tractors may be whole-track, half-track, or multi-wheel-drive vehicles, according to the weight of gun, nature of task, estimated condition of terrain, and considerations of the economics of provision and upkeep. Armoured cars and first line transport vehicles will probably be six-wheeled vehicles (with at least four wheels driving), or other improved multi-wheeled vehicles. Second and third line transport will be heavier six-wheeled vehicles, if available. If not, lighter pneumatic-tyred four-wheeled vehicles of comparatively small load capacity, and which are in extensive use commercially, may be used in the more forward echelons, and less mobile heavy commercial lorries, of three to six tons load capacity further in rear.

The Problem of Transport in Undeveloped Territories.—There are many territories awaiting development when cheap transport becomes available. In many cases the building of railways is prohibited by physical difficulties or financial considerations or the uncertainty and seasonal nature of the traffic available. Heavy and regular traffic is required to make a railway pay. The need appeared to exist for long-distance feeders to the arterial railways and waterways, approximating to branch railways in reliability and charge per ton of produce carried. In most cases the construction and maintenance of roadways suitable to carry normal motor-vehicle traffic is out of the question. Even if the roadways existed, the cost of carrying produce long distances in detail in ordinary lorries would be prohibitive. Only by moving large unit loads, say, 50, or even 100 tons, on transporters which can travel on dirt tracks without destroying them, could the cost per ton-mile be kept within economic limits. Such a transporter would travel, at moderate speeds only, on endless-track units, if possible consuming fuel of local origin.

The acceptance of the six-wheeler of suitable design is natural, since its cross-country performance is good, especially with the overall chains, which can be easily fitted and carried when not in use. At the same time it is economical and fast on good "going" and as easy to drive and look after as any ordinary car or lorry. There is great need of a flexible wheel or tyre which is unpuncturable, and which will provide a low rolling resistance on soft ground, similar to that provided by very low pressure pneumatic tyres. Tracks will probably be used for the heavier loads, and where very great towing capacity across country is required and no high-speed running is involved.

The big transporting unit may consist of a powerful tractor with articulating metal tracks to give the utmost adhesion, towing a train of large capacity trailers on girder tracks to give the lowest possible rolling resistance. Even though the loads be heavy the track surface can be made great and the pressure on the ground kept low so that the continuous passage of the machine will pack the ground and improve the "going." Thus, it seems probable that the development of transport vehicles for military use and for commercial use in the less highly developed parts of the world will follow similar lines and be mutually interdependent to some extent.

Conclusion.—Those nations in which the military transport authorities work in close collaboration with the civilian manufacturers and users of mechanical vehicles, are the most likely to be in a strong position in regard to mobility on the outbreak of war. Recent developments in wheeled vehicles have shown that the very features which are of advantage for use across country, are, to say the least, not detrimental to the performance of the vehicles on good roads. Thus, transport vehicles suitable for use in war may, by well directed efforts, be brought into use commercially even in countries provided with good roads. For countries having rich, but undeveloped districts, or possessions overseas, the task is simplified. Even in the case of the more special military types of vehicles incorporating tracks, technical development may be hastened by the judicious encouragement, by governments, of the use of heavy goods transporters for opening up undeveloped districts, and of agricultural tractors. The world is crying out for efficient transport—whether roads exist or not; the more the encouragement given, and the greater the production and employment of vehicles, the more effectively equipped will the armies of the world become in regard to the vital quality of mobility. (C. H. Ku.)

BIBLIOGRAPHY.—L. A. Legros, "Les Chars d'Assaut et le Matériel à Chenilles," *Mémoires de la Société des Ingénieurs Civils de France* (1921) (English abstract reprinted in *The Automobile Engineer,*

March, 1922); "Traction on Bad Roads or Land," *Proc. I. Mech. E.* (1918) and "La Traction hors Route," *Mémoires de la Société des Ingénieurs Civils de France* (1924) (reprinted as "Traction across Country" in *Engineering*, Feb. 22 and March 14, 1924); R. H. Brackenbury in *Journal of R. Soc. of Arts* (Feb. 24, 1924); P. H. Johnson, in *Engineering* (Sept. 11, 1925); C. H. Kuhne, "The Development of Mechanical Vehicles for General Load-carrying Duty in the Army," *Proc. I. Mech. E.*, No. 2 (1927). (Resumé:—*The Automobile Engineer, April*, 1927; Reprints, *Engineering*, March, 1927). "Military Transport Vehicles—Recent Developments and their Commercial Significance," *Journal of Inst. of Transport*, vol. ix., No. 3., Jan. 1928 and *Proc. Inst. Auto. Engrs.;* A. Stern, *Tanks, 1914–18;* C. F. T. Young, *The Economy of Steam Power on Common Roads;* J. F. C. Fuller, *The Reformation of War;* B. J. Diplock, *A New System of Heavy Goods Transportation on Common Roads;* E. H. Tennyson d'Eynecourt, *Account of British Tanks used in the War*, read before The British Association (Sect. G.) Sept. 10, 1919, reprinted in *Engineering*, Sept. 12, 1919.

MOTOR VEHICLE INSURANCE. The growth of motor transport during the last 25 years has resulted in a demand for very specialized insurances to protect private and commercial vehicle owners and motor traders. Each have their own particular risks necessitating widely different forms of cover.

The principal feature of any insurance covering the road risk is obviously that relating to liability to third parties, particularly when it is considered that thousands of persons are killed or injured by motor vehicles annually, resulting in the majority of cases in a monetary responsibility on the part of the vehicle owner for law costs incurred in his defence in subsequent proceedings, if not for damages eventually awarded to claimants. A feature of importance of all such third-party insurances is the legal representation of the insured by the insurers at any police-court proceedings or coroner's inquest, though this service does not extend to subsequent criminal proceedings. With few minor exceptions all British motor policies provide an indemnity unlimited in amount as regards the legal liability to third parties for personal injuries, though as regards damage to property of such persons the practice varies. Whilst owners using their cars solely for private and professional purposes may obtain an indemnity unlimited in amount in England, this is always limited as regards vehicles otherwise used to £10,000. Law costs incurred with the insurer's consent are invariably included. Elsewhere the limit of indemnity as regards personal injuries and damage to property must be fixed by the proposer at the outset. On signing a proposal form the proposer warrants the truth of his replies to the questions and his answers constitute the basis of the contract. Whilst most of the questions are designed to obtain the necessary information for rating and for the completion of the policy, others relate to the past experience of the risk.

Private Car Policies.—Both as regards the premiums charged and the cover provided the private motorist receives preferential treatment. The third-party cover has already been discussed and in addition the insured is indemnified, within the limits of the sum insured, for loss of or damage to the car caused by fire, theft or any attempt thereat, any accidental, malicious or wilful damage. Damage to tyres is not covered unless the car itself is also damaged. Mechanical breakdown risks are excluded, but all damage to the car and liability to third parties incurred subsequent to, though the result of, the mechanical breakdown are covered. Policies provide for the cost of removal of a car from the scene of the accident to the nearest competent repairers and the cost of redelivery to the insured.

Privileges confined solely to private car policies, in the form of medical and surgical expenses for all occupants and personal accident benefits for the owner, may be obtained and the British policy permits three months' Continental use in any one year of insurance. Most modern private car policies extend to indemnify the insured in respect of his third-party liability whilst driving other cars and friends of the insured whilst driving the insured car with the owner's general knowledge and consent. On payment of additional premiums the insured may cover special risks such as the loss of rugs, coats and luggage; medical and personal accident benefits for himself and other persons; compensation for loss of use; an indemnity for employer's liability, and mechanical breakdown.

Reductions of premium are allowed if the car is driven only by a named individual (other than a paid driver): if more than one car is insured under the policy; or if the insured bears a first amount of every loss under the damage or all of the sections of the cover. A bonus is allowed if no claim arises during the year of insurance. Private cars are generally rated according to the horse-power and value in England, though for third-party risk horse-power alone is considered.

Commercial Vehicles.—Under this heading are included all vehicles other than those mentioned previously and motor-cycles. The section provides for vehicles driven by petrol, steam or electricity whatever may be their use. For rating purposes these must of necessity be divided into appropriate classes, as, for example, private-type cars used for business purposes, rateable similarly to private cars; light and heavy goods vehicles each of which is rated according to the district and purpose for which it is used, the former on a horse-power-cum-value basis in addition; private and public hire vehicles rated on horse-power and value; and *chars-à-bancs* rated according to use and seating capacity.

The indemnity granted is more restricted than in the case of the private car policy to the extent indicated above, whilst in addition no provision is made for the driving of the vehicle by any person other than the insured or his servant, nor is the insured covered whilst driving a vehicle not belonging to him. It should be observed that whilst the private car policy indemnifies the insured in respect of his liability to passengers this risk is not covered under the commercial policy unless further premium is paid. Amongst the additional benefits which may be covered on payment of further premium are compensation for loss of use and, if the vehicle is steam driven, an indemnity for claims due to sparks and ashes escaping from the vehicle and explosion risks.

Motor-cycle.—In many respects insurances for motor-cycles are similar to private and commercial vehicle policies, except that even the private cycle policy does not indemnify the insured in respect of claims made by passengers unless additional premium is paid. Further, the cover is normally operative only whilst the cycle is being driven by the insured or, in the case of a commercial cycle, by the insured or his employees. Pillion riding suspends the policy cover unless an additional premium has been paid.

Motor Traders.—Difficulties arise over the insurance of vehicles for such traders, as it frequently happens that for most cars they are only temporarily responsible. Several methods have been devised to overcome this difficulty, the commonest of which entails the payment of premium based upon the number of identification plates held by the insured. Alternatively, tickets supplied by the insurers must be produced by the insured's driver to a policeman upon the occurrence of an accident, the premium being computed upon the number of tickets issued. Such policies cover the road risk only. Within recent years so-called "internal risk" policies have been issued designed to indemnify garage proprietors in respect of claims for accidents to customers' cars occurring upon their own premises. (A. G. M. B.)

American Practice includes five distinct types of coverage:

Public Liability is imposed by law on the owner for injuries or death suffered accidentally or alleged to have been suffered through the use of his automobile. The usual protection granted by such a policy covers the defence of all claims and suits for injury caused by the insured; the assumption by the insurance company of all costs incurred with its consent; the payment of all costs charged to the insured in the suit; the payment of all interest accruing and the repayment of any expense incurred in providing immediate and necessary relief to the injured at the time of the accident. The ordinary form of public liability insurance is usually limited to $5,000 for one person. The policy usually covers a person, a firm or corporation responsible for the operation of the car. The policy usually also covers any adult member of the insured's family, but not a chauffeur or a servant unless the policy is so indorsed.

Property Damage insurance is generally written with public liability insurance and sometimes with fire insurance. The policies cover against losses caused by any damage that the insured car has caused to the property of other persons, and any loss due to th

inability to use the damaged or destroyed property. Damage to the car of the insured, to the property of others while it is being used by or in charge of the insured, is not included.

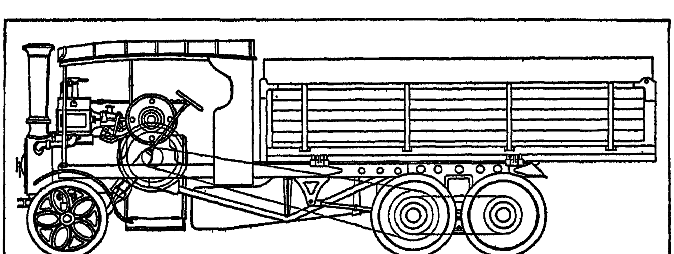
Collision Damage.—These policies protect the owner from any accidental collisions of his car with any other object, either moving or stationary. The insurance company's liability is limited to the actual cost of suitable repairs or replacements or to the actual value of the car at the time of the accident. Protection is limited to specified geographical limits. Damaged tyres are not covered unless there is other injury done to the car. The insurance company does not protect against collision damage incurred while racing or while the car is operated by a child under the age of 16. The rates are based on the degree of coverage, the territory, the age and the type of the car, the motive power, the bumper equipment and a classification based on price and size.

Fire and Transportation.—The protection against fire covers the body, the machinery and the equipment of the car while in the United States or Canada. The car may be in a building, on a road, in a railroad car or other conveyance, on a ferry, on an inland or coastal vessel. Fire and lightning are covered. Rates depend on use, construction, age of car, motive power and protection devices.

Theft.—This coverage is usually written with fire and transportation insurance and is governed by the same conditions. The theft of the car must be committed by a person other than one in the household or employment of the insured. Cars are divided in classes on basis of price lists. The cheaper cars have higher rates.

Motor vehicle insurance is subject to legislation in many States and there is a definite movement towards universal compulsory public liability insurance.

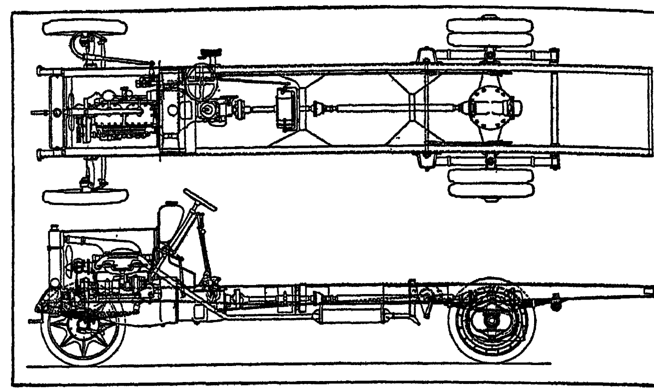
MOTOR VEHICLES, COMMERCIAL. Motor vehicles of commerce, and particularly omnibuses, have long since outlived their early discredit. It took over 200 years to develop horse-drawn vehicles so that one could travel in reasonable comfort at 15m.p.h., and nearly 75 years to develop railways to a similar degree of comfort and reliability for speeds of 50m.p.h. Commercial motors within 16 years reached such a stage of reliability and efficiency that they played a part of the highest importance in the World War. Subsequent progress in design and construction was so rapid that by 1928 the improvement in efficiency was such as to give 60 gross ton-miles per gallon (gross weight, multiplied by distance travelled on one gallon) of fuel consumed under ordinary circumstances, and the use of lorries and passenger vehicles had become a serious menace to any possible railway monopoly of transport. This development resulted from patient and systematic research in thermo-dynamics, metallurgy, petroleum technology, production methods and in the theory of structures. The standardization of materials and parts, the evolution of light-weight, high-grade aluminium alloys at commercial prices, improvements in the construction of pneumatic



FODEN'S OVER TYPE RIGID FRAME 6-WHEELER

tyres and the concurrent study of roads and road constructions are among the other contributory reasons for this rapid development. With each improvement in design and construction motor users have increased their demands for speed and capacity.

Petrol-engined vehicles of the four-wheel type predominate, and the engine usually is mounted over the front axle under a bonnet, but in order to give the maximum length of body for a given overall length, in some cases makers have adopted what is known as the forward drive, in which the driver is seated alongside the engine. The principal disadvantage of this arrangement lies in the engine being less accessible than in the bonnet type, but much ingenuity has been shown in overcoming this, and at least one maker (Pagefield) mounts the radiator, engine and clutch on a sliding sub-frame which may be withdrawn, like a table drawer, the weight meanwhile being partly supported on legs with castor wheels. The question of accessibility is of lesser importance to large users, who can install special appliances for

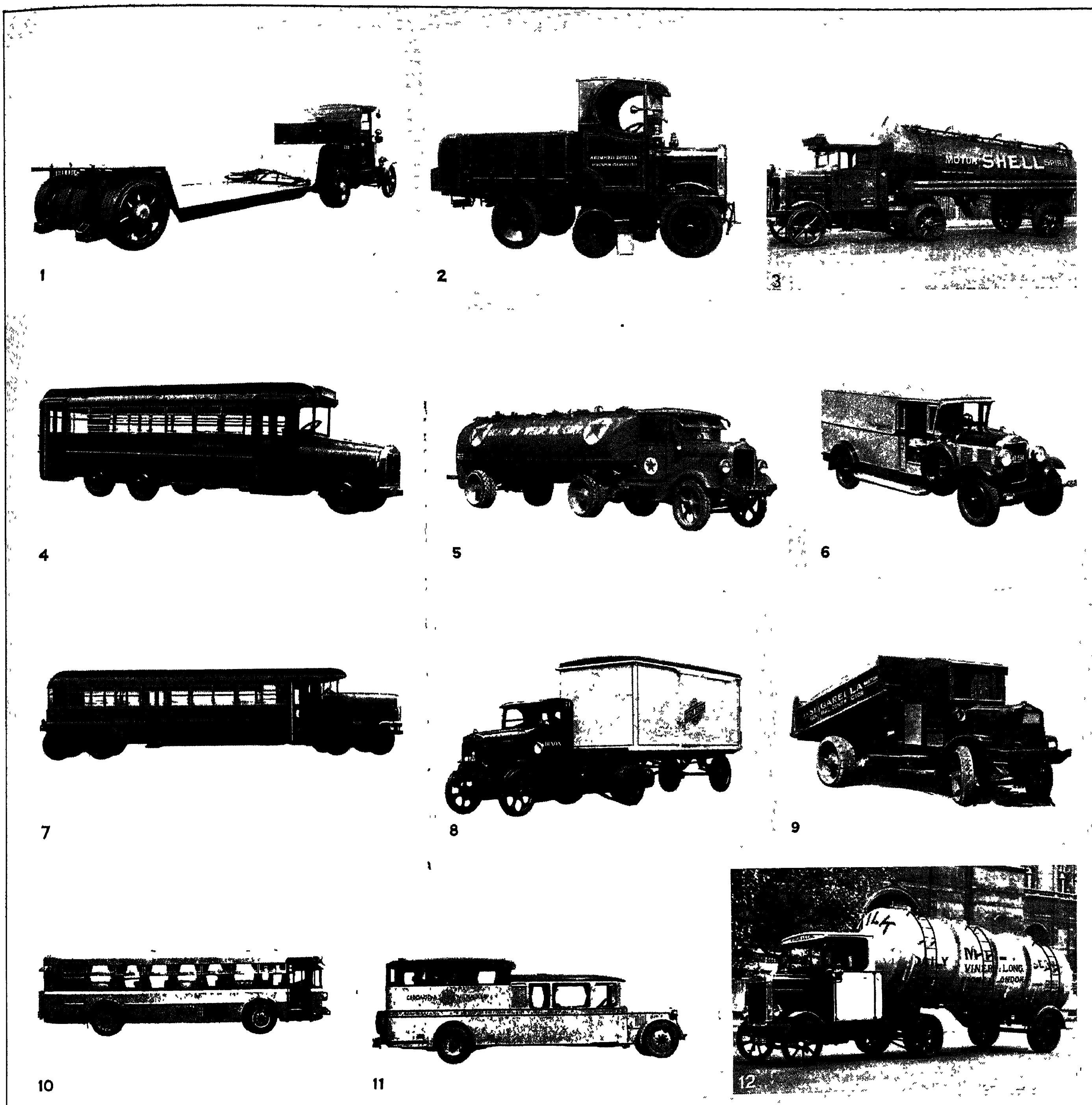


THORNYCROFT "Q" TYPE CHASSIS FOR LOADS OF 5 TO 6 TONS

dealing with maintenance, than is the case with the small user, who, having no large service organization behind him, must carry out adjustments as and when they become necessary.

As far back as 1898 Thornycrofts introduced a vehicle consisting of a short four-wheeled wagon, on which the forward end of a long two-wheeled trailer was superimposed, the complete vehicle constituting an articulated six-wheeler. It was in advance of its time, and not until 20 years later was interest revived in the type and its economic advantages appreciated for certain services in spite of its many disadvantages, among which is the difficulty of manoeuvring in a backward direction. A few years later the rigid-frame six-wheeler made its appearance, and by 1928 was largely employed. Its chief advantages are that both driving and braking efforts are distributed over four wheels instead of two, and as the two driving axles are carried on a bogie, over which the frame and body are mounted, road shocks are greatly minimized. For instance, when one of the driving wheels passes over an obstacle, the frame and body are lifted only one-half the height of the obstacle. It has an additional advantage in that an endless band or track may be fitted over the two driving-wheel tyres on each side, converting the drive into a creeper track or caterpillar, by which means soft and boggy land may be traversed which would usually be impassable for wheeled vehicles. The articulated type of six-wheeler is much used for furniture removal, the transport of liquids in bulk, cable drums and other bulky or heavy loads. In a further development of the articulated type one maker builds a vehicle having eight wheels, the rear four being mounted on two short pivoted axles which are in line on level ground, but which adjust themselves automatically to road inequalities (Plate, fig. 4). By this means heavy loads may be carried without unduly loading any one tyre or causing damage to the road. The rear four wheels act as load carriers only, and the drive is transmitted through the two wheels on the middle axle, the front axle being the steering axle.

Passenger Vehicles.—Before 1918 chassis employed for motor-buses and coaches were similar in most respects to standard 3–4 ton goods vehicle chassis. As the demand for increased speed and comfort became more insistent, designers had to find means of lowering the centre of gravity, lengthening the wheelbase and effecting improvements in springs, brakes and steering gear. Engines and driving gears had to be quieted and made more efficient, and as each new model was produced the platform level was lowered. No sooner had designers produced a reasonable type of chassis for solid tyres than users began to demand pneumatics. Designers were then faced with fresh difficulties, but by 1928 this class of vehicle left little to be desired in the way of safety, comfort, speed and economic running, many saloon buses engaged on inter-urban service being most luxurious. (An innovation in England in 1928 was a London-Liverpool night passenger



BY COURTESY OF (1, 3, 12) SCAMMELL LORRIES, LTD., (2) KARRIER MOTORS, LTD., (5, 6, 9) THE WHITE MOTOR COMPANY, (4, 7) THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, (8) THE INTERNATIONAL HARVESTER COMPANY, (10) THE TWIN COACH CORPORATION, (11) THE AMERICAN CAR AND FOUNDRY COMPANY

MODERN TYPES OF MOTOR LORRIES, OMNIBUSES AND TRUCKS

1. Tractor truck with drop-frame trailer for hauling heavy commodities, such as structural steel and building material. Trailer has four wheels per axle, fitted with solid rubber tyres. The bed, of riveted sheet steel, is dropped to facilitate loading and unloading
2. A modern street sweeper built for the city of Liverpool. It consists of a motor truck with transverse sweeper brush between the front and rear axles. Body and box at rear are useo for tools
3. Scammell six-wheeled frameless petrol tank weapons. Shell-Mex Ltd. own one hundred of these machines
4. Six-wheel electric-drive coach having entrance doors at front and rear; the body construction is similar to that of a railway car
5. Heavy-duty-type tractor truck with tank-type semi-trailer. Oval steel tank has capacity of 3,000 gal. oil and gasolene. The tank is divided into six compartments, each of which may be cleaned through a man-hole at the top
6. Package delivery body mounted on one-ton truck chassis
7. Eight-wheel electric-drive coach used in western United States. This type of public vehicle replaces trolley cars on roads
8. Tractor truck with trailer similar to railway freight car. Used in isolated regions in feeder service to railway main line freight stations
9. Contractors truck of 5-ton capacity, used for general hauling and in building construction. It has a power-operated dump body of steel
10. Twin-coach parlour car for interurban service. Main entrance door at front of coach (right). An emergency door at the rear end (left) gives access to the luggage space
11. Large motor coach in interurban service. It has a raised compartment at the rear, with space beneath for luggage
12. Scammell six-wheeled frameless 2,500 gal. milk tanker. There is an aluminium tank inside the steel shell. Cork insulation. Running between Salisbury and London these machines average about 65,000 miles a year

service, using sleeping coaches, fitted with berths and toilet accommodation; an attendant pressed clothes, served morning coffee, etc., while the inclusive charge was the equivalent of the 3rd-class rail fare.)

Apart from strictly engineering details, pneumatic tyres contributed to the improvement of these vehicles, and by their absorption of road shocks permitted the use of lighter and improved coach work, the construction of which has become as much an engineering as a coach-building matter, because of the extensive use of pressed steel and aluminium panels, brackets, etc. During the same period the design of taxicabs made relatively little progress, but this was due to police regulations which were formulated in the earliest days of motor-cars, and their enforcement prevented the adoption of modern chassis designs. Moreover, the market being a small one, few makers were tempted to build them and the result was stagnation in design. (*See* also OMNIBUS.)

Creeper-track Machines.—Before 1914 the caterpillar or creeper-track principle of propulsion was mainly used on agricultural tractors and for special cross-country service overseas. The principle was developed very largely for military purposes (tanks) from 1914 to 1918, but up to 1918 the tracks were of metal, noisy in operation and very costly to maintain where run on hard roads, although quite satisfactory on dirt roads, sand or boggy land. Shortly after 1918 experiments were made with tracks of rubber and canvas, and this form of track, known as the Kegresse, soon proved that it could travel as well and nearly as fast as pneumatic tyres on the road, traverse the snow-covered roads and passes of the Alps and Pyrenees and negotiate successfully a journey across the Sahara desert or other sandy wastes. Apart from agricultural machines, however, the creeper-track principle appears to have its greatest application for military and overseas purposes.

Motor fire-engines have almost completely ousted horse-drawn steam-driven fire pumps, and as a general rule they are driven by a powerful petrol engine, through a special design of gear-box which permits of the power being transmitted either to the road wheels or to a rotary pump, generally of the turbine type, because of its high efficiency, and the fact that when drawing from a hydrant the initial water-pressure in the main is fully utilized. (*See* also FIRE-ENGINE.)

Among vehicles specially designed for municipal purposes the Karrier and the Pagefield are examples. The former is a machine which sprinkles and sweeps the road and automatically collects the dust into a tipping body (Plate, fig. 2). It is operated by one man, is capable of easy manoeuvring and consequently may be employed at all hours of the day or night without interference with other traffic. The Pagefield machine is intended primarily for the collection of house refuse and consists of a wagon with a telescopic tipping platform, provided with elevating screws and winding gear. Refuse is collected in horse-drawn low-built containers and at predetermined stations a wagon arrives with an empty container, the wagon platform is tipped, its telescopic ramps extended and the empty container lowered. After this the full container is hauled up into its place and then lowered to the travelling position for conveyance to the refuse destructor or tip. By this means enormous quantities of refuse can be dealt with by a comparatively small staff and equipment. In both the examples named the requisite power for the sweeping, winding and elevating mechanisms is provided by the engine through a special arrangement of gears.

Engines.—Commercial vehicle engine requirements differ from those of other vehicles mainly in the necessity for maximum fuel economy, reliable service and durability. A fuel saving of 5% to 10% is of little importance to the owner of a private car but very important to the owner of a fleet of omnibuses, and to obtain it a designer is justified in adopting every known means short of increasing the running speeds unduly beyond those which may be met by the ordinary materials of commerce. Maximum economy of fuel can be obtained only by using a high compression ratio, but this must be limited by the commercial fuels available. For these reasons the side-by-side valve type of engine with a detachable head is the one most commonly employed, as in practice it gives smooth running, the valve tappets do not need frequent adjustment, such adjustment is easily effected, and decarbonizing of the combustion chamber is a simple matter. Collectively these features spell commercial efficiency. Four-cylinder engines are in the majority, but there is an increasing tendency to use six-cylinder engines for large passenger vehicles. Carburetation, ignition, lubrication and other details conform to the generally accepted practices in use on motor engines. Electric starting and lighting are not practicable for goods-delivery vehicles engaged on short distances with many stops, because the travelling time is too short to keep the batteries charged. For long distance work and on passenger service vehicles electric lighting and starting are generally adopted. The unit method of construction in which engine, clutch and gear-box are combined has been widely used for units up to about 30 h.p., but above that power it is more usual to employ separate units. Water cooling is employed for all but light parcel carriers, when the engines are sometimes air cooled. Water circulation is generally effected by the natural process of convection, but in high-duty engines it is assisted by a pump. In London-type omnibuses the ratio of engine power, at 1,000 revolutions per minute, to total weight is in the region of 4 brake horse-power per ton, but for motor-coaches, in which high point-to-point speeds must be maintained and the vehicle be capable of ascending gradients of 1 in 4, the ratio is usually nearer $6\frac{1}{2}$ b.h.p. per ton. For other classes a usual ratio lies in the region of 5 b.h.p. per ton, with a minimum of about 15 b.h.p. Engine speeds rarely exceed 2,500 revolutions per minute for passenger vehicles and 1,600 r.p.m. for heavy goods vehicles. The latter type should have good pulling capacity at low speeds, with a torque curve fairly flat in its middle range. In Great Britain petroleum spirit or a mixture of petroleum and benzol are the principal fuels. Paraffin is not in much favour for use on road vehicles but is much used for agricultural tractors. From 1914 to 1918 many vehicles were run on coal-gas, which was stored in fabric envelopes at low pressure or in steel cylinders under high pressure. An alternative was to generate gas from coke or charcoal in a producer carried on the vehicle. Alcohol-benzol-petrol mixtures were also used during the same period but found little favour. On the continent, however, the use of alcohol and producer gas has continued to find adherents, but so long as petroleum remains available at commercial prices alternative fuels are likely to receive little encouragement. The Diesel or heavy-oil type of engine makes steady progress in commercial use.

Clutches, Gear-boxes, etc.—The tendency is to fit fabric-faced plate clutches in preference to the cone or the multiple metal-plate type, for the reason that they are smooth in action, easy to adjust and maintain, and make gear changing easy because the spinning parts are of light weight and have low inertia. Except for small load vehicles, four speeds forward and one reverse are provided, the top speed generally being a direct drive. A usual range of speed ratios from engine to propeller shaft is approximately as follow:—first 5; second 3; third 1·75; fourth 1; reverse (min.) 5; reverse (max.) 7·5 to 1, respectively. Sideways or clash engagement gears are most common and although open to many objections are reliable and efficient. Attempts have been made to supplant them by ingenious inventions, but the old-fashioned type still remains the most popular and reliable. Chain-driven gear-boxes, with sliding couplings for engagement, have been used, particularly on London buses, but they are expensive and heavy, and their advantage of silent running has lost importance since the introduction of the gear-grinding process, which makes spur gears practically noiseless.

There are two chief methods of driving-axle construction, *e.g.*, the solid-forged and built-up types. In the former the imposed load is borne by a forged-steel axle shaped like a double-handled banjo, the driving and differential gears being mounted in a casing fitting to the banjo portion, whilst the wheels are mounted on the ends and the driving shafts pass through the hollow ends. This type is adopted extensively. The built-up type, in which the load and gearing are carried entirely by cast casings, finds little favour in Great Britain, but is much used by Continental builders.

For taxicabs and small delivery vans the final drive is generally by bevel gearing with a ratio of about 4·8 to 1, but for other types, and particularly for large passenger vehicles, axles are mostly worm-driven. For heavy-duty lorries, however, the double-reduction gear, by bevel and spur gears, continues in favour among some makers. Axle gear ratios vary from 6½ to 1 for small vans up to 12 to 1 for heavy goods vehicles. For large passenger vehicles the ratio ranges between 7½ and 8½ to 1, according to the class of service. The old system of transmission by chain from a differential countershaft to the road wheels is now employed mainly on steam wagons. Front axles are invariably of the Ackermann type, consisting of a load-carrying beam with pivoted stub axles on which the wheels are mounted. The stub axles are interconnected with each other, and to the steering gear, by levers and connecting rods. When front-wheel brakes are fitted the beam must be made strong enough to resist the braking torque in addition to the load carried on the axle.

The demand for greater loads and increased speeds has necessitated better braking facilities. These have been secured by fitting brakes to both front as well as rear wheels, or by the addition of power-multiplying devices, operated by mechanical, hydraulic or vacuum means, or by a combination of both methods. Modern brakes, when properly adjusted, have an efficiency in some cases approximating to 100% on hard, dry roads.

The spring-suspension system presents great difficulties because of the widely varying loads which have to be dealt with. To meet these and to ensure smooth riding springs are generally made of semi-elliptic shape and of considerable length and breadth. The combined length of one front and one rear spring in the case of a large passenger vehicle is rarely less than 65% of the wheel base. Springs must of necessity be made comparatively stiff and of small camber in order to avoid wide differences in platform height between the laden and unladen conditions, and to minimize these differences auxiliary springs or rubber buffers are frequently fitted.

Steam Wagons.—Interest in steam wagons appears to centre chiefly in Great Britain, though British makers in 1928 exported to South America, India, South Africa and Central Europe. For heavy loads over short or long distances steam wagons compete well with petrol wagons. In the over-type the engine is mounted above a locomotive-type boiler, whilst in the under-type the boiler is usually of the vertical pattern.

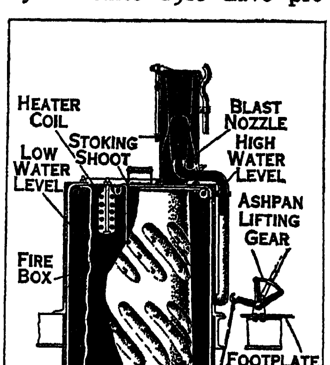
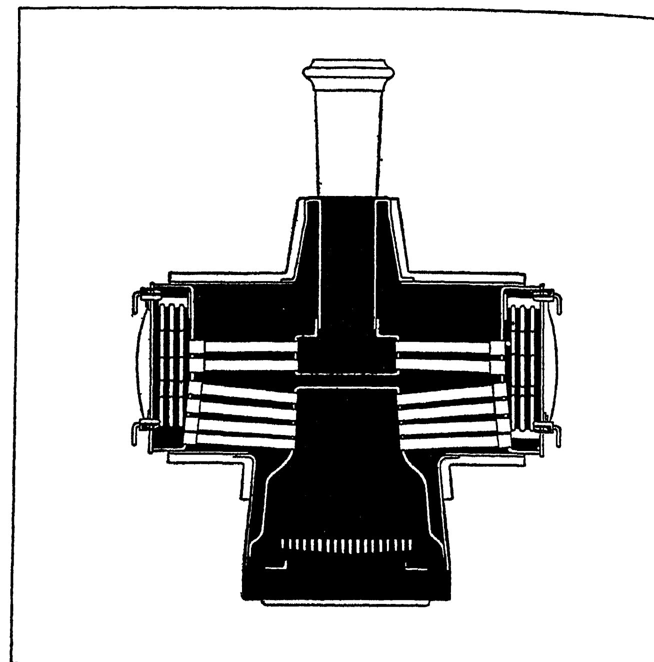


FIG. 2-A.—SENTINEL WATER-TUBE BOILER

As in all other branches, the years since 1918 have produced many improvements in steam wagons. When compound engines are used the high-pressure cylinder is about 4½in. diam., the low pressure 7½in. diam. and the piston-stroke from 7in. to 8in., whilst in twin-cylinder, high-pressure engines, the bore varies from 6in. to 7in. and the stroke from 8in. to 10in. Steam pressures vary from 215 to 275 lb. per sq.in. The grate area is about 3·3sq.ft., and the total heating surface from 60sq.ft. in the case of vertical water-tube boilers to 90sq.ft. in the fire-tube loco-type. Two representative makers are Foden and Sentinel. The former employs a loco-type boiler with a compound engine either mounted above the boiler or below the frame, the drive being taken by a two-speed gear and single chain to the rear axle. The latter employs a vertical water-tube boiler (fig. 2*a*), the inner shell of which has helical-shaped indentations to receive diagonally disposed water-tubes, an arrangement which avoids the need for stay rods; the outer shell may be removed for cleansing the water spaces and tubes. The Sentinel engine has two high-pressure cylinders and is slung beneath the frame, its poppet valves being operated by a camshaft. The crank-case incorporates a two-speed and differential gear from which the final drive to the rear wheels is by separate chains. The Yorkshire wagon is remarkable chiefly for its return-tube boiler (fig. 2*b*), the barrel of which is placed transversely across the front of the wagon, with the fire-box in the centre, thus dividing the products of combustion into two streams, each returning to a central smoke-box and uptake. A vertical compound engine, with its axis lying parallel to the centre line of the wagon, is employed, and drives a differential shaft, whence the final transmission is by a separate chain to each rear wheel. The Atkinson wagon also employs a vertical water-tube boiler, but its engine is of the two-cylinder uniflow type, slung under the frame. This wagon has no change-speed gear, and the final drive is transmitted by a single chain to the rear axle. In a Sentinel rigid-frame six-wheeled steam wagon the four rear wheels are coupled in pairs by roller chains, so that the driving and braking effort is shared by four wheels.


BY COURTESY OF THE YORKSHIRE PATENT STEAM WAGON CO.
FIG. 2-B.—ARRANGEMENT OF BOILER FITTINGS FOR W. G. WAGON

Electric Vehicles.—Electric vehicles which depend upon a storage battery for the source of current, although limited in their sphere of action by the battery capacity, have been developed and used to a considerable extent. There appears to be no standard form of chassis design, as is the case with petrol vehicles, neither is there any agreement on the relative merits of transmission by one or two motors. The motors, however, are usually of the series-wound type, driving the road wheels through spur gearing or by chains. The battery capacity ranges from 30 to 35 miles per charge, and the maximum speed is 14 to 15 m.p.h. for small vehicles, and 9 to 10 m.p.h. for the heavier type, the restricted range and low speeds necessarily limiting the scope of application to such purposes as factory and railway platform trucks, municipal vehicles and town delivery vans.

The trolley bus is a type of vehicle to which much attention was directed during the years 1918 to 1928 as a means of solving the problems of tramway engineers who were faced with the necessity of replacing worn-out rails and rolling stock. It is an electrically propelled vehicle which collects its source of energy by means of a trolley arm from a pair of overhead cables, instead of a single cable and rail return as used on many tramway systems. It is capable of being steered and brought to the edge of the foot-path for picking up and setting down passengers, and in this respect has many advantages over tram-cars, but it lacks one of the chief advantages of motor-bus service in that it must necessarily follow the route of the overhead cable. Unlike a battery-propelled vehicle, however, it may be run at speeds comparable with those of petrol buses, has a high rate of acceleration and low energy cost per bus mile, but at best it is considered only

as a vehicle for use in the transition stage from rail-bound tram-cars to free-moving motor-buses. (*See* also INTERNAL COMBUSTION ENGINE; OMNIBUS; MOTOR TRANSPORT, COMMERCIAL.)

MATERIALS.—The following is a list of materials used in the manufacture of parts: *cylinders*, close-grained cast-iron; *inlet valves*, 3% nickel or medium-carbon steel; *exhaust valves*, case-hardened nickel, 25% nickel or stainless steel; *pistons*, close-grained cast iron or aluminium alloy; *piston rings*, close-grained cast iron; *gudgeon pins*, 3% nickel, nickel-chrome or low-carbon steel case-hardened; *gudgeon-pin bushes*, phosphor bronze; *connecting rods*, 3% nickel, nickel-chrome, medium-carbon steel or duralumin; *bearings*, tin-base white metal; *crankshaft*, 3% nickel, nickel-chrome, chrome-vanadium or medium-carbon steel; *camshaft*, 3% nickel or low-carbon steel, case-hardened; *fly-wheel*, close-grained cast iron, malleable cast iron, cast steel or mild steel; *crank-cases* and *gear-cases*, aluminium alloy or close-grained cast iron; *gear wheels*, case-hardened nickel or oil-hardened and tempered nickel-chrome; *gear shafts*, oil-hardened and tempered 3% nickel or nickel-chrome; *driving worms*, case-hardened low-carbon steel or 5% nickel-chrome; *worm-wheels*, phosphor bronze; *front-axle beams*, medium-carbon steel or 3% nickel; *front-axle stubs*, 3% nickel; *solid-type rear axle*, 3% nickel or medium-carbon steel; *built-up type rear axle*, cast steel or medium-carbon steel casings with 3% nickel or medium-carbon steel sleeves; *steering levers*, 3% nickel or medium-carbon steel; *frame*, 3% nickel or medium-carbon steel; *brake shoes*, malleable cast iron, cast steel or die-cast aluminum alloy; *brake liners*, asbestos fabric; *clutch liners*, asbestos fabric, leather or cork; *brackets*, *levers*, etc., mild steel stampings; *differential cages*, malleable cast iron or mild steel stampings; *exhaust manifolds*, cast iron or malleable cast iron; *inlet manifold*, aluminium alloy; *springs*, silico-manganese or chrome-vanadium; *wheels*, mild steel, cast steel or aluminium alloy.

BIBLIOGRAPHY.—There are but few books on this subject, but a large amount of technical information will be found in the *Proceedings* (1913–27) of the Institution of Automobile Engineers. *See* the following volumes:—*Agricultural Tractors*, xii. and xvi.; *Axles (Live)*, x.; *Automobile Calculations*, xvi.; *Battery and Petrol Vehicles*, xix.; *Brakes*, xix.; *Chain Drives*, xvi.; *Coke Fuel for Commercial Vehicles*, xvi.; *Colonial Vehicles*, xx.; *Engines for Commercial Vehicles*, x.; *Electric Vehicles*, xiiii.; *Four-wheel Brakes*, xviii.; *Four-wheel Drive*, x.; *Gas Traction*, xv.; *Gear Grinding*, xiv., xvi., xvii.; *Heavy Commercial Vehicles*, viii.; *Lubrication of Commercial Vehicles*, xviii.; *Motor Fuel Research Report*, xix.; *Multi-Axle Vehicles*, xviii.; *Multi-Wheel and Track Machines*, xvii.; *Petrol-Electric Bus*, xix.; *Pneumatic Tyres for Heavy Loads*, xx.; *Rail-less Trolley Traction*, xvii.; *Road-less Vehicles*, xvii.; *Springs*, xvi., xvii., xx.; *Steam Commercial Vehicles*, xvii.; *Tractors*, xviii.; *Worm Gearing*, vii., xi. *See also*:—Heap, *Petrol Cars and Lorries* (1922, Pitman); Judge, *Motor Manuals* (1925–26, Chapman and Hall); Russell, *Motor Trucks and Automobile Motors* (1918, Pitman); Jones, *Steam Road Vehicles* (1923, Iliffe); Wimperis, *Application of Power to Road Transport* (Constable); Page, *Modern Motor-Truck Design* (1921, Constable); Schaefer, *Motor-Lorry Design and Construction* (Crosby Lockwood); Elliott, *Automobile Chassis* (McGraw Hill); Oliver, *Motor-Coach Painting* (Crosby); Lewis, *Liquid & Gaseous Fuels* (Constable); *Heavy-Motor-Car (Use and Construction Order (1904)* and *Amendment Orders (1923* and *1927)*, issued by H. M. Stationery Office, London. *See* also volumes of *The Automobile Engineer* (Iliffe), *Motor Transport* (Iliffe) and *The Commercial Motor* (Temple Press). (G. W. W.)

IN THE UNITED STATES

The World War gave a powerful impetus to the commercial vehicle industry, not only because of the large numbers of trucks, ambulances and other vehicles required at and near the battle fronts, but because in some of the countries involved the intense industrial activity overtaxed the capacity of the railroads and called for the provision of additional means of transport. The industry, particularly that branch of it devoted to the production of heavy trucks, outgrew the normal demand for its products, with the consequence that it suffered a serious setback during the industrial depression of 1921. Probably the most noteworthy development in the field of commercial vehicles during the decade which followed the war was the great increase in speed. At the beginning of this period all but the lightest classes were fitted with solid rubber tyres, which, together with the poor state of the roads in the United States, limited speeds to 15 or at most 20 m. per hour. In 1928 most of the new vehicles were equipped with pneumatic tyres. Development of the so called "giant" pneumatic tyre for use on commercial vehicles of the heavier types began during the war period. Tyres as large as 12 in. in width were produced, but it was found that 10 in. was the practical limit, on account of the impossibility of handling the larger size in the event of trouble on the road.

This limitation led to the development of the six-wheeled vehicle (classified into rigid and flexible six-wheelers in England, of which the "rigid" with 4-wheel drive is the dominant type). The U.S. Bureau of Roads showed that the maximum stress developed in the roadway by a six-wheeled vehicle is much less than that developed by a four-wheeled vehicle of equal weight, and several State legislatures recognized this advantage of the six-wheeler and raised its weight limit over that of the four-wheeler. In the United States the six-wheeler was first marketed as an omnibus.

Development in Design.—The increase in the speed of commercial vehicles called for more powerful brakes, and four-wheel brakes were largely adopted. These permitted of stopping in little more than half the distance required with rear-wheel brakes, providing the operator was capable of applying them to the point of practically locking the wheels. This, however, was beyond the strength of the average driver, and power brakes were applied on most of the faster commercial vehicles. One form of brake-applying mechanism, operated by the vacuum in the inlet manifold of the engine, was known as a booster or amplifier. Generally the connections were such that the pull exerted on the brake linkage by a piston in a cylinder was directly proportional to the pressure exerted by the operator on the brake pedal. The operator's pressure on the pedal and the air pressure on the piston combined to apply the brakes. Another device brought out in 1927 to assist the operator's control of a heavy truck is the Bethlehem torque amplifier, by means of which most of the energy required for steering a heavy vehicle could be derived from the engine.

Up to 1926 practically all trucks were equipped with four-cylinder engines, but with the demand for increased speed engines of greater power were necessary, and many manufacturers then adopted the six-cylinder type. Another effect of the demand for increased speed was the adoption of multiple speed transmissions. Up to 1920 the larger trucks generally were provided with four forward speeds. But if a truck was to be capable of high speed when light and at the same time capable of carrying a full load under bad traction conditions, it must have a range of gear speeds of about 8 to 1. Such a range could not be adequately covered with only four gear changes, and trucks designed for this wide range of adaptability were often provided with transmissions giving seven forward speeds.

New Types of Engines.—Several firms in Germany in 1926 and 1927 equipped trucks with light, high-speed Diesel engines. A 5-ton truck of this type equipped with a six-cylinder 70 h.p. engine operating normally at 1,300 r.p.m., was exhibited at the commercial vehicle show in London in 1927. These Diesel engines burned a cheaper fuel (gas oil) than the ordinary truck engines, and also used it more economically, consuming about 0·45 lb. per hp.-hr. at full load, as compared with 0·6 lb., of the common truck engine, while at part load its showing was even better.

In France, beginning in 1923, the Government sought to stimulate the use of producer gas fuel for trucks and other commercial vehicles, the producer gas itself being generated on the vehicle from charcoal or artificial fuels. At first a good deal of trouble was encountered by the engines becoming dirty from impurities in the gas, but devices to cleanse or wash the gas gradually eliminated this trouble.

In 1928 five firms in the United States manufactured electric commercial vehicles operated from storage batteries. The capacities of these vehicles ranged from ½ to 7½ tons. The lighter vehicles had a speed limit of about 15 m. per hour and the heavier of 10 m. per hour, while the distance covered on one charge of the battery ranged around 50 miles. While the largest user in the United States was the American Railway Express Company, these vehicles were also used to a considerable extent by department stores, large bakeries, creameries and meat products firms. The electric truck had proven to be economical in operation, but dependence upon charging stations and low speed retarded its rate of growth. At the commercial vehicle show in London in 1927 two trackless trolley vehicles were shown, one a six-wheeled double-deck omnibus. These vehicles took their current from overhead wires by means of a flexibly-supported trolley pole. They

were much lighter than storage battery vehicles, but required an overhead street electricity supply. In 1928 approximately 300 trolley buses of this type were in use in England.

Transportation by Motor Truck.—The truck was first used chiefly for transportation over short distances, in services in which horses had been used previously; but as its speed and reliability increased the motor truck served between points at greater distances. The maximum distance over which it was profitable to ship goods by truck as compared with shipment by railroad depended upon numerous factors that varied according to the circumstances. This limiting economic radius constantly increased as the mechanical details of the trucks were more thoroughly worked out and as (in the United States) the roads improved.

Some of the reasons which prompted many shippers to employ motor trucks for shipment over comparatively long distances were: reduced cost of packing, loading and unloading, since motor transport requires fewer handlings; saving of time; reduction of capital tied up in empty containers, quick delivery of perishable goods and elimination of the otherwise necessary system of depots.

An important development in the co-ordination of railroad and highway transport was the introduction of container service by several of the railroads in the United States beginning in 1922. Containers with a framework of steel sections and with sheet steel covering, 7 ft. 2½ in. long, 9 ft. 3½ in. wide and 8 ft. 2 in. high, were used for shipping "less-than-carload" lots of merchandise. These containers weighed about 3,000 lb. and could be loaded with merchandise up to 7,000 lb., making the loaded container a capacity-load for a 5-ton truck. Six of these containers could be placed side by side on a 48 ft. low-side gondola car by means of a crane. Loading and unloading the container while on the truck made it unnecessary for the shipper and consignee to have a crane. At the beginning of 1928 three of the larger railroad systems of the United States offered container service between certain of the more important cities along their lines.

Motor Omnibuses.—The early buses were similar in design, so far as the chassis was concerned, to the early motor trucks. A great step in advance was made when the safety bus was developed in 1922. As compared with earlier buses, the chassis was considerably lowered and tread widened; the vehicle, moreover, had an engine of increased power and was equipped with air brakes. In city bus services, where constant stops and starts have to be made, the ordinary sliding gear transmission did not prove as satisfactory as it had in passenger car work, partly because the constant operation of the clutch and the shift lever were a strain on the driver, and partly because the shocks due to constant clashing of the gears were injurious to all parts of the transmission line. It was for this reason that electric drive was introduced.

An electric generator of the compound-wound type was direct-connected to the gasolene (petrol) engine, supplying current to either one or two enclosed electric motors carried on the chassis frame to the rear of the generator, and connected to the rear axle by means of driving shafts with universal joints. Speed control was effected almost entirely by means of the engine throttle. Electrical transmission equipment was more expensive, heavier and somewhat less efficient than a mechanical transmission, but it possessed the advantages of a smooth and uninterrupted acceleration from a standstill to a maximum speed. Such an acceleration assured greater comfort to passengers; maintained a faster schedule; and relieved the strain on the driver, thus tending to reduce accidents.

In 1927 a new design of bus, known as the street-car type, made its appearance. Its object was to provide greater seating capacity for the same over-all dimensions and weight. In the prototype, the Twin-Coach, two separate engines were employed, one under the seats at each side of the bus, each engine driving one of the rear wheels. In later designs a single engine unit was used, located transversely at the extreme rear. In these later vehicles the gas-electric system of transmission was employed, which afforded greater liberty in respect to the location of the engine. That portion of the frame at the forward end of the chassis which is ordinarily occupied by the engine was rendered available for seating space, and the provision of doors at both ends made continuous circulation possible and speeded up traffic.

In 1926 a type of long-distance bus came into use in which the rear half of the floor was raised about 2½ ft. above the forward half, the roof over the rear being equally raised, in the form of a monitor, thus affording a clear vision in all directions. This so-called "observation" bus originated in California, but during the first few years of its existence found its widest application in continental Europe. The space under the floor of the rear, elevated compartment was used for luggage.

Travelling by Motor Bus.—In 1927 it was possible to travel by motor bus between practically all of the larger cities of the United States, and in 1928 a plan of through transportation by bus between New York and San Francisco was in effect. Travel by motor bus was slower than by train, but fares in general were somewhat lower and for many people the bus was more convenient, picking them up practically at their door and carrying them closer to their destinations. Applications for franchises for new bus lines generally were fought by the railroads, while, on the other hand, the railroads engaged in bus transportation themselves, either directly or through subsidiary corporations. In Jan. 1928, the American Railway Association at a meeting in Chicago formally organized a Motor Transport Division.

Before entering into rivalry with the railroads the motor bus had become a serious competitor to electric railways. After early opposition to bus service the street railway interests gradually recognized the bus as a legitimate factor in local transportation, and so proceeded to share in its exploitation. According to a census made by *Bus Transportation,* at the beginning of 1928, 8,482 buses were being operated in public services by American electric railway companies and their subsidiaries, while railway companies and their subsidiaries at the same time operated 994 buses. A very large number of buses (about 32,000 at the beginning of 1927) were used in carrying pupils to and from public and private schools.

The following table shows figures relating to the production and registration of commercial motor vehicles in various industrial countries:

Years	Motor Truck Production			Motor Truck Registration		
	U.S.A.	Canada	Great Britain	U.S.A.	Great Britain*	Germany
1911	10,681	..	..	20,000	53,918	4,206
1914	25,375	..	..	85,000	93,122	9,639
1918	227,250	..	..	525,000	64,399	..
1919	..	7,899	..	..	..	..
1921	..	5,148	..	..	..	31,363
1922	241,049	..	..	1,375,725	237,000	..
1923	..	19,226	21,604	..	..	..
1924	..	..	26,532	..	..	..
1925	..	25,812	32,000	..	..	..
1926	..	..	..	..	..	102,061
1927	455,019	32,556	..	2,941,930	412,374	..

*Great Britain registrations in this table include both vehicles and hackneys.

The average wholesale value of trucks produced in the United States decreased from $1,970 in 1911 to $880 in 1926. Of the trucks produced in the United States in 1926, 13·1% had a capacity of ¾ ton or less; 64·6%, 1 ton; 9·5%, 1½ tons; 4·7%, 2 tons; 3·2%, 2½ tons; 1·4%, 3½ tons; 1·4%, 5 tons, and 2·1%, over 5 tons.

BIBLIOGRAPHY.—Grupp, *Economics of Motor Transportation* (1924); Hauer and Scragg, *Bus-Operating Practice* (1925); Lane, *Motor Truck Transportation* (1921); White, *Motor Transportation of Merchandise and Passengers* (1923). (P. M. H.)

MOTRIL, a town of southern Spain in the province of Granada, at the foot of an offshoot of the Sierra Nevada and on the edge of a rich alluvial plain, about 1 m. from the Mediterranean and 40 m. S.S.E. of Granada. Pop. (1920) 16,809. The climate is semi-tropical, and the *vega* or plain of Motril has been found peculiarly adapted for the culture of sugar-cane and sugar-

beet. In the district, and especially at Salobreña, 3 m. W., there are numerous sugar-factories; cotton is also grown and manufactured, and alcohol, flour, soap, iron goods and cotton stuffs are among the other industrial products. The neighbourhood is rich in zinc and lead; and copper is also found. Grapes, barley, esparto grass, dry figs, almonds and zinc are exported.

MOTT, LUCRETIA (COFFIN), (1793–1880), American reformer, was born at Nantucket, Mass., on January 3, 1793. At 13 she was sent to a Friends' boarding school, at Nine Partners, near Poughkeepsie (N.Y.), where James Mott (1788–1868), whom she married in 1811, was then teacher. Both husband and wife took an active part in the campaign against slavery. About 1840 Mrs. Mott took up the cause of woman's rights. In the course of their work she and her husband travelled extensively on lecture tours. In 1848 she addressed the Anti-Sabbath Convention in Boston, and with Elizabeth Cady Stanton, whom she had first met in London in 1840, called a convention "to discuss the social, civil and religious condition and rights of women," which met at Seneca Falls, and passed a "Declaration of Sentiments," modelled on the Declaration of Independence. Mrs. Mott died on Nov. 11, 1880, near Philadelphia.

See *James and Lucretia Mott; Life and Letters* (1884), edited by their grand-daughter, Mrs. Anna Davis Hallowell.

MOTTEUX, PIERRE ANTOINE (1663–1718), English translator and dramatist, of French parentage, was born at Rouen on Feb. 25, 1663. After the revocation of the Edict of Nantes he settled in London with his kinsman and godfather, Paul Dominique Motteux. He acted as an auctioneer of pictures, and in 1706 he had a shop in Leadenhall Street for the sale of lace, stuffs, Chinese and Japanese commodities, duly advertised in the *Spectator* by his friend Richard Steele. After six years in England he began to edit the monthly *The Gentleman's Journal,* which contained verses by himself and by the chief wits of the day. In 1693 he edited the third book, hitherto unpublished, of Sir Thomas Urquhart's translation of Rabelais, and in 1694 he completed Urquhart's work by a translation of the fourth and fifth books. The translation, though not to be compared with the racy, nervous writing of Urquhart, shows a perfect mastery of colloquial English and an intimate sense of Rabelais's meaning. His *History of the Renowned Don Quixote de la Mancha* (1701), "translated from the original by many hands and published by Peter Motteux," is one of the most masterly and spirited translations in English. He also wrote several plays, including *Love's Jest* (1696). His later years appear to have been given to the shop in Leadenhall Street. He was murdered on Feb. 18, 1718, at a brothel near St. Clement's Church, London. The manner of his death was no criterion of his life, which appears to have been sober.

An excellent life by Henri van Laun is prefixed to the 1880 reprint (4 vols.) of J. G. Lockhart's edition of Motteux's *Don Quixote.*

MOTTEVILLE, FRANÇOISE BERTAUT DE (*c.* 1621–1689), French memoir writer, daughter of Pierre Bertaut, a gentleman of the king's chamber, married in 1639 Nicolas Langlois, seigneur de Motteville, president of the Chambre des Comptes of Rouen. He died two years later at the age of 82, and in 1642 the queen summoned Mme. de Motteville to court. Her chief work is her *Mémoires,* which are in effect a history of Anne of Austria, written briefly till the date of Mme. de Motteville's return to court, and then with fullness. They give a faithful picture of the life of the court at that time.

The best edition of her *Mémoires* is that of M. F. Riaux (2nd ed., Paris, 1891, 4 vols.); Eng. trans. (3 vols., 1902). *See* also E. Angot, *Dames du grand siècle* (1919).

MOTTL, FELIX (1856–1911), German conductor and composer, was born near Vienna, and studied at the Vienna Conservatoire. He made his name as a conductor of Wagner's music, and in 1876 was engaged for the *Ring des Nibelungen* at Bayreuth. From 1881 to 1903 he was conductor at the Carlsruhe Opera, where he produced many works of Wagner and Berlioz. In 1886 he directed the performance of *Tristan und Isolde* at Bayreuth. In later years he visited London and New York, and in 1904 he was made a director of the Academy of Music at Berlin. He composed some operas, of which *Agnes Bernauer* (Weimar, 1880) was the most successful, and numerous songs and other music. He died at Munich on July 1, 1911.

MOUCHEZ, AMÉDÉE ERNEST BARTHÉLÉMY (1821–1892), French astronomer, was born at Madrid of French parents on Aug. 24, 1821. At the age of 16 he entered the naval school at Brest, and then followed a naval career of distinction. On June 27, 1878, he was made director of the National Observatory with the rank of rear-admiral. The 14 years of his directorship were marked by a great increase in the activity of the institution. A spectroscopic department was established, and the gigantic task of re-observing all Lalande's stars was completed. He published 21 volumes of *Annales,* and the first two volumes of the *Catalogue de l'observatoire de Paris;* founded the *Bulletin astronomique,* and set on foot two schools of practical astronomy, one at Paris, the other at Montsouris, for the special instruction of naval and military officers, explorers and surveyors. His most memorable work was the inauguration of international co-operation for charting the heavens. The advances in stellar photography made by Paul and Prosper Henry and others suggested to him the magnificent idea of obtaining, through the collaboration of astronomers in all parts of the world, a chart of the entire celestial sphere containing more than fifty million stars, which should faithfully record in future ages the positions of the stars at the end of the 19th century. He died suddenly at his country seat at Wissous, near Antony, on June 25, 1892.

See *Month. Notices Roy. Astr. Society,* liii. 226; *Observatory,* xv. 305 (D. Klumpke); *Nature,* xlvi. 253; *Rapport annuel sur l'observatoire de Paris pour l'année 1892.*

MOUFLON or **MUFLON,** the wild sheep (*Ovis musimon*) of Corsica and Sardinia, where it is now very local. The ewes are hornless. The rams carry good horns, and in summer show a conspicuous light saddle-shaped mark on the otherwise dark-coloured coat. The Armenian mouflon (*O. gmelini*) of Persia and Armenia is a larger and redder sheep, with the horns curving in the reverse direction. A third, smaller species (*O. ophion*) inhabits Cyprus. *See* SHEEP.

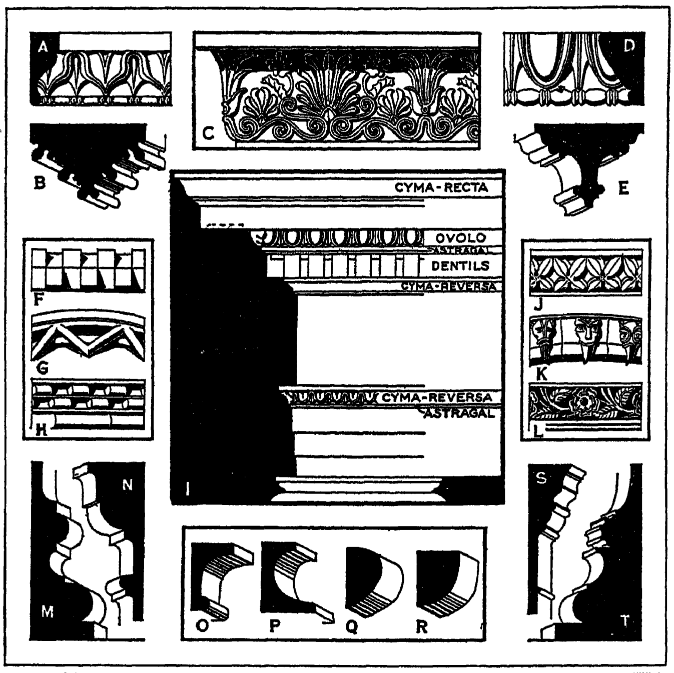
MOULDING in architecture and the decorative arts, a variation and modelling of a surface in a band, approximately continuous, whose profile or section is either always the same, or whose changes are rhythmically repeated. Mouldings are usually classified and named according to their profiles, in three general classes —flat or angular, single curved and compound.

Flat or Angular Mouldings.—(1) *The band, face, or facia:* A continuous member with a flat surface, parallel to the general surface of the wall or feature which it ornaments, and either projecting from, or slightly receding into, this surface. An inclined facia is one whose surface is neither horizontal nor vertical. (2) *The fillet, listel, or regula:* A band or facia, relatively narrow, and usually projecting. Its most common use is to separate curve mouldings, or to finish them at top and bottom. (3) *The chamfer or bevel:* An inclined band, facia or fillet, obtained by cutting off a projecting edge. (4) *Splay:* A large bevel.

Single Curved Mouldings.—(1) *The cavetto:* A hollow moulding whose section approximates a quarter circle, quarter ellipse, or similar curve, with its top and bottom tangent or nearly tangent to horizontal and vertical lines, respectively. (2) *Scotia:* A somewhat similar hollow moulding, whose section is more than a quarter circle or quarter ellipse, so that portions of it recede beyond the general face decorated, forming, thus, a sort of groove. (3) *Flute:* A small groove of either semi-circular, semi-elliptical, or segmental section. (4) *Ovolo:* A convex moulding, whose profile approximates a quarter circle or quarter ellipse. (5) *Torus:* A convex moulding whose profile approximates a semi-circle, or semi-ellipse. (6) *Roll moulding, or bowtell:* A convex moulding, whose profile approximates three quarters of a circle, generally used to decorate a projecting edge. (7) *Astragal:* A small torus, sometimes with fillet attached below. (8) *Apophyge:* A small cavetto, occurring at the top or bottom of a column, baluster, vase or similar form.

Compound Mouldings.—(1) *The cyma recta:* A projecting moulding, of which the portion closest to the original surface is convex, while the more projecting portion is concave; used both

as a crowning mould, when it is sometimes known as a cymatium, with the convex portion below, and also as a base, with the convex portion uppermost. (2) *The cyma reversa or ogee:* A projecting moulding, with the portion nearest the original surface concave, and the more projecting part convex. This, like the *cyma recta*, can be used either as a cap or base moulding. (3) *The bird's beak or thumb moulding:* A moulding with the lower part



(A) GREEK CYMA REVERSA WITH THE WATER LEAF, (C) GREEK CYMA RECTA WITH ANTHEMIONS, (D) GREEK OVOLO WITH EGG AND DART, (I) CLASSIC ENTABLATURE, (M, N) ROMAN BASE AND CAPITAL, (S, T) GREEK BASE AND CAPITAL, (F) BYZANTINE DENTIL, (G, H, J, K) ROMANESQUE, (B, L) ENGLISH GOTHIC, (E) ELIZABETHAN, (O) CAVETTO AND TORUS, (P) SCOTIA, (Q) TORUS, (R) OVOLO

concave, and the upper, more projecting part, convex. The two curves, however, do not merge into each other as in the *cyma reversa,* but intersect in a sharp edge. (4) *Keel-moulding:* A projecting moulding, consisting of a roll moulding or bowtell, with a small fillet attached at its most projecting point.

Decorations.—Mouldings may also be classified according to whether the surface is entirely continuous or undecorated, or whether it is carved. In classic art, decorations almost standard have been developed for various types of mouldings; these decorations, in all cases, are such as to emphasize the general shape or profile of the moulding, and so to emphasize its contour. In general, they are based on carving upon the surface of the moulding ornaments whose basic elements are, in elevation, or front view, curves similar to those of the profile of the moulding. These standard decorations are as follows: (1) For the ovolo, the *egg and dart;* in which egg-shaped solids, with semi-elliptical, projecting frames alternate with long, narrow dart or arrow shapes. The points of greatest projection of the egg, the dart or arrow, and of the frame are all on the surface of the ovolo. (2) For the torus, *wreath forms;* in which many parallel leaves circle the moulding, or bands of *guilloche* (*q.v.*), in which small bands are represented as interlacing and winding around circular buttons. (3) For the astragal, the *bead and reel* (*see* BEAD-MOULDING); in which long, narrow, oval beads alternate with short reel or wheel-shaped forms. (4) For the cyma recta, either successions of *anthemion* (*q.v.*), lotus and honeysuckle forms, or else successions of *acanthus* leaves, either close together or connected by, S-serolls. (5) For the cyma reversa, the *water leaf* or *Lesbian leaf,* which exists in two forms, simple and complex. In the simpler forms this consists of a generally heart-shaped leaf, with a deeply marked mid-rib, and usually a raised frame, alternating either with a dart shape, or a smaller and simpler leaf. In the more complex forms, used by the Romans for large mouldings, the decoration consists of a frame similar in shape to the frame of the simpler leaf. Within the frame, instead of a leaf surface, there is a deeply cut bunch of acanthus foliage, or a little flower. In general, it must be remembered that many mouldings which to-day are undecorated, were painted in Greek, Romanesque and Gothic work.

Egyptians, Hittites, Aegeans.—The historical use of mouldings in the Western world seems to have developed from two, and perhaps three sources: Egyptian, Hittite and possibly Doric or Hellenic. In Mesopotamia, where the chief building material was brick, mouldings were rare or absent in architecture, although they probably occurred in wooden furniture. In Egypt, on the other hand, where first reeds and mud, and later stone were the most common materials, the use of a cornice consisting of a cavetto above with a small torus below was universal. The torus was usually painted to represent a bunch of reeds tied together, and the cavetto with a series of vertical forms, as though to represent the tops of reeds used as walling. Many remains of stone bases, in Hittite sites, show that moulding was a common form of Hittite decoration, and Hittite influence may account for similar forms in Assyrian art and the Persian interest in mouldings on their columns. In Aegean art, on the contrary, mouldings are of little importance, except in the one case of the echinus (*q.v.*), or ovolo used as the capital of a column, as in the stair hall of the palace at Cnossus (*c.* 1500 B.C.), and the door of the *tholos* of Atreus at Mycenae (*c.* 1200 B C.). The latter is noteworthy in that the echinus is carved, and that below it is an apophyge decorated with little, vertical leaves, a form of ornament that also appears on certain early Doric capitals.

Hellenic Influx into Eastern Mediterranean.—This brought a new interest in mouldings, perhaps from an origin in common with the Hittite interest. At first this was tentative only, especially in Greece proper, and the Doric order makes but little use of mouldings except fillets, a small bird beak as a drip at the top of the cornice, and a cymatium on the sloping cornice of a pediment. The most important use of moulding is that in the echinus of the Doric capital, which is probably a development of earlier Aegean forms, and in the delicate mouldings which form the echinus of the anta (*q.v.*) capital. In the ovolo of the echinus there is a continual development from broad, flat, elliptical, much projecting profiles in the early work, through greater and greater refinement, until in such late work as the gate of the Agora at Athens, its sections is almost a straight line.

The greatest development of Greek moulding came through the Ionians of Asia Minor, and the adoption, throughout the Greek world, of the Ionic order, which originated in Asia. In this order, the rectangularity of the Doric yielded to the greatest possible graciousness of moulded surface, and the profiles of the cyma recta of the cymatium, the ovolo and cyma reversa of the bed mould, and the torus and scotia of the base represented, in many cases, the supreme refinement and perfection of curve to which such mouldings can attain. It is characteristic that these mouldings were almost all quirked (having the convex portion brought sharply in at the top to emphasize shadow, and in the cyma reversa, the concave portion also similarly brought out). Furthermore, Greek moulding profiles are always characterized by a constantly changing radius of curvature, and their decorations cut with the most exquisite delicacy.

Roman Architecture.—Mouldings are generally larger, bolder and more obvious, with sections in monumental work usually approximating circular curves, and the units of decoration more widely spaced and thicker, in order to count more strongly at their usually greater distance from the eye than in the smaller Greek examples. In the effort to obtain decorative richness, the Romans also experimented with various new moulding ornaments such as fish scales or imbrications, spiral rope mouldings, rows of flat, vertical leaves, etc. The results, while usually well composed and gorgeous in effect, often lacked the delicacy of Greek examples. In buildings of a smaller scale, such as the houses at Pompeii, all types and characters of mouldings were used; elliptical sections and quirks were common, as well as bevels, inclined planes and sharp, deep hollows.

Eastern Empire.—Byzantine art, with its love of intricately carved, flat surfaces, naturally modified the classic prece-

dents, and tended to substitute flat, inclined faces for all the classic mouldings, replacing richness of curved surface by richness of carved ornament.

Early Romanesque World.—This brought a new feeling into moulding design. Unable, through crudity of technique, to achieve either the refinement of classic profile or the intricacy of Byzantine carving, its mouldings are of the simplest, consisting usually of the roll moulding, or bowtell on the edges of arches, etc., and occasional cavettos and cyma reversas on string courses (horizontal mouldings), cornices and the abaci, or top members, of column capitals. With the developing technique of the later Romanesque period, more complexity of mouldings followed. In many 12th century buildings there is a close approximation of the Roman decorative mouldings, especially in Tuscany, south Italy and Provençe. In Lombardy the development was toward delicacy of scale and a rich use of such simple ornaments as spiral flutings. Norman builders, both in France and England, decorated their mouldings by breaking them into zig-zags, covering them with chevrons, projecting pyramids and birds' heads.

The Late 12th and 13th Centuries.—Gothic mouldings on the continent of Europe still remained simple in profile, and were usually confined to roll mouldings and occasional deep hollows. In cornices and abaci, however, much greater variety was common; cornices were often of cyma profile, or consisted of a cavetto and a torus; decoration with rows of crockets was frequent. Toward the end of the 13th century, the use of the keel moulding for arches, vault ribs, etc., became almost universal, and during the 14th century all mouldings became more and more delicate and attenuated, a development which reached its climax in the complex arch, rib and pier mouldings of 15th and 16th century flamboyant work. These flamboyant mouldings were of the greatest variety, usually with alternations of sharply projecting members, and deeply shadowed hollows; inclined fillets were common and the mouldings of arches and piers, arches and cornices, and gables and cornices were carved as interpenetrating or crossing each other.

English Gothic.—This was entirely different. In the 13th century, Early English and Decorated styles arch mouldings were enormously complex, formed of successions of alternately projecting and receding rounded members, sometimes with inclined fillets separating them, sometimes without fillets, so that the section formed a continuous, much waved line. Cornices were, however, simple, and hollow members were frequently decorated with ball-flowers or pyramid-flowers. Toward the end of the Decorated period (*q.v.*) mouldings became simpler, and their hollows more shallow, and in the Perpendicular period (*q.v.*), a general flatness of effect was common. A characteristic feature of Perpendicular mouldings is the pairing of two cyma curves, and the separation of two such pairs by a wide and shallow hollow. A great richness of carved decoration occasionally took the place of earlier richness of profile and hollow members were carved with realistic vine patterns, or rhythmical repetitions of the Tudor rose, or of square projecting blocks, carved with heraldic insignia or rosettes. During the late Gothic period, both on the continent of Europe and in England, the development of wood panelling created new moulding forms of small scale as decorations around panels (*see* PANEL). The most common form was a small cyma reversa, sometimes with a bead or astragal at the edge of its concave part, which was turned toward the panel.

Renaissance Mouldings.—These were based on classic precedent. The greatest differences were in the early transitional Renaissance style, in which rope mouldings, scale decoration and, occasionally, naturalistic leafage, were common. In the late Renaissance and Baroque the imaginative freedom of the period led to an almost similar freedom from classic correctness. No general forms of importance crystallized from this variety. The much contorted contours of Spanish Baroque, and the characteristic, projecting oval mouldings of the styles of Louis XIV. and XV. (*see* LOUIS STYLES) are typical of late Renaissance freedom.

Mohammedan.—In the Mohammedan countries, mouldings were always subsidiary to surface decoration both in modelling and colour. Projecting corners were often softened by roll mouldings, treated like colonnettes, and moulded cornices occasionally occurred, in Egypt, the Moorish countries and Turkey. In many cases the cornices were supported by stalactite (*q.v.*) ornament. Generally speaking, Mohammedan mouldings throughout were of delicate scale and small projection.

India.—Here, on the other hand, design was of the greatest complexity and variety. In much earlier work, in the north, Greek influence may be seen, but in all the styles throughout the peninsula an inordinate love of complex and repeated shadow lines led to tremendously complex and crowded combinations of mouldings, frequently covering large vertical surfaces. These mouldings were of all possible profiles; cymas, toruses, fillets, bands and ovolos. The ovolo and the torus were often decorated with fish scale or leaf forms, whose effect approximates that of the egg and dart. A somewhat similar richness of moulding invention can be found in the great Cambodian ruins of Angkor Wat.

Far East.—Chinese and Japanese mouldings are simple, and usually restricted to the masonry bases of wooden buildings, wooden doors, stelae (upright memorial structures), and the like. The usual panel mould is a torus of slight projection, but the bases are frequently deeply cut and powerful in design. A noteworthy characteristic is that the base of a building or stele may be carved as though it had legs, like a piece of furniture.

Modern.—Modernistic design is chary in its use of mouldings, which some of its exponents consider unnecessary, and therefore to be avoided. Simplified approximations of classic forms are found, especially in Scandinavian and American modernist work. Where mouldings are found they are used with the utmost freedom from precedent, as in the typical flat, horizontal cymas that formed a band around the "Austrian Building" by Josef Hoffman, at the Paris *Exposition des Arts Décoratifs* (1925). (*See* ORDER and the various historical articles on architecture.)

See also Viollet-le-Duc, *Dictionnaire Raisonné,* art. "Moulure" (1854–75). (T. F H.)

MOULINS, a town of central France, capital of the department of Allier, 121 m. by rail N.W. of Lyons. Pop. (1926), 20,305. The town is situated on the right bank of the Allier, which is here crossed by an 18th century bridge about 1,000 ft. in length Moulins did not attain any importance till the 14th century, before which it consisted chiefly of some mills belonging to the dukes of Bourbon. About the middle of that century it became the residence of the dukes and in the late 15th century the capital of the duchy. The mediaeval town occupied a small area. The cathedral consists of a huge choir of the 15th and 16th centuries, and a modern nave in early Gothic style, terminated by two towers with stone spires. The church possesses a fine triptych attributed to Domenico Ghirlandajo (d. 1494). A square tower of the 14th century (used as a prison) is the chief relic of the château of the dukes of Bourbon, and there is a belfry of the 15th century. Part of an old Jesuit college serves as the court-house, which contains an archaeological museum. The library, which possesses a valuable Bible of 1115, is part of the *hôtel-de-ville.* Numerous mansions of the 15th and 16th centuries border the streets of the old quarter. The town is the seat of a prefect, a bishop and a court of assizes, and has tribunals of first instance and commerce. It makes beer, cloths, chemicals and furniture.

MOULMEIN or **MAULMEIN,** the port and headquarters of Amherst district and Tenasserim division of Lower Burma. Pop. (1921) 61,301, and the increase in the last half of a century has been very slight. Ship-building, which formerly was an important industry, has now been given up, but there is still a considerable export of teak and rice, and there are several steam rice- and saw-mills. There is railway connection with Rangoon from Martaban, on the opposite bank of the Salween, and from Moulmein itself a railway runs southward to Yè, and is being continued to Tavoy and probably to Siam. River steamers run from Moulmein up the Salween and several of its chief tributaries. The town is protected from the sea by Bilugyun island, and the approach of the port is from the south, pilots being taken aboard at Amherst. The picturesque port, however, is silting up.

MOULTON, LOUISE CHANDLER (1835–1908), American poet, story-writer and critic, was born in Pomfret (Conn.), April 10, 1835, and was educated there and at Miss Willard's seminary in Troy (N.Y.). In 1855 she married a Boston publisher, William U. Moulton, who brought out her earliest literary work in the *True Flag*. Her first volume of collected verse and prose, *This, That and the Other* (1854), was followed by a story, *Juno Clifford* (1855), and by *My Third Book* (1859). Her literary output was then interrupted until 1873 when she resumed activity with *Bed-time Stories*, the first of a series of similar volumes. Through her critiques and literary letters contributed to the New York *Tribune* and Boston *Herald* as well as her Boston salon and her books, she became widely known. In 1876 she published a volume of notable *Poems* (English ed., *Swallow-Flights*, 1877) and visited Europe, where she began close and lasting friendships with men and women of letters. Thenceforward she spent the summers in London and the rest of the year in Boston, where her salon was one of the principal resorts of literary talent. Her later books include *In the Garden of Dreams* (1889), verse; several volumes of prose fiction; and travel sketches. She died in Boston, Aug. 10, 1908.

See Lilian Whiting, *Louise Chandler Moulton, Poet and Friend* (1910).

MOULTON OF BANK, JOHN FLETCHER MOULTON, Baron (1844–1921), British lawyer, was born at Madeley, Salop, Nov. 18, 1844. Educated at Kingswood School, Bath, and St. John's College, Cambridge, he was elected a fellow of Christ's College, and in 1874 was called to the Bar. He specialized in patent law, and rapidly acquired a large and lucrative practice, becoming a Q.C. in 1885. He sat in parliament for Clapham (1885–6) and Launceston (1898–1906). In 1906 he was appointed a lord justice of appeal, and in 1912 a lord of appeal in ordinary, with the title of Lord Moulton of Bank. He died in London on March 9, 1921. During his years on the bench, he rendered distinguished scientific service to the country, as first chairman of the medical research committee under the National Insurance Act (1912), and, during the World War, as chairman of the committee on chemical products and high explosives and director general of explosive supplies in the Ministry of Munitions. He was also chairman of the British Dyestuffs Corporation (1919).

MOULTRIE, WILLIAM (1730–1805), American soldier, was born in Charleston, S.C., on Nov. 23, 1730. His father, a physician, and a graduate of the University of Edinburgh, migrated to Charleston before 1729. The son was elected to the provincial assembly in 1754, 1769 and 1772. Although he was connected by many ties to the British, he espoused the American cause on the outbreak of the Revolutionary War, and was a member of the provincial congress of South Carolina in 1775–76. On Ft. Johnson, on James island in Charleston harbour, he raised what is said to have been the first American battle-flag—blue, with a white crescent in the dexter corner, inscribed with the word "Liberty"; the flag was devised by him in Sept. 1775. In March, 1776, he took command of a palmetto fort which he had built on Sullivan's island, off Charleston, which he held against the attack of Admiral Sir Peter Parker on June 28, and which soon after the battle was renamed Ft. Moultrie by the general assembly. He was thanked by Congress and was made a brigadier-general in the continental army in Sept. 1776. He dislodged the British from Beaufort, S.C., in Feb. 1779, and made it possible for the city of Charleston to put itself into a state of defence. He was one of those who advised against the surrender of Charleston, where he commanded the garrison until the arrival of General Benjamin Lincoln. His imprisonment after the surrender of Charleston (May, 1780) lasted until Feb. 1782. In 1782 he was made a major-general. He was governor of South Carolina in 1785–87 and in 1792–94. He died in Charleston Sept. 27, 1805.

He wrote *Memoirs of the Revolution so far as it Related to the States of North and South Carolina* (1802).

MOULTRIE, a city of southern Georgia, U.S.A., the county seat of Colquitt county; served by the Atlanta, Birmingham and Coast, the Georgia and Florida and the Georgia Northern railways. The population was 6,789 in 1920 (41% negroes) and was 8,027 in 1930 by Federal census. It has a cotton mill, a meat-packing plant, an overall factory, saw mills and turpentine plants, and is the trade centre and shipping point for a rich agricultural region. The city was founded in 1856 and incorporated in 1859.

MOUND, now used in the sense of a pile or heap of earth, especially such a pile raised over a grave or burial-place, a tumulus, or as a means of defence, and so used to translate Lat. *agger*. The word is obscure in origin, but was early influenced by "mount," *i.e.*, hill; Lat. *mons, montis*. A connexion with O.Eng. *mund*, guardianship, hand, has been suggested.

MOUND-BUILDERS, in North America, the name given to the prehistoric inhabitants who chiefly centred in the valleys of the Mississippi and Ohio. The remarkable mounds, which have given occasion for the name, are fortified enclosures and tumuli of the most varied appearance, round, conical, or in the shape of animals. They are scattered over an immense tract of country from the Great Lakes to the Gulf of Mexico, and from the Rockies to the Atlantic, but are specially frequent in the valley of the Mississippi, along its left tributaries, in Arkansas, Kansas and the basin of the Ohio. But the old theory that the mound-builders were a distinct race of highly civilised agriculturalists, who had lived from remote antiquity in the regions of the mounds and were eventually exterminated by the nomadic hordes coming from the northward, represented to-day by the present Indians, is no longer supported by the principal American ethnologists, who hold that the Indians are their descendants.

In Ohio there are thousands of mounds, some in the form of circles, others four-sided, and in a few cases eight-sided. Sometimes a square and a circle are united. Altar-mounds, small rounded heaps of earth, are found in Ohio. At their centre is a basin-shaped mass of hard clay showing effects of fire. These basins are 3 or 4 ft. across, and contain ashes and charcoal. Upon these altars are found many objects.

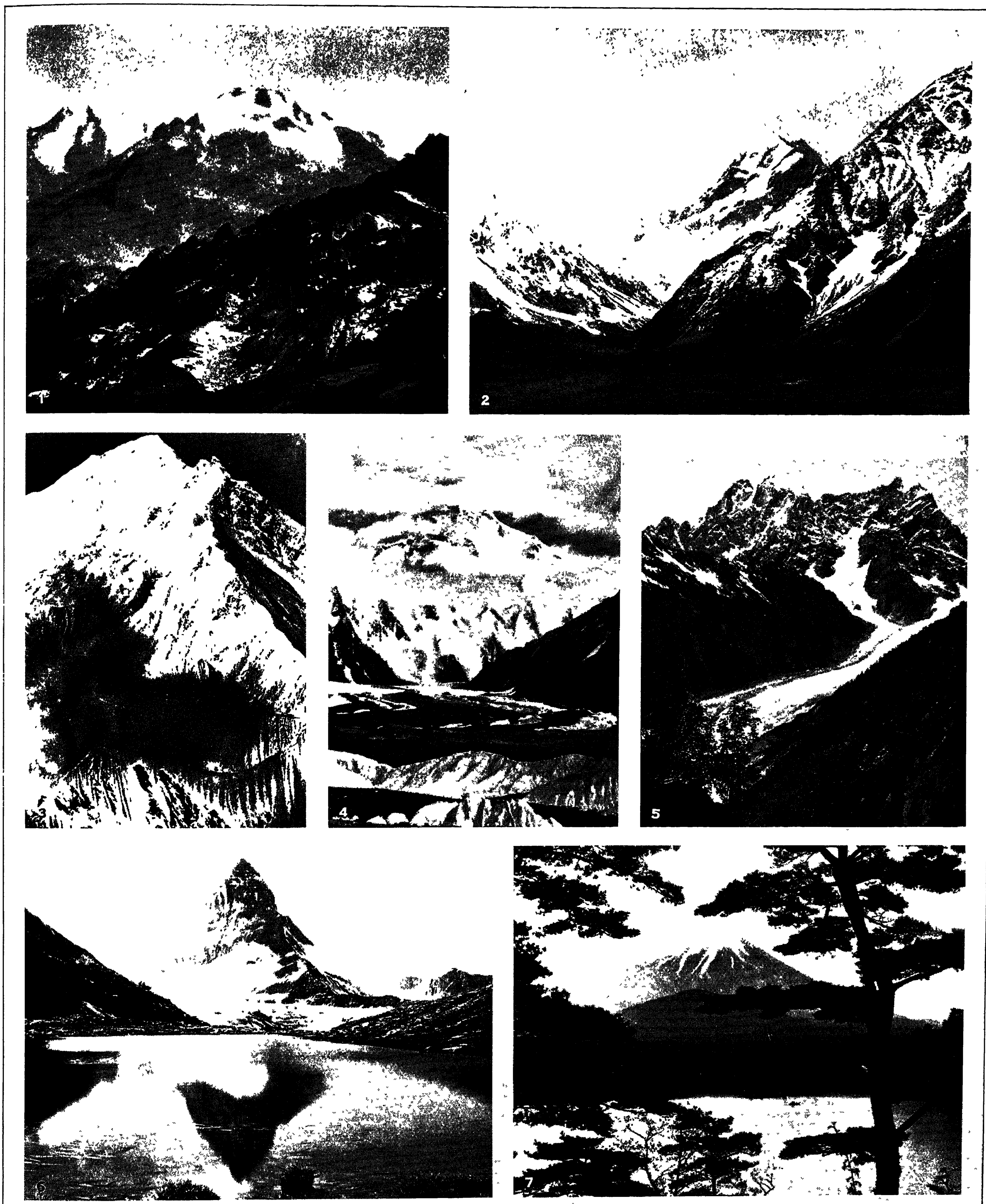
The most famous mound in Ohio is the "Great Serpent," in Adams county. It lies upon a narrow ridge between three streams which unite. It is a gigantic serpent made in earth. Across the widely opened jaws it measures 75 ft.; the body just behind the head measures 30 ft. across and is 5 ft. high; and, following the curves, the length is 1,348 ft. The tail is in a triple coil. In front of the monster is an elliptical enclosure with a heap of stones at its centre. Beyond this is a form somewhat indistinct, thought by some to be a frog.

In Wisconsin the most interesting mounds are the effigy mounds —earthen forms of mammals, birds and reptiles—usually in groups and of gigantic size. Among them are buffalo, moose, elk, deer, fox, wolf, panther and lynx. Some panthers have tails 350 ft. long, and some eagles measure 1,000 ft. from tip to tip of outspread wings. Occasionally the figures are cut or sunk in the earth, and near them are hundreds of simple burial mounds. The purpose of these effigy mounds is probably totemic, and they were objects of worship as guardians of the villages.

Further south in west Tennessee another class of mound is found. This contains graves made of slabs of stone set on edge. The simplest have six stones, two at the sides, two at the ends, one at the top and one at the bottom. Sometimes there is one of these graves on a mound, sometimes many. In one, 12 m. from Nashville, 45 ft. across and 12 ft. high, were found a hundred skeletons, mostly in stone graves ranged one above the other. The skeletons in the upper graves had been buried stretched at full length. The lower graves were short and square, and the bones in them had been cleaned and piled in little heaps.

The mound-builders were Stone Age men, and made many beautiful objects of stone, shell, bone and beaten metals, but they had no knowledge of smelting. That they were not one race is proved by a study of the skulls from the mounds.

Authorities.—E. G. Squier and E. H. Davis, *Ancient Monuments of the Mississippi Valley* (1847); I. A. Lapham, *Antiquities of Wisconsin* (1855); Stephen D. Peet, *Emblematic Mounds;* Cyrus Thomas, "Burial Mounds of the Northern Sections of the United States," in the *Fifth Report* (Washington, 1887), "Mound Explorations" in the *Twelfth Report* (1894) of the Bureau of American Ethnology; C. Thomas, *Earthworks of Ohio* (1889) *ibid* Problem of Ohio Mounds (1889); C. Whittlesey, *Ancient Works in Ohio* (1852). (O. G. S. C.)



BY COURTESY OF (2) THE NEW ZEALAND HIGH COMMISSIONER, PHOTOGRAPHS, (1, 4, 5) SELLA, (3) EWING GALLOWAY, (7) BURTON HOLMES FROM EWING GALLOWAY, (6) COPR. E. M. NEWMAN

MOUNTAIN PEAKS OF GREAT HEIGHT IN VARIOUS PARTS OF THE WORLD

1. The Ruwenzori Mountains, Central Africa, from Stairs Peak. 2. Mount Cook in the Southern Alps, New Zealand, el. 12,349 ft. 3. Mount Everest, in the Himalayas, Tibet, the highest known peak in the world, altitude about 29,120 feet. 4. K_2 seen from Baltoro Glacier, India, el. about 28,265 ft. 5. Mount Ushba seen from Leksyr Glacier in the Central Caucasus, Asia, altitude 15,400 feet. 6. The Matterhorn, in the Alps, Switzerland, el. 14,782 ft. The mountain is viewed from the so-called "Black Sea." 7. Fuji-Yama, the volcanic mountain of Japan, el. 12,395 ft.

PHOTOGRAPH, EWING GALLOWAY

MOUNTAIN TOP VIEW OF CLOUDS AND PEAKS

A sea of clouds about mountain peaks, seen from the crest of Kleinglockner in the Hohe Tauernmass of the Eastern Alps. Mountain climbers in the foreground have reached the top of a peak. Climbing staffs and lifeline are used to ensure a safe ascent and descent

MOUNDSVILLE, a city of West Virginia, U.S.A., the county seat of Marshall county; on the Ohio river, 12 m. S. of Wheeling, at an altitude of 690 ft. It is served by the Baltimore and Ohio Railroad and river steamers, and ½ m. W. is Langin Field, a landing ground of the Army Air Corps. The population was 10,669 in 1920 (89% native white) and was 14,411 in 1930 by Federal census. It is a coal-mining centre and has glass works, zinc smelters, aircraft factories and various other manufacturing industries, with a total factory output in 1925 valued at $8,075,-533. Natural gas is in use. Moundsville was laid out in 1831 and incorporated as a town in 1832. In 1866 it was consolidated with Elizabethtown, half a mile from the river (founded 1798), and was chartered as a city. At the mouth of Grave Creek, nearby, may be seen one of the largest remaining earthworks of the Mound-Builders.

MOUNET-SULLY, JEAN (1841–1916), French actor, was born at Bergerac, on Feb. 28, 1841. He entered the Conservatoire at the age of 21 and took the first prize for tragedy. He served in the war of 1870–71, and had almost decided to remain in the army, though he had been acting for two years before the war. But in 1872 he was asked to play the part of Oreste in *Andromaque* at the Comédie Française. His success in that part assured his return to the stage, and in 1874 he became a *sociétaire*. Perhaps his most famous rôle was that of Oedipus in *L'Oedipe roi*, by Jules Lacroix. This was first performed in the old Roman amphitheatre at Orange in 1888. Mounet-Sully's other famous parts were Achille in Racine's *Iphigénie en Aulide*, Hippolyte in *Phèdre*, Hamlet, the title parts in Victor Hugo's *Hernani* and *Ruy Blas*, Francis I. in *Le Roi s'amuse*, and Didier in *Marion Delorme*. He was created chevalier of the Legion of Honour in 1889. He wrote a play, *La Buveuse de larmes*, and in 1906, in collaboration with Pierre Barbier, *La Vieillesse de Don Juan* in verse. Mounet-Sully died in Paris on March 1, 1916.

MOUNT, WILLIAM SIDNEY (1807–1868), American artist, was born at Setauket, Long Island, N.Y., on Nov. 26, 1807. He studied in the schools of the National Academy of Design, New York, and in 1832 was made a full academician. Among his better-known works are "Turning the Grindstone" and "Farmer's Nooning," Jonathan Sturgis collection; "Turn of the Leaf," Lenox library, New York; "Bargaining for a Horse," New York Historical Society; "Raffling for a Goose," M. O. Robert's collection; "Long Story," Corcoran art gallery, Washington, and "War News," Metropolitan Museum of Art, New York. He died at Setauket, Long Island, on Nov. 19, 1868. His brother, Shepard Alonzo Mount (1804–1868), also an artist, best known as a portrait painter, became a National Academician in 1842.

MOUNTAIN, properly connotes a natural elevation of the earth's surface superior in height to that of a hill; but the distinction often depends on the prominence of a given elevation in relation to its surroundings.

For the classification of mountains according to the various processes of their formation, *see* GEOGRAPHY and GEOLOGY.

MOUNTAIN, THE (*La Montagne*), the name applied during the French Revolution to a political group, whose members, called *Montagnards*, sat on the highest benches in the Assembly. The term, which was first used during the session of the Legislative Assembly, did not come into general use until after the meeting of the National Convention in Sept. 1792. During their struggle with the Girondists, the Montagnards gained the upper hand in the Jacobin club, and for a time Jacobin and Montagnard were synonymous terms.

MOUNTAIN ASH, an urban district of Glamorganshire, Wales, in the Aberdare valley on the Cynon, a west bank tributary of the Taff, 18 m. N.E. of Cardiff, served by the G.W.R. Pop. (1931) 38,381. A branch of the Glamorganshire canal passes through the place. At the beginning of the 19th century Mountain Ash was a small village known only by its Welsh name of Aberpenar, but from 1850, with the development of its collieries, the population rapidly increased. The district has an area of 10,504 ac. and comprises, besides Mountain Ash, a string of villages, the chief being Cwmpenar, Penrhiwceiber, Abercynon and Ynysybwl. The development of the region is associated with the coal exporting phase in the rise of the South Wales industrial area. Trade depression after the World War has seriously affected this region. Mountain Ash shares with Merthyr and Aberdare the services of a stipendiary magistrate.

MOUNTAIN ASH (*Pyrus Aucuparia*). A tree of the rose family (Rosaceae: tribe Pomeae), native to Europe and Asia, so called from its resemblance to the true ash in its smooth grey bark, graceful ascending branches, and the form of the leaf. It is known in Scotland as the rowan tree. The mountain ash attains a height of 50 ft. and is widely cultivated for its handsome foliage and bright red clustered fruit both in Europe and North America where it is sparingly naturalized. The American mountain ash (*P. americana*), a similar but smaller tree, likewise grown for ornament, is native from Newfoundland to Manitoba and south to New York and Minnesota and in the mountains to North Carolina and Tennessee. The still smaller often shrublike western mountain ash (*P. sambacifolia*) occurs from Labrador to New England and north-westward to Alaska and Washington and southward in the Rocky Mountains to Colorado and Utah. By many botanists the mountain ash is separated from the genus *Pyrus* and regarded as part of the genus *Sorbus*.

MOUNTAINEERING, the art of moving about safely in mountain regions avoiding the dangers incidental to them and attaining high points difficult of access. The basis of it is discovery, and in its methods it bears a strong likeness to navigation, demanding many of the same qualities, such as foresight, endurance and ceaseless vigilance. It often resembles arctic exploration and, as its scale increases, partakes more and more of the character of a military expedition. It forms two main divisions, rockcraft and snowcraft. Rockcraft consists in the intelligent choice of a line of route and in activity and gymnastic skill to follow the line chosen. In snowcraft the choice of route is the result of a full understanding of the behaviour of snow under a multitude of varying conditions; it depends largely upon experience and much less upon agility. The dangers, to avoid which the craft of climbing has been developed, are of two main kinds; the danger of things falling on the traveller and the danger of his falling himself. The things that may fall on him are rocks, ice or snow, and he may fall from any one of them or into crevasses in ice. There are also dangers from weather. Thus in all there are eight chief dangers.

Falling Rocks.—Every rock mountain is falling to pieces, the process being specially rapid above the snowline. Rock faces are constantly swept by falling stones which it is generally possible to dodge. Falling rocks tend to form deep and wide channels (*couloirs*) in a mountain face and these channels have to be ascended with caution, their sides being often safe while the middle is stone-swept. Stones fall more frequently on some days than on others according to the recent weather. Local experience is a valuable help on such occasions. The direction of the dip of rock strata often determines whether a particular face is safe or dangerous. The character of the rock must also be considered. Where stones fall frequently débris will be found below, whilst on snow-slopes falling stones cut furrows which are visible from a great distance. In planning an ascent of a new peak such traces must be looked for. When falling stones get mixed in considerable quantity with slushy snow or water, a mud avalanche is formed (common in the Himalaya). It is necessary to avoid camping in its possible line of fall.

Falling Ice.—The places where ice may fall can always be determined beforehand. It falls in the broken parts (*seracs*) of a glacier and from overhanging cornices formed along the crests of narrow ridges. Large icicles are found on steep rock faces, and these fall frequently in fine weather following cold and stormy days. They have to be avoided like falling stones. Seracs are slow in formation and slow in arriving (by glacier motion) at a condition of unstable equilibrium. They generally fall in or just after the hottest part of the day and their débris seldom goes far. A skilful and experienced ice-man will usually devise a safe route through the most intricate ice-fall, but such places should be avoided in the afternoon of a hot day. Hanging glaciers (*i.e.*, those perched on steep slopes), often discharge themselves over

steep rock faces, the snout breaking off at intervals. They can always be detected by their débris below. Their track should be avoided.

Snow Avalanches.—These mainly occur on steep slopes when the snow is in bad condition, early in the year, or after a fresh fall. Days when snow is in that state are easily recognized and then it may be inadvisable to traverse snow-slopes which at other times may be as safe as a high road. Beds of snow collected on rock ledges in bad weather fall off when a thaw comes and are dangerous to rock-climbers. Snow which has recently fallen upon ice-slopes is always liable to slip off bodily. Such falling masses generally make the lower part of their descent by couloirs. Snow avalanches never fall in unexpected places, but have their easily recognizable routes, which can be avoided in times of danger by experienced mountaineers.

Falls from Rocks.—The skill of a rock-climber is shown by his choice of handholds and footholds and his adhesion to those he has chosen. Much depends on a correct estimate of the firmness of the rock where weight is to be thrown upon it. Many loose rocks are quite firm enough to bear a man's weight, but experience is needed to know which can be trusted, and skill is required in transferring the weight to them without jerking. On all difficult rocks the rope is the greatest safeguard for all except the first man in the ascent, the last in the descent. In such places a party of three or four men roped together 15 or 20 ft. apart will be able to hold up one of their number if only one moves at a time and the others are firmly placed and keep the rope tight between them, so that the fall of an individual may be arrested before his velocity is too great. In very difficult places help may be obtained by throwing a loose rope round a projection above and pulling on it; this method (*abseil*) is specially valuable in a difficult descent and has been skilfully developed by Austrian climbers.

The rope usually employed is a strong manila cord, though flax and silk are used by some. On rotten rocks the rope must be handled with special care lest it should start loose stones on to the heads of those below, and similar care is needed for handholds and footholds. When a horizontal traverse has to be made across difficult rocks, a dangerous situation may arise unless there be firm positions at both ends of the traverse. Even then the end men gain little from the rope. Mutual assistance on hard rocks takes all manner of forms; two or even three men climbing one upon another's shoulders or holding up an ice axe to form a foothold for the leader. The great principle is that of co-operation, all the members working with reference to the others and not as independent units; each when moving must know what the man in front and the man behind are doing. After bad weather steep rocks are often found covered with a veneer of ice (*verglas*) which may even render them inaccessible. Climbing irons (*crampons, steigeisen*) are useful on such occasions.

Ice and Snow-slopes.—Crampons are also most useful on ice or hard snow, as by them step-cutting can be reduced and the footing at all times rendered more secure. True *ice*-slopes are rare in Europe though common on tropical mountains, where newly fallen snow quickly thaws on the surface and becomes sodden below, so that the next night's frost turns the whole into a mass of solid ice. An ice-slope can only be surmounted by step-cutting. For this an ice-axe is needed (*pickel, piolet*), the common form having a steel head with an adze-like blade on one side and a long spike on the other at the end of a stick as long as from the elbow to the ground. This serves also as a walking-stick and is furnished with a spike at the foot. Snow slopes are very common and usually easy to ascend. A big crevasse called a *bergschrund* is often found at the point where the steeper final slopes join the glacier or snowfield. Such schrunds are generally too wide to stride across and a snow bridge must be sought, not to be crossed without careful testing and a painstaking use of the rope. A steep snow-slope in bad condition may come away bodily in the shape of an avalanche. Such slopes are less dangerous if ascended directly rather than obliquely; for a line of steps crossing the slope tends to sever it and cause a part to break away. New snow lying on ice is specially dangerous. Experience is needful for deciding on the advisability of advancing over snow in doubtful condition. Snow on rock is usually rotten unless it be thick; snow on snow is likely to be sound. A day or two of fine weather brings snow into sound condition. Snow cannot lie at very steep angles, and seldom exceeds an angle of 40°, though it often deceives the eye. Ice-slopes may be much steeper. In early morning snow is usually hard and safe, but in the afternoon quite soft and possibly dangerous; hence on big mountains a large portion of the work is done before dawn.

Crevasses.—These are the slits or chasms formed in the substance of a glacier, mainly at right angles to its line of movement as it passes over an uneven bed. They may be open or hidden. In the lower part of a glacier they are open. Above the snowline they are frequently hidden by arched-over accumulations of snow and the detection of them then requires care and experience. After fresh snow they can only be discovered by sounding with the pole of the ice-axe, or by looking to right and left where the extension of a hidden crevasse may be traceable. The safeguard against accidents is the rope and no one should ever cross a snow-covered glacier unless roped to one, or better to two, companions.

Weather.—Cold and wet bring the menace of frostbite to toes and fingers, but the main group of dangers caused by bad weather centres in the changes it makes in the condition of snow and rock, making ascents suddenly perilous which before were easy and so altering the aspect of things as to make it hard to find the way or retrace a route. Speed is of vast importance as giving the weather less time for change, so that, broadly speaking, the difficulty of a mountain varies as the height and distance of its summit from the nearest bed. In storm the man who can work by compass has great advantage over a merely empirical follower of his eyes. In large snowfields it is, of course, easier to go wrong than on rocks, but a trained intelligence is the best companion and the surest guide.

Outfit.—Clothing should be as near as possible windproof and wetproof, and coloured or smoked glasses are essential as a protection against the glare of the snowfields; great attention must be given to footgear. For all-round use nothing beats the heavy leather boot suitably nailed; but for special conditions the *abarca* (a crude Spanish moccasin), the *Kletterschuh* (a rag-soled slipper, giving wonderful grip on Dolomite rock), the grass shoe of India and the *alpargata* or *spadrille* of Spain, with its thick and springy hempen sole, are extremely useful. For certain kinds of slabby and difficult rock, thin rubber soles are indispensable.

HISTORY

Systematic mountaineering, as a sport, is usually dated from Sir Alfred Wills' ascent of the Wetterhorn in 1854. The first ascent of Monte Rosa was made in 1855. The Alpine club was founded in London in 1857 and soon imitated in most European countries. Edward Whymper's ascent of the Matterhorn in 1865 marks the close of the main period of Alpine conquest, during which the craft of climbing was invented and perfected, the body of professional guides formed and their traditions fixed.

Passing to other ranges, the exploration of the Pyrenees by Ramond, Packe, Russell and others was concurrent with that of the Alps. The Caucasus followed, mainly owing to the initiative of D. W. Freshfield; it was first visited by exploring climbers in 1868, and most of its great peaks were climbed by 1888. Trained climbers turned their attention to the mountains of North America in that year when the Rev. W. S. Green made an expedition to the Selkirks. From that time exploration has gone on apace, and English and American climbing parties have surveyed most of the highest groups of snowpeaks. The Alps of New Zealand were first attacked in 1882 by the Rev. W. S. Green, and shortly afterwards a local Alpine club was founded and by its activities the range was explored. In 1895 E. A. Fitzgerald made an important journey in this group. Of the high African peaks Kilimanjaro was climbed in 1889 by Dr. Hans Meyer; Mt. Kenya in 1889 by J. E. S. Mackinder and a peak of Ruwenzori by H. J. Moore in 1900.

The Asiatic mountains have as yet been little climbed, though those that lie within the British empire have been surveyed. In

1892 Sir Martin Conway explored the Karakoram Himalayas and climbed a peak of 23,000 ft. In 1895 A. F. Mummery was lost while exploring Nanga Parbat; in 1899 D. W. Freshfield journeyed to the snowy regions of Sikkim, and in 1899, 1903, 1906 and 1908 Dr. and Mrs. Workman made numerous ascents in the Himalaya, including one of the Nun Kun peaks (23,300 ft.). A number of Gurkhas trained in mountaineering by Brig.-Gen. C. G. Bruce have done good service to many explorers.

In 1907 C. G. Bruce, T. G. Longstaff and A. L. Mumm explored the mountains of Garhwal and Kumaon, and Longstaff with A. and H. Brocherel ascended Trisul (23,406 ft.). In 1906 an expedition under the leadership of the Duke of the Abruzzi explored the range of Ruwenzori, on the borders of Uganda and the Congo, and among his ascents were those of Margherita Peak (16,815 ft.) the highest point, Alexandria Peak (16,749 ft.), Elena Peak (16,388 ft.) and Savoia Peak (16,339 ft.).

The most important event of the period 1910–25 was, of course, the assault on Mt. Everest, which is the subject of a separate article (*q.v.*). Everest, however, did not monopolize the attention of Himalayan explorers. Useful work was accomplished by the Workmans during 1911 and 1912 in the Karakoram, by C. F. Meade in the Garhwal Himalaya, by Mr. and Mrs. Visser, by Kellas (who reached a height of 22,700 ft. on Kangchinjhau), and Major H. D. Minchinton, who lost his life in the Himalaya in 1927, did good work in 1926 while on a survey expedition to the Shaksgam district.

The main exploration of the New Zealand Alps was completed before 1910, but Harold Porter's two expeditions (1923 and 1925) proved that interesting pioneer work still awaits the explorer. The Caucasus has been closed to mountaineers since the World War. A British expedition in 1914 made a number of new ascents. Norway still offers the prospect of virgin climbs. Stedtind, described by Cecil Slingsby as "probably the most natural obelisk in the world and the greatest prize in all Scandinavia" was climbed in 1910 by C. W. Rubenson and friends. Three Oxford expeditions to Spitsbergen in 1921, 1923 and 1924, accomplished some excellent work.

Alpine Climbing.—In the Alps practically every peak had been ascended by 1910. No individual climber has a longer list of successes to his credit than G. W. Young. In 1911, with Professor H. O. Jones (killed soon afterwards in the Mt. Blanc range), he completed the ascent of the Brouillard ridge of Mt. Blanc, and achieved the first complete traverse of the great west ridge of the Grandes Jorasses and the first descent of the ridge that descends to the Col des Hirondelles. With Jones and Todhunter, G. W. Young made the first ascent of the Mer de Glace face of the Grepon, and climbed the Gespaltenhorn by the terrible west ridge, perhaps his finest performance. His leading guide on all these climbs was Joseph Knubel, of St. Niklaus. Among other first-class climbs by British mountaineers may be mentioned the conquest of the south face of Mt. Blanc by Oliver and Courtauld with the brothers Aufdenblatten in 1923, and the first crossing of the north face of the Dent d'Herens by a guideless party led by George Finch. The direct ascent of this face was achieved by Weizenbach and Allwein in 1925. The guideless conquest by Raeburn and Ling of the north face of the Disgrazia deserves mention, and also the new Brenva route made in 1927 by F. S. Smythe and T. G. Brown, for the British mountaineers with new climbs to their credit during this period have mostly had to divide it with their guides. On the other hand the Everest expeditions were guideless, as was some of the work done on the American continent by men of the Anglo-Saxon race.

Among other fine Alpine climbs of this period may be mentioned the north arete of Piz Badile by A. Zurchner, led by the guide Walter Risch, an exposed and difficult climb. The ascent of the north face of the Lauterbrunnen Breithorn by Chervet and Richardet, and the variation route taken by Lauper and Liniger up the north face of the Mönch, rank among the great mountaineering exploits, involving as they did, difficult work both on rock and ice. Richardet, Lauper and Chervet were members of the Akademischer Alpen club, Berne. The students of the Berne and Zurich universities have long been known for their mountaineering exploits. One of the last classic problems of the Oberland, the ascent of the Mittelegi ridge of the Eiger, was also solved during this period by a Japanese climber, Yuko Maki, led by the great Grindelwald guide, F. Amatter. Artificial aids were employed for this climb.

French Guideless Climbing.—A great feature of post-World War mountaineering has been the revival of French guideless climbing. Before the war, French climbers of the type of Fontaine were few. Since the war the guideless "Groupe de Haute Montagne" of the French Alpine club have to their credit a consistent record of brilliant work, combining the spirit of adventure with the sane British tradition. The "G.H.M." has been engaged in cairning the last untouched pinnacles of Mt. Blanc, and among its most brilliant achievements may be mentioned the ascent of the north face of the Aiguille du Plan by Lagarde, de Lepiney and de Segogne in 1924.

German Mountaineering.—In the Dolomites and the Kaiser Gebirge German and Austrian climbers have done some very remarkable climbs, but their successes have been paid for by an increasing death-roll. There is a grave tendency among German climbers to take chances, to risk bad weather and impromptu bivouacs. In severity there is nothing to choose between the climbs achieved in the eastern Alps and the new routes which have been made in Cumberland.

The Canadian Alps.—Exploration of the Canadian Alps has been very active. Many fine expeditions have been made, especially by A. H. MacCarthy, Howard Palmer and E. W. D. Holway. Of outstanding importance were the ascents in 1913 of Mt. Robson, culminating summit of the Canadian Rockies (12,972 ft.) by A. H. MacCarthy and W. W. Foster with the Austrian guide Conrad Kain; of Mt. Sir Sandford (11,590 ft.) and of Mt. Adamant (10,980 ft.) by Holway and Palmer; of Mt. Alberta (11,874 ft.) by Yuko Maki of Tokyo and five other Japanese with H. Fuhrer and H. Kohler, and Mt. Woolley (11,170 ft.) by the same party, and the most magnificent achievement of all, the 1925 first ascent of Mt. Logan (19,850 ft.) by a joint party of Canadian and American mountaineers led by A. H. MacCarthy.

No mountain in the Canadian Alps outside the Yukon approaches in technical difficulty a first-rate expedition in Europe. There is less risk of avalanches and the glaciers are much less complicated—on the other hand long distances have to be traversed, while the arranging of transport and camps is a big and expensive business. There is still room for much exploration, although most of the highest peaks in the various groups have been attained, including practically all in the Rockies above 11,000 ft., about 50 in number.

Recent books on special topics are:—
Himalayas: H. R. H. Prince Luigi Amadeo, duke of the Abruzzi, *Karakoram and the Western Himalaya* (1909); Hon. C. G. Bruce, *Twenty Years in the Himalayas* (1910), and *Kulu and Lahoul* (1914); Filippo de Filippi, *Storia della Spedizione Scientifica Italiana nel Himalaia Caracorum* (Bologna, 1924). (*See* also EVEREST.)
The Alps: Sir Claud Schuster, *Peaks and Pleasant Pastures* (1911); Prof. T. G. Bonney, *The Building of the Alps* (1912); Rev. W. A. B. Coolidge, *Alpine Studies* (1912); A. Steinitzer, *Der Alpinismus in Bildern* (1913); Guido Rey, *Peaks and Precipices* (1914); Walter Larden, *Recollections of an Old Mountaineer* (1919); Sir Martin Conway, *Mountain Memories* (1920); F. F. Tuckett, *A Pioneer in the High Alps* (1920); Douglas W. Freshfield, *Life of H. B. de Saussure* (1920), and *Below the Snow Line* (1923); G. I. Finch, *The Making of a Mountaineer* (1924); W. Lehner, *Die Eroberung der Alpen*.
Canada: Howard Palmer, *Mountaineering and Exploration in the Selkirks* (1914); Leroy Jeffers, *The Call of the Mountains* (1923); J. M. Thorington, *The Glittering Mountains of Canada* (1925); Howard Palmer and J. M. Thorington, *A Climber's Guide to the Rocky Mountains of Canada* (1922).
Other Ranges: Malcolm Ross, *A Climber in New Zealand* (1914); Rev. Walter Weston, *The Playground of the Far East* (1918); R. C. Carr and G. H. Lister, *Mountains of Snowdonia* (1925).
(W. M. C.; A. Ln.; X.)

UNITED STATES

Organized mountaineering in America dates from the founding of the Appalachian Mountain club in Boston in 1876 "to explore the mountains of New England and adjacent regions." At that time New England possessed many peaks that had not been climbed. The more active spirits of the club turned their atten-

tion to "the adjacent regions"—a phrase given a most liberal interpretation—with the result that a number of prominent peaks in Colorado capitulated between 1886 and 1889. Following this, the newly opened region of the Canadian Alps came into favour (1890–1900), and members of the club played an important part in exploring their summits. Now, most of the club's activities are in New England. The club had about 4,400 members in 1928.

American mountaineering in its more technical alpine sense was advanced materially by the founding in 1902 of the American Alpine club. This aimed to include in one group the kindred interests of alpinism and arctic exploration; to combine the travellers of high latitudes with the travellers of high altitudes. A more than superficial standard of attainment in both fields was required for membership, and it occupies a distinguished place among mountaineering organizations of the country. In 1916 it established the Bureau of Associated Mountaineering clubs of North America, which in the next 10 years grew to include 71 clubs and societies possessing a combined membership of over 100,000 people. The club contributed substantially, both with funds and personnel, to the successful Mt. Logan expedition of 1925.

In the United States, most of the mountains are of subdued relief, simple in contour and clothed to a large extent with forests. East of the Mississippi river, the highest peaks of the Appalachian system do not much surpass the timber-line and of course fall far short of the line of perpetual snow. In the Western States, the peaks rise farther above timber-line, but again not sufficiently to bring their summits into the realm of perpetual snow, except in the cases of certain isolated volcanic cones. The mountains for the most part resemble the Eastern type, though on a larger and more jagged scale. Dominating peaks may indeed bear large snow banks the year around, and occasional residual glaciers may be found tucked away in sheltered cirques, but in no sense do they challenge the attention of skilled alpinists. As possible exceptions to this generalization may be noted the comparatively compact group of the Olympic mountains in Washington (Mt. Olympus, 8,250 ft., is the highest), the Rockies of Glacier National Park, dominated by Mt. Cleveland (10,438 ft.), the range of the Tetons in Wyoming, of which the Grand Teton (13,747 ft.) is primate, and Mt. Moran (12,100 ft.) next in prominence, the whole perhaps constituting the nearest approach to a genuine alpine configuration to be found within the bounds of the United States proper. (*See* Rocky Mountains, The, and National Parks.)

Colorado and California, despite the multitude and the grandeur of their mountains, fail to satisfy a rigorous alpine standard, although admittedly containing individual summits where technical proficiency in rock climbing does not come amiss. In Colorado are to be found 46 peaks surpassing 14,000 ft. and 300 surpassing 13,000 ft. The best climbs are Lizard Head, first ascended in 1920, and Crestone Needle (14,191 ft.), first ascended in 1916. Difficult rock routes are to be found on many of these great peaks, but there is always an easy side. The Sierras of California boast of the highest peak in the United States, Mt. Whitney (14,501 ft.), and 11 mountains above 14,000 ft. and 150 exceeding 13,000 feet.

This great complex of mountains in the western United States has brought into being a number of organizations devoted to their exploration and conquest—the Sierra club of San Francisco (1892) including some 3,000 members; the Mazamas of Portland (1894) with over 700 members; the Mountaineers of Seattle (1907) having some 850 members and the Colorado Mountain club of Denver (1912) with some 1,200 members. It would not be proper to classify the field work usually accomplished by these organizations as genuine alpine climbing, which is conditioned by the presence of ice and snow as a predominant feature. These great peaks for the most part simply duplicate the winter conditions of such groups as the Adirondacks or White mountains and require no strategy to surmount them.

Such work, however, affords practice on snow slopes and glaciers and may easily develop a penchant for the craft in its advanced aspects. Recently Pacific Coast clubs have visited distant districts where alpine climbing proper could be secured.

Alaska.—Alaska is world-famous for its gigantic mountains and prodigious glaciers, but such climbing as has been accomplished has partaken more of the nature of arctic expeditions than of ordinary mountaineering.

Entirely in character with this land of superlatives is Mt. McKinley (20,300 ft.), the culminating point of North America. Its apex was first attained in 1913 by Dr. Hudson Stuck and Harry P. Karstens in an expedition of three months duration. The previous year Messrs. Browne, Parker and La Voy were driven back by a storm when just short of the summit, a most disheartening climax to their three seasons of persistent and plucky exploration against heavy odds. The North Peak (some 20,000 ft.) was ascended in 1910 by William Taylor and Pete Anderson, Alaska prospectors. Mt. Logan (19,850 ft.), next in rank, was conquered in 1925 by a joint party of Canadian and American mountaineers led by A. H. MacCarthy. It comprised Messrs. H. F. Lambart, W. W. Foster, Allen Carpe, N. H. Read, H. S. Hall, R. M. Morgan and A. Taylor. They were in the field upwards of six weeks, more than half of which was spent on the ice at elevations exceeding 14,000 feet. Two arduous preliminary expeditions, totalling three months and a half, had been made by MacCarthy in establishing supply depots and selecting a route.

Mt. St. Elias (18,024 ft.) was the first great Alaskan peak to fall to the assault of mountaineers. It was ascended in 1897 by a party of ten under the leadership of Prince Luigi, duke of the Abruzzi, following the route explored by I. C. Russell in 1890–91. Mt. Blackburn (16,140 ft.) was conquered in 1912, by Miss Dora Keen and G. W. Handy. The expedition occupied five weeks, of which 13 days of storm were weathered in ice caves dug in the glaciers. The party utilized six men and eight dog sleds for transport. Mt. Wrangel (14,005 ft.), an active volcano, was ascended in 1908 by Robert Dunn and William T. Soule. Mt. Natazhat (13,480 ft.) capitulated in 1913 to an attack by a boundary survey party under the direction of H. F. Lambart, who later ascended Mt. Logan. On no other mountains in the world must the climber live so long on snow and ice as in Alaska, and nowhere else must continuous gradients of snow from 14,000 to 17,000 ft. in height be overcome. (H. Pal.)

MOUNTAIN LAUREL (*Kalmia latifolia*), a North American shrub of the heath family (Ericaceae), called also calico-bush and spoonwood. It is native chiefly to rocky soils from New Brunswick to Ontario and southward to Florida and Louisiana. Usually it is a shrub with very stiff branches, forming dense thickets, 10 to 20 ft. high, but may become a tree 40 ft. high. It bears smooth, oval, pointed laurel-like leaves and handsome pink or white flowers, about 1 in. across, in large terminal clusters.

MOUNTAIN SICKNESS: *see* Anoxaemia.

MOUNTAIN WARFARE. The difficulties attending the prosecution of a campaign in mountains arise primarily from the physical features of the theatre of operations; and secondly, in a marked degree, from the effect those features have in moulding the character of the inhabitants.

Lack of Communications.—A mountainous district is, as a rule, undeveloped; and the means of communications, where any exist, are indifferent or bad. An invader is tied to certain existing roads or tracks as the only method of advance, and has little scope for effecting surprise by means of alternative routes. The observation which the defender can obtain from the hill tops is as good as, and in some ways better than, can be obtained by the invader from aeroplanes. As a result, the invader's intentions can be grasped almost from the start and the uncertainty common to war in normal theatres is largely discounted. The country is usually barren, and all supplies and stores for the invading force have to be carried into the country. Since communications usually consist of mere tracks, or of some boulder-strewn dry river bed, "pack" is the only possible means of transport. Consequently the invading commander is burdened with the guarding of long lines of slow-moving pack animals, and, owing to the fact that they have to convey their own and their drivers' food, they are able only to carry a relatively small useful load.

The climatic conditions in mountains tend to extremes of heat and cold. Changes in weather conditions are also sudden. The melting of snows or the bursting of a thunderstorm in the mountains may mean the flooding of the valley forming the route of

advance, and the washing away of the line of communications "road," which has often been cut out with great labour.

Characteristics of the Inhabitants.—The nature of their surroundings reacts, as elsewhere, on the characteristics of the inhabitants. Their life consists of a struggle with nature. The ease and luxury of the plains is absent. They live scattered in small hamlets close to such patches of ground as will yield to cultivation. Industries are based on the village system, and the local weavers, potters, carpenters and so on supply the needs of the small community. There is no centralised life as in the plains. The inhabitants of a given area (probably emanating from a common stock) usually own a tribal allegiance to each other, but are often again sharply divided into sub-tribes, the boundaries of which are the valleys which they inhabit. Life is hard, and only the physically fit survive early childhood. As a result the characteristics of mountaineers are exceptionally sound physique, bravery, great powers of endurance and ability to thrive on the bare necessities of life. They are, moreover, usually intensely patriotic (for it is a curious and almost universal fact that the wilder a man's country the more attached he is to it). Finally, they fight in mountains in their own element, on ground to which they are accustomed, and which confers on them a mobility twice as great as that of the invading plainsmen.

The above are valuable military attributes. But they are to some extent offset by others. The highly individualistic life in the mountains, whilst leading to an admirable independence, also leads to a lack of centralised purpose and interest. Whilst patriotism for the clan is great, patriotism for the sub-tribe is sometimes greater. There is consequently a tendency toward absence of cohesive effort if the operations be going adversely. This lack of cohesion renders them peculiarly averse to night operations, the success of which against mountaineers is noteworthy throughout history, though it must be added only when most carefully organised and prepared. Nevertheless, mountaineers have always been difficult opponents to overcome.

Operations of Two Kinds.—The consideration of operations in a mountain theatre falls naturally under two heads. First are operations in an area such as the Austro-Italian frontier. There, though the mountains exist, the area has been considerably opened up. Communications are relatively good; heavy stores can be brought up. The forces on both sides are possessed of all the appliances of war. Better theatres for operations exist on the flanks of the mountains, and it is there that the real struggle will be fought out. Neither attacker nor defender is in reality a true mountain race, for national armies are taking part. As a result, the operations tend more and more to take the colour of normal operations in the plains, modified, no doubt, but lacking most of the characteristics of campaigns against true mountaineers. Second are operations in an undeveloped mountain theatre against semi-civilised inhabitants. In describing them the theatre of the North West Frontier of India is taken as an instance.

MOUNTAIN WARFARE IN SEMI-CIVILIZED COUNTRIES

The inhabitants of this area possess all the characteristics noted above. As regards supply during operations, they normally carry seven to 10 days' food on them, and consequently are untroubled by anxiety about their line of communication. They are armed only with rifles and knives. But the rifles are modern for the most part; and it is for consideration whether the power of mobility conferred by such an armament and supply system does not largely compensate for the absence of artillery and other arms. A commander entrusted with the subjugation of a frontier tribe has a difficult task before him. It may be possible to overawe the tribe by air action alone. But targets for aerial attack are limited in such a form of society, and if the opposition of the tribe be determined, air action alone, will seldom suffice; an advance over the ground will, as a rule, be necessary.

Planning the Campaign.—The first difficulty is to select the objective. It can be said at once that the true objective is to bring the enemy to battle. But how is it to be done? Owing to absence of lines of communication, the enemy's strategical mobility is always superior. Owing to his upbringing, his tactical mobility is also superior, except against the best hill troops. Normally, a threat against an enemy's capital forces him to interpose, and brings on a battle. Here, the enemy may not consider any of his hamlets worth defending resolutely. He may prefer to adopt a purely guerrilla attitude, to be ubiquitous, and to worry the advance. That is the most difficult problem to deal with. As a rule he is ready to oppose an advance with resolution in measure as his hopes stand high. If defeated, he tends towards more guerrilla methods. A commander therefore has usually to select the line of advance most likely to produce massed resistance. In doing so he can advance as one column, or by several columns up several valleys. The first method has the advantage of simplicity and of inviting the enemy to concentrate. But the larger the force on one track the slower the movement, and so, if the enemy seeks to avoid decisive battle, the less hope there is of achieving it. A move in several columns has the advantage of speed, and gives greater hope of cornering an elusive enemy. But it involves a series of lines of communication, and is attended by all the difficulties of co-operation and mutual support between columns when separated by mountain ranges.

Progress of Operations.—Whatever the plan the method of conducting operations follows a fairly uniform course. The force advances up a valley protected by a strong advanced guard. This advanced guard throws out detachments to seize and hold tactical points on the hills flanking the valley, and so securing the advance of the column below. These detachments (or "piquets") are withdrawn by the rear guard when the column has passed. Since all commanding ground within rifle range must be denied to the enemy, it is clear that piquets often have to establish themselves 2,000 yd. from the column, and to climb 1,000 ft. or more. The process is therefore laborious and slow, and limits the length of march possible in a day.

Defence at Night.—For the night, all-round defence is essential against so ubiquitous an enemy. Arrangements therefore take the form of a central camp, protected by self-contained piquets posted on tactical points round the camp. These piquets must be sufficient in number, and be placed far enough out, to prevent the enemy firing into camp at night. But since complete protection against such sniping is impossible, a considerable amount of protection against fire has to be provided within the camp. The camp itself has also to be designed and organised to resist assault. It will be realised that there is, in consequence, an immense amount of heavy work to carry out at the end of an exhausting day's advance. Moreover, it is of primary importance that all movement shall have ceased and the camp be made entirely secure before dark. Because, though (as stated above) organised night operations frequently prove successful, unorganised movements are disastrous in face of a ubiquitous enemy who holds the initiative.

It is frequently necessary to raid and destroy villages in order to induce the enemy to stand and fight. Such raids need careful organisation in order to insure that the work is efficiently done in the time available. Raids are usually carried out in various directions, radially, from some semi-permanent camp, the force going out early and returning to camp before dark. The retirement is almost always followed up, and it is in harrying a retirement that the enemy is most dangerous. A running fight (with all its disadvantages) is unavoidable, because the enemy has no columns or guns moving on a road to deploy, but merely follows up deployed. The art of conducting such a retirement consists in the careful and timely laying out of troops in successive positions, so that the retreat of the rearmost is always efficiently covered, and in the skilful co-operation of fighting aeroplanes.

For the defence of the line of communication the system is a chain of piquets in assault proof posts dominating the route. These posts, often 2,000 ft. above the valley, have to be strongly built of dry stone, wired, and the garrisons supplied with food and water for (say) 10 days. It is obvious that the work involved is laborious. At suitable intervals on the line of communication larger posts are established capable of accommodating the convoys passing through. These posts also contain the mobile reserve for their section of the line of communication.

An Example.—Perhaps a small example will best illustrate the difficulties which beset a commander in mountain warfare. A force of four battalions (and attached troops) camps for the night. It is found necessary to use one company per battalion for camp piquets. Next morning the advance continues, but owing to the necessity for an early start it is impossible to relieve the piquets before moving. They must be withdrawn by the rearguard and rejoin units later. So the advance begins with all battalions only three companies strong. "A" battalion gives two companies as advanced guard, one available for piqueting. "B" is allotted entirely for piqueting. "C" heads the main body. "D" finds two companies for rearguard and one as baggage escort. In the advance it is found that piqueting is heavy, that an average of a company to a mile is needed. The force advances four miles (which means that the remaining company of "A" and all "B" battalion are used up on piquet) and is confronted by 1,500 enemy in position. In theory, a brigade is confronted by 1,500 men. In practice 1,500 men are being faced by the two advanced guard companies and the three companies of "C" battalion, perhaps actually some 500 or 600 in all; for that is all that the commander has immediately available. The above crude example is typical of the dispersion of resources inherent in mountain warfare.

As regards mountain warfare in general, history appears to point to two main lessons: firstly, that the true subjection of mountaineers can only be arrived at by opening up and developing the country. Short of that, they may be overawed and pacified for a time, but a change in the undeveloped and individualistic conditions of life is essential to their permanent pacification. Secondly, that if the operations for their primary subjugation are to be quickly and successfully carried out, the forces engaged must be definitely trained to the task, and the personnel composing the force should, as far as possible, be composed of men bred in mountains. (J. P. V.-S.)

MECHANIZATION IN MOUNTAIN WARFARE

With nations which may have to wage war in mountainous countries, and especially with colonial empires, such as the British and the French, military organisation is complicated by the terrain, for obviously mechanized weapons are more suited for warfare on the plains, and the older arms, particularly infantry and mountain artillery, for warfare in the mountains. Generally speaking hill tribes are of an independent spirit, and their social organisation being extremely fluid there is no political centre to strike at, consequently, to bring them to book, they must either be defeated in the field, or their villages, herds or crops must be destroyed. Whilst, until recently, most hill tribes have been indifferently armed when compared to the soldiers of civilised countries, to-day many of them are well equipped with modern rifles, and as they possess a far higher mobility than the drilled soldier, the problem of mountain warfare has become more and more difficult.

In these operations tactics are normally subordinated to the problem of supply, supply being most arduous because of lack of roads, and the difficulty of keeping roads, tracks and valley approaches free from flanking fire. On the North West Frontier of India this problem has been partially solved by constructing a network of strategical lorry roads, and to keep them open armoured cars have proved themselves most useful weapons, since being bullet-proof they reduce the necessity for close road picketing. Should the supply vehicles be also armoured this necessity will still further be reduced, and it will then be possible in all areas traversed by a road rapidly to reinforce and supply in bulk distant garrisons without extensive picketing of the hills; quite possibly whilst the convoys are running this protective duty will be taken over by the aeroplane.

Turning now to the tactical side, the use of the small Renault tank by the French in Morocco has not proved satisfactory. The reason for this is not so much the difficult nature of the ground, as the inefficiency of the machine, which is heavy, under-engined, extremely uncomfortable, and which was never designed for mountain warfare. A close and local study of the North West Frontier of India has led the writer to believe that with a suitable tank the advantages to-day possessed by hill tribes can be greatly reduced. The valleys traversed by rivers of any size should normally present few difficulties to the movement of modern tanks, but it must be realised that it is not in the valleys that the tribesmen fight; further, it must be understood that fighting does not usually take place on the summits of the mountains, but along nullahs, and on such eminences which directly command them, the reason being that nullahs are the only natural, and, frequently, possible, avenues of approach, and further that the native villages are built along them.

In the attack on villages two difficulties are normally met with: The village may be surrounded by sodden rice fields which prohibit the approach of wheeled vehicles, or it may be protected by mud or stone towers. To an efficient tracked machine the first will in most cases be readily overcome, but the second presents this further difficulty: Though the tower can be approached in safety, it is normally of great thickness and little liable to damage by field gun shells; how can it be destroyed? Three courses suggest themselves:—

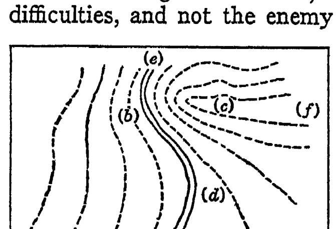
(i.) The tank can haul behind it one or more large oil drums (steel casks) filled with high explosive, and trail these up to the tower, unhitch them close to it, set in action a time fuse, and then retire.

(ii.) The tank can be used as a smoke producing machine, and when the tower is enveloped in smoke, it can be approached by infantry and destroyed in the normal way; or the village can be occupied and its tower, or towers, besieged.

(iii.) The tank can be moved to the foot of the tower, and shells fired through its loopholes. If these shells are filled with lachrymatory chemicals it will be quite impossible for the tribesmen to remain in occupation.

The approach to the village, in all probability a nullah, may run through a gorge, or Tangi, as it is called on the North West Frontier. It is at these gorges the tribesmen gather, and many of them have to be taken by a frontal attack. For infantry the forcing of a gorge is a particularly difficult and dangerous operation. The tribesmen occupy one or both sides of the gorge, and a frontal attack is costly; consequently, when it is possible, an outflanking movement has to be resorted to, for it is common knowledge that, once the tribesmen become aware that their rear is threatened, they retire.

The diagram shows a typical gorge. The nullah is marked by the letters *a–e;* the gorge is at *b,* and the tribesmen are holding the ridge *c.* To occupy this ridge, if infantry alone are used a frontal attack will have to be delivered from *d* on *c;* or, if the ground permits, a flanking movement will have to be made towards *f.* If light tanks are now introduced, these machines can, along a normal nullah, move from *a* to *e* in a few minutes, and deliver a rear fire attack on *c.* The result will be: either the enemy will be shot down as he evacuates *c,* or he will retire without casualties. In either event the gorge ceases to be an obstacle. It is the overcoming of obstacles, such as towers, gorges and supply difficulties, and not the enemy himself, which presents the main



problems in mountain warfare. From the above it will be seen that mechanized weapons are likely to play an important, if not a leading, part in hill fighting, and especially so in uncivilised countries, for in civilised ones this form of fighting is quite secondary to warfare on the plains. Then it will generally be more profitable to cut the enemy's communications and so starve him into surrender, than to enter the mountainous region and directly attack him.

See J. F. C. Fuller, *On Future Warfare* (1927), chaps. ix., xii. and xiv. (J. F. C. F.)

MOUNTAIN WARFARE IN CIVILISED COUNTRIES

In the mountainous parts of Europe the general principles of the art of war lose none of their force. The conduct of operations must be based upon the same strategical and tactical theories as

hold good in the plain. In practice, however, both strategy and tactics must be adapted to the features of the terrain, which give rise to appreciable differences between the two types of warfare. These will now be illustrated, with reference to the considerations given below.

(a) The experience of those armies that have been most engaged in mountain warfare, particularly the Italian army, whose knowledge is based on countless operations in the Alps during the World War, protracted study, and continual exercises both before and since the war.

(b) Features common to all the mountainous parts of Europe: the division of the ground by the mountains into self-contained areas—main valleys of strategic importance and secondary valleys of tactical importance, both in varying degrees presenting difficulties to the development of operations; great differences of altitude and an alternation of practicable and impracticable zones; scanty and protracted lines of communication, with a limited capacity, along the valleys; yet more scanty lateral communications; marked atmospheric changes; violent meteorological phenomena; and limited resources. Such an environment calls for a special organization; it decides the general character of the operations and influences their strategical, tactical and logistical aspects. The rules given below apply primarily to operations in easier and lower country (mountain operations), but brief remarks will also be made about operations in the high mountains (Alpine warfare) and winter operations.

Organisation.—Peace and war experience suggests the following:—*Infantry of the Line:* pack transport for supporting arms (machine-guns, artillery, bomb-throwers), ammunition and general stores; transport services to be organised separately by battalions, pack transport to be used where possible. For operations at greater altitudes there should be *special infantry* like the Italian *Alpini,* organised on the following lines: recruitment from Alpine districts; mountaineer's special clothing and equipment; supporting arms attached permanently to companies; almost exclusively pack transport, organised by companies so that the latter may be very largely independent. *Artillery:* should be easily dismountable so as to be carried as a rule by pack, or sometimes in pieces on light carts or sledges; high-angle fire is preferable; ammunition sections also should have pack transport, at least in part; men and supplies should be freely allotted for liaison and observation work. *Engineers:* sapper and miner battalions furnished with mining apparatus, explosives, drills and portable telpher systems; wireless telegraph, telegraph, searchlight and heliograph sections with portable equipment. *Auxiliary Services:* kitchens and equipment for portable hospitals are essential; medical corps detachments with plenty of stretchers; supply and evacuation arrangements suitable to mountain roads.

General Features of Operations.—The force that can be employed is limited by a logistical saturation-point that cannot be exceeded; with modern technical resources this point is reached less quickly, and large-scale operations can be developed, provided the principle of seeking a decision in the plain is observed. The strength of the terrain and the consequent difficulty of movement produce a situation favourable to the *defensive,* which has, however, the great disadvantage of entailing immobility. *Offensive operations* are difficult, but highly productive. To overcome the adverse combination of enemy and terrain, manoeuvre and surprise must be employed. The former should be designed to avoid any frontal attack, and should be directed towards the enemy's line of retreat, advantage being taken of the intimate connection between valleys, passes and nodal points of communication. Surprise is favoured by the environment, and assists the development of the manoeuvre. Both are difficult to carry out without a thorough knowledge of the country.

Communications are so scanty that a successful manoeuvre may have incalculable results. In the Battle of the Bainsizza (middle Isonzo—August 1917), the success gained by the XXIV. Army Corps in the Vrh valley obliged the Austrians to evacuate their extremely strong positions on the left bank of the Isonzo as far as Monte Santo. In the Battle of Vittorio Veneto, the capture of Trent by the Italian I. Army (Nov. 4, 1918) enveloped and decided the fate of the Austrian units still holding out in the mountainous area between the Adige and the Brenta.

Owing to the broken nature of the terrain, strategical and tactical dispositions have to be made with great care, cannot easily be altered, and must as a rule conform to a prearranged plan. The lack of any continuous field for operations necessitates *division of forces* and *decentralisation of command and supplies.* The commander should indicate the general purpose and objective of the operation, and allow great latitude as regards the means of carrying it out; each unit should be provided with everything required for independent action. *Operations* must be *simple;* when complicated, they often fail even if carefully organised beforehand. The *slow pace* of operations makes it advisable to proceed by stages, each with a separate objective. *Greater length of front* is imposed by the existence of tracts of impracticable country. *Columns* must be *deeper,* and therefore take longer to defile. The health and *moral* of the troops are of the utmost importance.

Factors Affecting Strategy.—Manoeuvre is necessarily controlled by the terrain, larger forces being required where the mountains are narrower, lower and cut by broad valleys. Strategic surprise cannot easily be effected, because the terrain teaches the same lessons to both sides. Concentration calls for night movements, since enemy observation is assisted by the terrain and by premature dispositions. Strategic reconnaissance is difficult. Cavalry can follow only certain fixed lines, and its reconnaissance work must be confined to limited sectors. It cannot be expected to do more than achieve contact with the heads of enemy columns. Aircraft have greater possibilities. Their field of observation is a fruitful one, because the zones occupied by enemy communications are clearly defined. Their work is hampered, however, by atmospheric conditions, deep shadows, extensive forest areas, and the necessity of flying at great altitudes.

The disposition of the major units is a long and difficult operation. The terrain is in favour of economy of force. Great importance attaches to the movement of the general reserve, which is usually conditioned by the road system at the junction of the valleys. If it cannot be moved freely as desired, it may be better to form local reserves. The decision is to be sought by operations wherever they may be expedient—in the bed of the valley, on the slopes, or on the heights. Operations on the heights should not, however, be an end in themselves; every operation should be directed towards opening up the valleys, along which success can be more easily attained. As the "switching" of units is more difficult, it is advisable to adhere to the original plan.

A passive defence will always be enveloped. Movements to repulse enemy threats are hampered by the terrain.

To avoid locking up large forces in passive defence, the defender should always seek to impose frontal action on his opponent. In a defensive campaign also, the movement of the general reserve is of great importance. That it may be readily brought into use, communications will often have to be opened up or repaired, and arrangements made in advance for moving it with transport locally available.

Offensive.—It is preferable to manoeuvre to take the enemy in the rear. For this purpose the action will generally have to be organized for several columns, which will act independently on account of the natural divisions of the terrain. The unity of the whole is secured by accurate preparation of the plan of attack; the following arrangements in particular must be made:—(a) The strength of each column must be limited to that allowed by the terrain (tactical saturation). (b) The time required by each column to attain its objective, every allowance being made for difficulties, must be calculated. (c) Each column must be allotted forces sufficient to allow of the formation of an individual advance-guard and reserve and the provision of auxiliary services (artillery and transport) and the ever-necessary flank- and rear-guards. The allotment of artillery among the columns depends on the width of the sector in which they are to operate. If this does not allow fire along the whole front, the artillery must be divided among the columns; if concentrated battery fire is pos-

sible, the question then arises how many should be allotted to columns and how many kept free for concerted action; also in what direction their march-routes should be assigned so that they may be ready to come in with effect at any stage of the engagement.

(d) Columns should use enveloping tactics within a radius varying with their strength. Weak forces operating within a small radius may not materially affect the issue of the engagement; while strong forces moving in too wide an arc will advance but slowly, leaving the enemy time to counter the threat. (e) The choice of objectives for the columns must be ruled by the terrain, on the principle that the arrival at each objective should facilitate the attack on those that follow. (f) Surprise has always decisive results, because the victim is pinned to the terrain. Every effort should be made to achieve this under cover of night, fog and bad weather. The capture of Monte Nero (middle Isonzo, June 1915) by an Italian Alpine battalion was an admirable instance of a night surprise. A surprise attack is favoured by the use, even if only by small detachments, of routes held to be impracticable. It must, however, be remembered that in mountain warfare the would-be surpriser may himself be surprised, and no precaution against this contingency should be neglected.

(g) The existence of local reserves does not dispense with the formation of a general reserve. The commander must decide whether to despatch it by an independent route or whether, in view of the broken character of the terrain, to make it follow the principal column. In deciding, he must remember that in mountain warfare an extended front means a shallower line, and that delay in the arrival of reserves may have very serious consequences. Local reconnaissance should be carried out by special infantry units pushed far forward from their base. Mountainous country involves reconnaissance along independent lines. One large body sending out patrols in various directions is an unsuitable arrangement; separate duties should from the outset be allotted to units according to circumstances, each unit being given freedom of action. The advance should be made by bounds. The method of approach should be: first, taking advantage of all communications that can be utilised; then, following the ridges, which give a commanding position and allow of deployment on less steep ground. Night marches are often unavoidable. The attack is always slow and difficult, and must be developed systematically. The more broken and uneven the ground, the greater the importance of the manoeuvre even of minor units.

In open country every inch of dead ground must be utilised, suitable formations adopted, and constant support given by artillery and machine-gun fire. Artillery can often support infantry up to the moment of the assault, while machine-guns can fire over the infantry's heads. In close country, where little artillery support is available, infantry can gain their best results by infiltration, systematically supported by their own arms.

As a rule the highest *axes* should be followed, for the sake of the better possibilities of manoeuvring afforded by a commanding position. *Reserve units* can almost always be concentrated under cover at a short distance from the forward troops. The better method of exploiting a success is to push the advance towards the enemy's communications, not to widen the breach. The nature of the engagement and the terrain make it impossible to support the advance with direct artillery fire, which ties the infantry down to a prearranged timetable. On the other hand, since the terrain localises the defence on certain obvious lines, a lifting barrage, the movement of which will be regulated by the infantry, is suitable. Containing actions are always of great value. Tanks can operate in the valleys, on broad passes, and on plateaux, but cannot as yet be used on a large scale.

Defensive.—The positions available permit of effectual resistance, but few are immune from the defect of shallowness, which limits the elasticity of the defence by making the same units responsible for observation and action. Preference should be given to positions which are difficult to outflank and command numerous approaches on a narrow front. In disposing forces it should be remembered that routes regarded as inaccessible are often the most dangerous. The crest of a ridge may be defended on the crest itself, or in front, or behind. Defence on the crest abandons good positions to the attack, offers much dead ground, but affords easy communication with the rear and good cover for reinforcements and reserves. Defence in front of the crest is much exposed to observation, and communications with the rear are difficult; but better observation is possible and there is less dead ground. Defence behind the crest has the quality of offering slight visibility. In practice it is best to seek a solution combining the advantages of all three and avoiding their defects, particularly that of shallowness. It will often be found advisable to establish *advanced centres of resistance.*

To defend a pass occupy the depression and the heights that command it; secure converging fire on the depression; keep reserves on the flanks, towards the heights. If the pass is long, organise several lines of defence; if narrow, command the outlet from positions in the rear. To defend the head of a valley occupy in force the branches forming it; obtain converging fire on the centre of the depression, pushing forward the wings of the position. It is of the greatest importance that machine-gun and artillery fire should be directed in front of the position so as to avoid dead ground. Prompt counter-attacks are most effective, and should be made as the attacking force is about to reach the top of the slope. Local reserves are useful, and the terrain generally allows of their being kept under cover not far from the position.

Artillery barrages should only be placed on ground over which the attack is bound to pass. Containing barrages are always most effectual, because the attacking force is necessarily confined within a few known channels. Trenches, underground posts and dugouts are most useful, but their construction is a long and difficult process; breastworks must often suffice.

Factors Affecting Transport and Supplies.—Owing to the necessity of collecting all local supplies and the small capacity of the railway and road systems—only mule-tracks and footpaths being available on the mountain ridges—the transport problem is immensely important. All existing communications must be systematically brought into use, and every means of transport, particularly pack transport on a large scale, must be utilised. Pack transport will frequently be found insufficient for revictualling the ridges, and telpher systems will have to be constructed. Dumps are useful as ensuring the continuance of supplies if interrupted from the rear; here again telpher lines are desirable.

Alpine Operations.—The special units ("Alpini" and mountain artillery) to which these are entrusted should preferably operate in areas believed to be impassable, or little known, so as to have the advantage of effecting a surprise. They should never be hampered by anxiety for their communications. A concerted attack is out of the question. Companies, and even smaller units, must operate independently, preferably at high altitudes; they should use the method of infiltration and skilfully envelop their opponents, avoiding frontal attacks. Sometimes heavily concentrated fire may be desirable, sometimes silence and a surprise attack with hand-grenades and the bayonet. Generally speaking, the greater the difficulties of the terrain, the greater the necessity for manoeuvring, taking advantage of night,. fog and inclement weather.

Winter Operations.—The inherent difficulties of mountain country are greatly aggravated by frost and snow and their attendant dangers. Winter operations are possible, but are limited to short engagements fought by units formed for the purpose (special infantry with a nucleus of troops on ski; ski units). It is essential to provide special equipment (snowshoes, crampons, white overalls, etc.), commissariat and transport (sleighs for arms and supplies). Thorough organisation and profound experience are indispensable. (A. FER.)

MOUNT AIRY, a town of Surry county, North Carolina, U.S.A., on Federal highway 121, 39 m. N.W. of Winston-Salem. It is served by the Atlantic and Yadkin railway. Pop. (1920) was 4,752 (90% native white); estimated locally at 7,500 in 1928. Mount Airy is a summer resort, in the foothills of the Blue Ridge, at an altitude of 1,150 feet. It has mineral springs, extensive granite quarries, cotton and woollen mills, furniture

factories and tobacco warehouses, and ships large quantities of fruit and honey. The town was incorporated in 1885.

MOUNTBATTEN, the name of an English family of peers. In 1917 the English members of the house of Battenberg, that is to say, the descendants of Princes Louis Alexander and Henry Maurice of Battenberg, renounced their German title and took the surname Mountbatten.

George Louis Mountbatten (b. 1892), who succeeded his father Louis Alexander as marquess of Milford Haven in 1921, married Countess Nadejda Torby, by whom he had one son and one daughter. His sister *Louise* (b. 1889) married Gustavus Adolphus, crown prince of Sweden, and his brother, *Louis Mountbatten* (b. 1900) married Miss Edwina Ashley, as his second wife.

Prince Henry of Battenberg (1858-96), who married Beatrice, youngest daughter of Queen Victoria, had three sons and one daughter. His eldest son *Alexander* (b. 1886) was created marquess of Carisbrooke and earl of Berkhampstead; he married Lady Irene Denison, daughter of the 2nd earl of Londesborough, and has one daughter. The second son, *Leopold,* died in 1922. (*See* also *Milford Haven, Louis Alexander,* and *Battenberg.*)

MOUNT CARMEL, a city of south-eastern Illinois, U.S.A., on the Wabash river, the county seat of Wabash county. It is served by the Big Four and the Southern railways. Pop. (1920) 7,456 and in 1930, 7,132. It is a division point on the Big Four, which maintains repair shops employing 400 skilled mechanics. An outdoor amphitheatre (to seat 25,000) is under construction (1928) on the side of the bluff. The city was founded in 1818.

MOUNT CARMEL, a borough of Northumberland county, Pennsylvania, U.S.A., 50 m. N.N.E. of Harrisburg. It is on Federal highway 120, and is served by the Lehigh Valley, the Pennsylvania and the Reading railways. Pop. (1920) 17,469 and in 1930 it was 17,967. It is an important anthracite-mining centre, and has a number of factories with an output in 1925 valued at $2,989,426. A town was laid out in 1848, and in 1862 the borough was incorporated.

MOUNT CLEMENS, a city of south-eastern Michigan, U.S.A., the county seat of Macomb county; on the Clinton river near Lake St. Clair, 20 m. N. by E. of Detroit. It is on Federal highway 25, and is served by the Grand Trunk and electric railways. The population was 9,488 in 1920, 84% native white, and was 13,497 in 1930 according to Federal census. It is primarily a health resort, visited by 20,000 persons annually. The mineral waters, from wells 1,200 ft. deep, contain a high percentage of solids (125 lb. to each bath of 65 gal.) and are especially efficacious in the treatment of rheumatism. Just east of the city, on Lake St. Clair, is Selfridge Aviation field (1,000 ac.), a training ground of the Army Air Corps. Mount Clemens was settled in 1802, made a village in 1837 and chartered as a city in 1879.

MOUNT DESERT ISLAND lies off the coast of eastern Maine, with which it is connected by a bridge. It is the easternmost and largest island in an archipelago extending from Frenchmans bay to Penobscot bay, the two most beautiful sheets of water on the Atlantic coast. Rock-built and mountainous, it has long been noted for the beauty of its scenery, which led some years ago to the establishment upon it of the first eastern national park in the United States, Lafayette National park. This island was discovered in Sept. 1604, by Champlain in exploration of the Acadian coast from St. Croix westward, and named by him L'Isle des Monts Deserts from his vision of the bare rock-summits of its mountains.

MOUNTFORT, WILLIAM (*c.* 1664–1692), English actor and dramatic writer, played leading parts for the Dorset Garden company. Captain Richard Hill accompanied by Charles, fifth Baron Mohun, murdered Mountfort in Howard street, Strand, on Dec. 9, 1692. Hill escaped. Lord Mohun was tried by his peers and acquitted by a vote of 69 to 14.

MOUNT HOLYOKE COLLEGE, the pioneer institution in America for the higher education of women, situated in the village of South Hadley, Mass., near Mount Holyoke. It was founded by Mary Lyon (*q.v.*) and was chartered as Mount Holyoke Female Seminary in 1836. In 1888 it obtained its college charter, five years later withdrawing the seminary course. The name was changed to Mount Holyoke college in 1893.

MOUNTMELLICK, a market town of Co. Leix, Ireland. Pop. (1926), 2,275. It is the terminus of a branch of the Great Southern railway, 7½ m. N. of Maryborough and 58½ W.S.W. of Dublin. A branch of the Grand Canal provides water communication with Dublin, and with Waterford by the river Barrow. There are industries of malting, tanning, woollen and salt manufactures and iron-founding. A settlement of Quakers has contributed largely to the prosperity of the town. A provincial school of the Leinster Society of Friends was founded here in 1796.

MOUNT PLEASANT, a city in the centre of the lower peninsula of Michigan, U.S.A., 50 m. N. of Lansing, on the Chippewa river and federal highway 27; the county seat of Isabella county. It is served by the Ann Arbor and the Pere Marquette railways. The population was 4,819 in 1920 and 5,211 in 1930. It is the seat of the Central State Teachers college (est. 1892), a shipping point for agricultural produce, and has various manufacturing industries, including factories making beet-sugar, bathroom fixtures and veneer, flour and lumber mills, and a condensed-milk plant. The city was founded in 1875 and incorporated in 1889. Since 1921 it has had a city-manager form of government.

MOUNT PLEASANT, a borough of Westmoreland county, Pennsylvania, U.S.A., 32 m. S.E. of Pittsburgh, on the Baltimore and Ohio railway and Federal highway 119. Pop. (1930) 5,869. It is surrounded by coal mines and has many coke ovens. Other important industries are the manufacture of table glass and fruit jars, lumber, iron, flour and lenses for automobile headlights. The borough was settled about 1782 and incorporated in 1828.

MOUNT PLEASANT, a city of north-eastern Texas, U.S.A., on federal highway 67 and served by the Paris and Mount Pleasant and the St. Louis South Western railways; the county seat of Titus county. Pop. (1920) 4,099 (27% negroes); 3,541 in 1930 by Federal census. It is the trade centre for a rich farming and dairying region; a shipping point for peaches; has mineral springs and lignite mines; and manufactures shirts, pottery, cotton-seed oil and meal, candy, barrel heads and staves, and various other products. The city was founded in 1846 and incorporated in 1900.

MOUNT UNION, a borough of Huntingdon county, Pennsylvania, U.S.A., among the foot-hills of the Alleghenies in the south-central part of the State, on the Juniata river and Federal highways 22 and 622. It is served by the East Broad Top and the Pennsylvania railways. Pop. (1930) 4,892. It has two hydro-electric plants, is an important coal-shipping centre and has large silica-brick plants, creosoting works and other manufacturing industries. The borough was incorporated in 1867.

MOUNT VERNON, a city of southern Illinois, U.S.A., 75 m. E. by S. of St. Louis; the county seat of Jefferson county. It is served by the Chicago and Eastern Illinois, the Jefferson and South-western, the Louisville and Nashville, the Southern and the Missouri Pacific railways. Pop. (1920) 9,815 (94% native white); 12,375 in 1930 by the Federal census. It is the trading centre and shipping point of a rich agricultural and coal-mining region, and manufactures flour, freight cars, shoes, hosiery, furnaces, stoves and various other articles. Mount Vernon was settled in 1819, incorporated in 1837, and chartered as a city in 1872. On Feb. 19, 1888, it suffered severely from a tornado.

MOUNT VERNON, a city in the south-western corner of Indiana, U.S.A., on the Ohio river; county seat of Posey county. It is served by the Chicago and Eastern Illinois, the Louisville and Nashville, and electric railways, and by river steamers and barges. Pop. (1920) 5,284 and 5,035 in 1930. It is a trade centre and shipping point for farmland produce, tractors, flour, paper, lumber, canned vegetables, corn-oil, hickory handles, and other products of its own factories. The first settlement was made in 1803. The town was laid out in 1819, became the county-seat in 1825, was incorporated in 1846, and in 1865 was chartered as a city.

MOUNT VERNON, a town of Linn county, Iowa, U.S.A., on the Lincoln Highway and the Chicago and North Western railway, 16 m. E. of Cedar Rapids. Pop. 1930 (Federal census)

1,441. It is the seat of Cornell college (Methodist Episcopal) opened as a seminary in 1853 and chartered as a college in 1857, which has (1928) an endowment of nearly $2,000,000.

MOUNT VERNON, a city of Westchester County, New York, U.S.A., on the Bronx River, just beyond New York City, between New Rochelle and Yonkers. It is served by the New York Central and the New York, New Haven and Hartford railways. Pop. (1920) 42,726 (24% foreign-born white, of whom over a third came from Italy); 1930 Federal census, 61,499. It is a residential suburb, and has few manufacturing industries. Mount Vernon known as the City of Homes was called "Ten Farms" at first, which was settled from Connecticut in 1664. A free school was established about 1682. St. Paul's churchyard dates back to the close of the 17th century. The church, which has a communion set and a bell sent over by Queen Anne, was begun in 1764, and was used as a British military hospital during the Revolution. Along the White Plains road (now Lincoln avenue) Washington retreated, pursued by Gen. Clinton, before the battle of White Plains (Oct. 1776). The city was founded in 1851 by a company of men from New York city and known as the Industrial Home Association, No. One, incorporated as a village in 1853 and chartered as a city in 1892.

MOUNT VERNON, a city of Ohio, U.S.A., 45 m. N.E. of Columbus, on the Kokosing river; the county seat of Knox county. It is served by the Baltimore and Ohio and the Pennsylvania railways. Pop. (1920) 9,237 (92% native white); 9,370 in 1930 by the Federal census. The city has abundant water-supply, electric power and natural gas, and is an important manufacturing centre, making steam, Diesel and gas engines, structural iron, bottles, window glass and various other commodities. The State sanatorium for the treatment of tuberculosis is here. Mount Vernon was laid out in 1807, incorporated as a town in 1845 and chartered as a city in 1853. It was the birthplace and home of Daniel Decatur Emmett, author of "Dixie," the battle-song of the Confederacy.

MOUNT VERNON, the former home of George Washington, in Fairfax county, Virginia, U.S.A., on the Potomac river, 15 m. below Washington, D.C. The mansion-house, which is the centre of interest, stands on a bluff overlooking the river. The house is built of wood, but the siding is of wide thick boards so panelled as to give the appearance of cut and dressed stonework. The rooms contain much of the furniture which was in them when they were occupied by Gen. Washington and his family; and the furniture that had been lost has been in part replaced by other furniture of historic interest and of the style in use in Washington's day. In the main hall hangs a glass casket containing the key to the Bastille which Washington received from Lafayette in 1790. From each end of the house a curved colonnade and a pavement lead westerly to a row of out-buildings which partially enclose a bowling green and spacious lawn with shaded drives and walks, and beautiful gardens (with trees planted by Washington, Franklin, Jefferson, Lafayette and others). A short distance south-west of the mansion-house and between it and the wharf is a plain brick tomb, which was built by Washington's direction on a site chosen by himself, and contains the remains of Washington and Mrs. Washington (removed to this tomb from the old family vault in 1831), and of about 30 relatives—members of the Washington, Blackburn, Corbin, Bushrod, Lewis and Custis families.

The estate, originally called "Little Hunting Creek Plantation," was devised in 1676 by John Washington (the first of the family in America) to his son, Lawrence, who in turn devised it to his daughter, Mildred, by whom (and her husband Roger Gregory) it was deeded in 1726 to her brother Augustine (George Washington's father). On Augustine's death (1743) it passed to Lawrence (George's half-brother), who built in 1743 the villa which forms the middle portion of the present mansion-house and named the estate Mount Vernon, in honour of his former commander, Admiral Edward Vernon (1684–1757). Lawrence left it (1752) to his widow Anne Fairfax (who in the same year married George Lee) with the proviso that it should pass at her death to George Washington, who meanwhile rented the estate, gaining full possession at her death in 1761. In 1784–85 he enlarged the villa into the mansion-house with its present dimensions by building an addition at each end, erected several of the out-buildings, and adorned the grounds, all according to his own plans and specifications. At Washington's death (1799) Mount Vernon passed to his widow; at her death (1802) it passed to his nephew, Bushrod Washington, and at Bushrod Washington's death (1829) to his nephew John Augustine Washington, who devised it in 1832 to his widow, by whom it was devised in 1835 to their son John A. Washington. This last was authorized by his father's will to sell the estate to the U.S. Government, and in 1847 offered the property for $100,000, but the offer was refused. In 1860 the mansion-house and 200 ac. of the original estate, fast falling into decay, were bought for $200,000 (much of which had been raised through the efforts of Edward Everett) by the Mount Vernon Ladies' Association of the Union. This association under its charter (1856) bound itself to restore the estate as far as possible to the condition in which it was in the lifetime of Washington and to keep it sacred to his memory, and Virginia agreed to exempt it from taxation as long as these terms were fulfilled.

See B. J. Lossing, *The Home of Washington: or Mount Vernon and its Associations* (Hartford, 1870); P. Wilstach, *Mount Vernon* (1916); C. H. Sipe, *Mount Vernon and the Washington Family* (1925); C. Moore, *The Family Life of George Washington* (1926); and E. E. Prussing, *The Estate of George Washington* (1927).

MOURNING: *see* FUNERAL RITES.

MOUSE, in its original sense probably the name of the house-mouse (*Mus musculus*), the type of the genus *Mus* and of the family *Muridae*. The distinctive characters of the typical mice, *i.e.*, those included in the genus *Mus*, are dealt with in the article RODENTIA. With the exception of Madagascar, the genus *Mus*, and its allies, ranges over practically the whole of the Old World, having indigenous representatives even in Australasia; while the house-mouse has established itself throughout the civilized world. *M. musculus*, the house-mouse, originally a native of Central Asia, has spread to all the inhabited parts of the globe. *Apodemus sylvaticus*, the wood or long-tailed field-mouse, is common in many parts of England, often taking to barns and out-houses for shelter during the winter. It is of about the same size as *M. musculus*, but of a bright reddish-grey with a white belly. *Micromys minutus*, the harvest-mouse, is the smallest of the European mice, 2½ or 3 in. in length, and a yellowish-red, with short ears and tail. It lives in wheat or hay fields, where it builds a round grass nest the size of a cricket-ball, in which it brings up its young. Its range extends from England to Japan. In Central Asia there exist wild mice *M. bactrianus*, and *M. wagneri* with the habits of a house-mouse, both closely allied to *M. musculus*; while there is a third kind (*M. gentilis*), also nearly related, in the deserts of North Africa. Mice derived from *M. musculus* are kept as pets in many parts of the world. Numerous breeds are known, of which the Japanese waltzing mice, which have the habit due to a defect in the labyrinth of the ear of spinning round and round after their tails, are perhaps the most remarkable.

BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE WHITE-FOOTED MOUSE

See G. E. H. Barrett-Hamilton, "Note on the Harvest-Mice of the Palaearctic Region," *Annals and Magazine of Nat. History* (April 1899); "On the Species of the genus *Mus* inhabiting St. Kilda," *Proc. Zool. Soc.* (1899); "On Geographical and Individual Variation in *Mus sylvaticus* and its Allies," *op. cit.* (1900); W. E. Clarke, "On Forms of *Mus musculus*, with Description of a New Subspecies from the Faeroe Islands," *Proc. Roy. Phys. Soc.* (Edinburgh, 1904), vol. xv. M. A. C. Hinton "Rats and Mice," *Brit. Mus.* (*Nat. Hist.*) *Pamphlet.*

MOUSE-BIRD, the name by which members of the genus *Colius* are known—probably from their habit of creeping along the boughs of trees with the whole tarsus applied to the branch. The colies are placed in the family *Coliidae*, amongst Coraciiform birds, near the trogons and swifts (*q.v.*). The *Coliidae* are small birds, with a rather finch-like bill, a more or less crested head, a very long tail, and generally a dun or slate-coloured plumage that

sometimes brightens into blue or is diversified with white or chestnut. They feed almost wholly on fruits, but occasionally take insects. All the species belong to the Ethiopian region ranging from Abyssinia southwards. There are nine species.

MOUSTACHE or **MUSTACHIO,** the hair worn unshaven on the upper lip (*see* BEARD).

MOUSTERIAN, a name given by the French anthropologist G. de Mortillet to the earliest epoch in his system of cave-chronology, from a cave (Le Moustier) on the right bank of the Vézère, a tributary of the Dordogne, above Les Eyzies, which has yielded typical palaeolithic implements. The epoch was characterized by the Neanderthal type of man, and by the occurrence of the musk ox, the horse, the cave bear, *Rhinoceros tichorhinus,* and the mammoth. The typical implements are flint points or "flake implements," smooth and flat on one side (the "bulbar" surface). Relics of the Mousterian age have also been found in most parts of Europe and in North Africa. An early or proto-Mousterian cave at Krapina, in Croatia, has yielded abundant remains. The Galilee skull was associated with Mousterian implements. The relation of the Mousterian period to the ice age is still obscure, but Mousterian remains are associated with both "warm" and "cold" fauna, and it is reasonable to infer that it "straddled" the last phase of glaciation. Remains have been found at Northfleet and Frindsbury in north Kent, and in Jersey.

BIBLIOGRAPHY.—J. L. Myres, in *Camb. Ancient Hist.,* vol. i. chap. 1 sec. 7 (1924) list of references on pp. 620–621.

MOUTH AND SALIVARY GLANDS. The mouth, in anatomy, is an oval cavity at the beginning of the alimentary canal in which the food is masticated. The opening is situated between the lips, and at rest its width reaches to the first premolar tooth on each side.

The lips are fleshy folds, surrounding the opening of the mouth, and are formed, from without inward, by skin, superficial fascia, orbicularis oris muscle, submucous tissue, containing numerous labial glands about the size of a small pea, and mucous membrane. In the deeper part of each lip lies the coronary artery, while in the mid-line is a reflection of the mucous membrane on to the gum forming the fraenum labii.

The cheeks form the sides of the mouth and are continuous with the lips, with which their structure is almost identical save that the buccinator muscle replaces the orbicularis oris and the buccal glands the labial. In the subcutaneous fascia is a distinct mass of fat, specially large in the infant, which is known as the sucking pad. On the buccal surface of the cheek, opposite the second upper molar tooth, is the papilla which marks the opening of the parotid duct, while, just behind, are four or five molar glands, larger than the buccal, the ducts of which open opposite the last molar tooth. The mucous membrane of the cheek, like that of the rest of the mouth, is of the stratified squamous variety (*see* EPITHELIUM) and is reflected on to the gums.

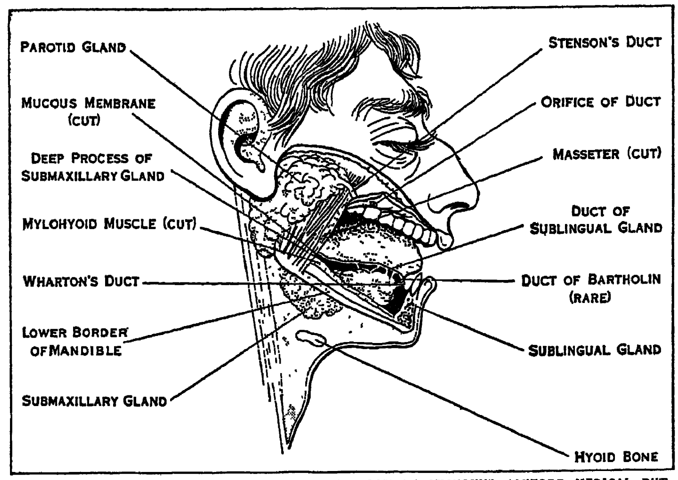
The gums consist of mucous membrane connected by thick fibrous tissue to the periosteum of the jaws. Round the base of the crown of each tooth the membrane rises to a little collar.

The roof of the mouth is concave transversely and antero-posteriorly, and is formed by the hard and soft palate. The hard palate consists of mucous membrane continuous with that of the gums and bound to the periosteum of the palatine processes of the maxillae and palate bones by firm fibrous tissue. In the mid-line is a slight ridge, the palatine raphe, which ends in front in the palatine papilla, marking the position of the anterior palatine canal. From the anterior part of the raphe five or six transverse ridges or rugae of the mucous membrane run outward. (For a description of the soft palate *see* PHARYNX.)

The floor of the mouth can only be seen when the tongue is raised, then the reflection of the mucous membrane from the gums to it is exposed. In the mid-line is a prominent fold (*fraenum linguae*), and on each side of this a *sublingual papilla,* on to the summit of which the duct of the submaxillary gland opens. Running outward and backward from this is a ridge (*plica sublingualis*), which marks the upper edge of the sublingual gland, and on to which most of the ducts of that gland open. (For a description of the TONGUE and the TEETH *see* special articles.)

Salivary Glands.—The salivary glands are the *parotid, submaxillary* and *sublingual,* though the small scattered glands such as the labial, buccal, molar, lingual, etc., probably have a similar function.

The parotid gland is the largest, and is situated between the ear and the ramus of the mandible. In cross-section it is roughly triangular, its outer wall or base being bounded by the parotid fascia,



FROM A. BIRMINGHAM, IN "CUNNINGHAM'S TEXTBOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

THE SALIVARY GLANDS AND THEIR DUCTS, WITH THE GREATER PORTION OF THE BODY OF THE MANDIBLE REMOVED TO SHOW THE SUBLINGUAL AND THE DEEPER PARTS OF THE SUBMAXILLARY GLANDS

its anterior by the jaw, and its posterior by the mastoid process and sterno-mastoid muscle. Where the anterior and posterior walls meet to form the apex is the styloid process. Above the gland reaches to the zygoma, and below to the level of the angle of the jaw, where a strong process of the deep cervical fascia separates it from the submaxillary gland. The outline of the gland is obscured by several processes, one of which, the facial lobe, runs forward, superficial to the masseter muscle, accompanying the duct; a separate part of this is called the socia parotidis. Others are pterygoid, pre-styloid and post-styloid, but all are very variable. The facial nerve, the temporo-maxillary vein, and the termination of the external carotid artery, among other structures, are embedded in the gland. The parotid duct (Stensen's duct) crosses the upper part of the masseter and then pierces the buccinator on its way to the mouth; it is about 2in. long.

The submaxillary gland lies deep to the posterior half of the body of the lower jaw; it is about the size of a walnut. The facial artery is embedded in the upper part of the gland. The submaxillary duct (Wharton's duct) runs forward to the sublingual papilla already mentioned.

The sublingual gland is placed farther forward than the submaxillary; it is like an almond in shape though larger; its outer flattened surface rests against the lower jaw; its ducts are small and numerous.

Embryology.—The fore-gut (*see* ALIMENTARY CANAL) at first ends blindly, ventral to the hind brain; in front of it is the overhanging fore-brain. When the heart develops, ventral to the fore-gut, it also projects forward toward the fore-brain, so that a transverse cleft, without any lateral boundaries and lined by ectoderm, is left between these two structures. This is the *stomatodaeum* or primitive mouth, the ectoderm of which rests against the entoderm of the fore-gut to form the *bucco-pharyngeal membrane,* and so separates the two chambers. The position of this membrane does not correspond to the fauces or hinder limits of the adult mouth, but is much more oblique, so that the front part of the roof of the pharynx is formed by stomatodaeum while the greater part of the floor of the permanent mouth is fore-gut. During the third week the membrane disappears, and no traces of it can be seen in the adult. Growing down from the region of the fore-brain is the fronto-nasal process, which forms the nose and the middle piece of the upper lip, while the lateral parts of the mouth are closed in by two processes, on each side of which the lower or mandibular proc-

ess rapidly meets its fellow in the mid-line to form the lower jaw and lip, thus separating the heart from the mouth cavity. The upper or maxillary process grows inward more slowly, but at last joins with the fronto-nasal process, and in the adult the lines of union are seen on each side as ridges of skin which run down from the nostril to the margin of the lip, and enclose that slightly depressed vertical gutter to which the term *philtrum* is given. Besides forming the philtrum the fronto-nasal process is responsible for that part of the roof of the mouth bounded by lines drawn on each side from between the lateral incisor and canine teeth to the palatine papilla. At first the cavities of the mouth and nose are one, but they are later divided by the *palatal processes,* which grow in like shelves from the maxillary processes and meet in the mid-line. The submaxillary and sublingual salivary glands develop as solid outgrowths of the buccal epithelium which are canalized later, while the parotid according to Hammar (*Archiv. f. mikr. Anat.* 1902) appears first as a groove. The parotid is ectodermal in origin, all the others entodermal.

For further details and literature *see* Quain, *Anat.* vol. i. (London, 1908); J. P. McMurrich *Development of the Human Body* (London, 1923); O. Hertwig, *Handbuch der Entwickelungslehre Th. II.* (Jena). *See* also VERTEBRATE EMBRYOLOGY. (W. S. L.-B.)

Comparative Anatomy.—In the Acrania (*Amphioxus*) the mouth is developed on the left side and gradually shifts to the mid-line; later an extra chamber, the oral hood, is formed in front of it, the external opening of which is provided with bristle-like cirrhi, so that in the adult the mouth is merely an aperture in the velum or membrane which separates the oral hood from the pharynx.

In the Cyclostomata (lampreys and hags) the mouth is a suctorial organ, and resembles a funnel, the narrow end of which opens into the pharynx. It is always open and is provided with horny teeth and a tongue. At this low stage of the vertebrate scale no jaws appear, but in the larval lamprey (Ammocoetes) an oral hood, resembling that of *Amphioxus,* is present. In the fishes jaws are present and the mouth can be closed at will. In the elasmobranchs (sharks and rays) the opening is crescentic and situated well on the ventral surface of the head, but in other fishes it is at the anterior end of the body. Until the Dipnoi (mud fish) are reached there is no communication between the mouth and the nose but in these fishes the internal or posterior nares open into the front part of the roof of the mouth, thus adapting them to air-breathing. In the Amphibia the mouth has usually an enormous gape, and the position of the posterior nares resembles that of the Dipnoi. It will be noticed that at this stage of phylogeny the condition resembles that of the ontogeny of man before the palatal processes appear. The premaxillary part of the fronto-nasal process separates the nasal cavity from the mouth in front, but behind that the cavity is the rudiment of the mouth and nose which no palate has yet appeared to separate. In reptiles the hard palate appears, and henceforward the digestive and respiratory tracts only form one passage in the pharynx. In mammals definite lips provided with muscles first appear, though the monotremes have such specialized mouths that lips are not found in that order. Many monkeys have the vestibule enlarged to form the cheek pouches. (F. G. P.)

MOUTH AND SALIVARY GLANDS, DISEASES OF. Most of the conditions affecting these parts have been described under separate headings (*see* TONGUE, DISEASES OF; DENTISTRY; CALCULI; DIPHTHERIA; PHARYNGITIS; TONSILLITIS; MUMPS; ACTINOMYCOSIS) while as constituting the commencement of the respiratory and alimentary systems the mouth shares in some degree in the affections of these systems, as well as in general diseases (*see* SCARLET FEVER; MEASLES; SCURVY; VENEREAL DISEASES; TUBERCULOSIS). A few other aspects of the subject remain to be considered.

Relaxed or Unduly Long Uvula.—Either because of its inordinate length or because it shares in a general pharyngitis the uvula may touch and irritate the back of the tongue leading to irritable cough or repeated attempts at clearing the throat. Usually an astringent gargle is sufficient treatment; formerly a portion of the uvula was burned with caustic or snipped off with scissors, but this procedure is undesirable since removal of too much leads to regurgitation of food or drink through the nose in swallowing from failure of complete coaptation of the uvula and anterior pillars of the fauces.

Xerostomia.—This rare condition is of nervous origin and probably is allied to the deficient secretion of saliva actuated by fear in ancient trials by ordeal. Dryness of the mouth in fever and in bella donna poisoning though equally due to deficient secretion of saliva, is not included under the term.

Salivation results from the action of certain poisons, *e.g.,* mercury, potassium iodide, and accompanies many diseased conditions of the mouth. In cancer of the tongue, floor of mouth, cheek or gingival border, salivation is one of the most distressing symptoms. Mercurial salivation has disappeared largely since modern methods of treating syphilis have been introduced, and at present is mainly the result of industrial conditions.

Ranula is an oral swelling in the floor of the mouth filled with clear fluid; it depends upon accumulation of saliva in the duct of the salivary gland behind an impacted salivary calculus.

"Phossy Jaw" has disappeared since the manufacture of matches with red phosphorus superseded use of the amorphous variety. Formerly it was common owing to the fact that the fumes attacked the jaws of workers in the region of carious teeth; extensive necrosis of the bones of the jaw and falling out of teeth, followed by severe constitutional disease often resulted and death was not uncommon.

Macroglossia and Macrocheilia are rare conditions in which the tongue and lips respectively are enormously enlarged from blockage of their main lymphatic channels. The condition is therefore akin to elephantiasis (*q.v.*). The tongue may be so large that it protrudes from the mouth for several inches.

MOVIMAN, a tribe or small group of tribes of South American Indians, constituting an independent linguistic stock. The Moviman live in north-eastern Bolivia, on the Yacuma river, a western tributary of the Mamore, in S. lat. 14°. They are a tall people, speaking a very harsh and disagreeable language. Their culture was much like that of the Moxos tribe, who were their neighbours on the south.

See A. D'Orbigny, *L'Homme Américain* (Paris, 1839).

MOWBRAY, the name of an Anglo-Norman baronial house, derived from Montbray (Manche) in Normandy south of St. Lo. It was founded at the Conquest by Geoffrey (de Montbray), bishop of Coutances. His nephew Robert, who rebelled with him against William Rufus on the Conqueror's death, was made, after their reconciliation, earl of Northumberland, as his uncle's heir but was imprisoned for life on rebelling again in 1095. Bishop Geoffrey's other nephews, Nigel and William, were given great estates in England by Henry I. William was made king's butler, and was father of William d'Aubigny ("de Albini"), first earl of Arundel (*see* ARUNDEL); Nigel was rewarded with the escheated fief of Geoffrey de la Guerche, of which Melton (Mowbray) was the head, and which forfeited lands in Yorkshire. Nigel's grandson William, a leader in the rising against King John, was one of the 25 barons of the Great Charter, and was captured fighting against Henry III. at the rout of Lincoln (1217). William's grandson Roger (1266–98), who was summoned to parliament by Edward I., was father of John (1286–1322), whose wife added Gower in South Wales and the Bramber lordship in Sussex to the great possessions of his house. Their son John (d. 1361) was father, by a daughter of Henry earl of Lancaster, of John, Lord Mowbray (*c.* 1328–1368), whose fortunate alliance with the heiress of Lord Segrave, by the heiress of Edward I.'s son Thomas, earl of Norfolk and marshal of England, crowned the fortunes of his race. In addition to a vast accession to their lands, the earldom of Nottingham and the marshalship of England were bestowed on them by Richard II., and the dukedom of Norfolk followed. (*See* NORFOLK, THOMAS MOWBRAY, 1st duke of.) His great grandson John, 4th and last duke was created earl of Warrenne and Surrey (1451). At his death (1475) his vast inheritance devolved on his only child Anne, who was married as an infant to Edward IV.'s younger son Richard (created duke of Norfolk and earl of Nottingham and Warrenne), but died in 1481.

The next heirs of the Mowbrays were the Howards and the Berkeleys, representing the two daughters of the first duke. Between them were divided the estates of the house, the Mowbray dukedom of Norfolk and earldom of Surrey being also revived for the Howards (1483), and the earldom of Nottingham (1483) and earl marshalship (1485) for the Berkeleys. Both families assumed the baronies of Mowbray and Segrave, but Henry Howard was summoned in his father's lifetime (1640) as Lord Mowbray, which was deemed a recognition of the Howards' right; their co-heirs, from 1777, were the Lords Stourton and the Lords Petre, and in 1878 Lord Stourton was summoned as Lord Mowbray and Segrave. The former dignity is claimed as the premier barony, though De Ros ranks before it.

MOWBRAY, HARRY SIDDONS (1858–1928), American artist, was born of English parents at Alexandria, Egypt, on Aug. 5, 1858. Left an orphan, he was taken to America by an uncle, who settled at North Adams, Mass. After a year at the U.S. Military academy at West Point, he went to Paris and entered the atelier of Léon Bonnat, his first picture, "Aladdin," bringing him to public notice. Other early canvases of high rank included "The Evening Breeze," "Scheherazade," "The Last Favorite." He was best known, however, for his mural paintings, and to these his later years were devoted. They included murals in the residences of F. W. Vanderbilt, J. Pierpont Morgan and Collis P. Huntington; the ceiling and walls of the library and decorations in the council room of the University club in New York city; mural paintings in the appellate court house, New York city; in the Federal court room, Cleveland; in the art gallery of Hon. Breckinridge Long, St. Louis; and in the church and Gunn Memorial library at Washington, Conn. He died on Jan. 13, 1928.

MOZAMBIQUE, a town of Portuguese East Africa, till 1907 capital of the province of Mozambique, and the seat of a Roman Catholic bishopric in the province of Goa, is in 15° 4′ S., 40° 44′ E., 7,157 m. from Southampton, and 175 m. from Ibo. The town occupies the whole of a small coral island at the mouth of Mossuril bay. The name Mozambique, used first to designate the island, was also given to the town and extended to the whole of the Portuguese possessions on the east coast of Africa. There are three forts, of which the principal, St. Sebastian, on the northern end of the island, was built in 1510 entirely of stone brought from Portugal. The harbour is deep enough to admit vessels drawing 28 ft. The channel is beaconed and lighted by buoys, and there is a lighthouse on Goa island. There is a milling establishment and an oil factory in the town. The Municipal council is appointed by the Government. In 1925, 1,669 ships entered and 1,689 left the port. There is a passenger pier. Malaria and bilious fever are prevalent in the rainy season.

The inhabitants, who number about 7,000, consist chiefly of Mohammedan natives of mixed descent speaking a dialect of the Makwa language. There are Parsee, Banyan, Goanese and Arab traders, and about 300 Europeans, besides half-caste Portuguese. The annual average value of the imports for the three years 1904–06 was £97,035, of the exports £71,636. The import trade is mainly with Great Britain and India, the chief articles being cotton, coloured shawls and hardware. The exports, of about 50,000 tons annually, are chiefly ground-nuts, a little rubber of inferior quality, sesame and other oil seeds and timber. Mozambique was discovered by Vasco da Gama in 1498. There was then a flourishing Arab town on the island, of which no trace exists. The history of the Portuguese town is closely identified with that of the province, for which *see* PORTUGUESE EAST AFRICA. Mozambique has been eclipsed by Lourenço Marques.

MOZARAB, a general term for persons not Arab by race who have assimilated themselves to the Arabs (Spanish *Mozárabe,* a corruption of the Arabic *Musta'rib,* coll. *Musta'riba*). It was applied by the Muslims in Spain to the Christian communities existing among them, in Cordova, Seville, Toledo and other large cities. The ancient liturgy used by the Christians of Toledo is commonly known as Mozarabic.

MOZART, WOLFGANG AMADEUS (1756–1791), Austrian composer, was born at Salzburg on Jan. 27, 1756. (In the baptismal register his name stands Joannes Chrysostomus Wolfgangus Theophilus [Lat. Amadeus, Ger. Gottlieb].)

He was educated by his father, Leopold Mozart, a composer with a high reputation as a violinist in the service of the archbishop of Salzburg. When only three years old he shared the harpsichord lessons of his sister Maria ("Nännerl"), five years his senior. A year later he played minuets and composed little pieces, some of which are still preserved. In 1762 Leopold Mozart took "Wolferl" and Nännerl on a musical tour, during the course of which they played before most of the sovereigns of Germany. The little Wolferl remained unspoilt by all the petting he received from royalty. At Vienna the emperor, Francis I., sat by his side while he played and called him his "little magician." When he slipped one day on the polished floor the archduchess Marie Antoinette, afterwards queen of France, lifted him up, whereupon he said, "You are very kind; when I grow up I will marry you."

Childhood and Youth.—In 1763 the whole family started on another tour. Wolferl now sang, composed and played on the harpsichord, the organ and the violin, winning golden opinions everywhere; but not enough money for more than bare necessities after the irreducible expenses of travel. In Paris they lodged at the Bavarian embassy, performing on a grand scale both there and at Versailles, where Wolferl's organ-playing was especially admired. Here also he published two sets of sonatas for the harpsichord and violin, having already composed several smaller pieces. In April 1764, Leopold Mozart took his family to England, where Wolferl astonished the royal family with his playing at sight and accompanied the queen in a song. He composed a symphony, published a third set of sonatas, dedicated to the queen; and wrote a tiny anthem (*Spruch*) for four voices, *God is our Refuge,* for presentation to the British Museum. (The autograph is numbered "Select Case C, 21 d.") Barrington contributed to the *Philosophical Transactions* for 1780 a paper on Mozart's prodigious talent as shown during his visit to London at eight years of age. In Sept. 1765 the family left England for the Hague, where, in March 1766, Wolferl made his first attempt at an oratorio, astonishing the Dutch as he had astonished the English, and playing with great effect, at Haarlem, on the largest organ in the world. In Sept. 1767 he paid a second visit to Vienna, and at the suggestion of the emperor, Joseph II., composed an opera buffa, *La finta semplice,* which, though acknowledged by the company for which it was written to be "an incomparable work," was suppressed by an intrigue. The archbishop of Salzburg thereupon commanded a representation of it in his palace, and gave Wolferl an honorary appointment as maestro di capella. Since this did not involve residence, Leopold Mozart took his son to Italy, in Dec. 1769, as the proper measure to complete a musician's education.

Wolfgang, now nearly 14 years old, received at Milan a commission to write an opera for the following Christmas. Arriving in Rome on the Wednesday in Holy Week, he went at once to the Sistine chapel to hear Allegri's famous *Miserere,* which afterwards he wrote down from memory, to the consternation of all who heard of the feat; for the composition was guarded as a mystery, and the singers were forbidden to transcribe it on pain of excommunication. Towards the end of June the pope made him a "cavaliere" of the order of "The Golden Spur," an honour which had some years previously been conferred on Gluck. Mozart prized it the more on that account, but soon gave up signing himself with the title, whereas the chevalier Gluck insisted on it to the end of his life. In July the Accademia Filarmonica of Bologna gave Mozart the degree of *compositore* in spite of a statute restricting this title to persons at least 20 years of age. His degree-exercise in strict counterpoint on the antiphon, *Quaerite primum,* is extant (Köchel's Catalogue, No. 86). His friendship with the learned padre, G. B. Martini (*q.v.*), was delightful to the boy and the sage, and it foreshadowed for Wolfgang what was afterwards to come to him from another spiritual father, "Papa Haydn." On Dec. 26, Wolfgang's new opera, *Mitridate Re di Ponto,* was triumphantly produced under his direction at Milan after a nerve-racking struggle with hostile intrigues. Mozart had been baulked of his hope to be allowed to set an opera by Metastasio; but the poetaster from Turin did his best; and the first rehearsal

settled all doubt as to the capacity of a German child of 14 to write an Italian opera and to control the orchestra of La Scala, the largest in Europe. The piece had a continuous run of 20 nights, a record for those times; and it established the boy as a master needing no apologies.

After this triumph, and after a concert-tour through many Italian cities, Wolfgang returned with his father to Salzburg, in March 1771, with large commissions for a dramatic serenata for the approaching marriage of the archduke Ferdinand, and an opera for La Scala, to be performed in 1773. The wedding took place at Milan on Oct. 21, and the serenata, *Ascanio in Alba,* was produced with an effect which eclipsed Hasse's new opera, *Ruggiero,* composed for the same occasion. The good Hasse prophesied: "This boy will cause us all to be forgotten." During the absence of Wolfgang and his father the good archbishop of Salzburg died; and in 1772 a successor was elected for whom nobody but the electors had a good word then or since. For his installation Wolfgang composed an opera, *Il Sogno di Scipione,* but the new prelate's interests were not intellectual; and before five years were past he made Salzburg a miserable place for musicians. The new opera for Milan, *Lucio Silla,* was produced at La Scala at Christmas, with a success equal to that of *Mitridate,* and it had a still longer run. Wolfgang was developing rapidly and beginning to create styles and forms that changed the nature of music. His opera buffa, *La Finta giardiniera,* produced Jan. 13, 1775, at Munich, tackles the action of an absurdly complicated play with unmistakable foreshadowings of the technique of *Figaro*. In March he set Metastasio's dramatic cantata, *Il re pastore.* Concertos, masses, symphonies and sonatas poured forth with a steady increase of power and resource. The *Missa brevis* in F (*see* MASS) is the last word in Neapolitan Church music, and the style of the symphonies and string-quartets of these years is full of wit and of terse formal devices. But these achievements did not earn money, and in 1777 Leopold Mozart asked the archbishop for leave of absence for a concert tour. The archbishop disapproved of "that system of begging." Wolfgang thereupon resigned his honorary appointment after furious protests from the archbishop; and on Sept. 23 started with his mother for Munich.

Manhood.—The results were not encouraging. Leopold discovered with surprise that a young musician of 21 could not make as much impression in palaces as an infant prodigy. Moreover, at Mannheim, where Stamitz (*q.v.*) had created a new standard of playing, Wolfgang not only imitated the Mannheim musicians but fell in love with Aloysia Weber, the daughter of the poorly paid prompter of the theatre. (Carl Maria von Weber, born 11 years later, was her cousin.) Leopold, dreading an improvident marriage, ordered his wife and son to start instantly for Paris, where they arrived on March 23, 1778. But in spite of the success of his Paris symphony (with its diplomatic initial *coup d'archet* and the unexpected pianissimo opening of the finale, which evoked an interruption of several minutes for applause), he found himself neglected by the aristocracy; and his mother fell seriously ill and died on July 3. After this catastrophe he left Paris in September and found Aloysia Weber cruelly changed towards him when he stopped at Mannheim. In June 1779 he returned to Salzburg and succeeded in inducing the archbishop to attach a salary of 500 florins to his "concertmeister's" appointment, with leave of absence in case he should be asked to write an opera elsewhere.

Two years later he was engaged to compose an opera for Munich for the carnival of 1781. The libretto was furnished by the abbate Varesco, the archbishop's court chaplain. On Jan. 29, 1781, the work was produced under the title of *Idomeneo, re di Creta* and made a great impression. It reveals Mozart's full powers of orchestration, vocal and choral style, accompanied recitative and nobly pathetic melody. In these respects it was incontestably the finest opera that had ever yet been placed upon the stage. Dramatically, it is not mature. Mozart, though profoundly influenced by Gluck in the accompanied recitative of the oracle-scene in the temple of Neptune, could as yet resist the temptations neither of coloratura singing nor of symmetrical form. And he had not yet learnt the art (and duty) of bullying his librettist. And now the archbishop realized that Mozart was an adornment to his servant's hall. On hearing of the success of *Idomeneo* he instantly summoned the composer to Vienna, where he was spending the season. Mozart soon found his position intolerable. Musicians of his standing were already becoming restive at being made to dine with flunkeys, but the archbishop's flunkeys copied their master's insolence. Mozart's salary was reduced from 500 to 400 florins, he had to pay his own travelling expenses, and he was forbidden to give concerts on his own account or to play anywhere but the archiepiscopal palace. Archbishop Hieronymus found himself omitted from the list of the emperor's summer guests and he quitted Vienna in disgust, sending his household to Salzburg, but leaving Mozart to find lodgings at his own expense. Thereupon Mozart resigned. The archbishop's language thereat was unprintable, but Mozart remained in Vienna in a house rented by his old friends, the Webers, vainly hoping for pupils in the dead season. One good thing we owe to the archbishop. Michael Haydn was also in his service and had been commissioned by him to write six duets for violin and viola. He fell ill after writing four and the archbishop refused to pay him unless all six were forthcoming. Mozart came to the rescue with two duets in his richest style; and Michael Haydn sent them in with his own. The archbishop showed no suspicion.

The emperor protected Mozart and commissioned him to write a German opera, *Die Entführung aus dem Serail,* which, on July 16, 1782, had great success in Vienna and afterwards at Prague. This great work was the first imperishable monument of the German *Singspiel* (or opera with spoken dialogues) as *Idomeneo* was the last living monument of the old Italian *opera seria.* Mozart had now mastered the art of bullying his librettist, whose chief characters he idealized to heroic proportions, while he himself exercised an extraordinary facility of comic rhyme and created the gigantic *buffo* character of Osmin.

On Aug. 16 Mozart married Constanze, the younger sister of Aloysia Weber, and the namesake of the heroine of *Die Entführung*. Much sour wisdom has been poured forth on this improvident marriage by biographers, who, accepting uncritically Mozart's steadfast creed of "Next after God, papa," are shocked by the fact that Constanze was not a good manager, and are disposed to see serious infidelity in the freedom of Mozart's manners with singers and actresses.

From the day of his marriage to that of his death Mozart was always in difficulties for lack of money. The happiness of Mozart's most private affairs is revealed to us by the exquisite quality of the works which he wrote especially for his wife; but of course these were the only works he could afford to leave unfinished! Life in the Mozart home could never have been comfortable, nor could its irregular hours have been good for children, such as Mozart's own, and his pupil, J. N. Hummel, who lived in his home, and who used sometimes to be roused at midnight to sing or play his master's latest piece while Frau Mozart gave him a glass of wine. But his children were devoted to his memory; and his widow afterwards married one Nissen, who spent untold efforts in collecting material for his biography and for a catalogue and canon of his works.

The court and nobility were kind, though not munificent, and Mozart had many friends. "Papa Haydn" told Papa Mozart that Wolfgang was the greatest musician he had ever seen or heard of; and that all the crowned heads of Europe would compete for his services if they could only be made to see his worth. But he had enemies also. His ability was terrifying and he was naively unconscious of the devastating sharpness of his criticisms. Salieri hated him, and laid up terrible odium for himself after Mozart's death, by having openly shown his dislike and baulking Mozart of a good appointment. Rumour accused him even of poisoning Mozart, and the slander is perpetuated in Rimsky-Korsakov's opera, *Mozart and Salieri.* Let us set against this the affection Beethoven and Schubert had for the poor old man, who sent for Moscheles in 1825 to make a death-bed statement in these words: "I did not poison Mozart."

Closing Years.—On Feb. 7, 1786, Mozart produced at Schönbrunn an exquisite little *Singspiel* in one act, *Der Schauspieldirektor,* and in less than three months followed it by *Le Nozze di*

Figaro. The emperor was afraid of Beaumarchais' subversive satire, but Mozart was able to assure his majesty that the abbé Da Ponte had made the libretto quite harmless. After an enthusiastic reception of *Figaro,* Mozart's enemies succeeded in so far spoiling his success that he declared he would never produce an opera in Vienna again. Fortunately, *Figaro,* like *Die Entführung,* was repeated with brilliant success at Prague, and Mozart there received a commission to write an opera for the next season, with a fee of 100 ducats. Da Ponte furnished a libretto, founded, not on Molière's *Festin de pierre,* but directly on Tirso de Molina's *Burlador de Sevilla* and entitled *Il Don Giovanni.* By Oct. 28, 1787, the whole was ready, except the overture, not a note of which was written. Yet the overture is the most elaborate Mozart had yet composed, and it was all written the night before the performance, while his wife kept him awake with coffee and amusing tales as he tossed page after page of the score to the copyists. The opera was produced on Oct. 29 with extraordinary effect, and the overture, though played without rehearsal, was as successful as the rest of the music. Michael Kelly, in his *Reminiscences,* has left a delightful account of the circumstances. Yet, when reproduced in Vienna, *Don Giovanni* was soon withdrawn in favour of Salieri's *Tarare*.

On returning to Vienna Mozart was appointed kammercompositor to the emperor, with a salary of 800 gulden. In April 1789 he accompanied Prince Lichnowski to Berlin, where King Frederick William II. offered him the post of kapellmeister, with a salary of 3,000 thalers (£450). Though most unwilling to quit the emperor's service, he informed him of the offer. "Are you going to desert me, then?" asked the emperor; and the good-natured Mozart remained, to starve. The emperor now commissioned Mozart to compose another Italian opera, which was produced on Jan. 26, 1790, under the title of *Così fan tutte*. The libretto, by Da Ponte, was designed to give Mozart unlimited opportunities for mock heroics. The public seem to have seen the point of Mozart's delicious three hours of parody, but the run of the opera was stopped by the emperor's death on Feb. 20. The well-meaning 19th century took *Così fan tutte* on a solemn estimate of the probability of its plot, and it did not come again into its rights until Richard Strauss produced it properly at Munich and inaugurated our better understanding of Mozart's irony.

In March, Schikaneder, the manager of a small suburban theatre, approached Mozart with a project for a fairy opera addressed cryptically to Freemasons, who were frowned upon by the empress, Marie Thérèse, and the Church, but of whose brotherhood Mozart was an enthusiastic member. As in the case of *Die Entführing,* he soon whirled Schikaneder off his feet and raised the fairy tale to sublime heights.

While he was working at *Die Zauberflöte* a stranger called on him, requesting him to compose a *Requiem* and offering to pay for it in advance. The stranger's behaviour was so mysterious that Mozart, who was already out of health, came to take him for a supernatural messenger of death. Meanwhile he received a commission to compose an opera, *La Clemenza di Tito,* for the coronation of the new emperor, Leopold II. at Prague. He carried out this work piece-meal, night and day, in travelling coaches and during rehearsals. The coronation took place on Sept. 6; the new empress called the opera "another German piggishness," but Metastasio's worst libretto had received better music than it deserved; and this was the swan song of opera seria. *Die Zauberflöte* was produced on Sept. 30 and had a splendid run. But the *Requiem* still remained unfinished; the stranger therefore made another appointment, paying a further sum in advance. Mozart put his greatest music into it, and became more and more convinced that he was writing it for his own death. When the stranger called the third time the composer was dead, and his terrified widow had induced Süssmayer to finish the score in an imitation of Mozart's handwriting. Süssmayer surely must have known how Mozart intended to carry out the *Lacrymosa,* of which he had only written seven bars. The rest of Süssmayer's work does him extraordinary credit. The mysterious messenger was afterwards found to be an emissary of a Count Walsegg, who wished to perform Mozart's *Requiem* as his own.

Mozart died Dec. 5, 1791, apparently from typhoid (which in Germany is called typhus) though he himself believed that he had been poisoned. Constanze broke down, and when she recovered and visited the churchyard his grave could not be identified.

Works.—The first period in Mozart's development must be taken seriously as beginning at the age of five and merging into the second somewhere about the age of 16 or 17. It was fortunate that the infancy of the sonata-forms (*q.v.*) coincided with the infancy of Mozart; for in no earlier or later epoch could his juvenile work have had so normal a relation to the musical world at large. The little pieces composed by Mozart in his fifth and sixth years show an unswerving progress in which every step is represented, and the same mistake is never made twice, nor is a form once mastered ever repeated mechanically. The violin sonatas, written in London and Paris at the age of seven, are full of inventiveness, and technically as competent as most contemporary works. Mozart's studies in strict counterpoint gave him the greatest mastery of choral music attained since Handel, and more than one movement of Church music, written before he was 15, deserves to take rank as a true masterpiece. There was a loss of freshness at the age of 15, especially in the numerous operas; but by this time the machine could run without effort, and the depths of the adolescent mind could mature in peace while the hand was reeling off coloratura arias. *Lucio Silla* is almost evenly divided between such automatic stuff and evidences that the boy of 17 was developing the cogency of a man. Some of its recitatives and choruses strike a solemn dramatic note hitherto undreamt of in stage music, except by Gluck. *La Finta giardiniera* contains Mozart's first concerted opera-finale and marks the beginning of his dramatic vitality, just as the masses in F and D, written in the same year, mark the close of his first period as a composer of Church music. But we must beware of trying to assign periods according to art-forms; for in every year of his life Mozart practised all art-forms at once; and his mastery depends neither on method nor on inspiration. Some early violin sonatas assigned by Köchel to his 13th year really belong (as Wyzlewa and Saint Foix have shown) to his adolescence, and are full of the romantic pathos of C. P. E. Bach and J. Schobert.

Idomeneo and Die Entführung.—*Idomeneo* is the only opera of Mozart in a form which could show the influence of Gluck. Its wonderful choruses and its mature orchestration and profound counterpoint are as far beyond Gluck's range as its formalities and hampered action are repugnant to Gluck's dramatic reforms. The problems of comic opera were far more suggestive to Mozart. In *Die Entführung* his exuberant music still needed (and to a slight extent received) pruning, but his dramatic genius, as shown in the part of Osmin, began to run away with his music instead of his music running away with the action. And his power of musical characterization was genuine, and not dependent on tagging each person with a mannerism. After *Die Entführung,* Mozart's record is a series of masterpieces, accompanied, but not interrupted by a running commentary of popular trifles, which often served him as studies. Almost every composition solves an art-problem, sometimes with the queerest materials. The répertoire of the modern organist contains, since Bach, no grander piece than the two fantasias which Mozart wrote for the barrel of a musical clock. Shortly before his death he wrote a beautiful adagio and rondo for the glass harmonica, in combination with flute, oboe, viola and violoncello, a perfect scheme which nobody else could have imagined. He wrote some effective processional music for two flutes, five trumpets and four drums; a beautiful adagio for two clarinets and three basset-horns (practically five clarinets), and a nice little sonata for bassoon and violoncello. His work in the larger instrumental forms is further discussed in the article SONATA FORMS.

Le Nozze di Figaro.—Mozart's later operas, from *Figaro* onwards, represent the nearest approach to a perfect art-form attainable in pre-Wagnerian opera. We cannot guess what he might have attained in serious opera had he lived to see the solemn triumphs of the French operatic stage in the austere sincerity of Cherubini and Méhul. We cannot doubt that he would have taught Beethoven to bully his librettist betimes, and that *Fidelio*

would not have stood in perilous and lonely splendour as an opera with a serious plot. But Mozart knew serious opera only as an Italian art form, which Gluck himself could not permanently rescue from the tyranny of singers. After *Idomeneo* he handled it only perfunctorily in *La Clemenza di Tito*. Comedy gave him full scope, and in *Figaro* he had the advantage of a libretto which was already a famous product of consummate stagecraft before it ever became an opera. Its absurdly complex intrigues do not worry the spectator, for no one attempts to follow them; but they keep every person on the stage in a state of excitement which is so idealized by the music that, while Beaumarchais' *Mariage de Figaro* has its place in literature, Mozart's *Figaro* is one of the greatest classics in all music. The subject is a social satire; but Mozart lives in Cloud-cuckoo-land. His characters are as irresponsible as fairies. Theirs is the world described by Lamb—the Utopia of gallantry, where pleasure is duty and the manners perfect freedom. The countess, however, is human. Producers destroy the purposes of Beaumarchais and of Mozart when they make her seem no longer young. It is only two or three years since she was Rosina in *Le Barbier de Séville;* the young Cherubino is in love with her; and the Count's intrigues have no excuse.

Don Giovanni.—In *Don Giovanni* Mozart rises, not only in the music of the ghostly statue, but also in that of Donna Anna and Donna Elvira, to heights that must be called sublime; the comedy of gallantry is in conflict with real human issues. Donna Anna's cadences are conventional when her grief has become a memory that stands between her and her lover; but at the first shock of her father's death her music is as tragic as Beethoven could have made it, cadences and all. Elvira, Don Giovanni's deserted wife, ought, like the Contessa in *Figaro,* to be represented as quite young. She enters in search of her vanished husband and sings Italian formulas which Wagnerian critics tell us are inadequate for the expression of her sorrows. Look at the *sforzando* in the second violins at the words *Ah se ritrovo l'empio*. Mozart is telling us that this inexperienced girl has not as yet come to any determination more serious than the wish to scratch Don Giovanni's eyes out. As soon as his character is revealed to her in Leporello's comic aria of the "catalogue," she determines that others at all events shall not suffer as she has suffered; and from that moment she becomes majestic. In the second act she weakens and Don Giovanni fools her to the top of her bent. Yet Mozart realizes better than Da Ponte a consistent development of her character. Her last confession of weakness, *Mi tradi,* was, like *Non mi dir,* inserted by Mozart afterwards. Both arias may be omitted; but at all events we need not make nonsense of Elvira's behaviour by putting *Mi tradi* into the first act as her second utterance, in immediate response to Leporello's catalogue aria! The final impression made by a well-conceived performance of *Don Giovanni* is of something grander than comedy. Da Ponte's stage directions should be respected; Don Giovanni should be carried off by little Italian pantomime devils, and the music should be allowed to rise undisturbed by the efforts of pantomime scenery to follow it. The beautiful final scene afterwards added by Mozart should be omitted, though with regret. Don Giovanni's indomitable courage should be that of a nobleman; and there should be no buffoonery in the comic figures of Leporello, Masetto and his fairylike Zerlina, whom Elvira snatches from the wicked hero's toils.

Die Zauberflöte and the Requiem.—In *Così fan tutte,* Da Ponte's wit and Mozart's irony were above the heads of musicians before Richard Strauss; but this work is now recognized as a subtle parody that constantly totters on the verge of reality. In *Die Zauberflöte* Mozart is in a masonic lodge of a degree higher than is known on earth. Though Mozart's head was in the heavens, his feet were very firmly planted on the stage, and he and Schikaneder understood each other perfectly and united to achieve something unique in opera; combining the gorgeousness of a pantomime with the solemnity of a ritual and the contemporary interest of a political satire.

From the solemnity of freemasonry there is but one step to that most pathetic of unfinished monuments, Mozart's *Requiem.* Its finished portions contain the most sublime Church music between Bach and the *Missa solemnis* of Beethoven. Süssmayer's completion is so well designed that even the slightness of his themes has the effect of a gesture of reverence and love. The return of the music of *Te decet hymnus* at the words *Lux aeterna,* which enables Süssmayer to end with ten pages of authentic Mozart is placed like a stroke of genius (though Mozart is reported to have contemplated an independent final number); while the latter part of the *Lacrimosa,* though not in Mozart's handwriting, must surely have been dictated by him. The instrumentation of Mozart's skeleton score is almost entirely ascertainable by the rules of his scheme; but that of the supplied numbers goes wrong at once. In the *Requiem,* as in some wonderful polyphonic designs before it, Mozart was forming a new style which might have transcended everything we know of him. Nevertheless, what he has left us is unique, and the intelligent love of Mozart's music is a liberal education in the meaning of art.

The Mozart Catalogue.—Mozart's extant works are catalogued by Köchel in 626 items, beginning with minuets written at the age of four and ending with the *Requiem.* In addition to these 626 there are many tantalizing fragments. Köchel's work was very necessary and, with corrections from the researches of Wyzlewa and Saint Foix, it remains necessary to-day, for no composer has had so many spurious works thrust upon him as Mozart. The famous "Twelfth Mass" and four others in Novello's edition ought never to have deceived good musicians. They were the work of one Zulehner, whose avowed compositions remain unpublished in the archives of Schott at the present day. Nor are such deceptions unknown in the 20th century. A concertante for four wind instruments went round Europe in 1905 as a long-lost work written in Paris in 1778.

On the other hand, five little divertimenti for two clarinets and bassoon were, in 1911, found to be Mozart's work in his ripest manner as soon as two spurious and hideous horn-parts were removed. A seventh violin concerto appeared in Nov. 1907 and, though inferior to the earlier ones, is in every detail exactly in keeping with Mozart's progress in 1777, its alleged date.

(D. F. T.)

MOZDOK, a town of Russia, in the North Caucasian Area in 43° 46′ N., 44° 38′ E., on the Terek river. Pop. (1926) 14,008.

MTSENSK, a town of Russia in the Orlov province in 53° 17′ N., 36° 33′ E., on the navigable Zusha river, near its confluence with the Oka. Pop. (1926) 10,045.

MTSKHET, a village in the Georgian S.S.R. in 41° 54′ N., 44° 42′ E., 13 m. N. of Tiflis, with which it is linked by rail. It stood at the outlet of the old Lake of Karthelia and was the residence of the Georgian kings in the 4th and 5th centuries. It is at the junction of the main routes from the Darial gorge through the Aragva valley and from the Caspian and Black seas through the Kura and Rion basins.

MUCH WENLOCK, market town, Wenlock municipal borough, Wrekin parliamentary division, Shropshire, England, 163 m. N.W. from London on the G.W. railway. (For history of the priory *see* WENLOCK.) It lies at the north end of Wenlock Edge, a low escarpment. There are beautiful remains of the priory church, chiefly Early English; but with a chapter-house of ornate Norman work. The prior's house, still inhabited, is a remarkable specimen of 15th-century work, adjoining and incorporating remains in earlier styles. The parish church of Holy Trinity is of mixed styles from Norman onwards. There is a picturesque half-timbered guild-hall (1589), with rich carved oak.

MUCIC ACID, a dibasic acid obtained as a crystalline powder melting at 213° C, insoluble in alcohol and sparingly soluble in water. Mucic acid, $CO_2H{\cdot}(CHOH)_4{\cdot}CO_2H$, is obtained by the oxidation of milk, sucrose, galactose, and most varieties of gums. The manufacture of mucic acid is practised at Eureka, Mont., where larch sawdust is hydrolysed with formation of galactose, this sugar being then oxidized with nitric acid, when mucic acid is isolated by concentrating the acidic solution. Mucic acid is used as a substitute for cream of tartar in baking powders and other effervescent preparations. On dry distillation mucic acid yields pyromucic or furoic acid, $C_4H_3O{\cdot}CO_2H$ (*see* FURFURANE), a solid melting at 132° C and resembling benzoic acid (*q.v.*).

MUCKERS, the nickname given to the followers of the teaching of Johann Heinrich Schönherr (1770–1826) and Johann Wilhelm Ebel (1784–1861). Shönherr was educated at the University of Königsberg, where the theological faculty was strongly rationalistic in tendency. Dissatisfied with this philosophy, Schönherr developed, with the aid of the Bible, a philosophy of his own and became the prophet of a dualistic theosophy very similar to Gnosticism. Schönherr died in 1826 but among his converts was Ebel, who was appointed pastor in Königsberg. In the pulpit Ebel was orthodox, but he taught Schönherr's doctrines privately to a select circle. In 1827 he was joined by Heinrich Diestel, also a Lutheran pastor of Königsberg. Together they became father confessors to a wide circle of fashionable people. But because of their peculiar teaching, which involved the minute regulation of the intercourse of married people, scandal was inevitable. In 1835 Count Finckenstein, an initiate, accused the pastors of immorality. The matter was placed before the consistory, whose proceedings became famous as the *Königsberger Religionsprozess* (1835–1841), which ended in the deprivation of both Ebel and Diestel.

See J. L. Mombert, *Faith Victorious* (1882); Hepworth Dixon, *Spiritual Wives* (1868); and, more especially, the article on Schönherr, by P. Tschackert, in Herzog-Hauck, *Realencyklopädie* (3rd ed., Leipzig, 1906), xvii. 676.

MUCUNA, a genus of twining plants, belonging to the family Leguminosae, and natives of the tropics. *M. pruriens* is popularly known as cowhage or cowitch, a corruption of the Hindu *Kiwach.* It is a tall annual climber with large dark purple pea-like flowers, and golden-brown velvety pods, the hairs or bristles on which often raise blisters on the skin. It is common in the tropical regions of India, Africa and America, and the hairs on the pod have long been used in medicine as a vermifuge. A variety of this plant is the Florida velvet bean, used as a fodder-plant.

MUDANIA (anc. *Apamea Myrlea*), a town of Asia Minor, on the south coast of the Sea of Marmora, and the port of Brusa. It is connected with Brusa by road and rail, and with Constantinople by steamers. Olive oil is produced. Pop. (1927) 13,838.

MUDEJAR, in architecture, the mixed style which was developed in Spain during the middle ages by the merging of Christian and Mohammedan traditions, especially applied to the style developed after the Christian conquest, by Mohammedans working under Christian supervision. The style affected particularly brick work, tile work and carpentry, in the detail treatment of which, Moorish forms and methods persisted long into the Renaissance. Good examples of the style are the tower of S. Andres at Calatayud (probably 15th century), the dome of Saragossa cathedral (*c.* 1412, present form 1500–20), the chapter room at Tordesillas (*c.* 1363) and many elaborate wooden ceilings, known as *artesonados.* For a thorough discussion *see* G. King, "Mudejar," *Bryn Mawr Notes and Monographs,* viii. 1927.

MUDFISH, a name given to several very different fishes, including the North American bowfin (*q.v.*) and the three living genera of lung-fishes (*q.v.*).

MUDIE, CHARLES EDWARD (1818–1890), English publisher and founder of Mudie's lending library, was born at Chelsea on Oct. 18, 1818, the son of a secondhand bookseller and newsagent. In 1840 he established a stationery and bookselling business in Bloomsbury, London. In 1842 he began to lend books. This department proved so successful that in 1852 he moved his "Select Library" to larger premises in New Oxford street, London. In 1860 these premises were substantially enlarged, and branches of the business established, and in 1864 "Mudie's" was converted into a limited company. Mudie himself died on Oct. 28, 1890.

MUD-PUPPY, the American name for *Necturus maculatus,* a water-breathing newt allied to Proteus (*q.v.*). *See* Amphibia.

MUFFLE FURNACE: *see* Furnaces, Metallurgical.

MUFTĪ, a consulting canon-lawyer in Islām, who, upon application, gives *fatwās* or legal opinions on points of the sacred law (*see* Islamic Law). These are asked and given in strictly impersonal form, but the cadi, or judge, then applies them to the case and decides in accordance with them. In theory, any learned man whose opinion is respected and whose advice is sought can give fatwās. But generally in a Muslim state there are muftīs specifically appointed by the government, one for each school of law in each place. In Turkey the chief muftī of Constantinople, with the title of Shaykh al-Islām, was the head of the ecclesiastical side of the state, while the grand vizier was at the head of secular matters; but his office was abolished in 1924 by the Turkish Republic. The use of the word for plain or civilian clothes worn instead of uniform is originally Anglo-Indian. It may have been suggested by the loose flowing robes of the "muftī."

Bibliography.—(Chap. v.); De Slane's trans. of Ibn Khaldūn's *Prolégomènes,* I. lxxviii. 447 *seq.;* Sir Charles Eliot, *Turkey in Europe* (chap. V.); art. "Shaikh al-Islām" in the *Encyclopaedia of Islam.*

MUG, a cylindrical drinking-vessel with or without a handle, made of earthenware or metal. The handle, also, makes it a convenient cup for small children, and a silver mug is frequently a christening gift to a child. (*See* Drinking Vessels.)

MUGGER (*Crocodylus palustris*), also called the marsh crocodile, is the best-known Indian species of crocodile. In times of drought it will undertake long migrations overland and has even been known to invade towns. (*See* Crocodile.)

MUGGLETON, LODOWICK (1609–1698), English sectarian, was born in Bishopsgate street, London. His father was a farrier, but he himself was bred to be a tailor. In 1651 he began to have revelations, and to proclaim himself and his cousin John Reeve, whose journeyman he was, as the two witnesses mentioned in Rev. xi. 3. In 1652 they put out their "commission book" under the title *The Transcendent Spirituall Treatise.* An exposition of their doctrines was published in 1656 under the title of *The Divine Looking-Glass.* Among other views (besides the doctrine of the divine mission of the authors) this work taught that the distinction of the three persons in the Trinity is merely nominal, that God has a real human body, and that He left Elijah as His vicegerent in heaven when He Himself descended to die on the cross. Muggleton's opinions gained some notable adherents, but also called forth much opposition. In 1653 he was imprisoned for blasphemy, and twice (1660 and 1670) his own followers temporarily repudiated him. His attack on the Quakers drew forth William Penn's book, *The New Witnesses proved old Heretics* (1672). In 1677 Muggleton was tried at the Old Bailey, convicted of blasphemy, and fined £500. Reeve died in 1658; Muggleton in 1698.

His collected works, including the posthumous *Acts of the Witnesses,* were published in 1756; and in 1832 some 60 Muggletonians subscribed to bring out a new edition of *The Works of J. Reeve and L. Muggleton* (3 vols.). Even as late as 1846 *The Divine Looking-Glass* was reprinted by members of the then almost extinct sect. *See* A. Jessopp, *The Coming of the Friars* (1888); G. C. Williamson, *Lodowick Muggleton* (1919).

MUGWORT, a plant name given to *Artemisia vulgaris,* found in Great Britain and widely naturalized in the United States and Canada; it is sometimes given also to *A. Absinthium* (wormwood, absinthium). In North America the name is applied to numerous herbaceous species of *Artemisia* native to the Great Plains region and westward, the shrubby species of the arid districts, as *A. tridentata,* being usually designated sage-brush. In Great Britain the crosswort (*Galium cruciatum*) is sometimes called mugwort. (*See* Galium.)

MUGWUMP, in American political slang, a name applied to any independent voter, and especially to those independents in the Republican Party who refused to support James G. Blaine, when nominated by that party for the presidency in 1884; as since adopted in England it usually means one who stays neutral and votes for no party. Originally "mugwump" (*mogkiomp*) was a North American Indian word, in the Massachusetts dialect of the Algonquian, meaning "great man" (*mogki,* great; *omp,* man); and in New England it was used of self-conceited politicians.

MUHAMMAD: *see* Mohammed.

MÜHLBERG, a town of Germany, in Prussian Saxony, on the left bank of the Elbe, 8 m. below Riesa. Pop. (1925) 3,540. It manufactures bricks, baskets and matches. Mühlberg is famous for the victory gained here, in 1547, by the emperor Charles V. over the elector of Saxony, John Frederick.

MUHLENBERG, HENRY MELCHIOR (1711–1787), German-American Lutheran clergyman, was born in Einbeck, Hanover, Sept. 6, 1711. When he was 12 years old, his father's

death forced him to assist in the family's support. Nevertheless he entered the University of Göttingen in 1735, and in 1738 he went to Halle, where he finished his theological studies and was a devoted worker in the Franckesche Stiftung, which later served as a partial model for his great-grandson's community at St. Johnland, Long Island. He was deacon at Grosshennersdorf, in Upper Lusatia, in 1739–41. In 1742, in reply to a call from the Lutheran churches of Pennsylvania, he went to America, stopping in England on the way further to qualify himself. Muhlenberg occupied himself more particularly with the congregation at New Providence (now Trappe) though he was practically overseer of all the Lutheran churches from New York to Maryland. In 1748 he organized the first Lutheran synod in America. He married in 1745 Anna Maria Weiser, daughter of J. Conrad Weiser, a well-known Indian interpreter. Throughout the Revolutionary War he and his sons were prominent patriots. He died at Trappe Oct. 7, 1787.

See W. J. Mann, *Life and Times* (Philadelphia, 1887); also various magazine articles and the biographical tale, *An Eagle of the Wilderness* (1924) by Margaret R. Seebach.

MUHLENBERG, JOHN PETER GABRIEL (1746–1807), American preacher and soldier, son of H. M. Muhlenberg (*q.v.*), was born at Trappe, Pa., on October 1, 1746. With his brothers he was educated in Germany. He entered the Lutheran ministry, had charge of churches at New Germantown and Bedminster, N.J., and after 1772 of a church in Woodstock, Va., and there in 1775 raised a German regiment, of which he was made colonel; in Feb. 1777, he became a brigadier-general in the Continental army. He took part in the battles of Brandywine, Germantown and Monmouth, and at Yorktown commanded the first brigade of light infantry. After the war he removed to Pennsylvania. He was a representative in Congress in 1789–91, in 1793–95, and in 1799–1801. In 1803 he became collector of the port of Philadelphia. He was a friend of Thomas Jefferson and of James Monroe.

See *Life* by Henry A. Muhlenburg (Philadelphia, 1849).

His brother, Frederick Augustus Conrad Muhlenberg (1750–1801), was pastor of the Christ (or Swamp) German Lutheran church of New York city from 1773 to 1776. In 1779–80 he was a member of the Continental Congress, and in 1789–97 was a member of the national House of Representatives, of which he was speaker in 1789–91 and 1793–95. On April 29, 1796, as chairman of the committee of the whole, he cast the deciding vote for the laws necessary to carry out Jay's treaty.

MUHLENBERG, WILLIAM AUGUSTUS (1796–1877), American philanthropist and Protestant Episcopal clergyman, was born in Philadelphia on Sept. 16, 1796, and graduated at the University of Pennsylvania in 1814. While at St. James's church in Lancaster, Pa., he wrote *A Plea for Christian Hymns* (1821), drew up for his own parish *Church Poetry* (1823), and was a member of the committee from the general convention which compiled an adequate collection of psalms and hymns, thus preparing the way for greater flexibility in the service. During his rectorship at St. George's, Flushing, L.I., he founded the Flushing institute in 1828, which developed after a time into St. Paul's college, and which was probably the first Protestant Episcopal school in the United States. The Church of the Holy Communion in New York city, a "free church" built in 1844–45 by his sister Mrs. Mary Rogers, he made a pioneer in the practical Christianity to which his later years were devoted. In addition to numerous parish activities he founded there the first American order of Protestant Episcopal deaconesses, the Sisterhood of the Church of the Holy Communion, which was formally organized in 1852. As a result of the work of the Sisters he established what he called his "hospital-church," St. Luke's in 1858. St. Johnland, his "church village" begun on Long Island in 1866 as an embodiment of Evangelical brotherhood, was designed to better the condition of the working class in general but particularly to provide healthy shelter for children and indigent old people. He died in New York city on April 8, 1877.

Anne Ayres, who was closely associated with him as "First Sister," described his life and work (1880); and W. W. Newton is the author of another biography (1890).

MÜHLHAUSEN, a town of Germany, in the Prussian province of Saxony, on the right bank of the Unstrut, 25 m. N.N.W. of Gotha by rail. Pop. (1925), 35,955. Mühlhausen is one of the oldest towns in Thuringia, and is said to have been fortified in 925. Its early importance is shown by the grant of privileges made to it by the German King Henry I., and by the diet held here in 1135. The Teutonic order established itself at Mühlhausen in 1200. During the Reformation period Mühlhausen became one of the chief seats of the Anabaptists. In 1802 it lost its independence and passed to Prussia, in 1807 it was attached to the kingdom of Westphalia, but in 1815 it again became Prussian. It consists of a new and an old town, and has numerous old churches and towers. The churches of St. Mary and of St. Blasius, date respectively from the 14th and the 12th century; the town hall is also a fine mediaeval structure. The chief industries are the spinning and weaving of wool and cotton. Other manufactures include machinery, soap, hosiery and furniture.

MUIR, JOHN (1810–1882), Scottish orientalist, was born on Feb. 5, 1810, in Glasgow, was a servant of the East India company from 1829 to 1853. He had a distinguished career in India. In 1862 he endowed the chair of Sanskrit in the University of Edinburgh, and was the main agent in founding the Shaw fellowship in moral philosophy. He died on March 7, 1882. Muir's most important work is his *Original Sanskrit Texts* (5 vols., 1858–70), of the utmost importance for the study of the Vedic age.

MUIR, JOHN (1838–1914), American naturalist and writer, was born at Dunbar, Scotland, April 21, 1838. His boy life there and on a backwoods farm in Wisconsin is delightfully told in his *Story of My Boyhood and Youth* (1913). Although both places increased Muir's inherent love of nature, he also had marked inventive genius and enjoyed the rush and turmoil of factory and city life. After he left the University of Wisconsin an accident which made him fear his eye was "closed for ever to all God's beauty" caused him to start on the long series of wanderings described in *A Thousand-Mile Walk to the Gulf* (1916); *My First Summer in the Sierra* (1911); *The Cruise of the Corwin* (1917) and *Steep Trails* (1918). The huge and spectacular forces of nature attracted him always—the pure air of the upper Yosemite, the majestic sequoia trees of California, the mighty glaciers of Alaska, to one of which his name was given; and in his letters and finished work he extols them in rhythmical prose. When he first started his study Muir had no intention of writing; after his marriage, April 14, 1877, to Louie Wanda Strentzel he devoted himself for a number of years to horticulture; at the end of his life he was working hard to put into shape the material he had accumulated, sufficient, he declared, for a dozen volumes. To his efforts are largely due the establishment of the Yosemite and other areas as national parks, and to a certain extent the national conservation policy. Muir died at Los Angeles (Cal.) Dec. 24, 1914.

See *Writings* (1916–24), a series which includes the *Life and Letters of John Muir* by the editor, W. F. Badé, and S. H. Young's *Alaska Days with John Muir* (1915).

MUIR, SIR WILLIAM (1819–1905), Arabic scholar, brother of the Sanskrit scholar, was born at Glasgow on April 27, 1819. He went out to India in 1837, and in 1865 became foreign secretary to the Indian Government. In 1867 he was knighted (K.C.S.I.), and in 1868 he became lieutenant-governor of the North-West Provinces. In 1874 he was appointed financial member of the Council, and retired in 1876, when he became a member of the Council of India in London. Through his help, the central college at Allahabad, known as Muir's College, was built and endowed. Muir was principal of Edinburgh University from 1885 to 1903. He died at Edinburgh on July 11, 1905.

His chief books are a *Life of Mahomet and History of Islam to the Era of the Hegira* (4 vols., 1858–61); *Annals of the Early Caliphate* (1883); *The Corân: its Composition and Teaching*; and *The Mohammedan Controversy*, a reprint of five essays published at intervals between 1885 and 1887.

See a notice by C. J. Lyall in the Royal Asiatic Society's *Journal* (1905).

MUIRHEAD, JOHN HENRY (1855–), British philosopher, was born in Glasgow, and educated at Glasgow academy and university, and at Balliol college, Oxford. He held professorships at Glasgow, London and Birmingham universities, and was then appointed Mills professor of philosophy in the University of Canada.

He has published several translations from the classics; many philosophical works, including *Philosophy and Life* (1908); *German Philosophy in Relation to the War* (1915), *Social Purpose* (with Hetherington, 1918); *Life and Philosophy of Edward Caird* (with Sir Henry Jones, 1921); and many articles. He also edited *Contemporary British Philosophy* (1924–25).

MUKADDASI[1] [the appellation of Shams ad Din Abu Abdallah Mohammed ibn Aḥmad] (*fl.* 967–985), Arabian traveller, author of a *Description of the Lands of Islam.* His descriptions rest on extensive travels through a long series of years. His first pilgrimage was made at the age of 20 (in A.H. 356=A.D. 967), but his book was not published till A.H. 375 (A.D. 985–986), when he was 40 years old.

The book became known in Europe through the copy brought from India by Sprenger, and was edited by M. J. de Goeje as the third part of his *Bibliotheca Geographorum Arabicorum* (Leiden, 1877). *See* also the English translation (unfinished) by G. S. A. Ranking and R. F. Azoo, in *Bibliotheca Indica,* New Series, Nos. 899, 952, 1001 (Bengal Asiatic Society, 1897–1901); Muḳaddasi's Syrian chapter has been separately translated and edited in English by Guy Le Strange (London, Palestine Pilgrims Text Society, 1886); in German by J. Gildemeister in *Zeitschrift des deutschen Palästina-Vereins,* vol. vii. (1884).

MUKDEN, the capital of Fengtien province, the seat of Government of the "Three Eastern Provinces," *i.e.,* Manchuria, and the ancestral capital of the Manchu Dynasty which ruled China from 1644 to 1911 (41° 51′ N. and 123° 25′ E.). It is known to the Chinese as Fengtien or Shêngking ("Abundant capital"). It is situated on the Hun-ho tributary of the Liao-ho, where the broad basin of central Manchuria contracts to a relatively narrow corridor between the east Manchurian Highlands and the Jehol hills which prolong the Mongolian Plateau almost to the coast. Mukden therefore controls the main north-south route which traverses this Liao corridor and the still narrower coastal sill giving access to the north China plain. Moreover the valley of the Upper Hun-ho, which here debouches on to the lowland, affords one of the chief routes through the east Manchurian Highlands. The strategic and focal significance of its position was realized at an early stage. In the 12th century it was the northernmost of the three capitals of the Empire of the Kin Tatars (Golden Horde), originally from the steppes of northern Manchuria. About the same period Aisiu Goro, from whom ultimately descended the Manchu dynasty, had his capital in the neighbourhood of the Chang-pai-shan mountains, north of the Korean peninsula. In the early 17th century his descendant Nurhachu, for the purpose of organizing and uniting the various Manchu tribes and with a view to the conquest of China, moved his capital down to the plain of the Liao-ho, towards the Chinese frontier. Mukden was then known as Shêngking and proved an admirable organising base for the conquest of China. In 1644 when the Manchus supplanted the Mings on the Imperial throne the capital was transferred to Peking. Shêngking, however, retained its prestige as the older capital of the reigning dynasty; the treasures of the royal house were deposited in its Palaces and the tombs of the earlier Emperors (particularly the mausoleum of Tatsung d. 1644 at Peilung, *i.e.,* North Mausoleum, about four miles from the city) are among the most famous monuments of China. In 1658 the provincial government of Fengtien was established and the city became known by its present name of Fengtien (Mukden).

In the period of struggle between Russia and Japan for dominance in Manchuria, Mukden was inevitably one of the key positions. It was for a time a Russian stronghold and was the scene of the protracted "Battle of Mukden" which lasted from February 19th to March 10th, 1905, when the city fell to the Japanese. Since the Russo-Japanese War the Japanese concession in Mukden has been one of their chief bases for the exploitation of South Manchuria, but it has also been the seat of government of the Chinese "Viceroy" of the three Manchurian provinces (Fengtien, Kirin and Heilungkiang). The relationship of this official to the Japanese on the one hand and the various parties contending for power in China Proper on the other has been for several years, and still is, one of the crucial factors in Chinese politics. During the Civil War (1924–27) Chang Tso-lin, the "Mukden War-Lord" governed Manchuria as virtually an independent country, from which he advanced, as the Manchus had done before him, to dominate the government of Peking. As a result of the advance of the Nationalist armies to the capital in 1928 and the dramatic death of Chang Tso-ling on his retreat to Mukden, the status of Manchuria has now somewhat altered. The position at the conclusion of 1928 was that the "War-Lord's" son, Chang Hsueh-liang, had given his adhesion to the Nanking Government and was one of its 16 State Councillors, but retained control over a separate sphere of administration in Manchuria.

As a focus of trade and industry Mukden reflects the remarkable economic development of Manchuria during recent years. The natural advantages of its site and its central position in relation to China on the one hand and the Japanese sphere in Korea and Kwantung on the other have made it the chief centre of the rapidly expanding railway system of South Manchuria. It is the central junction of the South Manchurian Railway where the main north-south line from Changchun (linked with the Chinese Eastern Railway) to Dairen in the Kwantung Leased Territory is connected with the Mukden-Antung-Korean system, and where too a short line runs to the Fushun coalfield. With China Proper it is connected by the Peking-Mukden (Chinese Government) Railway, recently continued north-eastwards to Hailung and ultimately to reach Kirin. Mukden lies near the junction of the rich agricultural Plain of South Manchuria with the forested highlands on the east and their resources are becoming increasingly available by the good system of communications. The chief crops of the plain are soya beans, grains, kaoliang and sugar-beet, along the S.M.R. zone, while the hills furnish forest products of various kinds, and other raw materials such as furs and hides reach Mukden from the North. In comparatively close proximity to the city are the Fushun coalfield, at present the most productive in all China, and the smaller Yentai field. Upon this varied basis of production many manufacturing industries have been developed in recent years. These include flour-mills, oil mills, tanneries, paper mills, soap factories and soy manufactures, while the expansion of the road system is making Mukden the headquarters of numerous transport companies, with good prospects for the motor industry. The railways and the Mukden Government Arsenal have created a strong demand for engineering material and Mukden has the beginnings of an important iron industry in the Ta Yeh works.

Mukden is the chief educational centre of South Manchuria, and its higher institutions include colleges established under Japanese, Chinese and missionary auspices, notably the North-Eastern University and the Mukden Medical College (Presbyterian Mission) which has done notable work in combating the bubonic plague, at times a serious menace to Manchuria.

Mukden now consists of three parts:—the old city, containing the Imperial Palaces and the Chinese Government Offices, surrounded by a brick wall about 30 feet high and four miles in circumference; the New Town or Japanese concession, which is the property of the South Manchurian Railway and laid out on a grand scale with wide macadamised roads, squares and parks; and an intermediate commercial quarter. The road system has been much improved; an electric-tram route under municipal control runs between the West Gate of the old city and the borders of the Japanese concession and a motor-omnibus service—a joint Chinese-Japanese enterprise—links the city with the South Manchurian Railway station. The Post Office estimate of the population of the Mukden administrative area (hsien) is 773,846 and the census of 1926 returned that of the native city at 245,315. (*See* MANCHURIA.)

MULA, a town of eastern Spain, in the province of Murcia; on the left bank of the Mula, a small right-hand tributary of the Segura. Pop. (1920), 12,319. The Sierra Espuña rises on the south to a height of nearly 5,200 ft. About 4 m. E. are two

[1]Al Muḳaddasi="the Jerusalemite."

groups of houses known as the Baños de Mula, with warm sulphurous springs.

MULATTO, a person one of whose parents is of a white race and the other a negro. In Latin America such half-breeds are sometimes called *mestizos* (*q.v.*).

MULBERRY, botanically *Morus* (family Moraceae), a genus of 12 species growing in the temperate regions of the northern hemisphere and in the mountains of the tropics. They are deciduous trees or shrubs with alternate, toothed, often three-lobed leaves and unisexual flowers in catkin-like inflorescences. The black mulberry (*M. nigra*), a native of western Asia, spread westwards in cultivation at an early period; it was cultivated by the Greeks and Romans, and in northern Europe by the 9th and 10th centuries. Up to the 15th century it was extensively grown in Italy for rearing silkworms, but has since been superseded by *M. alba*. It is now mainly cultivated for its oblong purplish-black fruit. The mulberry succeeds as a standard in the warmer parts of England, especially in sheltered situations, but in the north of England and the less favoured parts of Scotland it requires the assistance of a wall. The tree succeeds best in a rich, deep, and somewhat moist loam, but grows well in any good garden ground. It is usually propagated either by cuttings or layers. The mulberry may be grown in pots, and gently forwarded in an orchard house, and under these conditions the fruit acquires a richness of flavour unknown in the fruit ripened out of doors.

The white mulberry (*M. alba*), so called from its nearly white fruit, is the one mainly employed in silkworm culture. It is a native of China and has been cultivated from the earliest times in Asia and since the 12th century in Europe, especially in the Mediterranean region. There are many varieties, among which the Philippine mulberry (var. *multicaulis*) is perhaps most highly esteemed. The Indian species, *M. indica* (not to be confounded with *Morinda citrifolia*, a tree of the family Rubiaceae, sometimes also called Indian mulberry), is also cultivated for the same purpose.

The North American red mulberry (*M. rubra*) is the largest of the genus, often reaching a height of 70 ft. It produces dark red berries much inferior in flavour, however, to those of *M. nigra*. Both the white and the red mulberry have been grown in the eastern United States since colonial times and both have sparingly escaped from cultivation.

Broussonetia papyrifera, a member of a closely allied genus, is the paper mulberry, a native of Burma, China and Polynesia, and widely cultivated in Japan, where the bark is used for paper-making. The Tapa-cloth of the South Sea Islands is also made from it. The plant is a shrub or small tree with large mulberry-like lobed or entire hairy leaves. Several forms are cultivated, differing chiefly in the shape of the leaves. The paper mulberry, often planted for ornament in the south-eastern United States, has run wild in various localities from New York to Florida.

MULCAHY, RICHARD JAMES (1886–), Irish politician, was born in Waterford, and began his career in the engineering department of the Dublin General Post Office. He took part as a lieutenant in the Irish rebellion of 1916, and was afterwards interned in Frongoch. In Dec. 1918 he was returned as Sinn Fein M.P. for the Clontarf division of Dublin and retained his seat until 1922. He played a prominent part with Michael Collins in the reorganization of the Irish Volunteers, of which he had become chief-of-staff in 1918. He sat in the Dáil from 1921–23 as a member for the North-west division of Dublin, and after the treaty of 1922 became minister of defence for the Irish Free State. He succeeded Michael Collins, after the latter's death in 1922, as commander-in-chief of the Free State forces, and had the chief conduct of operations until the cease-fire order of 1923, in which year he was returned to the Dáil for Dublin city north. He resigned office in the spring of 1924 upon the executive requiring the resignation of three of his principal officers in connection with troubles arising out of demobilization and reorganizaton. In 1927 he resumed office as minister for local government.

MULE, a term sometimes applied, as equivalent to *hybrid*, to the produce of any two higher animals of different species, but in its ordinary acceptation employed to designate the offspring of the cross between the equine and asinine species. There are two kinds of mule—the *mule* proper, which is the hybrid produce of a male ass with a mare, and the *hinny*, the offspring of the stallion and female ass. The mule is the more valuable of the two, and the hinny, which is inferior in size, strength and beauty, is not deliberately bred.

In its short, thick head, long ears, thin limbs, small narrow hoofs, short mane, absence of "chestnuts" (horny growths) inside the hocks, and tail destitute of hair at the root, the mule resembles the ass, while in height and body, shape of neck and croup, uniformity of coat and in teeth it resembles the horse. It has the voice neither of the ass nor of the horse, but emits a feeble hoarse noise. The most common colour of the mule is a brown or bay-brown. It possesses the sobriety, patience, endurance and sure-footedness of the ass, and the vigour, strength and courage of the horse. As a beast of burden it is in many environments preferable to the horse, being less impatient under heavy weights, while the skin being harder and less sensitive renders it more capable of resisting sun and rain. The mule has been in use from early times; in modern times it has been largely employed for military transport.

Mules are wholly sterile both with other mules and with either parent species. Only one or two exceptions to this rule have been recorded, and even these are not usually regarded as authentic.

MÜLHAUSEN: *see* MULHOUSE.

MÜLHEIM-AM-RHEIN, a town in the Prussian Rhine province, on the right bank of the Rhine, 2 m. below Cologne, with which it was incorporated in 1914, and on the main lines of railway Cologne-Düsseldorf and Cologne-Elberfeld. Mülheim received municipal rights in 1322. Its industrial prosperity is in great part due to the influx of Protestants expelled from Cologne at the beginning of the 17th century. In 1784 the town suffered severely from an inundation caused by the rapid breaking-up of the ice on the Upper Rhine. There are important manufactures of silk, velvet, sailcloth, tobacco, vinegar, yarn and chemicals, in addition to rolling-mills, boiler works, telegraph works, breweries, tanneries and a shipbuilding yard.

MÜLHEIM-AN-DER-RUHR, a town in the Prussian Rhine province, on the Ruhr, an affluent of the Rhine, about 7 m. W.S.W. from Essen and at the intersection of several railways. Pop. (1925), 127,228. Mülheim was formerly included in the duchy of Berg, and became a town in 1508. In 1815 it passed to Prussia. It has a 12th century parish church. Its chief industry is iron-working and it has numerous blast-furnaces, rolling-mills, foundries and engine-works; it also manufactures leather, tobacco, paper and beer. Traffic is carried on in coal, and timber and colonial produce. In the neighbourhood are sandstone quarries, glassworks, and a carpet manufactory.

MULHOUSE (Mülhausen), a town of France, capital of an arrondissement in the department of Haut-Rhin, about 29 m. E.N.E. of Belfort, 56 m. S. of Strasbourg and 21 m. N.W. of Basle by rail. Pop. (1926) 96,019. It stands on the river Ill, here a part of the Rhone-Rhine canal system. Mulhouse was a free imperial city in the 14th century, and in 1648 was added to the Swiss confederation, with which it had been allied since 1466 and to which it belonged until 1798 when it joined France. From 1871 till 1918 it belonged to Germany. It is the great textile centre of Haut-Rhin and also manufactures machinery and chemicals. The *Hôtel-de-ville* (16th century) has curiously painted walls and a covered outside stairway. Here was made an interesting attempt at industrial town-planning, by Dollfus, in 1853.

MULL, the largest island of the Inner Hebrides, Argyllshire, Scotland. Pop. (1921) 3,389. It is bounded on the west and south by the Atlantic, on the north and north-east by the Sound of Mull, and on the east and south-east by the Firth of Lorne. Its greatest length is 27 m., and its greatest breadth 20 m. The coast is deeply indented, and there are several freshwater lakes. The principal mountains are Ben More (3,185 ft.), Ben Buy and Ben Creach. In the basaltic cliffs near Carsaig are numerous arches and caverns. Sheep and cattle are raised, and barley, oats and potatoes grown. Owing to the damp climate the island is better suited for grazing

than for cultivation. Granite is quarried. The fishing and shooting attract many sportsmen. There are several ancient castles, the principal being those of Duart and Aros. Close to the former is a lighthouse erected in memory of William Black, the novelist (d. 1898). About midway between Mull and Lismore is the Lady rock, visible at low water, on which, in 1523, Lachlan Maclean of Duart exposed his wife, a daughter of the second earl of Argyll, expecting that she would be drowned by the flowing tide. She was, however, saved by her clansfolk and her husband was afterwards slain by her brother. Tobermory ("the Well of Mary," so called from a spring of local celebrity), which rises from a picturesque bay, is the only town (pop. 850). Founded in 1788 as a station for fishing-boats, it has a harbour and considerable local trade. It is also a summer resort, with communication by steamer with Oban and Glasgow. Off the north-western shore of Mull, separated by a narrow strait, lie the inhabited islands of Ulva, $4\frac{3}{4}$ m. long and $2\frac{1}{2}$ m. broad, and Gometra. Little Colonsay lies about 2 m. south of Ulva. Farther west is the small group of the Treshnish Isles.

MULLAH, in Mohammedan countries a learned man, a teacher, a doctor of the law. (Arabic *maula,* a term which originally expresses the legal bond connecting a former owner with his manumitted slave.) In India the term is applied to the man who reads the Qu'ran and also to a Muslim schoolmaster. In countries like Afghanistan the mullahs exert an influence over the populace which sometimes rivals that of the amir himself.

In the Indian frontier risings of 1897–98 the "mad mullah" of Swat led the attack upon the Malakand, while the Hadda mullah was largely responsible for the risings amongst the Mohmands, Afridis, and Orakzais. The leader of the risings in Somaliland in 1899–1910 was similarly known as the "mad mullah."

MULLEIN (*Verbascum Thapsus*), a densely woolly, biennial herb of the figwort family (Scrophulariaceae), native to Europe and Asia, common in the British Isles and extensively naturalized in North America. It grows erect, 2 to 7 ft. high, with stout unbranched stems, conspicuously winged by the decurrent bases of the large, thick, oblong, slightly-toothed, pointed leaves, sometimes a foot long. The bright yellow flowers, about an inch broad, appearing from June to September, are closely crowded in a long, dense spike. In some districts the mullein is a troublesome weed.

BY COURTESY OF THE WILD FLOWER PRESERVATION SOCIETY

THE GREAT MULLEIN (VERBASCUM THAPSUS), FOUND IN EUROPE, ASIA AND NORTH AMERICA

MÜLLER, FERDINAND VON, Baron (1825–1896), German botanist and explorer, was born at Rostock on June 30, 1825, and was educated in Schleswig. In 1847 he emigrated to South Australia and five years later, was appointed government botanist for Victoria. As phytographic naturalist, he joined the expedition sent out under Augustus Gregory by the duke of Newcastle, secretary of state for the colonies. From 1857 to 1873 he was director of the Botanical Gardens, Melbourne, and not only introduced many plants into Victoria, but made the excellent qualities of the blue gum tree (*Eucalyptus globulus*) known all over the world, and succeeded in introducing it into the south of Europe, North and South Africa, California and the extra-tropical portions of South America. For these services he was decorated by many foreign countries, and was created baron of the kingdom of Württemberg in 1871. He died at Melbourne on Oct. 9, 1896.

His publications include *Fragmenta phytographica Australiae* (11 vols., 1862–81); *Plants of Victoria* (2 vols., 1860–65) and works on the Eucalyptus, Myoporeceae, Acacias and Salsolaceae.

MÜLLER, FRIEDRICH (1749–1825), German poet, dramatist and painter, usually known as Maler (*i.e.,* painter). Müller, was born at Kreuznach on Jan. 13, 1749, and became (1777) court painter at Mannheim. Next year he left for Italy, where the rest of his life was spent. He died in Rome on April 23, 1825. Müller abandoned painting soon after his arrival in Italy. His principal works are *Fausts Leben dramatisiert* (1778); *Golo und Genoveva* (begun in 1776, but not published till 1811); and the idylls, *Die Schafschur* (1775) and *Das Nusskernen* (1811).

See the selection, *Ausgewählte Dichtungen* (ed. H. Hettner 2 vols. 1868); monographs by Seuffert (1877), Luntowski (1908) and *Bibliographie* by Fr. Meyer (1912).

MÜLLER, GEORGE (1805–1898), English preacher and philanthropist, was born near Halberstadt, Germany, on Sept. 27, 1805, the son of an exciseman. In 1830 he became minister of a small congregation at Teignmouth, Devonshire. He contended that the temporal as well as the spiritual needs of life could be supplied by prayer, and on this principle abolished pew rents and refused to take a fixed salary. After two years at Teignmouth, Müller removed to Bristol, where he spent the rest of his life. He devoted himself particularly to the care of orphan children. He began by taking a few under his charge, but in course of time their number increased to 2,000, settled in five large houses erected for the purpose at Ashley Down, near Bristol. The money required for the carrying on of this work was voluntarily contributed, mainly as a result of the wide circulation of Müller's narrative *The Lord's Dealings with George Müller.* When he was over 70 he started on a preaching mission, which lasted nearly 17 years and included Europe, America, India, Australia and China. He died at Bristol on March 10, 1898.

See A. T. Pierson, *George Müller of Bristol* (1899).

MÜLLER, HERMANN (1876–), German politician, was born May 18, 1876 at Mannheim. From 1899 to 1906 he was editor of the Socialist newspaper the *Görlitzer Volkszeitung,* and from 1906 onwards was a member of the directing board of the German Social Democratic party. From 1916 to 1918 he was a member of the *Reichstag.* On Aug. 1, 1914, he went to Paris with the object of finding out whether international action by the Socialists of France and Germany could be initiated in order to avert the World War. His mission was unsuccessful, and he had great difficulty in making his way back to Germany through the French lines. His report did much to determine the attitude of the German Social Democrats in voting in the *Reichstag* for the first war credit. On June 21, 1919, he was appointed Minister for Foreign Affairs—under the chancellorship of Gustav Bauer—and in this capacity went to Versailles and with the Colonial Minister, Dr. Bell, signed the Peace Treaty for Germany on June 28, 1919. After the resignation of the Bauer Ministry, which followed upon the Kapp Putsch (March 1920), Müller was appointed Chancellor of the *Reich,* an office which he held till the following June, when the result of the general elections for the *Reichstag* necessitated the formation of a Coalition Ministry with Fehrenbach of the Catholic Centre party as Chancellor. Thereafter Müller continued to play a leading part in the affairs of the Social-Democratic party, whose chairman in the *Reichstag* he was. After the general election of May 1928, which brought a general swing to the Left, he was asked by the President to form the new Government. After wearisome negotiations with the different parties concerned, he succeeded in forming a "Cabinet of Personalities," based on the idea of the Great Coalition including all parties from the Social Democrats to the German People's party; he himself was Chancellor.

MÜLLER, JOHANNES PETER (1801–1858), German physiologist and comparative anatomist, was born in Coblenz on July 14, 1801. He studied at Bonn university, where he taught from 1824 until 1833, when he received the chair of anatomy and physiology at Berlin. He died on April 28, 1858. The appearance of his *Handbuch der Physiologie des Menschen,* 1833–40 (Eng. trans., Dr. William Baly, London, 1842) marked the beginning of a new period in the study of physiology, by showing its dependence on the other sciences. The most important part of the

work deals with the physiology of the nerves and the senses. Here Müller first declared that the kind of sensation following stimulation of a sensory nerve depends not on the mode of stimulation, but upon the nature of the sense-organ which transmits it to other nerve-terminals, and expounded the mechanism of voice, speech and hearing. Müller is also noted for his early investigations of specific nerve energies, his discoveries of the foetal Müllerian duct (1825) and of the lymph-hearts in the frog (1832), his work on tumours (1838) and his description of the parasitic disease, psorospermosis (1841). In the later part of his life he devoted himself to the study of ocean fauna and comparative anatomy.

In addition to his *Handbuch der Physiologie,* Müller published *Zur vergleichenden Physiologie des Gesichtssinns* (1826); *Ueber die phantastischen Gesichtserscheinungen* (1826); *Bildungsgeschichte der Genitalien* (1830); *De glandularum secernentium structura* (1830); *Vergleichende Anatomie der Myxinoiden* (1834–43); *Systematische Beschreibung der Plagiostomen* (1841) with F. G. J. Henle; *System der Asteriden* (1842) and *Horae ichthyologicae* (1845–49) with F. H. Troschel.

MÜLLER, JOHANNES VON (1752–1809), Swiss historian, was born on Jan. 3, 1752, at Neunkirch, near Schaffhausen, where his father was pastor. From 1774 to 1780 he lived at Geneva where he produced his *Allgemeine Geschichte,* a brilliant study of universal history (not published till 1810). In 1780 he completed the first volume of his *Geschichten der Schweizer,* bearing the imprint of Boston, U.S.A., on account of difficulties with the Swiss censor. His *Reisen der Päpste* appeared in 1782.

In 1786 he became librarian to the elector-archbishop of Mainz, who obtained his elevation to nobility from the emperor in 1791. In June 1786 he issued vol. i. (reaching to 1412) and two years later vol. ii. (to 1436) of the definitive form of his Swiss history.

After the capture of Mainz by the French (1792), he entered the service of the emperor Leopold as an imperial aulic councillor. At Vienna he became chief librarian of the imperial library in 1800, and in 1795 he issued vol. iii. (to 1443) of his Swiss history. In 1804 he became historiographer, war councillor and member of the Academy at Berlin. In 1805 vol. iv. (to 1475) appeared. But in 1806 he became strongly inclined towards Napoleon, from whom he accepted (end of 1807) the office of secretary of State for the kingdom of Westphalia. At the end of 1808 he published vol. v. (to 1489) of his great work. He died at Cassel on May 29, 1809. His *Swiss History,* based largely on the chronicles of Tschudi (*q.v.*), now possesses a literary value only, but it remarkably stimulated Swiss patriotism.

Müller's *Werke* were published at Tübingen, in 27 vols. (1810–19), and re-issued, in 40 vols., at Stuttgart (1831–35). The *Swiss History* was re-issued at Leipzig and Zürich, in 15 vols. (1824–53), with continuations by other hands. A French translation of the German edition appeared, in 18 vols., at Paris and Geneva (1837–51). His *Universal History* was translated into English by J. C. Prichard (1818).

See A. H. L. Heeren, *J. von Müller der Historiker* (1809); J. M. H. Döring, *Leben* (1835); C. Monnard, *Biographie* (1839); H. W. J. Thiersch, *Über J. von Müller und seinen handschriftlichen Nachlass* (1881); C. Henking, *J. von Müller* (1909 and 1928). F. Schwarz's pamphlet *J. von Müller und seine Schweizergeschichte* (Bâle, 1884) traces the genesis of the *History*. *See* also: *J. Müller's Briefe,* edit. J. H. Füsslin (Zürich, 1812); and those to Ch. Bonnet, etc. (Stuttgart, 1835); *Briefe,* edit. Maurer-Constant, 6 vols. (Schaffhausen 1839–40); *Der Briefwechsel der Brüder J. G. Müller und J. von Müller,* 2 vols. (1893).

MÜLLER, KARL OTFRIED (1797–1840), German scholar, was born at Brieg in Silesia on Aug. 28, 1797. He was educated partly in Breslau, partly in Berlin, and his first book, *Aegineticorum liber,* was published in 1817. In 1819 he became professor of ancient literature at Göttingen, but in 1839 political disturbances led him to travel. After investigating Athens and other places, he started excavations at Delphi. He died of intermittent fever at Athens on Aug. 1, 1840. His aim was to form a conception of Greek life as a whole, and his work marks an epoch in Hellenic study.

Among his historical works the foremost place belongs to his *Geschichte hellenischer Stämme und Städte: Orchomenos und die Minyer* (1820), and *Die Dorier* (1824; Eng. trans. by H. Tufnell and Cornewall Lewis, 1830). He introduced a new standard of accuracy in the cartography of ancient Greece. In 1828 he published *Die Etrusker,* a treatise on Etruscan antiquities. His *Prolegomena zu einer wissenschaftlichen Mythologie* (1825; Eng. trans., J. Leitch, 1844) prepared the way for the scientific investigation of myths; while the study of ancient art was promoted by his *Handbuch der Archäologie der Kunst* (1830; Eng. trans., J. Leitch, 1847), and *Denkmäler der alten Kunst* (1832), which he wrote in association with C. Osterley. In 1840 appeared in England his *History of the Literature of Ancient Greece* (published in Germany, 1841).

See memoir of his life by his brother Eduard, prefixed to the posthumous edition of K. O. Müller's *Kleine deutsche Schriften* (1847). A biography composed from his letters was published by O and E. Kern, *K. O. Müller, Lebensbild in Briefen an seine Eltern* (1908).

MÜLLER, LUCIAN (1836–1898), German scholar, was born at Merseburg in Prussian Saxony on March 17, 1836, and died at St. Petersburg (Leningrad), where he was professor of Latin, on April 24, 1898. He lived for five years in Holland, and wrote *Geschichte der klassischen Philologie in den Niederlanden* (1869). His *De re metrica poetarum latinorum* (1861) marks an epoch in the study of Roman metre.

MÜLLER, MAX [Friedrich Maximilian] (1823–1900), Anglo-German Orientalist and comparative philologist, was born at Dessau on the 6th of December 1823, being the son of Wilhelm Müller (1794–1827), the German poet, celebrated for his phil-Hellenic lyrics, who was ducal librarian at Dessau. Mendelssohn, who was Max Müller's godfather, dissuaded him from indulging his natural bent to the study of music; Professor Brockhaus of the University of Leipzig, where Max Müller matriculated in 1841, induced him to take up Sanskrit; Bopp, at Berlin (1844), made the Sanskrit student a scientific comparative philologist; Schelling at the same university, inspired him with a love for metaphysical speculation, though failing to attract him to his own philosophy; Burnouf, at Paris in the following year, by teaching him Zend, started him on the track of inquiry into the science of comparative religion, and impelled him to edit the *Rig Veda;* and when, in 1846, Max Müller came to England upon this errand, Bunsen, in conjunction with Professor H. H. Wilson, prevailed upon the East India Company to undertake the expense of publication. Bunsen gave him introductions to Queen Victoria and the prince consort, and to Oxford university. In 1848 the printing of his *Rig Veda* at the University Press obliged him to settle in Oxford. Max Müller was appointed deputy Taylorian professor of modern languages in 1850, and became an honorary fellow of Christ Church and a fellow of All Souls. He published during this period the essays subsequently collected as *Chips from a German Workshop,* and his *History of Ancient Sanskrit Literature* (1859).

When at last the chair of Sanskrit fell vacant in 1860, Max Müller failed to secure election on account of his foreign birth and his liberal connections, and the choice fell on Monier-Williams. It was the one great disappointment of Max Müller's life, and made a lasting impression upon him. Directly, Sanskrit philology received little more from him, except in connection with his later undertaking of *The Sacred Books of the East;* but indirectly, by emphasizing its importance, as he did in his *Science of Language,* two courses of lectures delivered at the Royal Institution in 1861 and 1863, he rendered great service. Prichard had proved the Aryan affinities of the Celtic languages by the methods of comparative philology so long before as 1831; Winning's *Manual of Comparative Philology* had been published in 1838; the discoveries of Bopp and Pott and Pictet had been recognized in brilliant articles in the *Quarterly Review,* and had guided the researches of Rawlinson. Max Müller popularized the subject. He was on less sure ground in another department of the study of language—the problem of its origin. He wrote upon it as a disciple of Kant, whose *Critique of Pure Reason* he translated. His essays on mythology are among the most delightful of his writings, but their value is somewhat impaired by a too uncompromising adherence to the seductive generalization of the solar myth.

Max Müller's studies in mythology led him to the comparative

science of religions. His *Introduction to the Science of Religion* (1873: the same year in which he lectured on the subject, at Dean Stanley's invitation, in Westminster Abbey, this being the only occasion on which a layman had given an address there) marks an epoch. It was followed by the four volumes of Gifford lectures, delivered between 1888 and 1892; but the most tangible result of the impulse he had given was the publication under his editorship, from 1875 onwards, of *The Sacred Books of the East,* in fifty-one volumes, including indexes, all but three of which appeared under his superintendence during his lifetime. These comprise translations by the most competent scholars of all the really important non-Christian scriptures of Oriental nations. Max Müller also wrote on Indian philosophy in his later years, and he stimulated the search for Oriental manuscripts and inscriptions which resulted in discoveries of early Buddhist scriptures, in their Indian form, made in Japan. He was on friendly terms with Japanese scholars, and after his death his library was purchased by the University of Tōkyō.

In 1868 Max Müller had been indemnified for his disappointment over the Sanskrit professorship by the establishment of a chair of comparative philology to be filled by him. He ceased to lecture in 1875, when entering upon the editorship of *The Sacred Books of the East.* He was a curator of the Bodleian Library, and a delegate of the University Press. His hospitality was ample, especially to visitors from India, where he was far better known than any other European Orientalist. His distinctions, conferred by foreign governments and learned societies, were innumerable. He became a naturalized Englishman, was in high favour at court, and was sworn of the privy council. He died at Oxford on Oct. 28, 1900.

Max Müller's *Collected Works* were published in 1903.

(R. G.; X.)

MÜLLER, WILHELM (1794–1827), German lyric poet, was born at Dessau on Oct. 7, 1794, and died there on Sept. 30, 1827. His reputation was made by the *Gedichte aus den hinterlassenen Papieren eines reisenden Waldhornisten* (2 vols., 1821–1824), and the *Lieder der Griechen* (1821–1824), a collection inspired by the Greek war of independence. Two volumes of *Neugriechische Volkslieder,* and *Lyrische Reisen und epigrammatische Spaziergänge,* followed in 1825 and 1827. Müller also translated Marlowe's *Faustus,* and edited a *Bibliothek der Dichtungen des 17. Jahrhunderts* (1822–1827; 10 vols.). Schubert set many of his lyrics to music, among others "Die Schöne Müllerin" and "Winterreise."

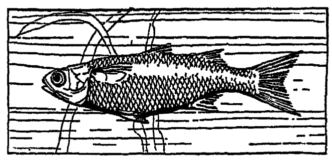
Wilhelm Müller's *Gedichte* were first collected in 1837 (4th ed., 1858); edited by his son, F. Max Müller (1868); there are also numerous more recent editions, notably one in Reclam's *Universalbibliothek* (1894); critical edition by J. T. Hatfield (1906). Müller's *Vermischte Schriften* were edited with a biography by G. Schwab (3 vols., 1830).

MÜLLER, WILLIAM JAMES (1812–1845), English landscape and figure painter, was born at Bristol on June 28, 1812, his father, a Prussian, being curator of the museum. He studied painting under J. B. Pyne. His early subjects deal mainly with the scenery of Gloucestershire and Wales. In 1833 he figured for the first time in the Royal Academy with his "Destruction of Old London Bridge—Morning," and next year he made a tour through France, Switzerland and Italy. Four years later he visited Athens, extending his travels to Egypt, and in the sketches executed during this period and the paintings produced from them his power and individuality are apparent. After his return he settled in London, where he exhibited regularly. In 1840 he again visited France, where he executed a series of sketches of Renaissance architecture, twenty-five of which were lithographed and published in 1841, in a folio entitled *The Age of Francis I. of France.* In 1843 he accompanied Mr. (afterwards Sir) Charles Fellows to Lycia, where he made a number of masterly sketches. He died at Bristol on Sept. 8, 1845. The print room of the British Museum and the Tate Gallery possess rich collections of Müller's works.

A biography by N. Neal Solly was published in 1875.

MULLET, the name of two different kinds of fishes, distinguished as red mullets and grey mullets.

Red mullets (genus *Mullus*) are marine fishes, with two short dorsal fins, the first composed of feeble spines, the second of branched rays. The body is covered with large thin scales. The anterior profile of the head slopes downwards to the small mouth, which has small, feeble teeth. There are two sensitive barbels on the lower jaw, generally laid back in a groove, but capable of erection when needed. About 40 species are known, chiefly from the tropical and subtropical parts of the Indo-Pacific ocean. In European waters two species occur (*Mullus surmuletus* and *M. barbatus*). The former, in addition to the general red colour,



BY COURTESY OF THE NEW YORK ZOOLOGICAL SOCIETY

THE COMMON MULLET

has three to five bright yellow bands along the sides from head to tail; these are absent in the other form. The striped form is usually found on the coasts of England, while in the Mediterranean both kinds occur.

The largest red mullets weigh only two or three pounds. They are ground-feeders, using their barbels in discovering their food, which consists of crustacea, worms, and, in the larger species, of small fishes. Their brilliant colours are simple and evanescent; in many, red prevails. All the species are esteemed as food, but none equals the European species. During winter the fish retire into deep water, late in spring and during summer they approach the coasts and enter even brackish water, but they do not come towards the shore to breed. At Naples they spawn from May to August; their ova are buoyant and transparent.

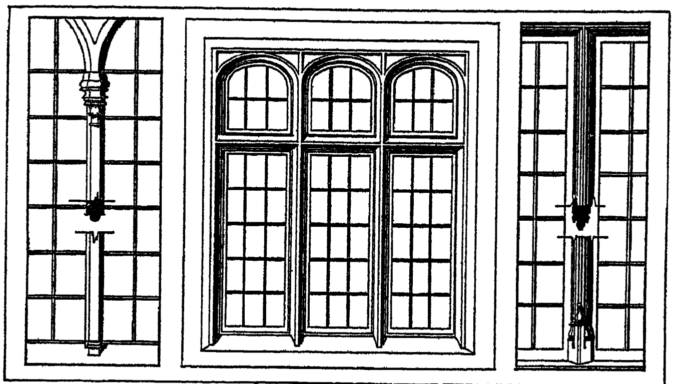
The grey mullets form a very distinct family, *Mugilidae.* They enter brackish water, live always close to the shore, and some of the tropical forms inhabit the fresh water without, however, penetrating far inland. Their body is elegantly formed, wedge-shaped, and covered with scales of moderate size. The anterior of the two short dorsal fins is composed of four stiff spines. The caudal fin is strong and bilobed. The mouth is narrow, transverse in the true *Mugil,* and without, or with but feeble, teeth. About 70 different species are known, from most parts of the temperate and tropical zones; they swim in small schools and are abundant wherever they occur. The commonest British species is *Mugil cephalus;* found also on both coasts of North America and elsewhere. Some of the fresh-water grey mullets of the tropics have been formed into a separate genus, *Agonostoma.*

Grey mullets may grow to a weight of 10 or 12 pounds. Those in which distinct teeth are developed feed on small aquatic animals, while the diet of those without teeth consists of animalcules, confervae, or minute organic débris mixed with the mud and sand, which they swallow in large quantities. To prevent the gills from being clogged by sand or mud, each branchial arch is provided with a series of closely set gill-rakers, each series fitting into the series of the adjoining arch; they constitute a sieve permitting the passage of the water, while retaining other substances. Grey mullets are plainly coloured, generally greenish on the upper parts and more or less silvery on the side. They are wholesome food. Grey mullets are cultivated in fish farms in Italy.

MULLINGAR, county town of co. Westmeath, Ireland, near the River Brosna and on the Royal canal, 50 m. W. by N. of Dublin. Pop. (1926) 5,293. It is a junction on the Great Southern railway. Here is the Roman Catholic cathedral for the diocese of Meath. Tanning, brewing and the manufacture of coarse woollens are carried on, and the town is an agricultural centre. Mullingar was one of the ancient palatinate towns. It possessed an Augustine convent (1227) and a Dominican convent (1239), but both were dissolved by Elizabeth. The town was the headquarters of William III. before the siege of Athlone. It is a centre for trout-fishing in Loughs Ennell and Owel.

MULLION, in architecture, a slender, vertical division between adjacent lights or sub-divisions in a window, or between adjacent windows in a group. Mullions appear with the invention of tracery (*q.v.*), and are particularly characteristic of Gothic architecture throughout, and early Renaissance in north and west Europe. In traceried windows, mullions are frequently chamfered or bevelled on the edges, and sometimes decorated, in addition, with a colonnette; but in late Gothic work, more

elaborate mouldings are common. In the rectangular window groups common in late Gothic and early Renaissance secular work, the face of the mullion is usually set back from the face of the wall so that one moulding or series of mouldings runs unbroken round the entire group. The mullion itself is usually moulded or chamfered and this moulding or chamfer is continued around the top and sides of each light. In windows whose



MULLION. LEFT AND RIGHT, LATE FRENCH GOTHIC; CENTRE, ENGLISH TUDOR

tracery sub-divides the whole into more than three lights, mullions may be of different sections, with certain mullions increased in size, or may carry an additional moulding. The entire group is systematized into sub-divisions of two or three lights each, the larger mullions enclosing each sub-division.

MULLITE (named from the island of Mull, where it was first recognized as a rock mineral), a mineral of the composition $3Al_2O_3{\cdot}2SiO_2$ crystallizing in the rhombic system. The mineral shows an extraordinary similarity in its physical properties to sillimanite (*q.v.*) as is indicated by the following data:

	Mullite	Sillimanite
Prism angle 110, 110	89° 13′	88° 15′
Cleavage	010	010
Refractive indices	α 1·642 γ 1·654	α 1·657 γ 1·677
Optic axial angle	45°–50°	25°–30°

The refractive indices of artificial mullite rise with a content of Fe_2O_3 and TiO_2; with 0·86% Fe_2O_3+1·12% TiO_2 the values become α=1·651, γ=1·668 thus approaching those of natural sillimanite. Such iron- and titanium-containing mullites are pleochroic in pink and violet tints. Laboratory investigations show that mullite is the only compound of alumina and silica stable at high temperatures. Mullite itself melts incongruently at 1810° C with separation of corundum while sillimanite is essentially different in its thermal behaviour, dissociating at 1545° C (the eutectic temperature of mullite and cristobalite) into mullite and a silica-rich liquid. The two other compounds of alumina and silica, viz. andalusite and kyanite, similarly break up into mullite and silica on heating, but at lower temperatures, decomposition beginning in andalusite at about 1400° C and in kyanite between 1100° C and 1200° C. Natural mullite has so far been recognized only in buchites or fused argillaceous enclosures in intrusive igneous rocks. In the island of Mull, it occurs together with cordierite, corundum, spinel and anorthite, forming xenoliths in Tertiary tholeiite intrusions. In normal contact aureoles the place of mullite is taken by andalusite and sillimanite. Its presence in any assemblage may be taken as evidence of exceptionally high temperatures. Between mullite and sillimanite there is no evidence of any transition in composition, no solid solutions being recognized in laboratory experiments. It may be mentioned that mullite is regarded by W. Eitel and his co-workers as $2Al_2SiO_5+Al_2O_3$, that is, extremely fine or disperse corundum in fibrous sillimanite, but these conclusions are unconfirmed. Examined in fine powder by X-ray methods mullite and sillimanite give identical spectra.

Mullite is an important constituent of ceramic wares and forms practically the sole constituent of Marquardt porcelain. The mullite of these wares was previously regarded as sillimanite. The importance of the recognition of the compound $3Al_2O_3{\cdot}2SiO_2$ is clear when the refractory character of various $Al_2O_3-SiO_2$ mixtures is considered. Mixtures of the composition $3Al_2O_3{\cdot}2SiO_2$ and those still richer in alumina begin to melt only at 1810° C, whereas the slightest excess of silica over the $3Al_2O_3{\cdot}2SiO_2$ ratio suffices to cause an initial melting at 1545° C, the eutectic temperature. (C. E. T.)

MULOCK, SIR WILLIAM (1843–), Canadian statesman and jurist, was born at Bond Head, Ontario, on Jan. 19, 1843, the son of T. H. Mulock, M.D. From 1882 to 1905 he was a prominent member of the Liberal party in the Federal house; postmaster-general from 1896 to 1905, and minister of labour from 1900 to 1905. He introduced many improvements into the Canadian postal service, and in 1898 in face of much opposition induced the Inter-Imperial Postal Conference to adopt the principle of penny postage within the British Empire. In 1905 he resigned office, and was appointed chief justice of the exchequer division of the High Court of the province of Ontario (1905–23). In 1923 he was made chief justice of Ontario. From 1881 to 1900 he was vice-chancellor of the university of Toronto, and chancellor since 1924, and was largely responsible for the federation between that body and the Victoria university (Methodist).

MULREADY, WILLIAM (1786–1863), Irish subject painter, was born at Ennis, Co. Clare, on April 30, 1786. When he was about five years old his father, a leather-breeches maker by trade, removed to London. In 1800 he was admitted a student of the Academy, and two years later he gained the silver palette of the Society of Arts. He was associated with John Varley, the eccentric water-colour painter and drawing-master, whom he assisted in the tuition of his pupils, who included Cox, Fielding, Linnell, William Hunt, and Turner of Oxford. At 18 he married a sister of Varley's, and at 24 he was the father of four sons. The marriage was unhappy, and the pair separated before many years. He "tried his hand at everything," as he said, "from a miniature to a panorama." He painted portraits, taught drawing, and up till 1809 designed illustrations to a series of children's penny books.

Mulready had a special aptitude for genre-painting, and in 1809 produced the "Carpenter's Shop," and in 1811 the "Barber's Shop," pictures influenced by the example of Wilkie and the Dutch painters. In 1813 he exhibited his "Punch," a more original and spontaneous work, and two years later his "Idle Boys" procured his election as A.R.A. Next year he became R.A., and showed his "Fight Interrupted." It was followed by the "Wolf and the Lamb" (1820), the "Convalescent" (1822), "Interior of an English Cottage" (1828), "Dogs of Two Minds" (1830), the "Seven Ages" (1838), and in 1839 and 1840 by the "Sonnet and First Love," two of the most perfect and poetical of the artist's works. In 1840 he designed an allegorically covered postal envelope (the "Mulready envelope," soon discontinued) for Rowland Hill, and a set of illustrations to *The Vicar of Wakefield*, which were succeeded by his paintings of the "Whistonian Controversy" (1844), "Choosing the Wedding Gown" (1846), and "Sophia and Burchell Haymaking" (1849). He died on July 7, 1863.

MULTAN or **MOOLTAN**, a city, district and division of British India, in the Punjab. The city is 4 m. from the left bank of the Chenab, near the ancient confluence of the Ravi with that river. Pop. (1921), 84,806. The city is enclosed on three sides by a wall, but large and irregular suburbs have grown up outside the wall. The principal buildings in the Fort include the shrines of two Mohammedan saints and an ancient Hindu temple. The cantonments form the headquarters of a brigade. Multan has manufactures of carpets, silk and cotton goods, shoes, glazed pottery and enamel work, and an annual horse fair. It is moreover one of the most important trade-centres in the Punjab.

The District of Multan occupies the lower angle of the Bari Doab, or tract between the Sutlej and the Chenab, with an extension across the Ravi. Area, 5,939 sq.m. The population in 1921 was 890,264. The principal crops are wheat, millets, pulse, oil-seeds, cotton and indigo. There are factories for ginning and pressing cotton. Indigo is made only by native processes. Irriga-

tion was till recently conducted only by inundation channels from the boundary rivers, but there is now a large area irrigated from the lower Bari Doab permanent canal. The heat of Multan is notorious.

The early Arab geographers mention Multan as forming part of the kingdom of Sind, which was conquered for the caliphate by Mohammed bin Kasim in the middle of the 8th century. On the dismemberment of the Mogul Empire in the middle of the 18th century, Multan fell to the Afghans, who held it with difficulty against the Sikhs. At length, in 1818, Ranjit Singh, after a long siege carried the capital by storm; and in 1821 he made over the administration of Multan with five neighbouring districts to Sawan Mal, who raised the province to a state of prosperity by excavating canals and inducing new inhabitants to settle. After the establishment of the council of regency of Lahore, difficulties arose between Mulraj, son and successor of Sawan Mal, and the British officials, which led to his rebellion, and culminated in the second Sikh war and the annexation of the whole of the Punjab. The city of Multan, after a stubborn defence, was captured in January 1849. The district at once passed under direct British rule, and order was not disturbed even during the Mutiny.

MULTIGRAPH: *see* Office Appliances.

MULTIPLEPOINDING, in Scots law, the technical term for a form of action by which conflicting claims to the same fund or property are determined. The action is brought either by the holder of the fund as pursuer and real raiser on the allegation that he is called on to make double payment, or by a claimant on the fund who brings the action in the name of the holder as pursuer and nominal raiser, calling himself a defender and real raiser. All who have any claims in the fund or property in question are ordered to appear and give in their claims; the court then prefers them according to their respective rights, and the holder of the fund or property in dispute on payment or delivery is absolved from any further claim in regard to it. It corresponds to the process of *inter-pleader* in English law.

MULTIPLE SHOPS: *see* Chain Stores.

MULTITUBERCULATA, an order of extinct mammals. Their relationships to other groups are best considered by giving a brief outline of the Mesozoic mammals.

Although the Cenozoic Era is popularly known as the age of mammals, about two-thirds of mammalian evolution took place during the Mesozoic. The remains of Mesozoic mammals are among the rarest, most fragmentary and most valuable of all fossils. These earliest mammals were very small, averaging about the size of a rat. It is clear that they were locally abundant and included insectivorous, carnivorous and herbivorous types.

The oldest known mammals are from the late Triassic (or possibly earliest Jurassic) of England, Germany and South Africa. These belong to two quite distinct groups both referred to the Allotheria (*see* below). Both are very aberrant, however, and the true ancestral Triassic types of mammals are still unknown.

The Jurassic mammals are much better known, and are divided into four orders, all extinct. Characteristic of the whole Mesozoic and also of the oldest Cenozoic (Paleocene) were the Allotheria or Multituberculata, ranging from the upper Triassic into the true Eocene and known to have occurred in Europe, Africa, Asia and North America. They had a single pair of enlarged incisors below and two or three pairs, of which only one was enlarged, above. The cusps of the molars were arranged in two or three straight longitudinal rows. In the Jurassic each molar had only five or six cusps, but in some of the later types as many as 30 cusps occurred on a single tooth—whence the name. The upper premolars were generally composed of conical cusps, less regularly arranged than those of the molars, and, except in a few aberrant forms, the lower premolars were developed into large, compressed, sharp-edged shearing teeth. They appear to have been vegetarians. Some show a superficial resemblance to the living rat-kangaroos of Australia, but recent work indicates that the multituberculates constituted an entirely separate subclass, not ancestral to any later mammals and related to the latter only through common ancestry in the Triassic or even earlier.

In the second Jurassic order, the Triconodonta, the molar teeth have three cusps each, arranged in a straight longitudinal line. Although small, these mammals were predaceous carnivores. They were confined to the Jurassic and probably represent another aberrant offshoot of the earliest mammalian stock.

A third Jurassic order, the Symmetrodonta, includes mammals long classed with the Triconodonta, although recent work indicates they are a distinct order related rather to the Pantotheria than to the Triconodonta. Confined to the upper Jurassic, so far as known, they are characterized by triangular teeth, typically with three cusps.

The last order of Jurassic mammals, the Pantotheria, was the most important phylogenetically. The dentition, while more primitive and different in details, has a broad resemblance to that of the most generalized insectivores and marsupials. The typical dental formula was $I\frac{4}{4}$; $C\frac{1}{1}$; $P\frac{4}{4}$; $M\frac{7}{8}$, although various genera show marked modifications from this, chiefly by reduction. The upper molars were triangular with a large internal cusp and usually one main external cusp and several lesser ones. The lower molars typically had four main cusps arranged in an asymmetrical triangle, followed by a heel, or talonid, with one cusp. The pantotheres apparently represent the stock which gave rise early in the Cretaceous to the marsupials and placentals. The earliest and most primitive pantothere was *Amphitherium* from the English middle Jurassic (Stonesfield).

Lower Cretaceous mammals are known only from a few poorly preserved teeth from the English Wealden, of slight importance, but the upper Cretaceous mammals are relatively well known. The multituberculates continue as more advanced forms referred to the family Ptilodontidae, with more numerous molar cusps. The other Jurassic forms, however, have disappeared and are replaced by the earliest members of the Insectivora and Marsupialia (*qq.v.*).

The Cretaceous marsupials, known at present only from North (and possibly South) America, are all closely related to the living opossums, but are much more varied in size and other characters. They probably represent a widespread complex of primitive marsupials from which the later and more specialized South American and Australian forms were derived.

Of the upper Cretaceous Insectivora, only a single genus, *Gypsonictops,* is known with certainty from North America, but in Asia the expeditions of the American Museum of Natural History have brought to light eight skulls. These are very close to the ancestral stock from which the majority of placental mammals were derived. *Zalambdalestes,* a peculiar long-snouted form, and *Deltatheridium,* a very primitive and generalized type, are the most important.

The following is an outline classification of the major groups of the Mammalia:

Class Mammalia
- *Subclass Allotheria*
  - Order Multituberculata
- *Subclass Prototheria*
  - Order Monotremata (*q.v.*)
- *Subclass Theria*
  - Infraclass Pantotheria
    - Order Symmetrodonta
    - Order Pantotheria, *sensu stricto*
  - Infraclass Metatheria
    - Order Marsupialia (*q.v.*)
  - Infraclass Eutheria
  - *Incertae sedis:* Order Triconodonta.

See Mammalia, Palaeontology; also G. G. Simpson, *Catalogue of the Mesozoic Mammalia in the Geological Department of the British Museum* (1928). (G. G. Si.)

MUMMERS, bands of men and women in mediaeval and later England and elsewhere, who, during periods of public festivity, particularly at Christmas, dressed in fantastic clothes and wearing masks or disguised as animals, serenaded the people outside their houses or joined in the revels within. The term is also applied to the actors in the old English rural folk-plays of St. George, etc.; and "mumming" thus becomes a contemptuous synonym for any form of stage-playing.

The verb "to mum" means both to mutter and to be silent, and "mummer" apparently comes from one or both of these

senses. Mumming seems to have been a survival of the Roman custom of masquerading during the annual orgies of the Saturnalia. Mumming led to such outrages in England in the 16th century that Henry VIII. issued a proclamation declaring the wearing of a mask or disguise a misdemeanour. Stow gives an account of an elaborate mummery held in 1377 by the London citizens to amuse the son of the Black Prince, then living at Kennington (*Survey*, 1603, p. 97). In Scotland, where mumming long survived at Christmas, Hogmanay, New Year's Day and Handsel Monday, mummers were called "guisards." They usually presented on these four nights a crude drama called *Galatian*, which, in various versions, was common throughout the Lowlands of Scotland (*see* Chambers's *Popular Rhymes*, p. 170).

MUMMIUS, LUCIUS (2nd century B.C.), surnamed Achaïcus, Roman statesman and general. Consul in 146 B.C. Mummius was appointed to take command of the Achaean War. On capturing Corinth he massacred the inhabitants, removed all the works of art to Rome and destroyed the city. This is explained by Mommsen as due to the interference of the commercial party in the Senate. In 142 he was censor with the younger Scipio Africanus. Mummius was the first *novus homo* of plebeian origin who received a distinctive cognomen for military services. His indifference to works of art and ignorance of their value is shown by his well-known remark to those who contracted for the shipment of the treasures of Corinth to Rome, that "if they lost or damaged them, they would have to replace them."

MUMMY, a dead body preserved by the ancient Egyptian or other method of embalming (Persian *mumiai*, wax; later meaning pitch or asphalt).

Origin of Mummification.—In Egypt, in prehistoric times, the dead were buried, sometimes loosely wrapped in mats or skins, in shallow graves, the body being placed in a flexed position. The hot, dry, desert sand came into direct contact with the skin and often so completely arrested the process of decay that the hair, skin and soft parts are entirely preserved. This phenomenon of natural preservation was probably made known to the Egyptians through the ravages of grave-robbers whose depredations exposed the bodies to view. The discovery that the corpses of the dead did not suffer corruption undoubtedly strengthened, perhaps originated, the belief in the physical survival of the dead, which underlies the practice of mummification throughout the historic period, and prompted the ampler provision of food, utensils and other objects necessary to physical life which were buried with the dead. As the number of objects placed in the grave increased, the grave itself had to be more spacious in order to accommodate these larger supplies. But the burial of the dead in roomier graves or in constructed tombs in which the corpse, no longer embedded in desiccating sand, was in a space filled with air which assisted decomposition, defeated the very object that had inspired the more lavish equipment. The body decayed, and the dead man did not survive to enjoy the objects with which he was surrounded. Thus arose the attempt to achieve by art the preservation of the body which unaided nature could no longer accomplish in the larger tombs.

Development of Mummification.—It is probable that attempts at mummification were being made at the time of the 1st dynasty, but the earliest evidence of such attempts is afforded by a mummy of the 2nd dynasty, which was lying in a coffin in a flexed position, and was wrapped in a complex series of bandages, the innermost of which were corroded by the action of some preservative (probably crude natron) that had been applied to the skin (*Report, British Association*, Dundee, 1912, p. 612). Similarly treated bodies belonging to the 3rd and 4th dynasties have been discovered. By the time of the 5th dynasty considerable advances had been made. The body was now laid in the extended position and the internal organs were removed through an incision in the left flank, the vacant cavity being filled with linen and resin. The outer wrappings were saturated with resin and the form of the body was then moulded into shape, the details of the features being carefully modelled and emphasized by means of paint (*Journ. of Egyptian Archaeology*, i., 1914, p. 192). During the Middle Kingdom, the art of embalming deteriorated somewhat, for, owing to the less lavish use of resin and to imperfect desiccation, the mummies of this period are usually very fragile and ill-preserved. There is definite evidence that at this period the custom of macerating the body in a salt-bath had been introduced, but no attempt had as yet been made to remove the brain.

In the New Kingdom (18th–20th dynasties) numerous improvements in method were introduced. The brain was removed by forcing a passage into the skull, a better method of desiccation was used which preserved the tissues, and greater skill had been acquired in the preparation and application of the resinous preservative material with which the body was treated. Mummies of many of the kings and other members of the royal family of this period have survived, and although they have all been mutilated by tomb-robbers, many of them are excellent specimens of the embalmer's art (G. Elliot Smith, *The Royal Mummies*, 1912).

The order of events in the process of making a mummy was this. The corpse was taken to a specially erected tent or kiosk, where the operator first extracted the brain, and opened the body by an incision in the left flank. Through this incision all the viscera were removed with the exception of the heart, which was carefully left *in situ*. The body-cavity having been washed out, the corpse was doubled into the smallest possible compass and placed in a large jar filled with a solution of salt or natron that reached to the level of the neck. In this jar the body remained for several weeks, during which time the fatty matter was dissolved away, and the whole of the epidermis peeled off, except from the head which was not immersed, and from the fingers and toes where the skin had been previously cut so as to form natural finger-stalls or thimbles of skin in order to retain the nails. Threads or wires were wound round the digits, or metal sheaths placed upon them in order to prevent the nails from becoming detached and lost. The body was then taken out of the jar, washed, straightened and desiccated. The final stages in the process involved the packing of the body-cavity and skull with preservatives, plastering the body all over with a paste made of resin and fat, and wrapping it in a complex series of bandages. The internal organs were separately treated and placed in four vases known as the "Canopic Jars." The whole process occupied 70 days (*Journ. of Egyptian Archaeology*, xiii., 1927, pp. 40–49).

During the 21st and 22nd dynasties the art of mummification reached its highest pitch of perfection. In order to make the body more life-like, an elaborate system of introducing packing material *under* the skin was devised. A schematic series of incisions was made in various parts of the body, and through these sand, mud, or other material was forced into the space between the skin and the underlying muscular tissue. The material was distributed and moulded into shape, and the shrunken contours of the body were thus plumped out into the form they had assumed during life. The use of canopic jars was discontinued, and the viscera were made into linen parcels and replaced in the body. The mummy was painted all over with red-ochre, the lips and cheeks were rouged, artificial eyes were inserted, and, in short, every care was taken not only to preserve the body but to make it complete and life-like. This distinctive method of embalming was first described by Prof. Elliot Smith from the examination of 44 mummies of the period (*Contribution to the Study of Mummification*, 1906). Since then numerous other specimens of the same kind have been examined. After this period the art declined and, although well made mummies of the later periods are occasionally found, the embalmer's craft had become superficial and slipshod, and less care was devoted to the body than to the arrangement of the superficial bandages so as to give the mummy a presentable exterior. In the Ptolemaic period, the body was usually merely treated with molten resin, which destroyed the tissues: the resulting mummy was a mere cast of the contours of the body. During the 26th dynasty and after, mummies were sometimes eviscerated *per anum* instead of by the usual flank-incision. Mummification survived the advent of Christianity by several centuries. The bodies of this period were not eviscerated or treated with resin but packed in large quantities of common salt, and are usually well preserved (*Archaeological Survey of Nubia, Report for 1907–08*, vol. ii., pp. 194–220, 1910).

Objects of Mummification.—Throughout the period of more than 30 centuries during which mummification was practised in Egypt, the embalmers had two definite objects in view: first, the preservation of the body from decay; and, secondly, the perpetuation of the personal identity of the deceased. During the Pyramid Age the features of the mummy were painted on the outer wrappings, and in some cases a thin layer of plaster was applied to the head and the features painted upon it. In the 11th dynasty, the face and wig were modelled in cartonage, and this head-piece was placed upon the head of the mummy. The use of cartonage masks lasted until Ptolemaic times, but out of it was early evolved the anthropoid coffin, on which the features, dress and ornaments of the mummy were elaborately detailed. In Roman times, painted portrait-panels were employed (Petrie, *The Hawara Portfolio,* 1913). All these measures had one object—the preservation of the dead man's personal identity. That the idea underlying mummification was physical survival is further indicated by the magical ceremonies to which the finished mummy was subjected. These ceremonies, which are usually known as "Opening the Mouth," had for their object the reanimation of the mummy by restoring to it the faculties of which death had deprived it. By means of magical instruments and the recitation of formulae, the eyes, mouth and ears of the dead man were opened in order that he might once more see, speak, eat and hear. The use of his limbs was restored that he might move and walk, and amulets were used to stimulate the functions of the heart, the spine and the blood. Moisture and warmth were restored to the mummy by the ceremonial use of incense and libations. The funerary banquet which followed was envisaged, not as spiritual food for the soul, but materialistically as physical sustenance to be consumed by the mummy with its restored faculties.

Just as many of the drugs used in ancient Egyptian medicine, even when wholesome and rational, were originally introduced into the pharmacopoeia for purely magical reasons, so the use of natron, salt and resin, all of which are excellent preservatives, was probably first employed in mummification because these substances were credited with life-giving or life-preserving properties. Natron was used in the daily ceremonies for the rebirth of the sun-god, the life-giving power of salt was a tradition which survived till Classical times (*cf.* Plutarch, *Symposiacs,* v. 10), and resin was believed to be the blood or some other bodily emanation of Osiris. When therefore the necessity for artificial preservation of the dead first became apparent, it was natural that the attempt to confer or prolong life should have taken the form of applying to the corpse substances which were believed to possess divine or magical potency to that end. Bitumen was not used by the Egyptians for embalming. The staple material in all periods was resin, and the fact that resin often has a lustrous pitch-like appearance probably gave rise to the assertion expressed by Strabo (xvi., ii., 45) and repeated by modern writers that the Egyptians used bitumen for their mummies. Modern chemical analysis has failed to discover any trace of bitumen in hundreds of samples of various periods (A. Lucas, *Preservative Materials used by the Ancient Egyptians,* 1911). Neither Herodotus (ii., 85–88) nor Diodorus Siculus (i., 91), in their well known accounts of Egyptian embalming, makes any reference to bitumen. Their accounts of mummification are on the whole correct although seriously wrong in certain details.

Mummified Animals.—In relatively late periods the Egyptians mummified various sacred animals. Large quantities of mummified cats and dogs have been found, but especially elaborate was the ritual employed in embalming the Apis bulls (*Zeitschrift f. äg. Sprache,* lvi., 1920, pp. 1–33), and their tombs and gigantic sarcophagi are familiar to visitors to Egypt. Amongst the birds, the ibis, falcon, owl and others have been found, likewise the preserved remains of various reptiles (especially crocodiles) and of fishes. Joints of meat and trussed poultry were mummified and provided with wooden coffins shaped to fit them. The systematic study of the technique of animal mummification has yet to be made.

Geographical Distribution.—Mummification in various forms has had a wide geographical distribution. In some areas, the custom has long been extinct and only tradition remains to attest its former practice, but in others it survived until more recent times, or still persists in a debased form. In studying the technique of mummification in countries from which actual mummies have been obtained, it is interesting to find that many of the arbitrary details of Egyptian procedure are revealed. The examination of specimens from the Canary Islands, for instance, has revealed the fact that the Guanches employed certain methods which are distinctive of the Egyptian technique of the 21st dynasty (*see* p. 954). They made incisions for packing material under the skin, the sites of these incisions closely corresponding with those of the 21st dynasty Egyptian mummies, and there is a similar distribution of sandy mud in the tissues. In some cases at least, the viscera, which were always removed through a flank-incision, were made into parcels and returned to the body. The epidermis was removed from the whole body, but carefully retained on the fingers and toes, the nails being tied on in the characteristic Egyptian fashion (*Proc. Royal Society of Medicine,* xx., pp. 832–842, 851–854, 1927). Again, in the Islands of Torres Straits, mummification was practised until recent years. The viscera were removed through a flank-incision, or by the perineum, the brain was extracted, the body painted with red-ochre and provided with artificial eyes. The thimbles of skin on the fingers and toes were cut, but they were pulled off, and thus stultified the object for which the Egyptians devised them (*Annals of Archaeology and Anthropology,* xi., pp. 87–94, 1924). In Australia, mummification has survived in a debased form. The bodies are flexed and are often painted with red-ochre, and in some cases the epidermis is carefully removed from the body even when it is destined for cremation immediately afterwards. In North, Central and South America mummies have been found in various localities but the most numerous are those of the Inca civilization from Venezuela, Colombia, Ecuador, Bolivia and Peru. It has generally been asserted that the preservation of these Inca mummies is due to natural properties of the soil and climate, and not to artificial measures. Whilst the natural conditions in many localities certainly favour preservation, the circumstances in which many of the mummies have been discovered, closely wrapped in dense coverings and tightly corded, show that they must have been artificially desiccated before burial. The wrappings prevent contact of the body with the desiccating influence of the soil, and the coverings moreover closely embrace the shrunken contours of the corpse. In many instances mummies have been found which prove to have been eviscerated *per anum* or by an incision in the trunk, and others again are thickly coated with preservative material. Further, Inca mummies are often painted red, and specimens have been examined in which the epidermis had been removed from the whole body except the fingers and toes. The occurrence of such arbitrary details of Egyptian technique, especially as they often serve no useful purpose, in mummies from widely separated countries, supports the hypothesis that mummification, of Egyptian origin, spread with various other cultural elements from Egypt. (*Journ. Royal Anthropological Inst.* lviii., Pt. 1, 1928.)

Mummy as a Drug.—The belief that Egyptian mummies were prepared with bitumen or asphalt led to the virtues of that substance being transferred to bodies that had been mummified. Throughout the Middle Ages, and until the 18th century, mummies were exported to Europe for sale in the apothecaries' shops, and the material obtained by pounding them was reputed to have great medicinal virtue. In course of time it was forgotten that the supposed value of mummy was due to asphalt, and the virtue was transferred to bodies themselves. This led to the manufacture of spurious "mummy" from the bodies of felons and suicides, and the term was finally applied to medicated flesh in general. In spite of the denunciation of such eminent physicians as Paré, the traffic in mummy was continued until the 18th century, and the substance is frequently mentioned in the "dispensatories" of the period. In the East, mummy is still sold in the drug-bazaars (*Proc. Royal Society of Medicine,* xxi., pp. 34–39, 1927).

Bibliography.—Works dealing with special points have been cited in the text: for general works *see* T. J. Pettigrew, *History of Egyptian*

Mummies (1834); G. Elliot Smith, *Contribution to the Study of Mummification* (1906); *The Royal Mummies* (1912); G. Elliot Smith and W. R. Dawson, *Egyptian Mummies* (1924); W. R. Dawson, "Contributions to the History of Mummification," *Proceedings Royal Society of Medicine*, vol. xx. (1927); "Making a Mummy," *Journal of Egyptian Archaeology*, vol. xiii. (1927). (W. R. D.)

MUMPS (syn. *Cynanche parotidaea, parotitis;* also, "the branks"), a specific infectious disease caused by a filter-passing virus (*q.v.*), characterized by inflammatory swelling of the parotid and other salivary glands, frequently occurring as an epidemic, and affecting mostly young persons. The disease generally sets in with symptoms of a slightly febrile cold; soon followed by swelling and stiffening in the region of the parotid gland in front of the ear. The swelling speedily increases and spreads towards the neck and under the jaw, involving the numerous glands in that locality. The condition is often bilateral. Pain is seldom severe, nor is there much redness or any tendency to suppuration. There is, however, great interference with mastication and swallowing. After four or five days the parts return to their normal condition. During convalescence there occasionally occur swelling and tenderness in other glands, such as the testicles in males (*orchitis*), and the mammae or ovaries (*oöphritis*) in females, and possibly involvement of the pancreas, but these are of short duration and usually of no serious significance. Mumps is in general a mild disease, and requires no special treatment.

BIBLIOGRAPHY.—J. D. Rolleston, *Acute Infectious Diseases* (London, 1925, bibl.); E. W. Goodall, *Textbook of Infectious Diseases*, 3rd ed. (London, 1928, bibl.); W. P. Lucas, "Mumps—Epidemic Parotitis," the *Oxford Medicine*, vol. v. (New York, 1927, bibl.); C. J. Zoeller, "De quelques données nouvelles concernant l'infection ourlienne," *Arch. de Méd. et de Pharm. Mil.*, lxxxiv., i. (1926); Y. Kermorgant, "Sur l'étiologie des oreillons," *Ann. de Méd.*, xix. 301 (1926); E. Seifert, "Ueber den Infektions-weg bei postoperativer Parotitis," *Deutsch. Ztschr. f. Chir.*, cxcviii., 387 (1926 bibl.).

MUN, ADRIEN ALBERT MARIE DE, COUNT (1841–1914), French politician, was born at Lumigny (Seine-et-Marne), on Feb. 28, 1841. He entered the army, saw much service in Algeria (1862), and took part in the fighting around Metz in 1870. A fervent Roman Catholic, he advocated a type of Christian Socialism. His eloquence made him the most prominent member of the Cercles Catholiques d'Ouvriers. He resigned his commission (Nov. 1875), and in the following February stood as Royalist and Catholic candidate for Pontivy which he represented from 1876 to 1910. He was for many years the most conspicuous leader of the anti-Republican party. "We form," he said on one occasion, "the irreconcilable Counter-Revolution." It was chiefly through his influence that the support of the Royalist party was given to General Boulanger. But as a faithful Catholic he obeyed the encyclical of 1892, and declared his readiness to rally to a Republican Government, provided that it respected religion. In 1897 he succeeded Jules Simon as a member of the French Academy. He died at Bordeaux on Oct. 6, 1914.

He wrote *La loi des suspects* (1901); *Contre la séparation* (1905); *La guerre de 1914* (1915); *Discours* (1888–1904, 7 vols.). *See* Giraud, *Un grand Français: Adrien de Mun* (1918).

MUN, THOMAS (1571–1641), English writer on economics, was the third son of John Mun, mercer, of London. As a member of the committee of the East India company, and of the standing commission on trade, appointed in 1622, he was a prominent figure in mercantile circles, and well qualified to discuss current economic problems. In 1621 he published *A Discourse of Trade from England unto the East Indies,* in which he defended the East India company from the attacks made by Thomas Malynes, who in the vein of the early mercantilists asserted that the export of bullion was harmful to English trade. Mun argued that so long as exports exceeded imports, the drain of specie from a country had no significance, an argument which he further developed in his *Discourse on England's Treasure by Forraigne Trade,* published posthumously in 1664. In this most important work, Mun gave the first clear and vigorous statement of the theory of the balance of trade.

MUNCH, EDWARD (1863–), Norwegian painter, was born on Dec. 12, 1863, at Löten, Hedemark. He went to Christiania (Oslo) at an early age and studied at the royal school of drawing under Krohg who introduced him to the naturalistic school of painting. The genius of Munch, however, reacted against this teaching. He was more inclined to express feelings inspired by a troubled mind than impressions engendered by reality. The most famous work of this early period is "Spring" (1899), one of the gems of the National Gallery at Oslo. In the beginning of the 'nineties, the undercurrent of mental agitation broke through in all its power, and in a number of works (mostly in the Oslo National Gallery), Munch revealed an extraordinary sensitiveness, displayed alike in the subjects of his pictures and the artistic method of execution which he employed. From the beginning of the 20th century Munch's art assumed a more realistic character. This is particularly evident from his landscapes of this period, the outstanding features of which are vigorous plainness and impressive colouring. In 1913 Munch completed the fresco decorations of the University Festival Hall at Oslo.

See G. Schliefler, *Das graphische Werk E. Munchs* (1907); C. Glaser, *Edward Munch* (1922).

MUNCHAUSEN, BARON. This name is famous in literary history on account of the amusingly mendacious stories known as the *Adventures of Baron Munchausen.* In 1785 a shilling book of 49 pages was published in London, called *Baron Munchausen's Narrative of his Marvellous Travels and Campaigns in Russia.* No copy is known to exist, but a second edition (apparently identical) was printed at Oxford early in 1786. The publisher was a certain Smith, and he then sold it to another bookseller named Kearsley, who brought out in 1786 an enlarged edition, with illustrations under the title of *Gulliver Reviv'd: the Singular Travels, Campaigns, Voyages and Sporting Adventures of Baron Munnikhouson, commonly pronounced Munchausen; as he relates them over a bottle when surrounded by his friends.* Four editions rapidly succeeded, and a free German translation by the poet Gottfried August Bürger, from the fifth edition, was printed at Göttingen in 1786. The seventh English edition (1793), is the usual text. In 1792 a *Sequel* appeared, dedicated to James Bruce, the African traveller, whose *Travels to Discover the Nile* (1790) had led to incredulity and ridicule. Munchausen increased in popularity and was translated into many languages. Continuations were published, and new illustrations provided (*e.g.,* by T. Rowlandson, 1809; A. Crowquill, 1859; A. Cruikshank, 1869; the French artist Richard, 1878; Gustave Doré, 1862, W. Strang and J. B. Clark, 1895).

The original author was Rudolf Erich Raspe (*q.v.*). Raspe had apparently become acquainted at Göttingen with Hieronymus Karl Friedrich, Freiherr von Münchausen, of Bodenwerder in Hanover. This Freiherr von Münchausen (1720–97) had been in the Russian service and served against the Turks, and on retiring in 1760 to his estates used to amuse himself by relating extraordinary instances of his prowess as soldier and sportsman. His stories became a byword among his circle, and Raspe, when hard up for a living in London, utilized the suggestion for his little brochure. Raspe can only be held responsible for the nucleus of the book; the additions were made by bookseller's hacks, suggestions being taken from Baron de Tott's Memoirs (Eng. trans. 1785), the aeronautical feats of Montgolfier and Blanchard and any topical "sensations" of the moment, such as Bruce's explorations in Africa. Munchausen, as we have it, is therefore a medley of material of all ages, from Lucian's *Vera Historia* and Renaissance *facetiae* to contemporary travels, real and imaginary.

See the introduction by T. Seccombe to Lawrence and Bullen's edition of 1895. Carl Muller-Fraureuth's *Die deutschen Lügendichtungen auf Münchausen* (1881) and Griesbach's edition of Bürger's translation (1890).

MÜNCH-BELLINGHAUSEN, ELIGIUS FRANZ JOSEPH, FREIHERR VON (1806–1871), Austrian poet and dramatist (who wrote under the pseudonym "Friedrich Halm"), was born at Cracow on April 2, 1806, the son of a district judge. In 1840 he became Regierungsrat, in 1845 Hofrat and custodian of the royal library, in 1861 life member of the Austrian Herrenhaus (upper chamber), and from 1869 to 1871 was intendant of the two court theatres in Vienna. He died at Hütteldorf near Vienna on May 22, 1871. Münch-Bellinghausen's dramas, among

them notably *Griseldis* (1835; publ. 1837; 11th ed., 1896), *Der Adept* (1836; publ. 1838), *Camoens* (1838), *Der Sohn der Wildnis* (1842; 10th ed., 1896), and *Der Fechter von Ravenna* (1854; publ. 1857; 6th ed., 1894), are well written and cleverly constructed, and were popular in their day.

See F. Pachler, *Jugend und Lehrjahre des Dichters F. Halm* (1877).

MUNCIE, a city of eastern Indiana, U.S.A., 54 m. N.E. of Indianapolis, on the White river, at an altitude of 950 ft.; the county seat of Delaware county. It has a municipal airport 1½ m. from the business district, and is served by the Big Four, the Chesapeake and Ohio, the Nickel Plate, the Pennsylvania, and three belt-line railways, and by numerous interurban trolleys and motor-bus lines. The population was 36,524 in 1920 (92% native white) and was 46,548 in 1930 by the Federal census. It is a well built city, occupying 7 sq.m. of level ground, with an assessed valuation for 1927 of $59,980,220. The residential sections are beautiful with trees and wide lawns; zoning regulations are in force; and a boulevard along the river is under construction (1928). The Ball Teachers' college in the western part of the city (named after the Ball brothers, manufacturers of Muncie, who since 1918 have given about $500,000 to the institution) is the eastern division of the State Normal school. It has a plant valued at $2,000,000 and an enrolment of about 1,250. Muncie has a wide trading territory, embracing 22 counties of eastern Indiana and western Ohio. Its manufacturing industries are many and varied, with an output in 1927 valued at $52,381,207. The principal products are automobile parts, tops, bodies, hoods and castings; storage batteries, glass fruit jars and jelly glasses, insulators and bottles; and steel wire and cable and articles made from them. The combined resources of the banks amounted in 1927 to $15,000,000. Muncie was founded about 1833, incorporated as a town in 1847 and as a city in 1865. Its name (originally Munseytown, but changed by the state legislature in 1845) commemorates the Munsees, a division of the Delaware Indians, who formerly lived along the White river.

MUNDA, BATTLE OF (45 B.C.). Whilst Caesar was campaigning in Africa, Pompey's cause was revived in Spain by his sons Gnaeus and Sextus who had recruited a large army. From Africa Caesar returned to Rome, and towards the end of 46 B.C. once again proceeded to Spain where he suffered a reverse on the river Baetis; but, worsting Gnaeus Pompey at Soricaria, that general retired southwards towards Carteia; Caesar, however, headed him off and forced him to retrace his steps to Munda.

The site of Munda is undecided; some historians consider that it is the same as modern Monda, but the description of the battle renders this unlikely. It was probably north of the river Singulis in the neighbourhood of Montilla.

The town of Munda was situated on a hill, and under its walls Cn. Pompey camped on March 15, 45 B.C. The next day, Caesar arrived and entrenched a camp near a small stream some five miles away. On the 17th, learning that Gn. Pompey had been standing in battle array for some time he ordered his standards to be raised. The two camps were separated by an undulating plain traversed by a stream, and on this plain and behind the stream Caesar marshalled his army, hoping that Gn. Pompey would come down from the hill of Munda and fight him in the open. Gn. Pompey was in command of some 50,000 men, his position was exceptionally strong, for any attack on him would have to be made up-hill and over marshy ground.

Caesar's army numbered some 40,000, and as Gn. Pompey refused to come down from the hill he advanced towards him. On reaching the stream he halted his line, and pointed out to his officers the disadvantage of attacking up-hill. This becoming known to the men, considerable insubordination was displayed, as they felt certain of victory. Caesar thereupon ordered the advance to be continued. This halt, however, had induced Pompey to believe that Caesar had hesitated through fear, which was the case, and plucking up courage he moved his line down the hill, but not so far from Munda that he could not retire to it if defeated.

When the lines met the greatest enthusiasm was shown on both sides. Caesar's legions charging up the hill with great gallantry were met by a storm of *pila* (javelins). Pompey's men, remembering the terrible slaughter at Thapsus, fought with determination and fury. The flight of javelins was followed by a charge which struck Caesar's front "like a ram" and staggered his line. The clinch then took place, and little by little Caesar's cohorts were pushed back. The situation now became extremely critical for Caesar was some five miles from his camp, and should his line break, annihilation must follow. Seizing a sword and a shield he rushed forward in the front rank before the ensigns, and by his personal example stimulated the *moral* of his men.

As evening approached both sides had exhausted their reserves, the auxiliaries had left the field, there was no chance of manoeuvring except by cavalry, and though both sides had a considerable number of horsemen, apparently no such manoeuvre was made—very few Roman generals ever understood the use of this arm. At length, as the situation became still more critical, Caesar turned to his veteran Xth legion and cried: "Are you not ashamed to deliver your general into the hands of boys?" Stung by this taunt the Xth legion once again charged forward driving back Pompey's left, and compelling him to draw on his right in order to reinforce it. Caesar's cavalry then fell upon the weakened right wing, which was badly shaken. This apparently stimulated Caesar's Numidian cavalry into action, for they moved round Pompey's right wing towards his camp. Labienus, who commanded this wing, despatched five cohorts to head them off; this rearwards movement was mistaken by the Pompeian army as a general withdrawal. Thereupon the line broke and fell back on Munda in confusion. At last Caesar's 8,000 horsemen were launched, and 30,000 of the enemy were slaughtered. Caesar's losses were 1,000 killed and 500 wounded.

See PHARSALUS. (J. F. C. F.)

MUNDĀS. The Mundā (*Muṇḍā*) family is the least numerous of the linguistic families of India. It comprises several dialects spoken in the two Chota Nagpur plateaux, the adjoining districts of Madras and the Central Provinces, and in the Mahadeo hills. Santālī, Mundārī, Bhumij, Birhâr, Kōḍā, Hō, Tūrī, Asurī and Korwā are only slightly differing forms of one and the same language, which can be called Kherwārī, a name borrowed from Santālī tradition. Kherwārī is the principal Mundā language, and quite 88% of all the speakers of Mundā tongues belong to it. The Korwā dialect, spoken in the western part of Chota Nagpur, connects Kherwārī with the remaining Mundā languages. Of these it is most closely related to the Kūrkū language of the Mahadeo hills in the Central Provinces. Kūrkū, in its turn, in important points agrees with Khariā and Juāng, and Khariā leads over to Savara and Gadabā. The two last-mentioned forms of speech, which are spoken in the north-east of the Madras Presidency, have been much influenced by Dravidian languages.

The Mundā dialects are, as a rule, only found in the hills and jungles, while the plains and valleys are inhabited by people speaking some Aryan language. When brought into close contact with Aryan tongues Mundā forms of speech have been partly superseded by Aryan dialects. Thus some Aryanized tribes in northern India have formerly belonged to the Mundā stock. Such are the Cheros of Behar and Chota Nagpur, the Kherwars, who are found in the same localities, in Mirzapur and elsewhere, the Savaras, who formerly extended as far north as Shahabad, and others. An old Mundā element is present in some Tibeto-Burman dialects spoken in the Himalayas from Bashahr eastwards.

They are short, dark skinned, broad nosed, with curly hair, with medium to long heads—features possessed by the jungle tribes of southern India, the Veddas, Sakai, etc.

The Mundā family of languages in India proper belongs to the Austro-Asiatic division of the Austric family. They must have been settled in India from a very early period. The Sabaras, the ancestors of the Savaras, are already mentioned in old Vedic literature.

The Mundā languages abound in vowels, and also possess a richly developed system of consonants. They avoid beginning a word with more than one consonant. They shorten short consonants at the end of words. The usual stopped consonants—viz., *k*, *c* (*i.e.*, English *ch*), *t* and *p*—are formed by stopping the current of

breath at different points in the mouth, and then letting it pass out with a kind of explosion. In the Mundā language this operation can be abruptly checked half-way, so that the breath does not touch the organs of speech in passing out. The result is a sound that makes an abrupt impression on the ear, and has been described as an abrupt tone. Such sounds are common in the Mundā languages. They are usually written *k'*, *c'*, *t'* and *p'*. Similar sounds are also found in the Mōn-Khmēr languages and in Indo-Chinese.

The vowels of consecutive syllables to a certain extent approach each other in sound. Thus in Khērwārī the open sounds *å* (nearly English *a* in all) and *ä* (the *a* in care) agree with each other and not with the corresponding close sounds *o* (the *o* in pole) and *e* (the *e* in pen). The Santālī passive suffix *ok'* accordingly becomes *åk'* after *ä* or *å*; compare *sän-åk'*, go, but *dal-ok'*, to be struck.

Words are formed from monosyllabic bases by means of various additions, suffixes (such as are added after the base), prefixes (which precede the base) and infixes (which are inserted into the base itself). Suffixes play a great rôle in the inflexion of words, while prefixes and infixes are of greater importance as formative additions. Compare Kurku *k-ōn*, Savara *ōn*, son; Kharia *ro-mong*, Kherwārī *mū*, nose; Santālī *bor*, to fear; *bo-to-r*, fear; *dal*, to strike; *da-pa-l*, to strike each other.

The various classes of words are not clearly distinguished. The same base can often be used as a noun, an adjective or a verb. The words simply denote some being, object, quality, action or the like, but they do not tell us how they are conceived.

Inflexion is effected by means of additions to the unchanged base. There is no grammatical distinction of gender. Nouns can be divided into two classes, viz., those that denote animate beings and those that denote inanimate objects respectively. There are three numbers—the singular, the dual and the plural. There are no real cases, at least in the most typical Mundā languages. The direct and the indirect object are indicated by means of additions to the verb. Relations in time and space are indicated by means of suffixes. The genitive, which can be considered as an adjective preceding the governing word, is often derived from such forms denoting locality. Compare Santālī *hår-rä*, in a man; *hår-rän*, of a man. Higher numbers are counted in twenties. The pronouns have double sets of the dual and the plural of the pronoun of the first person, one including and the other excluding the person addressed. There are also short forms, used as suffixes and infixes, which denote a direct object, an indirect object, or a genitive. The pronoun "that" in Santālī has different forms to denote a living being, an inanimate object, something seen, something heard, and so on. There is no relative pronoun, the want being supplied by the use of indefinite forms of the verbal bases, which can in this connection be called relative participles.

Every independent word can perform the function of a verb, and every verbal form can, in its turn, be used as a noun or an adjective. The bases of the different tenses can therefore be described as indifferent words which can be used as a noun, as an adjective, and as a verb, but which are in reality none of them. Each denotes simply the root meaning as modified by time. Thus in Santālī the base *dāl-ket'*, struck, which is formed from the base *dal*, by adding the suffix *ket'* of the active past, can be used as a noun (compare *dal-ket'-ko*, strikers, those that struck), as an adjective (compare *dal-ket'-hår*, struck man, the man that struck), and as a verb. In the last case it is necessary to add an *a* if the action really takes place; thus, *dal-ket'-a*, somebody struck.

The pronominal affixes to indicate direct and indirect object are inserted before the assertive particle *a*. Thus the affix denoting a direct object of the third person singular is *e*, and by inserting it in *dal-ket'-a* we arrive at a form *dal-ked-e-a*, somebody struck him. Similar affixes can be added to denote that the object or subject of an action belongs to somebody. Thus Santālī *håpån-iñ-e dal-ket'-tako-tiñ-a*, son-my-he struck-theirs-mine, my son who belongs to me struck theirs.

A single verbal form often corresponds to a whole sentence or a series of sentences in other languages. The most developed Mundā languages possess different bases for the active, the middle and the passive; there are different causal, intensive and reciprocal bases, which are conjugated throughout, and the person of the subject is often indicated in the verb, which is, however, quite regular throughout.

See *Linguistic Survey of India*, vol. iv., p. i. and vol. i., 1927.

MUNDAY (or MONDAY), **ANTHONY** (*c.* 1553–1633), English dramatist and miscellaneous writer, son of Christopher Monday, a London draper, was born in 1553–1554. He had already appeared on the stage when in 1576 he bound himself apprentice for eight years to John Allde, the stationer, but in 1578 he was in Rome. In spite of the opening lines of his *English Romayne Lyfe* (1582), he must be regarded, if not as a spy at least as a journalist whose copy was the designs of the English Catholics in France and Italy. He says that in Paris, under a false name, as the son of a well-known English Catholic, Munday gained recommendations which secured his reception at the English College in Rome. He gives a detailed account of the routine of the place, of the dispute between the English and Welsh students, of the carnival at Rome, and finally of the martyrdom of Richard Atkins (? 1559–1581). He returned to England in 1578–1579, and became an actor again, being a member of the Earl of Oxford's company between 1579 and 1584. He brought back material for five anti-popish pamphlets, among them the tract entitled *A Discoverie of Edmund Campion and his Confederates*, the first part of which was read aloud from the scaffold at Campion's death in December 1581. The tract *A True Report of . . . M. Campion* (1581), which says that he "played extempore" and was hissed off the stage, is a reply. His political services against the Catholics were rewarded in 1584 by the post of messenger to her Majesty's chamber, and from this time he seems to have ceased to appear on the stage. In 1598–1599, when he travelled with the earl of Pembroke's men in the Low Countries, it was in the capacity of playwright to furbish up old plays. He devoted himself to writing for the booksellers and the theatres, compiling religious works, translating *Amadis de Gaule* and other French romances, and putting words to popular airs. He was the chief pageant-writer for the City from 1605 to 1616, and it has been conjectured that he supplied most of the pageants between 1592 and 1605. It is by these entertainments of his, which rivalled in success those of Ben Jonson and Middleton, that he won his greatest fame. He was buried in St. Stephen's, Coleman street, on Aug. 10, 1633.

Of the eighteen plays between the dates of 1584 and 1602 which are assigned to Munday in collaboration with Henry Chettle, Michael Drayton, Thomas Dekker and other dramatists, only four are extant.

The completest account of Anthony Munday is T. Seccombe's article in the *Dict. Nat. Biog.* A life and bibliography are prefixed to the Shakespeare Society's reprint of his *John a Kent and John a Cumber* (ed. J. P. Collier, 1851). His two "Robin Hood" plays were edited by J. P. Collier in *Old Plays* (1828), and his *English Romayne Lyfe* was printed in the *Harleian Miscellany*, vii. 136 *seq.* (ed. Park, 1811). For an account of his city pageants *see* F. W. Fairholt, *Lord Mayor's Pageants* (Percy Soc., No. 38, 1843). *See* also *Modern Language Review*, 1909, 1913, 1920; M. St. C Byrne, *Anthony Munday and his Books* (1921); E. K. Chambers, *The Elizabethan Stage* (vol. iii., 1923); C. R. Hayes, *Anthony Munday's Romances of Chivalry* (1925).

MUNDELEIN, GEORGE WILLIAM (1872–), American cardinal, was born in New York city on July 2, 1872. He received his education at Manhattan college and St. Vincent seminary, Beatty, Pa., subsequently proceeding to Rome and studying theology at the Urban College of the Propaganda in that city. He was ordained priest on June 8, 1895, at Rome, and became secretary to Bishop McDonnell of Brooklyn, N.Y., and pastor of the Lithuanian Church, being made chancellor of the diocese in 1897. He was appointed auxiliary bishop of Brooklyn, with the titular see of Loryma, on Sept. 2, 1909, and founded and became president of the Seminary of the Immaculate Conception in 1913. He became archbishop of Chicago on November 30, 1915, and was created a cardinal by Pope Pius XI. on March 24, 1924. He was a prominent figure at the Eucharistic Congress held in Chicago in June, 1926.

See J. J. Walsh, *Our American Cardinals* (1926).

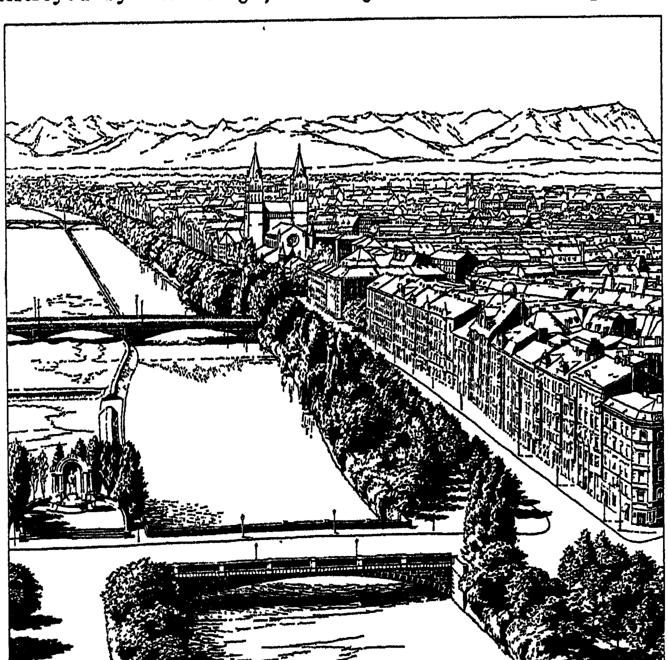
MÜNDEN, a town of Germany, in the Prussian province of Hanover, situated at the confluence of the Fulda and the Werra, 21 m. N.E. of Cassel by rail. Pop. (1925) 11,983. Münden, often called "Hannoversch-Münden" (*i.e.*, Hanoverian Münden), to

distinguish it from Prussian Minden, was founded by the landgraves of Thuringia, and passed in 1247, when it received municipal rights, to the house of Brunswick. A few ruins of its former walls still survive. The churches include that of St. Blasius (14th–15th centuries) and the 13th-century Church of St. Aegidius. The town hall (1619), and the ducal castle, built about 1570, and rebuilt in 1898, are the principal secular buildings. The manufactures include rubber, leather, and lead piping with trade in timber.

MUNHALL, a borough of Allegheny county, Pennsylvania, U.S.A., on the Monongahela river, eight m. S.E. of Pittsburgh, adjoining Homestead (*q.v.*). It is served by the Pennsylvania Railroad, and for freight by the Pittsburgh and Lake Erie and the Union. Pop. (1920) 6,418 (29% foreign-born white); 12,995 in 1930 by the Federal census. It is an integral part of the Homestead district, the steel mills lying largely within its limits. The borough was incorporated in 1901.

MUNICH, capital of the republic of Bavaria, and the fourth largest town in the German Republic, stands on the river Isar, 25 m. N. of the foot-hills of the Alps, about midway between Strasbourg and Vienna. Pop. (1925) 680,704. Owing to its lofty site (1,700 ft.), the climate is changeable, and its temperature ranges from a January average of 27° F to a July average of 63° F. The annual rainfall is 35 in. Munich is the centre of an important network of railways connecting it directly with Strasbourg (for Paris), Cologne, Leipzig, Berlin, Rosenheim (for Vienna) and Innsbruck (for Italy via the Brenner pass).

The Villa Munichen or *Forum ad monachos,* so called from the monkish owners of the ground, was the site of a mint in 1158 and an emporium for salt coming from Hallein and Reichenhall. In 1255 Duke Louis made it his capital, having previously surrounded it with walls and a moat. The town was almost entirely destroyed by fire in 1327. In 1632 Munich was occupied by Gustavus Adolphus, and in 1705, and again in 1742, it was in possession of the Austrians.



BY COURTESY OF THE GERMAN STATE RAILWAYS
VIEW OF MUNICH FROM THE OBSERVATION TOWER OF THE GERMAN MUSEUM, SHOWING MOUNTAIN PEAKS AND THE BANKS OF THE RIVER ISAR

The old town forms a semicircle with its diameter towards the left bank of the river, while round its periphery has sprung up the greater part of modern Munich. The walls with which Munich was surrounded were pulled down in 1791, but some of the gates have been left. The most interesting is the Isartor and the Karlstor, restored in 1835 and adorned with frescoes.

The chief buildings were built in the 19th century and most of them have been erected after celebrated prototypes of other countries and eras. The architectural style which has been principally followed in the later public buildings is the Italian and French Rococo, or Renaissance, adapted to the traditions of Munich architecture in the 17th and 18th centuries. A large proportion of the most notable buildings in Munich are in two streets, the Ludwigstrasse and the Maximilianstrasse. At one end the former is terminated by the Siegestor, while at the other is the Feldherrenhalle (or hall of the marshals), a copy of the Loggia dei Lanzi at Florence. Adjacent is the church of the Theatines, containing the royal burial vault. The Maximilianstrasse extends from Haidhausen on the right bank of the Isar to the Max-Joseph Platz. At the east end it is closed by the Maximilianeum, adorned externally with large sculptural groups and internally with huge paintings representing scenes of world-history. Towards the west are the old buildings of the Bavarian national museum, the government buildings and the mint. On the north side of the Max-Joseph Platz lies the former royal palace. The Allerheiligen-Hofkirche, or court-church, is in the Byzantine style, with a Romanesque façade.

On the Frauenplatz in the centre of the old town stands the Frauenkirche, the cathedral church of the archbishop of Munich-Freising. It is imposing from its size, and interesting as one of the few examples of indigenous Munich art. On the adjacent Marienplatz are the 14th century town hall (restored in 1865), and the new town hall, a modern Gothic erection.

Among the other churches are St. Boniface, a copy of an early Christian basilica; the parish church of Au, in the Early Gothic style; and the church of St. John in Haidhausen, another fine Gothic structure. St. Michael's in the Renaissance style, erected for the Jesuits in 1583–95, contains the monument of Eugène Beauharnais by Thorwaldsen. St. Peter's is interesting as the oldest church in Munich (12th century).

The old Pinakothek, erected in 1826–36, contains a valuable collection of pictures by the earlier masters, the chief treasures being the early German and Flemish works and the unusually numerous examples of Rubens. Opposite stands the new Pinakothek, built 1846–53, devoted to works by painters of the last century. The Glyptothek, a building in the Ionic style, contains a valuable series of sculptures, extending from Assyrian and Egyptian monuments down to works by Thorwaldsen and other modern masters. The celebrated Aeginetan marbles are preserved here. The Schack Gallery is rich in works by modern German masters, and the Lotzbeck collection contains sculptures and paintings. Munich is associated with a school of German artists among whom may be mentioned von Klenze (1784–1864), the architect; Cornelius (1783–1867) and von Kaulbach (1804–74), the painters; and Schwanthaler, the sculptor.

The Bavarian national museum contains an ethnographical museum, and collections of fossils, minerals, physical and optical instruments and coins. The art union is the oldest and most extensive in Germany, while the observatory is equipped with instruments by Josef Fraunhofer.

The university, founded at Ingolstadt in 1472 and removed to Landshut in 1800, was transferred thence to Munich in 1826. On the Theresienwiese is situated the Ruhmeshalle or hall of fame, a Doric colonnade containing busts of eminent Bavarians.

Munich is the seat of the archbishop of Munich-Freising as well as of the general Protestant consistory for Bavaria. The town has long been celebrated for its artistic handicrafts, such as bronze-founding, glass-staining, silversmith's work, and wood-carving, while the astronomical instruments of Fraunhofer and the mathematical instruments of Traugott Lieberecht von Ertel (1778–1858) are also widely known. Lithography, invented at Munich at the end of the 18th century, is extensively practised. Other industrial products include wall-paper, railway plant, machinery, gloves, rubber, margarine, chemicals, various motors, pianos and artificial flowers.

See *Mittheilungen des statistischen Bureaus der Stadt München* (vols. i.–v., 1875–82); Söltl, *München mit seinen Umgebungen* (1854); Reber, *Bautechnischer Führer durch die Stadt München* (1876); Daniel, *Handbuch der Geographie* (new ed., 1895); Prantl, *Geschichte der Ludwig-Maximilians Universität* (Munich, 1872); Goering, *30 Jahre München* (Munich, 1904); von Ammon, *Die Gegend von München geologisch geschildert* (Munich, 1895); Kronegg, *Illustrierte Geschichte*

der Stadt München (Munich, 1903); the *Jahrbuch für Münchener Geschichte* edited by Reinhardstöttner and Trautmann (Munich, 1887–94); Aufleger and Trautmann, *Alt München in Bild und Wort* (Munich, 1895); Rohmeder, *München als Handelsstadt* (Munich, 1905); H. Tinsch, *Das Stadtrecht von München* (Bamberg, 1891); F. Pecht, *Geschichte der münchener Kunst im 19 Jahrhundert* (Munich, 1888); and Trautwein, *Führer durch München* (20th ed., 1906). There is an English book on Munich by H. R. Wadleigh (1910).

MUNICIPAL HOUSING: *see* TOWN AND CITY PLANNING and HOUSING.

MUNICIPALITY, a modern term now used both for a city or town which is organized for self-government under a municipal corporation, and also for the governing body itself. Such a corporation in Great Britain consists of a head as a mayor or provost, and of superior members, as aldermen and councillors, together with the simple corporators, who are represented by the governing body; it acts as a person by its common seal, and has a perpetual succession, with power to hold lands subject to the restrictions of the Mortmain laws; and it can sue or be sued. Where necessary for its primary objects, every corporation has power to make bylaws and to enforce them by penalties, provided they are not unjust or unreasonable or otherwise inconsistent with the objects of the charter or other instrument of foundation.

See BOROUGH, COMMUNE, CORPORATION, LOCAL GOVERNMENT, and, for the functions of the municipal government, the sections under the general headings of the different countries.

MUNICIPAL TRADING. Trading, either monopolist or in competition with private enterprise, *e.g.*, municipal authorities, is not properly defined as a branch of Socialism though the Socialist Parties alone have advocated it as part of a general policy. Certain of the most remarkable experiments have been undertaken under anti-Socialist direction, as in Blackpool where municipal enterprise caters for amusement, and Birmingham, which has a municipal bank.

Great Britain.—It is not possible to fix with certainty limits to the field of municipal trading. Industries of national extent, such as railways or coal mining, may be ruled out by nature, but the restricted field of municipal enterprise in Great Britain is largely due to the legal position. A Local Authorities Enabling Bill has been sponsored by the Labour Party but at present (1929) local authorities have powers only to undertake such enterprises as are specifically permitted to them by legislation, and any further developments require a special act of parliament, which is difficult to get. These acts almost always carry stipulations as to prices chargeable, utilization of profit and repayment of loans, which are more onerous than the usual practice of private industry, nor are they granted as a matter of course. For example, that municipal banking has not been undertaken outside Birmingham is due, not to any ill-success of the Birmingham city bank, but to the fact that the political complexion of Parliament was for years unfavourable to any solicitations for similar permissions elsewhere. A survey of the present field of municipal enterprise is given by the Ministry of Health *Report* of 1926 which divided the outstanding municipal loan debt (England and Wales) as follows:

	£
Housing and town planning	199,451,481
Water works	144,772,500
Highways and bridges	73,580,481
Electric light supply undertakings	58,699,552
Sewer and sewage disposal	46,211,403
Tramways and light railways	36,801,408
Elementary education	33,396,438
Gas works	24,728,978
Small holdings and allotments	19,738,815
Parks, pleasure grounds and open spaces	10,983,058

Roads, education, police (not given above) and park services are perhaps not to be classed as municipal trading.

The *water supply*, according to the *Municipal year book 1928*, is in the hands of about two-thirds of the country boroughs of England and Wales, of nearly all the non-county boroughs and of about half the urban districts. In the metropolitan area it is also in the hands of a public authority, the metropolitan water board. The following table gives the position of certain of the main undertakings according to the *Labour Year Book 1927*.

	Total capital expenditure from loans and other sources		Total capital repaid or in sinking fund, or provided by revenue	Total loans outstanding
	Up to end of 1923–24	During 1924–25		
	£	£	£	£
Birmingham	8,808,912	85,861	1,245,078	7,654,673
Bradford	5,572,135	41,363	550,258	1,443,117
Glasgow	5,188,634	56,729	2,695,924	2,574,824
Leeds	4,628,270	123,555	1,698,486	3,237,374
Liverpool	6,892,412	73,276	2,129,193	4,878,734
Manchester	10,179,664	374,995	3,216,360	7,331,698

Over 170 *tramway* undertakings in Great Britain are owned by municipal authorities. The following figures are given according to the *Return of Tramways, etc., Undertakings 1925–26.*

Capital expenditure	£76,761,999
Gross receipts	£23,918,662
Working expenses	£19,009,122
Net receipts	£ 5,269,042
Passengers carried	4,065,268,307
Car miles run	323,391,979

Nearly all these are run under special acts. The problems of intermunicipal co-ordination and the general problems arising out of trams will be found discussed under TRAMWAYS. Permission for municipal motor bus services has been less freely granted: only 66 towns had in 1927 a motor bus service of their own.

The shortage of *houses* after the World War caused the passing of measures which enabled municipal authorities to embark on housebuilding, with the encouragement of a subsidy from the Government. Under C. Addison's act of 1919 174,583 houses had been built by the beginning of 1928 and 39,186 under his Private Builders' Act. Of the 315,749 houses built under N. Chamberlain's 1923 act, the majority were provided by private enterprise; of the 161,363 built under J. Wheatley's 1924 act the majority were supplied by local authorities. This building was undertaken very largely with the advice and under the direction of Joint Town Planning Committees, of which there were 53 in England and Wales. For further details *see* HOUSING.

Under the item *Parks* notice should be taken of the increase in municipal golf courses (municipal tennis courts and other playing fields are almost universal). These are maintained by Birmingham (4 courses), Bournemouth (2), Brighton, Leeds, Leicester, Llandudno, London City Corporation, London County Council, Manchester, Margate, Nottingham (2), Portsmouth, Sheffield, Southend, Southport, Wallasey, Yarmouth and others.

In Scotland there are even more: Alloa, Arbroath, Berwick, Campbelltown, Carnoustie, Dornock, Edinburgh, Glasgow (3), Gourock, Greenock, Kilmarnock, Kinghorn, Kirkcaldy, Montrose (6), Musselburgh, Rothesay, St. Andrews (4), Troon (3) and others.

The following figures, selected from the *Municipal Year Book 1928*, refer to 4 of the most important municipal *gas* undertakings.

	Belfast	Birmingham	Edinburgh	Manchester
Date of origin	1874	1875	1888	1843
Total capital expenditure:				
(a) up to end of 1925–26	£1,856,944	£3,318,433	£2,509,621	£5,175,522
(b) in 1926–27	16,446	670,466	34,906	440,963
Total capital repaid or in sinking fund	1,010,579	2,027,613	1,544,796	3,267,146
Loans outstanding	1,079,056	2,698,381	999,731	2,309,186
Income 1926–27	838,914	999,658	792,297	1,792,164
Charges	3/4 cu.ft.	3/2–3/2 less 5% discount	3/6–4/6 cu.ft.	10d. per term within city: 10·67d. without

The position of municipal *electricity* has been complicated by the appointment of the national Electricity Commissioners and

the Central Electricity Board (*qq.v.*): under whose direction the electrical industry as a whole is to be systematised. At the end of March 1927, out of 623 authorized undertakings in Great Britain, 374 were those of local authorities. The provision of *markets and slaughterhouses* has rapidly increased since it was first legalized by the act of 1875. The reasons adduced are: excessive profits by private concerns, insanitary and dangerous conditions, cruelty to animals. The following figures (quoted in the *Labour Year Book, 1927*) indicate the position of 6 of the largest enterprises.

	Birmingham	Bradford	Glasgow	Leeds	Liverpool	Manchester
1. Date of acquisition or inauguration	1824	1866	1845	1842	1892	1846
Total capital expenditure from loans and other sources:						
2. Up to end of 1923–24	£453,510	£343,636	£452,600	£474,358	£302,083	£894,705
3. During 1924–25	13,045	6,167	2,751	4,295	..	..
4. Total capital repaid or in sinking fund or provided by revenue	370,451	227,703	228,839	237,733	276,519	600,076
5. Total loans outstanding	89,999	120,303	225,261	311,851	25,564	302,899
6. Total income	83,351	72,766	85,265	56,218	93,857	131,538
7. Expenditure (excluding capital charges)	52,091	54,157	52,039	20,848	51,297	101,462
8. Surplus (+) or deficiency (−) before charging Columns 9 and 10	+ 31,260	+ 18,609	+ 33,226	+ 35,370	+ 42,560	+ 30,076
9. Sinking fund or loan repayments	7,778	3,438	12,384	8,617	1,493	12,410
10. Interest on loans	3,571	4,276	10,420	10,795	899	12,421
11. Net surplus (+) or deficiency (−)	+ 19,911	+ 10,895	+ 10,422	+ 15,958	+ 40,168	+ 5,245*
Application of surplus (+) or provision of deficiency (−):						
12. Rates	+ 19,911	+ 3,300	..	+ 15,958	+ 40,168	..
13. Other purposes	..	..	..	..	..	..
14. Carried forward	..	+ 7,595	+ 10,422	..	..	..
15. Balance of reserve or renewal funds	..	19,274	..	..	..	7,040

*Added to £6,586 taken from balance and applied £10,331 rates, £1,500 renewals fund.

BIBLIOGRAPHY.—*Municipal Year Book* annual; P. Geddes, *City Development* (1904); R. B. Suthers, *Mind Your Own Business* (1905); H. R. Meyer, *Municipal Ownership in Great Britain* (1906); G. Bernard Shaw, *Commonsense of Municipal Trading* (1908); D. Knoop, *Principles of Municipal Trading* (1912); D. M. Stevenson, *Municipal Glasgow* (1914). (R. W. P.)

UNITED STATES

Complete official reports are not available as to the extent of municipal trading in the United States. From unofficial but more or less dependable sources, however, the following table has been compiled, showing the state of the movement in the year 1928:—

Municipal Enterprises in the United States

Kind	No. of municipalities owning	Value of properties in about 200 of the largest cities
Water works	6,900[1]	$1,745,245,581[2]
Electric light and power	2,581[3]	137,910,381[2]
Gas plants	109[4]	..
Street railways	16[5]	68,626,475[5]
Markets	112[6]	43,592,143[2]
Ice plants, ferries, toll bridges, land, harbour services and farms[7]	..	684,144,697[2]
Total for the 200 cities given in official reports	..	$2,610,892,804[2]
Total—estimated	7,000	$3,000,000,000

[1]Estimated by the American Water Works Association, reported by C. W. Steffler in *Commerce and Finance* (Aug. 4, 1926); [2]U.S. Census, *Financial Statistics of Cities*, Table 19, p. 398 (1925); [3]U.S. Census, *Central Electric Light and Power Stations* (1922); [4]Brown's *Directory of American Gas Companies;* [5]U.S. Census, *Electric Railways*, pp. 236, 238 (1922); [6]U.S. Census, *Financial Statistics of Cities*, pp. 398 *seq.* (1925); [7]the Census report, *Financial Statistics*, p. 398 (1925) under the heading, "All other," lumps the receipts from several municipal service enterprises. On p. 48 of the same report there is an explanation that these receipts are principally from "ferries, toll bridges, harbour tollage and pilotage, land development, ice plants and farms." Of the large amount for New York city, $3,741,920 was received from ferry tolls and $328,273 from bridge tolls.

The only official figures available on municipal enterprises in the United States are those of the U.S. Census, and they cover only 247 cities. This includes only the larger cities—those having 30,000 population and over. As there are, in all, 15,692 cities, towns, villages and incorporated places in the United States, it is obvious that the census reports give a very incomplete picture of the situation. And especially so as several thousands of these smaller cities own and operate municipal waterworks, while the great majority of the 2,581 municipal light and power plants officially reported are in cities and towns of much less than 30,000 population. The total number of cities owning and operating municipal enterprises has been therefore estimated as 7,000, and the total aggregate value or investment at $3,000,000,000. The official figures do give some interesting data with reference to the municipal enterprises of the larger cities of the country, which are presented in the following table:—

Municipal Enterprises in the United States in 247 Cities of 30,000 Population and Over

Kind of utility	Number of plants	Value	Outstanding indebtedness	Outlays
Waterworks	206[1] (Out of 6,900)	$1,745,245,581[1]	$ 679,975,768[2]	$116,665,610[3]
Electric light, power and gas enterprises	28[1] (Out of 2,581)	137,910,383[1]	77,988,320[2]	18,568,854[3]
Markets	31[1]	43,592,143[1]	13,830,211[2]	3,925,537[3]
Street railways	16[4]	68,894,398[4]	37,881,600[4]	..
Ferries, bridges, harbours, ice plants and farms[5] (not segregated)	108[5]	684,144,698[1]	351,597,829[2]	62,313,364[3]
Total	247	$2,677,787,203[6]	$1,131,587,455[7]	$201,473,365

[1]U.S. Census, *Financial Statistics of Cities*, pp. 398 *seq.* (1925); [2]*ibid.* p. 430; [3]*ibid.* p. 366; [4]U.S. Census, Electric Railways, pp. 236–239 (1922); [5]Census lumps all these under heading "All other" as previously explained; [6]this includes $60,920,633, given in the report as value of "municipal service enterprises" not included in items in this table; [7]this includes $8,195,317 given in report as indebtedness of "municipal service enterprises" not included in this table.

The table on next page shows the "revenues, receipts," expenditures or "government cost payments for expenses" and net earnings or "excess of receipts over expenditures" of public service enterprises carried on by 247 of the largest cities in the United States.

Revenues, Expenditures and Net Earnings of Public Service Enterprises in 247 of the Largest Municipalities in the United States

Kind of utility	Revenues [1]	Expenditures "cost payments"	Excess of receipts over expenditures [4]
Waterworks	$157,898,606	$ 76,251,133 [2]	$81,647,473
Electric light and power	31,178,574	20,671,789 [2]	10,506,785
Street railways	35,745,013	27,880,868 [2]	7,864,145
Sewers and sewage disposal	..	19,855,414 [3]	−19,855,414
Garbage disposal	..	39,832,778 [3]	−39,832,778
Docks and wharves	13,505,453	5,888,516 [2]	7,616,937
Gas plants	7,143,504	4,363,785 [2]	2,779,719
Markets	3,451,849	1,964,520 [2]	1,487,329
Street construction, maintenance and lighting	118,606,532	133,214,039 [3]	−14,607,507
Cemeteries and crematories	1,926,541	2,443,950 [2]	− 517,409
Subways for pipes and wires	494,284	63,360 [2]	430,924
Scales	70,334	80,801 [2]	− 10,467
Ferries, toll bridges, harbours, lands, ice plants and farms	5,577,421	5,969,217 [2]	− 391,796
Public convenience stations	..	823,827 [3]	− 823,827
Halls	..	1,024,600 [2]	− 1,024,600
Total	$375,598,111	$340,328,597	$35,269,514

[1] All of the figures in the column on revenues are from the U.S. Census report, *Financial Statistics of Cities*, pp. 246, 230; [2] *ibid.* p. 342; [3] *ibid.* p. 286; [4] this column and totals our own.

Municipal Waterworks.—By far the most extensive field of "municipal trading" in the United States is that of public waterworks. The figures given above give only a very partial view of the situation. They cover only 247 out of nearly 7,000 municipalities that own and operate water-supply systems. The American Water Works Association estimates that over 90% of the urban population in the United States is served by public plants. We give below a table showing the financial operations of the four largest municipal water-supply systems:—

*Four Largest Water Systems**

	New York	Chicago	Philadelphia	Detroit
Value	$415,021,347	$91,908,955	$75,659,319	$45,362,806
Liabilities	196,000,000†	8,209,969	38,486,672	19,286,114
Revenues	20,281,284	10,162,361	6,835,521	5,323,295
Expenses	7,318,712	5,434,060	2,660,715	1,607,835
Gross surplus	12,962,572	4,728,301	4,174,806	3,715,460

*Compiled from U.S. Census report, *Financial Statistics of Cities*, pp. 246, 342, 398, 420; †Cornelius Sheehan, "Municipal Waterworks of New York," in *Public Ownership*, p. 39 *seq.* (March, 1926).

Municipal Light and Power Plants.—There are 2,581 municipally-owned light and power plants in the United States. The majority of these are in the smaller cities, towns and villages, but a number of the larger cities have very successful projects. Cleveland, O., was one of the first of the larger cities to establish a municipal plant, and has the distinction of being the first and only city to offer a maximum rate for domestic service of 3 cents per kilowatt hour. Los Angeles now has the largest of the municipal systems, with Seattle following closely. Tacoma has a complete monopoly of the power business. The table at the foot of the preceding column shows the financial operations of these four largest municipal plants.

Financial Operations of the Four Largest Municipal Electric Light and Power Plants in the United States

	Los Angeles*	Cleveland†	Seattle‡	Tacoma¶
Total assets	$64,104,668	$13,359,974	$40,963,740	$16,205,766
Liabilities	..	7,388,000	31,971,658	8,640,902
Revenues	12,658,994	3,377,132	37,142,955	1,758,202
Expenditures	6,504,885	1,690,637	17,504,057	561,268
Gross income before interest and depreciation	6,154,108	1,687,494	19,638,898	1,217,651
Interest and depreciation	2,895,620	365,970	11,472,845	623,315
Net income	3,258,488	1,320,524	8,166,052	594,336

*Audit by Price, Waterhouse and Co. (Los Angeles, 1927); †resumé of the 1927 reports of the Cleveland Lighting Plant, by F. W. Ballard; ‡*Annual Report*, Dept. of Lighting (Seattle, Dec. 1927); ¶Llewellyn Evans, superintendent, Light Division, Tacoma, Wash.

Street Railways.—As compared to England, there are but few municipally-owned street railways in the United States—only 16 in all. However, the city of San Francisco has had a long and quite satisfactory experience with its municipal railways; Seattle is working out its problems gradually; and Detroit now owns and operates the largest publicly-owned system in America, if not in the world. The following table will show the financial operations of the three largest municipal systems:—

The Three Largest Municipal Railway Systems in the United States

	Detroit*	San Francisco†	Seattle‡
Assets	$60,612,707	$11,080,168	$14,285,763
Liabilities	60,567,462	4,018,724	14,823,326
Revenues	23,787,435	3,466,715	5,758,291
Expense	18,535,903	2,879,905	5,491,770
Net income before capital charges	5,251,531	586,810	266,520
Interest and depreciation	1,897,178	415,130	168,073
Net income	2,805,361	171,679	156,590

**Financial Statement*, Detroit Street Railways (Aug. 31, 1928); †*Financial Report*, Municipal Railways of San Francisco (June 30, 1927); ‡Seattle Municipal Street Railways' *Annual Report* (Dec. 31, 1927).

(C. D. T.)

MUNICIPIUM, the term applied primarily to a *status*, a certain relation between individuals or communities and the Roman state (Lat. *munus*, a duty or privilege); subsequently to a community standing in such a relation to Rome.

Early History.—The status had its origin in the conferment of citizenship upon Tusculum in 381 B.C., and was widely extended in the settlement made by Rome at the close of the Latin War in 338 B.C. (*see* ROME: *History*). Italian towns were then divided into three classes: (1) *Coloniae civium Romanorum*, the members of which had all the rights of citizenship; (2) *municipia*, which received partial citizenship; (3) *foederatae civitates*, separate from Rome, and in relations with her separately arranged for each state by treaty (*foedus*). The *municipia* stood in very different degrees of dependence on Rome. Some, such as Fundi, enjoyed a local self-government only limited in the matter of jurisdiction; others, such as Anagnia, were governed directly from Rome. But all had certain features in common. Their citizens were called upon to pay the same dues and perform the same service in the legions as full Roman citizens, but had not the right of voting in the Comitia (*ius suffragii*) or of holding Roman magistracies (*ius honorum*). Jurisdiction was entrusted in every *municipium* to *praefecti iuri dicundo* sent out from Rome to represent the praetor urbanus. *Municipium* must therefore have been more a burden than a privilege. But after the Second Punic War, when Rome had become the chief power in the Mediterranean, we can trace a tendency among the Italian cities to regard citizenship of this great state as a privilege and to claim complete citizenship as a reward of their services in helping to build up the Roman power. During the 2nd century B.C. the *ius suffragii* and *ius honorum* were conferred upon numerous *municipia*. They can have exercised their public rights but seldom, owing to their distance from Rome.

Later Republic and Empire.—The result of the social war (*see* ROME: *History*) was the establishment of a new uniform municipality throughout Italy. By the Lex Iulia of 90 B.C. and the Lex Plautia Papiria of 89 B.C., every town in Italy which made application in due form received the complete citizenship. The term *municipium* was no longer confined to a particular class of Italian towns but included all urban communities of Roman citizens in Italy. The organization of a municipal system, which should regulate the governments of all these towns on a uniform

basis and define their relation to the Roman government, was probably the work of Sulla. Julius Caesar extended the sphere of the system by his enfranchisement of Cisalpine Gaul and the inclusion of all the towns of that region in the category of *municipia.* Augustus and his successors granted to existing towns in the provinces either the full citizenship or a partial *civitas* known as the *ius Latii,* and the distinction survived for some time in the provinces between *coloniae, municipia iuris Romani,* and *municipia iuris Latini.* But the uniform administration gradually adopted in all three classes rendered the distinction unimportant, and the general term *municipium* is used of all alike.

Internal Constitution.—Of the internal life of the *municipia* very little is known before the Empire, when a series of municipal laws gives us a detailed knowledge of the constitution imposed on the *municipia,* and a host of private inscriptions gives particulars of their social life.

The municipal constitution of the 1st century is based upon a type common to Greece and Rome from earliest times. The government of each town consists of magistrates, senate, and assembly, and is independent of the Roman government except in cases of higher civil jurisdiction, which come under the cognizance of the praetor urbanus at Rome (*see* PRAETOR). Each community is bound to perform certain services to the Imperial government, such as the contribution of men and horses for military service, the maintenance of the imperial post, and the entertainment of Roman officials or billeting of soldiers. The citizens were of two classes: (1) *cives,* whether by birth, naturalization, or emancipation, (2) *incolae,* who enjoyed a partial citizenship based on domicile for a certain period. Both classes were liable to civic burdens, but the *incolae* had a limited right of voting. The citizens were grouped in tribes or *curiae,* and accordingly the *comitia* sometimes bore the name of *tributa,* sometimes that of *comitia curiata.* The theoretical powers of these *comitia* were extensive, but the growing influence of the municipal senates gradually made popular election a mere form.

Social Organisation Under the Empire.—The *municipia* of the empire may be treated under three heads: (1) as centres of local self-government, (2) as religious centres, (3) as industrial centres. (1) The chief feature of the local government is the activity of the authorities in improving the conditions of life in the town. Provision was made out of the public funds for feeding the poor and providing corn which could be bought by ordinary citizens at a moderate price. In Pliny's time there existed in many towns schools controlled by the municipal authorities. Pliny promoted another kind of school at Como, where the leading townspeople subscribed for the maintenance of the school and the control remained in the hands of the subscribers. Physicians seem to have been maintained at the public expense. The water-supply was provided out of the municipal budget and controlled by magistrates. To enable it to bear the expense involved in all these undertakings, the local treasury was assisted by benefactions from individual citizens; but direct taxation was hardly ever resorted to. The treasury was filled out of the proceeds of the landed possessions of the community, especially mines and quarries, and out of import and export duties.

(2) The chief feature in the religious life of the towns was the position they occupied as centres for the cult of the emperor. Caesar-worship developed spontaneously in many provincial towns during the reign of Augustus, and was fostered by him and his successors as a means of promoting a strong loyalty to Rome and the emperor, which was one of the firmest supports of the latter's power.

(3) The development of this free industrial class is the chief feature of the *municipia* considered as centres of industry and handicraft. The rise of the equestrian order had to some extent modified the old Roman principle that commerce was beneath the dignity of the governing class; but the aristocratic notion survived in Rome that industry and handicrafts were fitted only for slaves. In the provincial towns, however, this idea rapidly disappeared, and even in Italy the inscriptions give evidence of the existence of a flourishing free industrial class. The members of this class show a strong tendency to bind themselves together in gilds (*collegia, sodalitates*). These societies were viewed with suspicion by the emperors as politically dangerous; but in spite of opposition the gilds in the provincial towns grew and flourished. The ostensible objects of such *collegia* were the worship of some god and provision for the funerary rites of their members.

The policy of encouraging the independence and civic patriotism of the towns was superseded in the 3rd and 4th centuries A.D. by a deliberate effort to use the towns as instruments of the imperial government, under the control of representatives of the emperor in the provinces. This policy was accompanied by a decay of civic feeling and municipal enterprise, which showed itself in the unwillingness of the townsmen to become candidates for local magistracies. Popular control of the towns was ceasing to be a reality by the end of the 1st century. Two centuries later local government was a mere form.

BIBLIOGRAPHY.—A. H. J. Greenidge, *Roman Public Life* (1901); S. Dill, *Roman Society from Nero to Marcus Aurelius* (1904); J. E. Sandys, *Companion to Latin Studies* (1921); W. E. Heitland, *The Roman Republic* (1923), with useful bibliography.

MUNISING (mū′nĭ-sĭng), a city of the Upper Peninsula of Michigan, U.S.A., on the south shore of Lake Superior; the county seat of Alger county. It is served by the Lake Superior and Ishpeming railroad. The population was 5,037 in 1920 (88% native white) and was 3,956 in 1930 by the Federal census. It has lumber, saw, paper, stave, shingle and veneer mills, and is a summer resort of many and varied attractions. The city is built around a semi-circular bay, protected by wooded headlands, and faces Grand island, a private game preserve, kept in primaeval beauty. Munising was founded in 1897 and incorporated as a city in 1913. It has a commission form of government.

MUNITIONS, MINISTRY OF. The Ministry of Munitions of the United Kingdom was created by act of parliament in May 1915 on the formation of the first Coalition Government.

The events which preceded its formation belong to the political history of that period, but, in effect, the creation of the Ministry resulted from the fact that the early months of the World War had shown that former methods of obtaining army supplies from a limited number of firms were inadequate to meet the needs of an army of unprecedented size and whose requirements were far beyond any previously contemplated, even for so large a force.

Its first obvious task was to make good the serious shortage revealed of guns and gun ammunition, but events moved so rapidly that during the formulation, in concert with the War Office, of the first detailed programme of requirements the demands became expanded beyond those first contemplated even in that programme. From that time onwards programme succeeded programme, each larger than its predecessor, in order to keep pace with the sustained bombardments at the front and with the introduction of new apparatus and methods of war.

With regard to the supplies that entered into the first programme, the subsequent increases specially affected the number and weight of guns and of their ammunition, as well as the numbers of machine guns; but the first of many successive programmes of trench warfare munitions soon followed, and the trench warfare department came to be responsible for the provision not only of grenades, bombs and mortars, but of steel helmets, chemicals and a great variety of special devices.

In the year 1916 the first considerable programmes of tanks and of aeroplanes were added, and the manufacture of agricultural implements, railway material and other supplies became the duty of the Ministry about the same time. In the end the Ministry became responsible for the complete mobilization of the whole of the British metal, engineering and heavy chemical trades, as well as of many related industries, and its powers were added to accordingly in successive acts of parliament.

The Plan of Operations.—The plan of the Ministry's operations was worked out during the summer of 1915, and, although it underwent enlargements and adjustments as new tasks were assumed, it remained unaltered in essentials. An understanding of these methods may be gained by reference to the procedures found to be necessary in the first year of the Ministry's activity.

It was necessary to enlist the aid, on some organized plan, of

the whole of the engineering and allied industries. There was a universal willingness to help, but in order to make that help available the widespread supply of designs and models, gauges and precise specifications was a first essential. This work involved the co-operation of many skilled trades, such as jewellers, scientific instrument makers, and others who were not obviously allied to munitions manufacture. Next, the variety in the equipment and capacity of the workshops, both in men and machinery, necessitated the improvisation of an elaborate machinery of association whereby it could be arranged that each should make such parts as they were suited for. These circumstances led the Ministry to become responsible for the supply of materials or parts, to claim priority of execution and to supply or move machinery or labour. In these cases, therefore, as well as where the firms were already suited to munitions manufacture, a class of "controlled establishments" was created, wherein the powers of the Ministry in regard to manufacture, materials and labour conditions were paramount. The number of these controlled establishments was constantly being added to as the work increased.

In order, locally, to marshal the help so freely available, a district, or "area organization" was set up under the superintendence in each area of a "munitions committee." These committees were usually staffed by experienced men in the locality, and they arranged, particularly, for the mobilisation and assistance of firms that had not previously been concerned with this type of work. The district offices of the Ministry also became the headquarters of its own officers who had direct responsibility for manufacture, inspection, materials and labour supply, costs and other duties.

Apart from the widespread assistance secured by the foregoing measures, the volume of contracts arranged directly by the ministry increased very rapidly as works extensions and the concentration of manufacture enabled many firms to undertake greater orders. The execution of the first programme, however, made it evident that the requirements would exceed all that could be provided by all such methods, and a number of "national factories," under the direct ownership of the Ministry, were provided. Some of these factories were of vast capacity, and they came to furnish an increasing proportion of the output. The national factories varied considerably in type; some were under the direct management of the local munitions committees, and were chiefly named after the towns in which they were situated, but these factories were not often large; others, sometimes of great size, for guns, machine guns, trench warfare and chemical supplies, for tanks or for aeroplanes, were erected by the Ministry but managed on an agency basis by experienced firms; others, and finally, the largest factories, were directly owned by the Ministry itself and managed by men appointed by it. The great explosive factories at Gretna, Queensferry and elsewhere, most of the filling factories, many special trench warfare and chemical factories, as well as some larger gun and shell factories, belonged to this group.

The widespread activities of the Ministry necessarily led to the institution of many novel methods of working and extensions of State activity, and a review of some of them is required for an understanding of the scope of the gigantic enterprise.

Intelligence and Improved Methods.—A central department was charged with the duty of transmuting into terms of machinery, materials and labour requirements the successive programmes supplied by the War Office. As a corollary of this work it was necessary, for example, to take the census of existing machinery in order to ascertain the new machinery requirements, and a special executive department was made responsible for the supply of all the machine tools and machinery shown to be required. Similar relations existed between the intelligence department and the other executive supply departments.

In the course of time the collection and analysis of progress reports, in comparison with the time-programme that had been worked out, led to the provision of "weekly reports" in such a form that the minister and the chief officers could readily keep in touch with events. In order also to facilitate the united exploration of deficiencies and difficulties a "fortnightly conference" was held of the minister and the chief heads of the departments; and the chief of the intelligence services was responsible for supplying the minister with a synopsis and criticism of the progress reports for that purpose.

The pooling of information as to progress and methods enabled the Ministry to have knowledge of the relative efficiency of different firms and processes and to use the knowledge thus obtained in promoting improvements. There was in consequence a rapid advance in many industrial methods.

Allied in aim to the intelligence service a valuable system sprang up in the executive departments, whereby there were regular conferences with works managers as to the value and results of different processes, and the recommendations were made available directly to the different firms as well as through the district officers of the Ministry.

On parallel lines a munitions inventions department was set up to receive and examine the numberless suggestions that were forthcoming from the humblest workers to trained experts, and many of the most fruitful new processes of the war period were obtained in this way. There was, of course, much that was useless in the mass of the material submitted to the different scientific and expert committees, but some thousands of suggestions were approved and ultimately adopted through the agency of this department.

Costs and Cost Accounting.—Owing to the fact that the requirements often involved the total producing capacity of the country competitive tenders were inapplicable, and the Ministry came to base prices upon an examination of the costs of production in typical cases after making adequate allowances for other charges and profits. The different national and co-operative factories afforded excellent facilities for these investigations although many of the more enterprising firms readily co-operated. The powers of the Ministry in this respect were added to in the first Munitions of War Amendment Act, but, after a short time, the powers to investigate costs compulsorily were not widely exercised. For the most part, prices became based upon an examination of the costs as found by the Ministry and by the different firms, although an independent special examination was often undertaken by the Ministry with the concurrence of the firms before a final agreement was arrived at. The first and most dramatic result of the use of these powers occurred in Feb. 1916 after it had been found that, making generous allowance for repayment of factory costs, many types of shell cases were being obtained at a little more than half former contract prices in the national factories and elsewhere. The prices for the principal shell cases were reduced as follows:

Shell Cases	*Previous Price*	*Reduced Price*
18 pounders	20s. to 23s.	12s.6d.
4·5″	47s. to 65s.	34s.
60 pounders	60s. to 82s.4d.	52s.6d.
6″	80s. to 90s.	70s.6d.
8″	240s.	157s.6d.
9·2″	262s. to 305s.	227s.6d.

As a part of the agreement entered into when these reductions were obtained, future prices became subject to periodic adjustment on the basis of the costs of materials and labour-rates over which the firms themselves had little control. The reductions in prices, as compared with earlier contracts, were also materially assisted by the great size of the contracts that were entered into, as well as by the economies that were subsequently secured, in the reduction in the amounts used of costly materials, or in the substitution for them of less costly ones. Nevertheless the savings effected by the examination and control of costs were of a prodigious character. The first cut in shell prices resulted in a saving of £400,000 a week on the 1916 gun ammunition programme, if the prices had been the same as those of 1915. Wages rose steadily throughout the war, but the economies effected in other directions made further reductions in the level of shell prices possible, notwithstanding the additional labour rates.

Supply of Materials, Priority and Allocation.—The first programme, when resolved into material requirements, showed that, in some cases, all, or more than all, of the available supplies would be needed. The scarcity also was leading to soaring prices, and in some instances the Ministry had to protect itself against

cornering. The result was that in successive "orders" the Ministry made itself the nominal holder of supplies as well as responsible for overseas purchases and shipments. The existing machineries of importation and distribution were used so far as possible and the different firms acted as agents on an agreed basis. In this way stability of price was secured and control over distribution. Apart, however, from the demands of the Ministry and other war departments, it was necessary to satisfy, so far as possible, the requirements of a multitude of private industries that were ministering to the essential needs of the community. For these reasons an increasingly elaborate system of priority and allocation came to be established, and the scarcity of the later years of the war became so acute that the priority organization became subject to a special cabinet committee. This cabinet tribunal, or its officers, was responsible for the adjudication of the conflicting claims of the different war departments on the one side, and of private industries on the other, but each war ministry was responsible for the allocation within itself of its own supplies. In order to secure an orderly presentation of the needs of private industry the Ministry of Munitions inaugurated a system, during 1916, whereby the industries were grouped, in order to present their requirements collectively, and, later on, these industrial organizations were mainly responsible for the administration of their own priorities and allocations.

The ever-tightening grip of the Ministry upon many materials affected the life of the nation in numberless intimate and, seemingly, indirect ways, and became itself responsible for the Ministry having to undertake the provision of some supplies of a non-munitions character. For example, the explosives programme so completely absorbed the output of gas plants, coke ovens and the chemical trade, that the Ministry had to become responsible for the supply of fertilizers to the agricultural industry. The demands for glycerine necessitated a pooling of all the industries dealing with oils and fats, and of their raw materials, with the result that the Ministry was compelled to regulate and assume responsibility for the supplies of cattle-cake and other products. Similarly the requirements for alcohol involved control of the whole distilling industry, and indirectly of the supply of yeast for bread-making.

Economy of Materials and Increased Production.—The restriction of overseas supplies that accompanied the submarine campaign of 1917 was mitigated to some extent by a great development in the economy of metals and in the improvement of salvage and scrap collection and utilization.

The successes of the materials economy department were dependent upon the initiation and conduct of research and experiment on an extensive scale and by the embodiment of their results in the modifications of design, as well as in minimizing the waste in many manufacturing methods. In a similar way the work of salvage and the collection and utilization of scrap from works was entrusted to special departments, and a number of factories were set up to convert or re-form the supplied materials. On the other hand the scarcity of some materials greatly stimulated home production where the necessary ores were obtainable and the Ministry was responsible for many extensions of steel works, recovery plants, chemical works, mining operations and so on. With regard to the non-ferrous metals the guidance and inspiration of this work was under the superintendence of a mineral resources development department.

Labour.—Just as the supply of materials involved the Ministry in many unforseen undertakings, so did the supply of labour, only in this case the difficulties were much greater owing to the intimate human interests that were involved. When the Ministry was established the demands of the fighting services for men had already begun to affect, not only the volume of available labour, but its quality, because so many highly-skilled craftsmen had already joined the colours. This double scarcity of volume and quality was the determining cause of the devices that came to be adopted.

Prior to the establishment of the Ministry, an agreement had been entered into with the trades unions of the engineering and allied trades (the "Treasury agreement"), an important ingredient of which was that future modifications of conditions of employment should not be accompanied by a reduction of rates paid for piece-work, and a pledge was given for the post-war restitution of pre-war conditions. (A similar pledge accompanied subsequent agreements.) The arrangement as to piece-rates, although just in itself, was the cause of much subsequent difficulty, because, as a result of training new labour and of the growing scarcity of skilled men, it became more and more necessary to remove skilled men from repetition work and use them for the more expert processes, which, by their nature, could only be paid by time rates. The consequence was that skilled men often found themselves receiving less pay than the unskilled workers introduced in the process of "dilution" whom they themselves had often trained for the work.

In order to assist the Ministry with the vexed questions that arose daily a joint committee (the "munitions labour supply committee"), of representative employers and trades unionists was set up and rendered invaluable service. This committee marked the beginning of a system of joint consultative bodies that worked both centrally and in the different districts and shops, in helping to deal with the multitudes of points that arose as to classification, wages, work conditions, hours and the rest.

Various devices were adopted to promote the augmentation of labour supplies. The War Munition volunteers was a body consisting of skilled men who were prepared to go wherever required, and they were often used in starting new factories or workshops, as well as in helping to speed up supplies that were urgently required.

The Army Reserve Munition workers was another body that came into being later on, and consisted of men who, owing to their skill, or for other reasons, had been brought back from the colours, or were not fit to rejoin them, and who were used somewhat similarly to the war munition workers.

Dilution of Labour.—But by far the greatest augmentation of labour was obtained by training men and women who were drawn from all manner of other occupations. The technical schools, colleges and universities were participants in the training schemes, but the greatest schools for training of the less expert crafts were in the works themselves. This process of "dilution" was signally successful. Its introduction and conduct were naturally attended by innumerable difficulties, and it is probably not too much to say that it could not have been successfully carried out except by the goodwill of the workmen and employers' representatives throughout the country. In one form or another dilution was responsible for the serious strikes that took place in the Clyde area, at Barrow and elsewhere, and these disturbances led to the creation of a special body of dilution commissioners who were set apart to superintend the introduction of new workers and to adjust disputes.

The breach with old industrial methods, and the utilization of vast numbers of new workers, especially of women workers, compelled the Ministry to take powers to regulate hours, wages and conditions of employment generally. This first introduction of women on a great scale into what had hitherto been regarded as the sphere of men's work, as well as other devices adopted at that time, are clearly destined to have an enduring social importance. A body of experts was set aside to study the conditions affecting the health and industrial capacity of munition workers (the "health of munition workers committee"). The work of this committee was sometimes of a striking, if of transitory importance, as in the elimination of T.N.T. poisoning in the explosive factories, but their inquiries into physique, into the effect of hours, posture, food supplies and methods, upon health and industrial output, are of permanent value. This work led to the establishment of the industrial fatigue research board, which is now attached to the national council of medical research under the Privy Council. Concurrently a close study of industrial welfare developed, and one branch of it was concerned with the provision of canteens in the different works and factories; but in many ways it has led to modifications in the conduct and standards of employment.

In order to safeguard essential labour from indiscriminate enlistment, the Ministry was made responsible for the issue of

exemption badges to skilled workers, and, later on, was required to issue badges on behalf of other war departments. The accompanying, but more difficult, work of de-badging that arose as the demands of the army for men became more urgent, was attached to the Ministry, and some serious industrial disputes arose over questions of exemption, or of alleged, improper recruitment, notably the disputes in Sheffield and in Lancashire, but, for the most part, such disputes, through the agency of the different local consultative committees, were capable of ready adjustment.

The Output of Munitions.—A brief summary will suffice to indicate, in terms of output, the results of this progressive mobilization of the resources of the nation in machinery, materials, science and invention, as well as in men and women so far as they were available.

The manufacture of explosives of different kinds at the commencement of the Ministry amounted to about 400 tons per week, and subsequently it exceeded 7,000 tons. The undertaking involved the unified direction of the chemical industries, gas works, distilleries, oils and fats trades and many allied industries. The filling of the shells, bombs, etc., involved the creation of vast filling factories, of assembly stations and transport arrangements, so that the weekly tonnage of filled ammunition sent across the English Channel came to exceed 53,000 tons per week.

During the progress of the war, the proportion of shells of the heavier natures was constantly increased, but the rise in the numbers of shells delivered as "completed rounds" is indicated in the following table:—

	Completed rounds per week
June 1915	200,000
June 1916	1,000,000
March 1917	2,000,000

The increase in the output of guns and machine guns was on similar lines, except that the number of machine guns per unit increased even more greatly towards the end of the war than that of guns. The trench warfare department became responsible for an increased volume of supplies, entirely comparable to that of shells, together with the materials for chemical warfare, both for offensive and defensive purposes. A committee of experts from the Royal Society and other learned bodies acted jointly for the Ministry and the War Office in this branch of supply, of which the character could only be described as increasingly ghastly as the war proceeded.

The provision of tanks in the first instance arose out of the work of a band of experts on mechanical warfare that had been set up by Winston Churchill at the Admiralty. Subsequently this organization was transferred to the Ministry of Munitions, which became responsible for experimentation with and for the supply of tanks. The supply of aircraft devolved from the air board upon the Ministry towards the end of 1916, and in this respect the Ministry acted as the supply department to the Ministry of Air, as it did in other respects for the War Office. Here, as in other cases, the elimination of a needless multiplicity of type and the standardization of production, together with scientific research, was attended with signal success.

The Ministers of Munitions.—The successive ministers were:—D. Lloyd George (from the commencement to June 1916), E. Montagu (June to Dec. 1916), Christopher Addison (under-secretary from commencement; minister Dec. 1916 to July 1917), Winston Churchill (from July 1917 to the end of the war).

See the official *History of the Ministry of Munitions* (8 vols., 1922); also G. A. B. Dewar, *The Great Munition Feat* (1921); G. D. H. Cole, "Trade Unionism and Munitions" and "Workshop Organization" (both 1923) in *Economic and Social History of the Great War, British Series;* Christopher Addison, *Politics from Within* (1924); D. Carnegie, *History of Munitions Supply in Canada* (1925).

(C. A.)

MUNKAČEVO, a town of Ruthenia, Czechoslovakia, situated on the left bank of the Latorica where it leaves the East Beskid highlands. Traditionally believed to be near the point where the Magyar entered the plain, the old fort on a hill in the vicinity has played an important part in Hungarian history as a defence and later as a prison. The town acts as a market and centre of contact for the hill and plain peoples and has several distilleries, breweries and small tobacco and flour-milling interests. Pop. (1923), 20,865, including 4,936 Ruthenians, 4,864 Magyars and 8,394 Jews.

MUNKACSY, MICHAEL VON (1844–1900), Hungarian painter, whose real name was MICHAEL (Miska) LEO LIEB, was born at Munkács, Hungary, on Feb. 20, 1844. He was apprenticed to a carpenter in 1855, but shortly afterwards made the acquaintance of the painters Fischer and Szamossy, whom he accompanied to Arad in 1858. About the end of 1867 he was working at Düsseldorf, where he painted (1868–69) "The Last Day of a Condemned Prisoner," exhibited in the Paris Salon in 1870. He had already paid a short visit to Paris in 1867, but in 1872 he settled there permanently. Munkacsy's other chief pictures are "Milton dictating *Paradise Lost* to his Daughters" (Paris Exhibition, 1878), "Christ before Pilate" (1881), "Golgotha" (1883), "The Death of Mozart" (1884), "Arpad, chief of the Magyars, taking possession of Hungary," exhibited at the Salon in 1893, and "Ecce Homo." He died on April 30, 1900, at Endenich, near Bonn.

See F. Walther Ilges, "M. von Munkacsy," *Künstler Monographien* (1899); C. Sedelmeyer, *Christ before Pilate* (1886).

MÜNNICH, BURKHARD CHRISTOPH, COUNT (1683–1767), Russian soldier and statesman, was born at Neuenhuntorf, in Oldenburg, in 1683, and was in the French, Hesse-Darmstadt and the Saxon services before, and with the rank of general-in-chief and the title of count, he joined the army of Peter II. of Russia. In 1732 he became field-marshal and president of the council of war. In 1734 he took Danzig, and with 1736 began the Turkish campaigns which made Münnich's reputation as a soldier. Working along the shores of the Black Sea from the Crimea, he took Ochakov in 1737, and in 1739 won the battle of Stavutschina, and took Khotin (or Choczim), and established himself firmly in Moldavia. Marshal Münnich now entered on political rivalry with Biron, duke of Courland. During the revolution of 1741 he was condemned to death, reprieved, and sent to Siberia, where he remained until 1762, when he was released. Catherine II. employed the old field-marshal as director-general of the Baltic ports. He died in 1767. As a statesman he is regarded as the founder of Russian Philhellenism.

He wrote an *Ébauche pour donner une idée de la forme de l'empire de Russie* (Leipzig, 1774), and voluminous diaries, of value for the history of the period, have appeared in various publications—Herrmann, *Beiträge zur Geschichte des russischen Reichs* (Leipzig, 1843). *See* Hempel, *Leben Münnichs* (Bremen, 1742); Halem, *Geschichte des F. M. Grafen Münnich* (Oldenburg, 1803; 2nd ed., 1838); Kostomarov, *Feldmarschall Münnich* (*Russische Geschichte in Biographien,* v. 2).

MUNRO, HUGH ANDREW JOHNSTONE (1819–1885), British scholar, was born at Elgin on Oct. 19, 1819, and died at Rome on March 30, 1885. He was educated at Shrewsbury and Trinity college, Cambridge, and was professor of Latin at Cambridge. His main editions are: Lucretius, his greatest work (text, 1 vol., 1860; text, commentary and translation, 2 vols., 1864); *Aetna* (1867); Horace (1868); *Criticisms and Elucidations of Catullus* (1878).

See *Memoir* by J. D. Duff, prefixed to a re-issue of the trans. of Lucretius in "Bohn's Classical Library" (1908).

MUNRO, MONRO or **MONROE, ROBERT** (d. *c.* 1680), Scots general. He served in the Scottish rebellion against Charles I., and in 1644 was appointed to command the parliamentary forces in Ireland. For disobedience to orders he was superseded by Monk in 1648. He was in part the original of Dugald Dalgetty in Sir Walter Scott's *Legend of Montrose.*

See J. T. Gilbert, *Contemporary History of Affairs in Ireland 1641–1652* (3 vols., Dublin, 1879–80).

MUNSEY, FRANK ANDREW (1854–1925), American publisher and newspaper proprietor, was born at Mercer, Me., on Aug. 21, 1854. Educated in public schools, he began business in a country store, and became manager of the Western Union Telegraph office in Augusta, Maine. In 1882 he went to New York city and in the face of great obstacles established the *Golden Argosy,* a magazine for children, later changing this to the *Argosy,* a magazine for adult readers. In 1889 he founded *Munsey's Week-*

ly, replaced two years later by *Munsey's Magazine*, the first monthly of its class to sell for 10 cents. He also founded the *All-Story Weekly* (1904) and the *Railroad Man's Magazine* (1906), and published various other magazines. In 1891 he purchased the New York *Star*, changing its name to the *Daily Continent* and making it a pioneer attempt to give the news in tabloid form. Among his outstanding newspaper purchases were the *Baltimore News* (1908), the *New York Press* (1912) and the *New York Sun*, both morning and evening issues (1916). He merged the *Press* in the *Sun*. In 1920 he bought from the executors of James Gordon Bennett's estate the New York *Evening Telegram* and the *New York Herald*, together with its Paris issue. He combined the *Herald* and the morning *Sun* as *The Sun and the New York Herald*, but in Oct. 1920, changed the name to the *New York Herald*, at the same time continuing the evening paper as the *Sun*. He died in New York city Dec. 22, 1925. By his will, after providing for relatives, he left the residue of his estate, estimated at $40,000,000, to the Metropolitan Museum of Art, New York. His financial success was due to unremitting labour and great shrewdness. He was the author of several books for boys.

BIBLIOGRAPHY.—*See* articles by R. L. Duffus (*American Mercury*, July 1924), by R. H. Titherington (*Munsey's Mag.*, March 1926), by Allan Nevins (*McNaught's Monthly*, March 1926) and by O. G. Villard in *Some Newspapers and Newspaper Men* (1926). Some personal material is available in Munsey's introduction to *A Munsey-Hopkins Genealogy* (1920) and *The Story of the Founding and Development of the Munsey Publishing House* (1907).

MÜNSTER, SEBASTIAN (1489–1552), German geographer, mathematician and Hebraist, was born at Ingelheim in the Palatinate. He entered the Franciscan order, but adopted Lutheranism about 1529, and was appointed court preacher at Heidelberg. From 1536 he taught at Basle, where he published his *Cosmographia universalis* in 1544, and where he died of the plague on May 23, 1552. He was the first German to edit the Hebrew Bible (2 vols., fol., Basle, 1534–35). His most important work was his *Cosmographia*, which also appeared in German as a *Beschreibung aller Länder*, the first detailed, scientific and popular description of the world in German. In this Münster was assisted by more than 120 collaborators. The most valued edition of the *Cosmographia* or *Beschreibung* is that of 1550, especially prized for its portraits and its city and costume pictures. Besides the works mentioned above we may notice Münster's *Germaniae descriptio* of 1530, his *Novus orbis* of 1532, his *Mappa Europae* of 1536, his *Rhaetia* of 1538, his editions of Solinus, Mela and Ptolemy in 1538–40; his *Horologiographia* (1531) on dialling (*see* DIAL), his *Organum uranicum* of 1536 on the planetary motions, and his *Rudimenta mathematica* of 1551.

See V. Hantzsch, *Sebastian Münster* (1898), in vol. xviii. of the *Publications of the Royal Society of Sciences of Saxony* (*Historical-Philological Section*).

MUNSTER, a town in the department of Haut-Rhin, France, 16 m. from Colmar by rail, and at the foot of the Vosges mountains at the junction of two arms of the Fecht. Pop. (1926) 3,742. Its principal industries are spinning, weaving, bleaching and cheese-making. The town owes its origin to a Benedictine abbey, which was founded in the 7th century, and at one time it was a free city of the empire. The *hôtel de ville* is 16th century, and part of the abbot's palace remains. The town was much bombarded by the French during the war of 1914–18.

MÜNSTER, a town of Germany, capital of the province of Westphalia, lies in a sandy plain on the Dortmund-Ems canal, at the junction of several railways, 107 m. S.W. of Bremen on the line to Cologne. Pop. (1925) 105,889. Münster is first mentioned about the year 800, when Charlemagne made it the residence of Ludger, bishop of the Saxons. Owing to its distance from any available river or important highway, the growth of the settlement round the *monasterium* was slow, and it was not until after 1186 that it received a charter, the name Münster having supplanted the original name of Mimegardevoord about a century earlier. During the 13th and 14th centuries the town was one of the most prominent members of the Hanseatic League. At the time of the Reformation, the armed intervention of the bishop suppressed all divergence from the older faith. The authority of the bishops, who usually resided at Ahans, has been limited, but in 1661 the bishop built a citadel, and deprived the citizens of many privileges. The bishopric of Münster, embracing about 2,500 sq.m., contained about 350,000 inhabitants, and its bishops were princes of the empire. The bishopric was secularized in 1803.

The town preserves its mediaeval character, especially in the "Prinzipal-Markt" and other squares, with their gabled houses and arcades. The fortifications were dismantled during the 18th century. The cathedral was rebuilt in the 13th and 14th centuries, and combines Romanesque and Gothic forms; its chapter-house is specially fine. The Gothic church of St. Lambert (14th century) was largely rebuilt after 1868; on its tower hang three iron cages in which the bodies of John of Leiden and two of his followers were exposed in 1536. The church of St. Ludger, erected in the Romanesque style about 1170, was extended in the Gothic style about 200 years later. The church of St. Maurice, founded about 1070, was rebuilt during the 19th century, and the Gothic church of Our Lady dates from the 14th century.

Other noteworthy buildings are the town-hall, a Gothic building of the 14th century, and the Stadtkeller, which contains a collection of early German paintings. The room in the town-hall called the Friedens Saal, in which the peace of Westphalia was signed in Oct. 1648, contains portraits of many ambassadors and princes who were present at the ceremony. The Schloss, built in 1767, was formerly the residence of bishops of Münster. The private houses are admirable examples of German domestic architecture in the 16th, 17th and 18th centuries. The University of Münster, founded after the Seven Years' War and closed at the beginning of the 19th century, was reopened as an academy in 1818, and again attained the rank of a university in 1902. Münster is the seat of a Roman Catholic bishop and is a garrison town. Industries include weaving, dyeing, brewing and printing, and the manufacture of furniture, pianos, chocolates, surgical instruments, ropes, soap, cement and machines.

MUNSTER (*Mumha*) was one of the traditional five provinces or "Fifths" of Ireland which appear about A.D. 300, its capital being Cashel and its dynasty bearing the name "Eoghanachta," or descendants of Eoghan Mór (*floruit c.* A.D. 270). From these sprang the MacCarthys of Desmond (Des Mumha) or south Munster, while from a kindred stock came the Dalcassian kings of Thomond or north Munster (*Tuadh-Mumha*). Under Brian Boru (940–1014) the latter attained and kept the throne of Cashel. The Norman Conquest led to the O'Briens being reduced to the modern county Clare and the MacCarthys to west Cork and south Kerry. Munster was shired into Cork, Limerick, Kerry, Tipperary, Waterford and Thomond (Clare). The real sovereignty of Munster, however, passed to the Fitzgeralds, who from 1329 held the earldom of Desmond, and the Butlers, who similarly held the earldom of Ormond, both palatinates under the Crown. The Lord Deputy Sidney in 1576 added Clare (*q.v.*) to Connaught, but it reverted to Munster at the Restoration. Sidney also made Munster a presidency and in 1583, the Desmond rebellion was suppressed.

MÜNSTERBERG, HUGO (1863–1916), German-American psychologist and philosopher, was born in Danzig on June 1, 1863, and died in his lecture-room at Radcliffe college on Dec. 16, 1916. He was educated at Danzig *Gymnasium*, at Geneva and at the universities of Leipzig (Ph.D., 1885) and Heidelberg (M.D., 1887). At Freiburg, where he began his teaching, he had a psychological laboratory in his house. Through the influence of William James he went to Harvard university in charge of the psychological laboratory in 1892–95. Later, he was chairman of the department of philosophy. He was Harvard exchange professor at the University of Berlin in 1910–11. He did much to promote the new science, not only through his college teaching, but through his contacts with industrial firms. His numerous writings include *Beiträge zur experimentellen Psychologie* (Freiburg, 1889–92), *Grundzüge der Psychologie* (Leipzig, 1900), *Die Amerikaner* (1903) and *Grundzüge der Psychotechnik* (1914). In English he published text-books and lighter essays, including *American Traits* (1901); *Psychology and the Teacher* (1909); *American Problems* (1910); *Psychology and Industrial Efficiency*

(1913); and *Psychology: General and Applied* (1914), as well as his books on the great conflict *The War and America* (1914) and *The Peace and America* (1915). His system of philosophy, the consummation of his previous effort, he presented, however, in both German and English as *Philosophie der Werte* (1908) and *The Eternal Values* (1909).

MUNTJAC, a small deer, of the genus *Cervulus*, only found in south-eastern Asia (*see* DEER). They have long bodies and short limbs and necks. The antlers of the buck are short, simple and supported on very long processes of the frontal bones, the front edges of which are continued downwards as ridges on to the face. The upper canine teeth of the male form long tusks, loosely implanted in their sockets. The presence of both tusks and antlers in the same species is very unusual. Solitary in habit, the muntjacs haunt hilly forests, living in the dense thickets and only emerging at dawn and dusk to graze. They are remarkable for the facility with which they creep through tangled undergrowth. Their alarm cry is a short, shrill bark. The Indian muntjac is *C. muntjac;* other species inhabit Tibet, Tenasserim, and south-eastern China.

MUNTZ METAL, a variety of brass, invented by G. F. Muntz in 1832, is also known as "yellow metal" because the large zinc content gives it a very yellow colour. The alloy is composed of 60% copper and 40% zinc. It can be forged, and is employed for machine parts, exposed to corrosion. (*See* ALLOYS; BRASS.)

MÜNZER, THOMAS (*c.* 1489–1525), German anabaptist, was born at Stolberg in the Harz, and educated at Leipzig and Frankfort, graduating in theology. In 1520 he became a preacher at the church of St. Mary, Zwickau, and his rude eloquence, together with his attacks on the monks, soon raised him to influence. Aided by Nicholas Storch, he formed a society on principles akin to those of the Taborites, and claimed that he was under the direct influence of the Holy Spirit. Driven out of Zwickau he went to Prague, where he won numerous adherents, but his violent language brought about his expulsion from this city also. At Easter 1523 Münzer came to Allstedt and began to preach at the church of St. John. His preaching and his denunciation of Luther's teaching soon produced an uproar in Allstedt, and he left the town for Mühlhausen, where Heinrich Pfeiffer was already preaching doctrines similar to his own. The union of Münzer and Pfeiffer caused a disturbance in this city and both were expelled. Münzer went to Nuremberg, where he issued a writing against Luther. He now denounced established governments, and advocated community of goods. After a tour in south Germany he returned to Mühlhausen, overthrew the governing body of the city, and established a communistic theocracy. The Peasants' War had already broken out in various parts of Germany; and Münzer collected a body of men, and established his camp at Frankenhausen. On May 15, 1525, the peasants were dispersed by Philip, landgrave of Hesse. Münzer was executed on the 27th at Mühlhausen.

His *Aussgetrückte Emplössung des falschen Glaubens* was ed. by R. Jordan (Mühlhausen, 1901), and a life of Münzer, *Die Histori von Thome Müntzer des Anfengers der döringischen Uffrur*, has been attributed to Philip Melanchthon (Hagenau, 1525). *See* O. Merx, *Thomas Münzer und Heinrich Pfeiffer* (Göttingen, 1889); J. Zimmermann, *Thomas Münzer* (1925). The Saxon Historical Commission had (1928) in hand an edition of his letters.

MURAD I., surnamed Khudavendighiar (1319–1389), Ottoman sultan, was the son of Orkhan and the Greek princess Nilofer, and succeeded his father in 1359. He was the first Turkish monarch to obtain a definite footing in Europe and his main object throughout his career was to extend the European dominions of Turkey. The revolts of the prince of Caramania interfered with this plan, and the trouble continued until the decisive battle of Konia (1387), when the power of the prince was broken. The state of Europe facilitated Murad's projects; the feudal system was at its last gasp, and the Balkan states were divided by jealousies. The capture of Adrianople and other conquests led to a coalition under Hungary against Murad, but his able lieutenant Lalashahin, the first *beylerbey* of Rumelia defeated the allies at the battle of Maritsa in 1363. In 1366 the king of Servia was defeated at Samakov and forced to pay tribute. Kustendil, Philippopolis and Nish fell into the hands of the Turks; a renewal of the war in 1381 led to the capture of Sofia two years later. Europe was now aroused; Lazar, king of Servia, formed an alliance with the Albanians, the Hungarians and the Moldavians against the Turks.

Murad hastened back to Europe and met his enemies on the field of Kossovo (1389). Victory finally inclined to the side of the Turks. When it was complete, a Servian named Milosh Kabilovich penetrated to Murad's tent on pretence of communicating a secret and stabbed the conqueror. Murad was of independent character and remarkable intelligence. He was fond of pleasure and luxury, cruel and cunning. Long relegated to the command of a distant province in Asia, while his brother Suleiman occupied an enviable post in Europe, he became revengeful; thus he exercised great cruelty in the repression of the rebellion of his son Prince Sauji, the first instance of a sultan's son taking arms against his father. Murad transferred the Ottoman capital from Brusa to Adrianople. The feudal system of *timars* and *ziamets* and its extension to Europe were largely his work.

MURAD II. (1403–1451), Ottoman sultan, succeeded his father Mahommed I. in 1421. The attempt of his uncle Prince Mustafa to usurp the throne, supported as it was by the Greeks, gave trouble at the outset of his reign, and led to the unsuccessful siege of Constantinople in 1422. Murad maintained a long struggle against the Bosnians and Hungarians, in the course of which Turkey sustained many severe reverses through the valour of Janos Hunyadi. Accordingly in 1444 he concluded a treaty at Szegedin for ten years, by which he renounced all claim to Servia and recognized George Brancovich as its king. Shortly after this, being deeply affected by the death of his eldest son Prince Ala-ud-din, he abdicated in favour of Mahommed, his second son, then fourteen years of age. But the treacherous attack, in violation of treaty, by the Christian powers, imposing too hard a task on the inexperienced young sovereign, Murad returned from his retirement at Magnesia, crushed his faithless enemies at the battle of Varna (November 10, 1444), and again withdrew to Magnesia. A revolt of the janissaries induced him to return to power, and he spent the remaining six years of his life in warfare in Europe, defeating Hunyadi at Kossovo (October 17–19, 1448). He died at Adrianople in 1451.

MURAD III. (1546–1595), Ottoman sultan, was the eldest son of Selim II., and succeeded his father in 1574. His accession marks the definite beginning of the decline of the Ottoman power, which had only been maintained under Selim II. by the genius of the all-powerful grand vizier Mahommed Sokolli. For, though Sokolli remained in office until his assassination in October 1578, his authority was undermined by the harem influences, which with Murad III. were supreme. Of these the most powerful was that of the sultan's chief wife, named Safié (the pure), a beautiful Venetian of the noble family of Baffo, whose father had been governor of Corfu, and who had been captured as a child by Turkish corsairs and sold into the harem. This lady ruled over him to the last.

His one attempt at reform, the order forbidding the sale of intoxicants to the janissaries, broke down on the opposition of the soldiery. He was the first sultan to profit by the corrupt sale of offices. This corruption was fatally apparent in the army, the feudal basis of which was sapped by the confiscation of fiefs for the benefit of nominees of favourites of the harem, and by the intrusion, through the same influences of foreigners and rayahs into the corps of janissaries, of which the discipline became more and more relaxed and the temper increasingly turbulent. In view of this general demoralization not even the victorious outcome of the campaigns in Georgia, the Crimea, Daghestan, Yemen and Persia (1578–1590) could prevent the decay of the Ottoman power; indeed, by weakening the Mussulman states, they hastened the process, since they facilitated the advance of Russia to the Black Sea and the Caspian.

Murad, who had welcomed the Persian War as a good opportunity for ridding himself of the presence of the janissaries, whom he dreaded, had soon cause to fear their triumphant return. Incensed by the debasing of the coinage, which robbed them of part of their pay, they invaded the Divan clamouring for the heads of the sultan's favourite, the *beylerbey* of Rumélia, and of the *defterdar* (finance minister), which were thrown to them

(April 3, 1589). This was the first time that the janissaries had invaded the palace: a precedent to be too often followed. The outbreak of another European war in 1592 gave the sultan an opportunity of ridding himself of their presence. Murad died in 1595, leaving to his successor a legacy of war and anarchy.

It was under Murad III. that England's relations with the Porte began. Negotiations were opened in 1579 with Queen Elizabeth through certain British merchants; in 1580 the first capitulations with England were signed; in 1583 William Harebone, the first British ambassador to the Porte, arrived at Constantinople, and in 1593 commercial capitulations were signed with England. (*See* CAPITULATIONS.)

MURAD IV. (1611–1640), Ottoman sultan, was the son of Sultan Ahmed I., and succeeded his uncle Mustafa I. in 1623. For the first nine years of his reign his youth prevented him from taking more than an observer's part in affairs. But the lessons thus learnt were sufficiently striking to mould his whole character and policy. In 1631 the spahis of Asia Minor rose in revolt, in protest against the deposition of the grand vizier Khosrev; their representatives crowded to Constantinople, stoned the new grand vizier, Hafiz, in the court of the palace, and pursued the sultan himself into the inner apartments, clamouring for seventeen heads of his advisers and favourites, on penalty of his own deposition. Hafiz was surrendered, a voluntary martyr; other ministers were deposed; Mustafa Pasha, aga of the janissaries, was saved by his own troops. But Murad was now beginning to assert himself. Khosrev was executed in Asia Minor by his orders; a plot of the spahis to depose him was frustrated by the loyalty of Koes Mahommed, aga of the janissaries, and of the spahi Rum Mahommed (Mahommed the Greek); and on May 29, 1632, by a successful personal appeal to the loyalty of the janissaries, Murad crushed the rebels, whom he surrounded in the Hippodrome. At the age of twenty he found himself possessed of effective autocratic power.

His severity has remained legendary. Death was the penalty for the least offence, and no past services—as Koes Mahommed was to find to his cost—were admitted in extenuation. The use of tobacco, coffee, opium and wine were forbidden on pain of death; eighteen persons are said to have been put to death in a single day for infringing this rule. The tale of his victims is said to have exceeded 100,000.

Murad's great physical strength was maintained by constant physical exercises. He was also fond of hunting, and for this reason usually lived at Adrianople. He broke through the alleged tradition, bequeathed by Suleiman the Magnificent to his successors, that the sultan should not command the troops in person, and took command in the Persian war which led to the capture of Baghdad (1638) and the conclusion of an honourable peace (May 7, 1639). Early in 1640 he died, barely twenty-nine years of age. The cause of his death was acute gout brought on by excessive drinking. In spite of his drunkenness, however, Murad was a bigoted Sunni, and the main cause of his campaign against Persia was his desire to extirpate the Shia heresy. He amused his entourage by feats of strength, and by verses, some of which were published under the pseudonym of Muradi.

See, for details of the lives of the above, J. von Hammer-Purgstall, *Geschichte des osmanischen Reiches* (Pest, 1840), where further authorities are cited.

MURAD V. (1840–1904), Ottoman sultan, eldest son of Sultan Abd-ul-Mejid, was born on Sept. 21, 1840. On the accession of his uncle Abd-ul-Aziz, Prince Mahommed Murad Effendi—as he was then called—was deprived of all share in public affairs and imprisoned, owing to his opposition to the sultan's plan for altering the order of succession. On the deposition of Abd-ul-Aziz on May 30, 1876, Murad was haled from his prison by a mob of softas and soldiers of the "Young Turkey" party under Suleiman Pasha, and proclaimed "emperor by the grace of God and the will of the people."

Three months later, his health, undermined by his long confinement, gave way; and on Aug. 31, he was deposed to make room for his younger brother, Abd-ul-Hamid II. Confined in the Cheragan palace, he died on Aug. 29, 1904.

See Kératry, *Mourad V., prince, sultan, prisonnier d'état 1840–1876* (Paris, 1878); Djemaleddin Bey, *Sultan Murad V., the Turkish Dynasty Mystery, 1876–1895* (London, 1895).

MURAENA, name of an eel common in the Mediterranean, and sometimes applied to the whole genus. Some 90 species are known from tropical and sub-tropical seas, especially in rocky parts or on coral reefs. The skin is scaleless and smooth, in many species ornamented with varied and bright colours, so that they are frequently mistaken for snakes. The mouth is wide, the jaws strong and armed with formidable teeth, which enable the *Muraena* not only to seize its prey (which chiefly consists of other fishes) but also to inflict serious wounds on its enemies, including man.

Some of the tropical *Muraenas* exceed a length of 10ft., but most of the species attain to only half that length. *M. helena* of the Mediterranean was a great delicacy of the ancient Romans. Some are said to have thrown slaves into their fish-ponds to feed the *Muraenas*. This form ranges through the Indian Ocean and reaches Australia.

MURAL CROWN, in heraldry (*q.v.*), a crown taking the form of an embattled tower given to the man who first set up his standard in a captured city.

MURAL PAINTING concerns that branch of art which has for its object the covering or "dressing" of a building so that its purpose may be "sweetened" or intensified by the decoration. This decoration, therefore, must be considered from two points of view: fitness and adornment. Fitness prescribes the nature; adornment the aesthetic design of such paintings. Most buildings are structures composed, roughly speaking, of two elements: the space-bearing and the space-enclosing. The tentpole and the four posts, or columns, with their transverse beams, are the space-bearing parts of architecture; the walls, whether of canvas, like a tent's, of wood, lath and plaster, brick or stone, are the space-enclosing but not necessarily structural elements; nor are the roofing and the ceiling necessarily structural. The decorations of architecture, therefore, naturally fall into two categories —those which are applied to the structural parts and those which cover the enclosing parts. In good architecture, at all events, these differences are discernible so that one may say that the structural elements are decorated with ornament whilst the enclosing or mural parts are covered with some kind of "dressing," of which mural painting is, aesthetically, the most important, but to which must also be reckoned panelling, mosaic, tapestry, painted patterning and papering, and even stained glass, which after all is only a translucent wall.

Egypt.—Such painted architectural decoration appears to have found its earliest and certainly its most vital expression in Egypt. The Egyptians were, like all primitive races, symbolizers. The fitness of any given design would therefore be decided not merely by its natural derivation and consequent position, but also by its symbolic significance. They were thus the most logical mural decorators imaginable, for their ornament had its origin in nature, its position from its original place and its meaning from its associations with their religious belief. This also is true of the pictorial decoration of their walls. Aesthetic considerations were here as little dominant as in their ornament. Every discovery of Egyptian art points to the fact that they had very logical but also very simple notions of aesthetic composition, which was founded upon symmetry. This symmetry is an expression of the *natural* instinct for aesthetic order before it has become aware of more subtle modes of achieving balance.

Magnificent imitators of natural form as they were—at all events, at some periods of their six or seven thousand years of history—they never in their mural painting, as distinct from their sculpture, sacrificed clarity of meaning to beauty or truth of expression. Hence their custom of representing the human figure partly *en face*, partly in profile, so that one might see both legs and feet, both shoulders, arms and hands. To think of Egyptian mural decoration as an expression of aesthetic pleasure would therefore be manifestly wrong; what aesthetic pleasure might be derived was, if not an unconscious result, at all events no more than a means to an end. Indeed, Egyptian art appears to have been the source of all that kind of art which became eventually not

only conscious but self-conscious and, so to speak, self-sufficient.

What is true of Egyptian art is true to a great extent also of that of the neighbouring civilization of Mesopotamia comprising the Babylonian, or Chaldaean, the Assyrian and the Persian empires, and covering a period from 4000 to 333 B.C.

Greece.—The Greeks painted the structural features of their temples and even coloured their sculpture, but we know little about their painting except from their literature. This may be because it was not truly mural, but hung on the walls in wooden frames. Moreover, from their habit of personifying time, place and event, and the addition in script of the names of the persons represented, which we notice on their vases, we may judge that their method of composition was not aesthetic but ideological. The Parthenon shows a curious contradiction in aesthetic notions; for, whilst the tympana or gable-fields are decorated with figures that are roughly symmetrical in arrangement and follow the triangular shape of the architecture, they have no organic rhythm, they do not belong together. On the other hand, the sculptured frieze, with its rhythmical procession of horsemen, is the most magnificent decoration of that part of architecture imaginable, precisely because it has the two fundamentals, continuity and variety.

Rome.—Roman pictorial art, like sculpture, followed the Greek, but in mural decoration the Romans have invented a style peculiar to themselves. They are the inventors or, at all events, the exploiters of that form of painted ornamentation known as "grotesque," which had originally not the connotation of the bizarre with which it is invested now, but only indicated a stylized and decorative composition of human, animal and plant forms—especially used for the filling of long and narrow spaces such as that of pilasters. Typical of their domestic interior decoration is that found in Pompeii; it was mural painting in the fullest meaning of the word. The walls were made to resemble feigned architectural "scenes"; the wall, itself usually coloured (Pompeian) red, sometimes yellow or, more rarely, blue or green, was divided horizontally in three parts by means of a narrow frieze and dado, and, at intervals, vertically with devices of feigned architectural "prospects." The centres of the main fields of the walls were embellished either by a mural subject picture or by small isolated figures appearing as it were to be floating in space; the dado, often representing a niche or architectural recess, also contained little compositions of landscape or still life, whilst the frieze and margins of the wall might have fanciful embellishments of "grotesques," festoons or abstract pattern. The impression of Pompeian decoration is, with its incidents of gambolling "putti," doves and quaint attempts at *trompe-l'oeil,* is light and playful and reminds one in spirit at least of the decorations of the 18th century in France, the "Rococo." As regards the more ambitious subject paintings which formed part of the walls—such as the celebrated Aldobrandini-Wedding, now in the Vatican, dating from the 1st century A.D., which was discovered in 1606 and then created a sensation—it is clear that they are infinitely more modern in feeling than the art of the middle ages and the paintings before Raphael's time; but they are less "decorative," not only than mediaeval art but also than the paintings of Egypt, Crete or Assyria.

A more vital form of decoration which the Romans received by way of the Greeks from Asia and Egypt is mosaic. The well-known "Battle of Alexander" from the "House of the Faun" in Pompeii gives one some idea of the technical skill with which the mosaicist was able to translate into mosaic a picture designed originally in another medium; the original of this subject is supposed to have been a Greek painting. Mosaic, indeed—apart from its use as a floor covering—took the place of mural painting in Byzantine times.

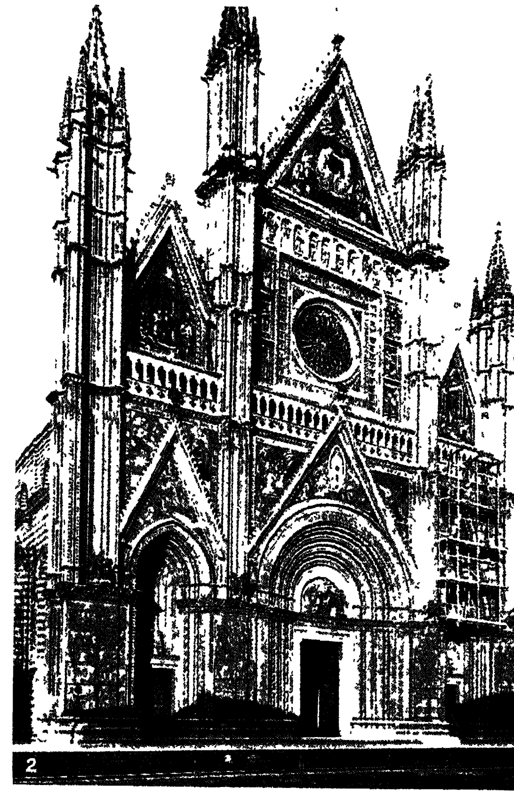
The Near East.—A fresh development in mural painting took place when Islam came upon the scene and spread from Arabia east and west so far as India and Spain. The Arabs and the Jews kept alive the scientific and abstract philosophic culture of the Greeks which Christianity destroyed. They were the scientists, mathematicians and geometricians of their era; furthermore their religion forbade them the representation of natural forms. Out of these two conditions sprang the logical, intricate yet marvellously beautiful and consistent style of their decoration. Its beauty was formal and abstract; but it is against human nature to create or to be satisfied with pure aesthetics, that is to say, beauty without associative significance. They therefore extracted from their science the ingenious geometrical forms which characterize their ornament, whilst their picturesque script took the place of pictorial representation and so invested the decoration with meaning. The gold script on blue ground, the primary colours used to embellish the geometrical ornament, carved on stucco in relief, and their very original "stalactite" ceilings combined to give their mural decoration an effect of clear-cut yet romantic splendour not surpassed by any other style. The best-known specimen of Saracenic decoration is the Alhambra at Granada, dating from the middle of the 13th century, but magnificent earlier examples are in the mosques of Jerusalem, Damascus and Cairo. In the use of script, the Saracenic decorators were, perhaps, only rivalled in ingenuity by the Mayas of Central America who evolved a decorative effect with literary meaning from the square which appears to have been the unit, not only of their ideograms but of their architecture in general.

The Renaissance.—Mural painting fell into disuse as the highest form of mural decoration when mosaic took its place: but it may, perhaps, be doubted whether until the Renaissance it had ever taken the foremost place in decoration—sculpture being probably regarded as superior. When next we meet with the remains of wall paintings, during the 10th to 14th centuries—virtually the "Gothic" era—they are inferior in decorative value to that most wonderful of all decorative devices, stained glass (*q.v.*) and even to tapestry. (*See* TAPESTRY.) The painted chamber is, at all events, always one of less importance in a palace than the rooms decorated with arras and tapestry—an art which incidentally the Christian world owes to the preservative energy of the Saracens.

Mural painting owes its eminence as a fine art—that is to say, as distinct from pure decoration—to a movement towards a return from Byzantine formalism to nature. This movement in so far as it was religious is associated with St. Francis and in so far as it was artistic with Giotto. Giotto was a realist—his aims were naturalistic, *i.e.,* directed towards discovering means of greater verisimilitude. This is perhaps best proved by comparison of the paintings of the later upper chapel in Assisi with those of the earlier lower chapel. The latter obey the architecture to a far greater degree and have in consequence a much more decorative effect than those in the upper chapel which are mainly a series of story pictures. In Masaccio's paintings, Byzantine formalism is overcome; the *mise en scène* is more natural, but also the decorative value is not so pronounced.

In Fra Angelico's art we have a reaction; no progress is made in naturalism, but a truer sense of decorative values, within the area of each picture, is discernible. In the art of his pupil, Benozzo Gozzoli, however, we find a strongly pronounced decorative sense best seen in the so-called "Journey of the Magi" in the Riccardo palace in Florence. This is in the main due to Gozzoli's concentration upon forms and colours as such; they are to him all of equal interest whether they happen to belong to men or dogs, to trees or rocks—they are all considered in relation to the scheme as a whole. In spirit, therefore, if not in form, they are akin to the Flemish tapestries which reached their best period at about the same time, the latter part of the 15th century.

It is no exaggeration to say that decorative painting was, as a conscious aesthetic effect, misinterpreted by the great painters of the Renaissance. The interest in natural form, the discovery of Greek sculpture, and the very fact that the painters educated themselves from these sculptural models account for the fact that the solid qualities of the figure, the suggestion of the third dimension, became the preoccupation of these masters, who aimed at realism and, it may be added, were expected to do so. In Correggio's agreement for the frescoes in the Parma cathedral, dated Nov. 3, 1522, it was expressly stipulated: "That he shall engage to paint the choir, the arcades and arches with their mouldings and all the wall space in the chapel decorating these with given subjects which shall either be imitations of life or

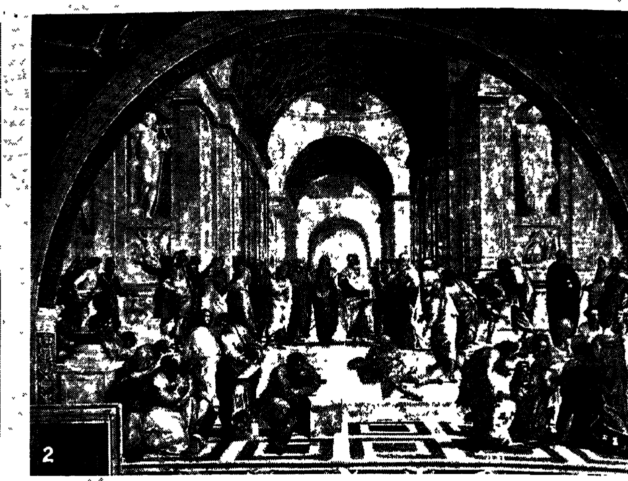


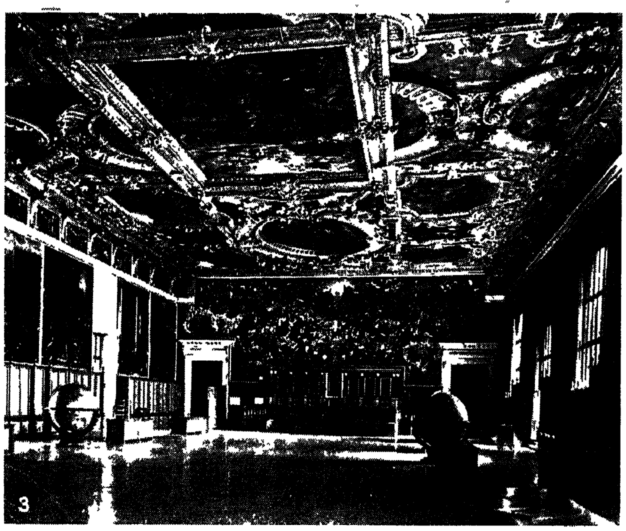
BY COURTESY OF (4) THE NATIONAL GALLERY, LONDON, PHOTOGRAPHS (1, 6) ANDERSON, (2) BURTON HOLMES FROM EWING GALLOWAY, (3) PUBLISHERS PHOTO SERVICE, (5) ALINARI

MOSAICS AND FRESCOES

1. Interior of the Lower Church of St. Francis, at Assisi, Italy. Frescoes (*c.* 1300) in the vaulting above the high altar, representing the Mystic Marriage of St. Francis with Holy Poverty, Chastity, Obedience, and St. Francis in glory, are ascribed to Giotto or to one of his pupils
2. Façade of Orvieto Cathedral (begun in 1310), showing the use of mosaics for exterior wall decoration
3. Interior of the Basilica of St. Paul's Outside the Walls, Rome, founded in 386. The space above the triumphal arch is filled with a mosaic decoration executed under Galla Placidia; portraits in mosaic of all the popes from St. Peter to Benedict XV. form a frieze around the nave walls below the clerestorey windows
4. "The Rout of San Romano," one of a group of three frescoes painted by Paolo Uccello (15th century) for decoration of the Palazzo Medici, Florence. Now in the National Gallery, London
5. Interior of the Sistine Chapel of the Vatican, showing above the altar "The Last Judgment," by Michelangelo (1475–1564). The ceiling also is entirely covered with frescoes by Michelangelo, arranged in a symmetrical architectural grouping. The frescoes on the side walls are by Botticelli, Ghirlandaio, Perugino, Pinturicchio and other painters of the Renaissance
6. "The Crucifixion," by Tintoretto (Jacopo Robusti, 1518–94), in the Scuola di San Rocco, Venice

MURAL PAINTING





BY COURTESY OF (5) THE METROPOLITAN MUSEUM OF ART, NEW YORK; PHOTOGRAPHS (1, 3, 4) PUBLISHERS PHOTO SERVICE, (2) ANDERSON

MURAL PAINTINGS AND TAPESTRIES

1. "The Last Supper," by Andrea del Sarto (1519), Florentine, on the wall of the refectory in the Abbazia di San Salvi, near Rovezzano, Tuscany
2. "The School of Athens," by Raphael (Raffaello Sanzio, 1483–1520), in the Stanza della Signatura, the Vatican. The scene represents the triumph of Philosophy with Plato and Aristotle as the centre of a gathering of philosophers and scholars of all the ages
3. Sala del Maggior Consiglio, Doges Palace, Venice. The walls are decorated with large canvases by the brothers Tintoretto, and other 16th century painters. On the entrance wall is "Paradise," by Jacopo and Domenico Tintoretto. It is 72 by 22 ft., and is said to be the largest oil painting in the world
4. Gobelin tapestries used as wall decoration in the Palace of Versailles, France. In the 17th century such tapestries replaced mural paintings, but were designed in the manner of paintings, with borders imitating the carved and gilt frames of the period
5. Sketch for a ceiling painting by Tiepolo (1727–1804), Venetian

of bronze or marble, according as the place may demand. . . ."

It is for such reasons that all the famous masters of the Renaissance as, for example, Piero della Francesca, with his decorations in S. Francesco, Arezzo, Signorelli in the cathedral of Orvieto, Pinturicchio in the Appartamenti Borgia in the Vatican, Raphael in the Stanze there, Michelangelo in the Sistine chapel, must all be appreciated as painters, as creative artists, but not decorators pure and simple. Their object was to create an illusion of space which should destroy the architecture, not preserve it. This architecture-destroying aim is visible also in the work of one of their best masters, Correggio, though his earlier work, the decoration of the convent of S. Paolo in Parma, shows, especially in the ceiling of the dome, a better compromise, since by means of a trellis work of vine leaves from which are hung branches of fruit he preserves the structure of the architecture. If illusion-creating and architecture-destroying qualities are to be regarded as characteristic of mural decoration then Raphael, Michelangelo, Correggio, Tintoretto were great decorators and Tiepolo the last and perhaps greatest of them all.

How confused the ideas in this respect were may be judged from the fact that when in the 17th century tapestries (Gobelins) once more replaced mural paintings they were designed in imitation of oil paintings and bordered not by "verdures"—the flowered pattern of the earlier tapestries—but by imitations of the carved and gilt frames of the time.

The 18th Century.—What is probably the best period in European decoration is the French of the 18th century, in which a perfect consistency ran through every part of interior architecture and every piece of furniture, down to the smallest article—such as a snuffbox. Although painting was widely used for the decoration of almost every conceivable object, it is significant that wall paintings fell into comparative disfavour, mirrors being preferred as wall decorations. Boucher, however, is typical of such painted decoration as there was in France. It is also to be noted that serious easel picture painting had almost ceased; Chardin, the only serious painter of the age, was soon "despised and rejected." This attitude is also characteristic of the only complete English style of decoration, that of the brothers Adam. The great English portrait painters certainly furnished the walls with their portraits, but the decorative picture was hung over the mantelpiece and doors—often not even properly filling the space of the panel—or let into medallions in the ceiling where it soon blackened and became unsightly. Mention must, however, be made of the hand painted wallpaper, done in imitation of Chinese models, or even imported from China.

The 19th Century.—As a result of the industrial and political revolutions, decoration, and with it mural painting, disappeared as a natural expression of culture from civilization. Where there is not one dominating spirit such as that of the tribe, the village community, the church, the prince, the aristocracy, there the soil out of which the life of decoration grows becomes sterile and has to be artificially fed. This happened in European civilization during the 19th century. There was no class which demanded mural painting as an expression of its social significance, however laudably, if wrongly, artists like Haydon tried to press its need. Commercial manufacture took the place of the hand; the craft of decoration slipped into the offices of commercial contractors who employed "hands," no longer craftsmen with a tradition behind them.

Individual efforts at the resuscitation of mural decoration were made by German artists, notably Peter von Cornelius (1783–1867) who painted the Casa Bartholdy in Rome in 1811 and many others in Munich and Berlin, and his pupil Wilhelm von Kaulbach (1805–74), whose decorations in the Neues museum, painted in a kind of fresco, are his chefs-d'oeuvre.

Under German influence Lord Leighton painted his two lunettes in the Victoria and Albert museum, London, of which one, "the Arts of War," is a really admirable example of true mural painting, both in design and technique. Ford Madox Brown deserves mention in this connection on account of his wall paintings in the Manchester town hall, though they are more successful as story-telling pictures than as decoration.

To William Morris is mainly due the revival of the interest in interior decoration which has spread throughout the world, but, in his scheme, mural painting as such was not understood, he having rather Gothic stained glass, tapestries and textiles in mind for the purpose, and employing Burne-Jones to design the former. During this time Puvis de Chavannes made a noble attempt to create a new logic of mural painting which would exclude any tricks of illusion, but would preserve the sense of the wall. To that end he simplified his drawing, distributed his points of interest by the arrangement of his figures and bound the composition together by a landscape setting which fulfilled its function as a foil and background without "making a hole in the wall." The principal means by which he achieved the desired flatness was the restriction of his palette to a scheme of grey-blues and grey greens. One of his ablest successors is Maurice Denis who, acting on similar principles of simplification, added nevertheless more gaiety—rose pinks—to his palette.

Two great American painters, John Singer Sargent and Edwin Abbey, tried their hand also at mural painting, but the former was too much of a nature imitator, the latter too much of an illustrator to solve the problems satisfactorily. So with Albert Besnard of France.

Modern Decoration.—Modern conditions have prevented the traditional development of a true style in decoration.

All that such a decorator can hope to achieve in the circumstances is the creation of an aesthetic unity within such limits as the purpose of the building and the architectural setting of the space he is to cover with a painting will permit.

Fresco painting and its various methods, "in which carbonate of lime is formed and encloses the colours applied to the wet wall" (*see* Hamilton Jacks on *Mural Painting*), are laborious and unsuitable for damp climates. A more convenient medium is distemper or tempera painting, in which the colours are bound by egg, size or gum.

Yet another is the wax medium, not the old encaustic process, but one recently invented: it has the advantage of being as easily handled as oil colours and of producing a pleasing surface which is not so dull or "mat" as fresco nor so shiny as ordinary oil painting. There is, however, also a method of using oil as a vehicle without producing a shiny surface.

Whatever medium be employed, the principal thing is that the design should be conceived in the spirit of the architecture which the mural painting is to decorate, and by the term decorating is here meant not only an adornment envisaged but, for less ambitious schemes, a feeling of physical and mental comfort.

The next consideration is that the design as such should form a connected whole, so that the eye, passing from one wall to the next, should travel by pleasant successive stages. This means that if there are several paintings there must be a uniform scale to link them together, a uniformity that is not only in the scale of the design but also its colours. It may be better to paint, for example, a historical personage who is known to have worn a red cloak on that occasion in a grey one if grey will fit better into the general scheme, or to paint the trees blue or brown rather than green if that produces a better harmony. In short, a mural painting should be treated as if it were a page in a book of poetry and not as a chapter in a tome of history.

Having thus determined the general scheme and the details of composition, the artist makes a series of sketches trying out various ideas and possibilities of composition and ultimately deciding on those which best seem to fulfil the conditions imposed. He next makes the many necessary studies from life and ultimately draws, from memory rather than from the models, the cartoon, that is to say, the outlines of the design in the actual size of the painting. He then transfers the cartoon by tracing to the wall, or to the canvas, which latter should be fixed to the wall by "marouflage"—a kind of glue partly formed of the remains of brush washings. The wall or canvas is now ready for painting.

As a matter of aesthetic effect, it is well to remember that colours have a different carrying power, so that those parts of the wall which are in shade must be treated differently from those

which are in light, and the colours in any case so orchestrated that they, as it were, hold each other in the same plane; otherwise the painting will look restless or patchy like a faded Gobelin.

It is further necessary to distribute the interest of the design over the whole surface, otherwise the effect of decoration will be lost, and, in the most favourable circumstances, a purely pictorial interest result; for whilst easel pictures are a form of art in which concentration of interest within the frame is permissible and even desirable, mural paintings should have their interest so distributed that they fulfil their function, which is to decorate the larger architectural unit, like a pattern. For this reason, too, the decorator or his patrons should consider whether the architecture is of a kind that calls for mural paintings and would not perhaps be better served by ornamentation with colour of the architectural parts bearing the wallspaces to be covered with abstract pattern. The ceiling offers particular difficulties. If it must be painted otherwise than with simple colour or architectural ornament at all, it is best to treat it as lightly as possible so as not to give its representations of nature the appearance of physical weight, and moreover to see to it that its main design links up architecturally everywhere with the walls so as to give the figures or other features a visible means of support—as Correggio did in the S. Paolo or Tiepolo in the Escorial ceilings. The mural painter's task is now the more difficult as he has the distracting experience of many styles of different ages and climes before his eyes or in his mind. The tendency in England is towards a thin early Italian drawing and colouring, whilst on the Continent everywhere extravagance, either in subject or in treatment, down to perfect abstraction is in vogue. Every form of design is justifiable, provided it keeps within the spirit of the environing architecture and the purpose of the building. "Jazz" pattern in a church would be as unsuitable as "church" pattern in ball-, bath- or bed-room. (F. Bn.)

Bibliography.—*See* the art section of bibliographies to articles on various countries, also those on individual masters, and Greek Art, Roman Art, Fresco, etc., and works on the general history of art, such as A. Venturi, *Storia dell' Arte Italiana* (15 vols., Milan, 1901–28). M. Jourdain, *English Interiors in Smaller Houses, 1660–1830* (1923), may be consulted. *See* also F. Hamilton Jackson, *Mural Painting* (1904); G. Ronchetti, *Pittura Murale* (1911); C. J. Wall, *Mediaeval Wall Paintings* (1914).

MURANO, an island in the Venetian lagoon about 1 m. N. of Venice. Pop. (1921) 5,131—in the 16th century about 30,000. It was a favourite resort of the Venetian nobility before they began to build their villas on the mainland; and in the 15th and 16th centuries its gardens were famous.

The town is built upon one broad main canal, where the tidal current runs with great force, and upon several smaller ones. The cathedral, SS. Maria e Donato, is a fine basilica, of the 9th–12th century. The pavement (of 1111) is richly inlaid, and the mosaics of the tribune are remarkable. The beautiful exterior of the tribune has been well restored. The church of St. Peter the Martyr contains a fine picture by Gentile Bellini and other works. Murano has from ancient times been celebrated for its glass manufactories. (*See* Glass.)

The island of Murano was first peopled by the inhabitants of Altinum. It originally enjoyed independence under the rule of its tribunes and judges, and was one of the 12 confederate islands of the lagoons. In the 12th century the doge, Vital Micheli II., incorporated Murano in Venice and attached it to the Sestiere of S. Croce, placing it under a Venetian podestà.

MURAT, JOACHIM (1767–1815), king of Naples, younger son of an innkeeper at La Bastide-Fortunière (Lot), was born on March 25, 1767. He studied canon law at Toulouse, but enlisted in a cavalry regiment, from which he was dismissed in 1790 for insubordination. Through the good offices of J. B. Cavaignac, he was enrolled in the New Constitutional Guard of Louis XVI.

In 1795 he met Napoleon Bonaparte, whom he assisted on the 13th Vendémiaire, and to whom he acted as first aide-de-camp in Italy. He distinguished himself in the campaign of 1796 and '97, became commandant at Rome in 1798 and in the same year accompanied Bonaparte to Egypt. At the battle of the Pyramids he led his first famous cavalry charge, and for his exploits in Syria was made general of division (Oct. 1799). Returning to France with Bonaparte, he led into the orangery of Saint Cloud the 60 grenadiers whose appearance broke up the Council of Five Hundred (18th Brumaire), and for his success was made commandant of the consular guard. On Jan. 20, 1800, he married Caroline Bonaparte, youngest sister of the first consul. He commanded the French cavalry at the battle of Marengo, was made governor of the Cisalpine Republic, and in 1801, he forced the Neapolitans to evacuate the Papal States and to accept the Treaty of Florence. As governor of Paris (1804) he appointed the commission by which the duc d'Enghien was tried and shot; in May he was made marshal of the empire; in Feb. 1805 he was made grand admiral, with the title of prince, and invested with the grand eagle of the Legion of Honour. For his prowess as commander of the Grand Army in the German campaign of 1805, Napoleon made him grand duke of Berg and Cleves (March 15, 1806). He subsequently commanded the cavalry at Jena, Eylau and Friedland, and in 1808 was made general-in-chief of the French armies in Spain. Though disappointed of the throne of Spain, he was made king of Naples on Aug. 1, in succession to Joseph Bonaparte.

King Joachim Napoleon, as he styled himself, entered Naples in September, and soon after wrested Capri from the British. At Naples he set up a sumptuous court, created a new nobility, nominated marshals, swept away the last relics of the effete feudal system, and effectively suppressed brigandage. From the first his relations with Napoleon were strained. The emperor upbraided him sarcastically for his "monkey tricks" (*singeries*); Murat ascribed to the deliberate ill-will of the French generals who served with him, and even to Napoleon, the failure of his attack on Sicily in 1810. A breach was averted by Napoleon's invitation to Murat to command the cavalry of the Grand Army in the Russian Campaign of 1812; but although Murat displayed his usual intrepidity in the disastrous retreat, his suspicions of Napoleon, and his wife, Caroline, led him to throw up his command and return to Naples in December. The battle of Leipzig found him again at Napoleon's side, but on Oct. 16, Metternich opened a separate negotiation with him, and feeling that on his acceptance of Austrian advances depended his chance of continuing a king, Murat agreed to withdraw his support from Napoleon if his throne were guaranteed by England and Austria. Having obtained the emperor's leave to return to Naples, he entered that city on Nov. 4, and immediately made overtures to the allies through the Austrian envoy. On Jan. 11, 1814, a treaty was signed by which Austria guaranteed to Murat the throne of Naples, and promised her good offices to secure the assent of the other Allies. Secret articles further stipulated that Austria would endeavour to secure the renunciation by Ferdinand of his rights to Naples, in return for an indemnity to hasten the conclusion of peace between Naples and Great Britain, and to augment the Neapolitan kingdom at the expense of the States of the Church.

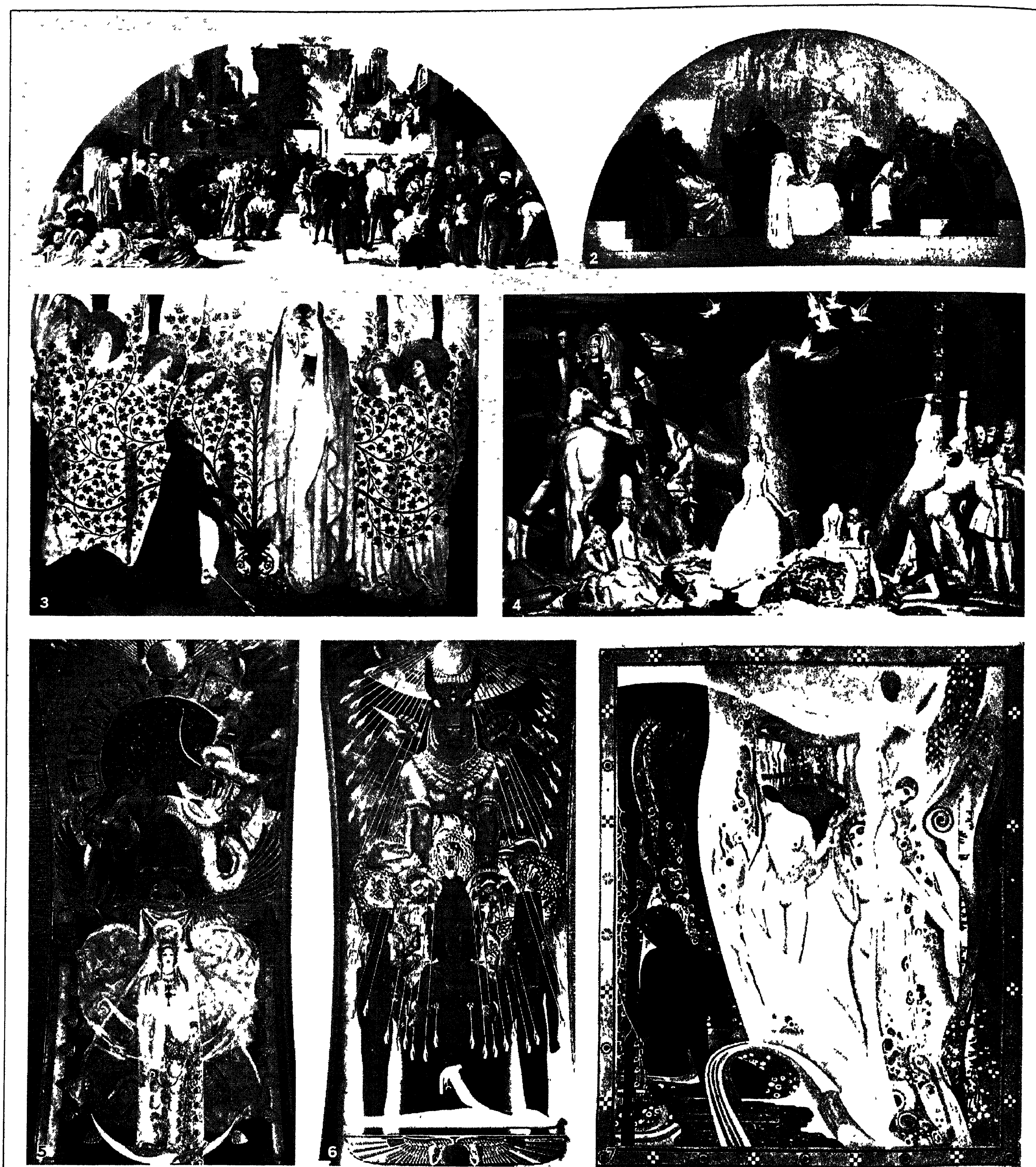
Meanwhile Murat had formally broken with Napoleon and on Jan. 16, the French envoy left Naples. But he now became the cat's-paw of the Allies, who, with the exception of Austria, refused to recognize his title. At the opening of the Congress of Vienna, Talleyrand affected not to know "the man" who was referred to as "the King of Naples," and his attitude was representative of the other congressistes who wished for the restoration of the Bourbons. The tortuous diplomatic proceedings which ensued roused Murat's suspicions, and, breaking with Austria as he had formerly broken with Napoleon, he determined to secure his throne by proclaiming the cause of united Italy. Already popular with the Neapolitans, his chances of success were enhanced by the escape from Elba of Napoleon, with whom he had been corresponding, but as soon as he mobilized his troops, the Allies commissioned Austria to deal with him. Ferdinand IV. was to be restored to Naples, on promising a general amnesty and giving guarantees for a "reasonable" system of government. Meanwhile Murat's popularity in Naples had waned, and his troops were routed at Tolentino on May 2; Austrians advanced on Naples, Ferdinand IV. was restored, while Queen Caroline and her children

BY COURTESY OF (3) THE NATIONAL GALLERY, LONDON, (2) THE TOWN HALL COMMITTEE OF THE MANCHESTER CORPORAT ON, PHOTOGRAPH, (1) GIRAUDON

MODERN ENGLISH AND FRENCH WALL DECCRATIONS

1. Mural decorations by Puvis de Chavannes (1824–98), French, on the walls of the Sorbonne, Paris
2. "The Romans Building," a wall decoration by Ford Madox Brown (1821–93), English. In the Manchester town hall
3. "Faa Iheihe" by Paul Gauguin (1848–1903), French, one of the pioneers of the Post-Impressionist movement. This decoration, a Tahiti subject in Gauguin's later style, is now in the National Gallery, Millbank

MURAL PAINTING



BY COURTESY OF (1) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM, (5, 6) THE BOSTON PUBLIC LIBRARY EMPLOYEE BENEFIT ASSOCIATION, PHOTOGRAPHS, (2) MONGER AND MARCHANT, (3) EDWIN A. ABBEY FROM A COPLEY PRINT (COPR. CURTIS AND CAMERON)

EXAMPLES OF MODERN MURAL PAINTING BY ENGLISH, FRENCH AND AMERICAN ARTISTS

1. "The Arts of War," one of two lunettes by Lord Leighton (Frederick Leighton, 1830–96). In the Victoria and Albert Museum
2. "Moses and the Tablets of the Law" by Gerald Moira, English, contemporary. In the Central Criminal Court, London
3. "The Golden Tree and the Achievement of the Grail" by Edwin Austin Abbey (1852–1911). The last panel of the series of the Holy Grail, a frieze decoration in the Boston Public Library
4. "Sylvie" by Jean Dupas, French, contemporary. In the salon of the S.S. "Ile de France"
5. "Astarte" by John Singer Sargent (1856–1925), American. One of the panels of the series The Pageant of Religion in the Boston Public Library
6. "Moloch" by John Singer Sargent. Another panel of the same series in the Boston Public Library
7. "L'Après-midi d'un Faune" by Louise Janin, American, contemporary

were deported to Trieste.

Murat himself escaped to France, where his offer of service was contemptuously refused by Napoleon. He hid for a while near Toulon, with a price upon his head, then, after Waterloo, refusing an asylum in England, he sailed for Corsica, where he was joined by a few rash spirits who urged him to attempt to recover his kingdom. Refusing Metternich's offer to allow him to join his wife at Trieste and to secure him a position and a pension, Murat sailed for Calabria on Sept. 28, with a flotilla of six vessels and about 250 men. Four of his ships were scattered by storm, one deserted him, and on Oct. 8, he landed at Pizzo with only 30 men. Captured almost immediately, he was imprisoned at Pizzo, and on Oct. 13 was court-martialled and shot.

He was the most dashing cavalry leader of the age. Rash, hot-tempered and brave, he was adored by the troops, who followed him against the most terrible odds. Napoleon lived to regret his refusal to accept his services during the Hundred Days, declaring that Murat's presence at Waterloo would have inspired the cavalry charges and might have changed defeat into victory.

By his wife Maria Annunciata Carolina, Murat had two sons. The elder, Napoleon Achille Murat (1801–1847), during his father's reign prince royal of the Two Sicilies, emigrated about 1821 to America, and settled near Tallahassee, Florida, where in 1826–1838 he was postmaster. In 1826 he married a great-niece of Washington. He published *Lettres d'un citoyen des États-Unis à un de ses amis d'Europe* (Paris, 1830); *Esquisse morale et politique des États-Unis* (*ibid.*, 1832); and *Exposition des principes du gouvernement républicain tel qu'il a été perfectionné en Amérique* (*ibid.*, 1833). He died in Florida, on April 15, 1847.

The second son, Napoleon Lucien Charles Murat (1803–1878), created prince of Ponte Corvo in 1813, lived with his mother in Austria after 1815, and in 1824 started to join his brother in America, but was shipwrecked on the coast of Spain and held for a while a prisoner. Arriving in 1825, two years later he married in Baltimore a rich American, Georgina Frazer (d. 1879); but her fortune was lost, and for some years his wife supported herself and him by keeping a girls' school. After several abortive attempts to return to France, the revolution of 1848 at last gave him his opportunity. He was elected a member of the Constituent Assembly and of the Legislative Assembly (1849), was minister plenipotentiary at Turin from October 1849 to March 1850, and after the *coup d'état* of Dec. 2, 1851, was made a member of the consultative commission. On the proclamation of the empire, he was recognized by Napoleon III. as a prince of the blood royal, with the title of Prince Murat. He died on April 10, 1878, leaving three sons and two daughters, (1) Joachim, Prince Murat (1834–1901) in 1854 married Maley Berthier, daughter of the Prince de Wagram, who bore him a son Joachim (b. 1856) who succeeded him as head of the family, and two daughters, of whom the younger, Anna (b. 1863), became the wife of the Austrian minister Count Goluchowski. (2) Achille (1847–1895) married Princess Dadian of Mingrelia. (3) Louis (b. 1851), married in 1873 to the widowed Princess Eudoxia Orbeliani (*née* Somov), was for a time orderly officer to Charles XV. of Sweden. (4) Caroline (b. 1832) married in 1850 Baron Charles de Chassiron and in 1872 John Garden (d. 1885). (5) Anna (b. 1841), married in 1865 Antoine de Noailles, duc de Mouchy.

Bibliography.—*See* A. Sorel, *L'Europe et la révolution française* (8 vols., 1885–92) *passim*, but especially vol. viii. for Murat's policy after 1812; Helfert, *Joachim Murat. seine letzten Kämpfe und sein Ende* (Vienna, 1878); G. Romano, *Ricordi muratiani* (Pavia, 1890); *Correspondance de Joachim Murat*, Juillet 1791–Juillet 1808, ed. A. Lumbroso (Milan, 1899); Count Murat, *Murat, lieutenant de l'empereur en Espagne* (1897); Guardione, *Gioacchino Murat in Italia* (Palermo, 1899); M. H. Weil, *Prince Eugène et Murat* (5 vols., 1901–04); Chavenon and Saint-Yves, *Joachim Murat* (1905); Lumbroso, *L'Agonia di un regno; Gioacchino Murat al Pizzo* (Milan, 1904). *See* also the bibliography to Napoleon I.

MURATORI, LUDOVICO ANTONIO (1672–1750), Italian scholar, historian and antiquary, was born of poor parents at Vignola in the duchy of Modena on Oct. 21, 1672. Having taken minor orders in 1688, Muratori took his doctorate in law before 1694, was ordained priest in 1695, and appointed by Count Carlo Borromeo one of the doctors of the Ambrosian library at Milan. From manuscripts now placed under his charge he made a selection of materials for several volumes (*Anecdota*), which he published with notes. He returned to Modena in 1700, on the invitation of the duke, as keeper of the archives. The preparation of numerous valuable tracts on the history of Italy during the middle ages, and of dissertations and discussions on obscure points of historical and antiquarian interest, as well as the publication of his various philosophical, theological, legal, poetical and other works absorbed the greater part of his time. These brought him into communication with the most distinguished scholars of Italy, France and Germany. But they also exposed him in his later years to envy. His enemies spread abroad the rumour that the pope, Benedict XIV., had discovered in his writings passages savouring of heresy, even of atheism. Muratori appealed to the pope, and was assured of his protection. Muratori died on Jan. 23, 1750.

Muratori is rightly regarded as the "father of Italian history." This is due to his great collection, *Rerum italicarum scriptores*, to which he devoted about 15 years' work (28 vols., 1723–38). This was followed by a series of 75 dissertations on mediaeval Italy (*Antiquitates italicae medii aevi*, 6 vols., 1738–42). To these he added a *Novus thesaurus inscriptionum* (4 vols., 1739–43), which was of great importance in the development of epigraphy. He then set about a popular treatment of the historical sources he had published. These *Annali d'Italia* (1744–49) reached 12 volumes, but were imperfect and are of little value. In addition to this national enterprise (the *Scriptores* were published by the aid of the Società palatina of Milan) Muratori published *Anecdota ex ambrosianae bibliothecae codd.* (2 vols., Milan, 1697, 1698; Padua, 1713); *Anecdota graeca* (3 vols., Padua, 1709); *Antichita Estens* (2 vols., Modena, 1717); *Vita e rime di F. Petrarca* (1711), and *Vita ed opere di L. Castelvetro* (1727). In biblical scholarship Muratori is famous as the discoverer of the so-called *Muratorian Canon*, the name given to a fragment (85 lines) of early Christian literature, which he found in 1740, embedded in an 8th-century codex which forms a compendium of theological tracts followed by the five early Christian creeds. The document contains a list of the books of the New Testament, a similar list concerning the Old Testament having apparently preceded it. There is little doubt that it was composed in Rome, and we may date it about the year 190. It is the earliest document known which enumerates the books in order. It is interesting to notice the coincidence of the compiler's list with the evidence gained from Tertullian for Africa and from Irenaeus for Gaul and indirectly for Asia Minor.

Muratori's *Letters*, with a *Life* prefixed, were published by Lazzari (2 vols., Venice, 1783). His nephew, F. G. Muratori, also wrote a *Vita del celebre Ludov. Ant. Muratori* (Venice, 1756). *See* also A. G. Spinelli, "Bibliographia delle lettere e stampa di L. A. Muratori," in *Bolletino dell' instituto storico italiano* (1888), and Carducci's preface to the new *Scriptores*. The *Muratorian Canon* is given in full with a translation in H. M. Gwatkin's *Selections from Early Christian Writers*. It is also published as No. 1 of H. Lietzmann's *Kleine Texte für theologische Vorlesungen* (Bonn, 1902). *See* also *Journal of Theological Studies*, viii. 537.

MURAVIEV, MICHAEL NIKOLAIEVICH, Count (1845–1900), Russian statesman, was born on April 19, 1845. He was the son of General Count Nicholas Muraviev (governor of Grodno), and grandson of the Count Michael Muraviev, who became notorious for his drastic measures in stamping out the Polish insurrection of 1863 in the Lithuanian provinces. He was educated at a secondary school at Poltava, and was for a short time at Heidelberg university. In 1864 he entered the chancellery of the minister for foreign affairs at St. Petersburg, and was soon afterwards attached to the Russian legation at Stuttgart. He served in various European capitals, and finally became minister at Copenhagen. In Denmark he was brought much into contact with the imperial family, and on the death of Prince Lobánov in 1897 he was appointed by the Tsar Nicholas II. to be his minister of foreign affairs. As regards Crete, Count Muraviev's policy was vacillating; in China his hands were forced by Germany's action at Kiaochow. But he acted with singular *légèreté* with regard at

all events to his assurances to Great Britain respecting the leases of Port Arthur and Talienwan from China; he told the British ambassador that these would be "open ports," and afterwards essentially modified this pledge. When the Tsar Nicholas inaugurated the Peace Conference at the Hague, Count Muraviev extricated his country from a situation of some embarrassment. When Russian agents in Manchuria and at Peking connived at the agitation which culminated in the Boxer rising of 1900, the relations of the responsible foreign minister with the tsar became strained. Muraviev died suddenly on June 21, 1900.

MURCHISON, SIR RODERICK IMPEY (1792–1871), British geologist, was born at Tarradale, Scotland, on Feb. 19, 1792. Educated at Durham and the military college, Great Marlow, he landed (1808) with Wellesley in Galicia, and was present at the actions of Roriça and Vimiera. Under Sir John Moore he took part in the retreat to Corunna.

In 1818 he sold his paternal property in Ross-shire and settled in England, where he took to field sports. He soon became one of the greatest fox-hunters in the midland counties. Sir Humphry Davy persuaded him to attend lectures at the Royal Institution. He joined the Geological Society of London, and, with the help of W. H. Fitton, prepared his first scientific paper, read to the society in 1825. In three years he had explored large parts of England and Scotland, had obtained materials for three important memoirs, as well as for two more written in conjunction with Sedgwick, and had risen to be a prominent member of the Geological Society and one of its two secretaries. He then explored with Lyell the volcanic region of Auvergne, parts of southern France, northern Italy, Tirol and Switzerland. Later, with Sedgwick as his companion, he attacked the difficult problem of the geological structure of the Alps, and their joint paper giving the results of their study is one of the classics in the literature of Alpine geology.

In 1831, at the suggestion of Buckland, he visited the Welsh border, to discover whether the greywacke rocks underlying the Old Red Sandstone could be grouped into a definite order of succession, as the Secondary rocks of England had been made to tell their story by William Smith. For several years he worked in that region. The result was the establishment of the Silurian system—under which were grouped for the first time a remarkable series of formations, each containing distinctive organic remains older than and very different from those of the other rocks of England. These researches, together with descriptions of the coal-fields and overlying formations in south Wales and the English border counties, were embodied in *The Silurian System* (1839), illustrated with map, sections, pictorial views and plates of fossils. As years passed on the types of existence brought to light by him from the rocks of the border counties of England and Wales were ascertained to belong to a geological period of which there are recognizable traces in almost all parts of the globe. Thus the term "Silurian," derived from the name of the old British tribe Silures, soon passed into the international vocabulary.

The establishment of the Silurian system was followed by that of the Devonian system, an investigation in which, aided by the palaeontological assistance of W. Lonsdale, Sedgwick and Murchison were fellow-labourers, both in the south-west of England and in the Rhineland. Murchison then projected an important geological campaign in Russia. He was accompanied by P. E. P. de Verneuil (1805–73) and Count A. F. M. L. A. von Keyserling (1815–91), in conjunction with whom he produced a magnificent work on *Russia and the Ural Mountains* (1845). In 1846 he was knighted, and in the same year he presided over the meeting of the British Association at Southampton. During the later years of his life a large part of his time was devoted to the affairs of the Royal Geographical Society, of which he was in 1830 one of the founders, and he was president 1843–45, 1851–53, 1856–59 and 1862–71. He was interested in the work of Livingstone. He devoted his last year to the Scottish Highlands, where he believed, erroneously, he had succeeded in showing that the vast masses of crystalline schists, then supposed to be part of what used to be termed the Primitive formations, were really not older than the Silurian period, for that underneath them lay beds of limestone and quartzite containing Lower Silurian (Cambrian) fossils.

In 1855 Murchison was appointed director-general of the geological survey and director of the Royal School of Mines and the Museum of Practical Geology in Jermyn street, London. He prepared successive editions of his work *Siluria* (1854, 5th ed., 1872), which was meant to present the main features of the original *Silurian System* together with a digest of subsequent discoveries, particularly of those which showed the extension of the Silurian classification into other countries. In 1863 he was made a K.C.B., and three years later was raised to the dignity of a baronet. The learned societies of his own country bestowed their highest rewards upon him, and he received many foreign honours.

Murchison founded a chair of geology and mineralogy in the University of Edinburgh. He died on Oct. 22, 1871. Under his will there was established the Murchison medal and geological fund to be awarded annually by the Geological Society.

See Sir A. Geikie, *Life of Sir Roderick I. Murchison* (1875).

MURCIA, a maritime province of south-eastern Spain. Pop. (1920), 638,639; area, 4,453 sq.m. It was the first Spanish possession of the Carthaginians, and the Romans included it in Hispania Tarraconensis. Under the Moors the province was known as Todmír, which included, according to Edrisi, the cities Murcia, Orihuela, Cartagena, Lorca, Mula and Chinchilla. The kingdom of Murcia, which came into independent existence after the fall of Omayyads (*see* CALIPHATE) included the present Albacete as well as Murcia. It became subject to the crown of Castile in the 13th century. Until 1833 the province of Murcia also included Albacete.

The extent of coast is about 75 m. and the mountains reach their highest point (5,150 ft.) on the Sierra de Espuña, between the Mula and Sangonera valleys. They are rich in iron, copper, argentiferous lead, alum, sulphur and saltpetre. Mineral springs occur at Mula, Archena (hot sulphur), and Alhama (hot chalybeate). The climate is hot and dry, and agriculture is largely dependent on irrigation, which, where practicable, has been carried on since the time of the Moors. Wheat, barley, maize, hemp, oil and wine (the latter somewhat rough in quality) are produced; fruit, especially the orange, is abundant along the course of the Segura; mulberries for sericulture are extensively grown around the capital; and the number of bees kept is exceptionally large. Esparto grass is gathered on the sandy tracts. Large quantities of lead and esparto, as well as of zinc, iron and copper ores, and sulphur, are exported. The province is traversed by a railway which connects Murcia with Albacete and Valencia; from Alcantarilla there is a branch to Lorca and Baza. The chief towns are Murcia, the capital, Cartagena, Lorca, La Unión, Mazarrón, Yecla, Jumilla, Águilas, Caravaca, Totana, Cieza, Mula, Moratalla and Cehegín.

MURCIA, the capital of the Spanish province of Murcia; on the river Segura, 25 m. W. of the Mediterranean sea. Pop. (1920), 141,175. Murcia was a town before the Punic Wars, but its name then, and under Roman rule, is not known, though some have tried to identify it with the Roman Vergilia. To the Moors it was known as Medinat Mursiya. After the fall of the caliphate of Cordova it passed successively under the rule of Almería, Toledo and Seville. In 1172 it was taken by the Almohades, and from 1223 to 1243 it became the capital of an independent kingdom. After its recapture by the Christians, Moorish princes continued to rule in name over a mixed population, but in 1269 a rising against the suzerain, Alphonso the Wise, led to the final incorporation of Murcia (which then included the present province of Albacete) into the kingdom of Castile.

Murcia has been an episcopal see since 1291. It is built nearly in the centre of a low-lying fertile plain, known as the *huerta* or garden of Murcia, which includes the valleys of the Segura and its right-hand tributary the Sangonera, and is surrounded by mountains. Despite the proximity of the sea, the climate is subject to great variations, the summer heat being severe, while frosts are common in winter. The streets are broad, straight and planted with avenues of trees, but the Calle de Platería and Calle de la Trapería are lined with old-fashioned balconied houses, and so

narrow that wheeled traffic is not easy. The cathedral, dating from 1388–1467, is in the main late Gothic, but a Renaissance dome and a tower 480 ft. high were added in 1521, while a Corinthian façade was erected in the 18th century. Since 1875 the industrial importance of Murcia has steadily increased. Mulberries (for silkworms), oranges and other fruits are largely cultivated in the *huerta,* and the silk industry, which dates from the period of Moorish rule, is still carried on. Manufactures of woollen, linen and cotton goods, of saltpetre, flour, leather and hats, have been established.

MURDER, in law, the unlawful killing of a person with malice aforethought (*see* HOMICIDE). It is defined by Lord Coke in his *Institutes* as "where a person of sound memory and discretion unlawfully killeth any reasonable creature in being and under the King's Peace. with malice aforethought, either express or implied."

MURDOCK, WILLIAM (1754–1839), British inventor, was born near Auchinleck, Ayrshire, on Aug. 21, 1754. In 1777 he entered the employment of Boulton & Watt in the Soho works at Birmingham, and about two years afterwards he was sent to Cornwall to superintend the fitting of Watt's engines. At Redruth he is said to have carried a series of experiments in the distillation of coal so far that in 1792 he was able to light his cottage and offices with gas. After his return to Birmingham about 1799, he made such progress in the discovery of practical methods for making, storing and purifying gas that in 1802 a portion of the exterior of the Soho factory was lighted with it in celebration of the peace of Amiens, and in the following year it was brought into use for the interior. Murdock was also the inventor of important improvements in the steam-engine. He was the first to devise an oscillating engine, of which he made a model about 1784; in 1786 he was busy—somewhat to the annoyance of both Boulton and Watt—with a steam carriage or road locomotive; and in 1799 he invented the long D slide valve. He is also believed to have been the real deviser of the sun and planet motion patented by Watt in 1781. In addition his ingenuity was directed to the utilization of compressed air, and in 1803 he constructed a steam gun. He retired from business in 1830, and died at Soho on Nov. 15, 1839.

MURE, SIR WILLIAM (1594–1657), Scottish writer, born at Rowallan, Ayrshire, was a member of the Scottish parliament in 1643, and took part in the English campaign of 1644, and was wounded at Marston moor. He wrote *Dido and Aeneas;* a translation (1628) of Boyd of Trochrig's Latin *Hecatombe Christiana; The True Crucifixe for True Catholikes* (1629); a paraphrase of the Psalms; the *Historie and Descent of the House of Rowallane; A Counter-buff to Lysimachus Nicanor; The Cry of Blood and of a Broken Covenant* (1650); besides much miscellaneous verse.

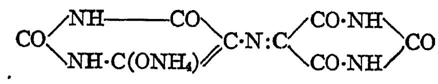
A complete edition of his works was edited by William Tough for the Scottish Text Society (2 vols., 1898). Mure's *Lute-Book,* a musical document of considerable interest, is preserved in the Laing collection of mss. in the library of the University of Edinburgh.

MURETUS, the Latinized name of MARC ANTOINE MURET (1526–1585), French humanist, who was born at Muret near Limoges on April 12, 1526. At the age of eighteen he attracted the notice of the elder Scaliger and soon made his name as a teacher of Latin. Some time before 1552 he delivered a course of lectures in the college of Cardinal Lemoine at Paris, which was largely attended, Henry II. and his queen being among his hearers. His success made him many enemies, and he was thrown into prison on a disgraceful charge, but released by the intervention of powerful friends. After a wandering and insecure life of some years in Italy, he accepted the invitation of the Cardinal Ippolyte d'Este to settle in Rome in 1559. In 1561 he revisited France, at the conference at Poissy. He returned to Rome in 1563. In 1578 the King of Poland invited him to teach jurisprudence at his new college at Cracow, but Gregory XIII. induced him to stay in Rome, where he died on June 4, 1585.

Complete editions of his works: editio princeps, Verona (1727–30); by D. Ruhnken (1789), by C. H. Frotscher (1834–41); two volumes of *Scripta selecta,* by J. Frey (1871); *Variae lectiones,* by F. A. Wolf and J. H. Fäsi (1791–1828). Muretus edited a number of classical authors with learned and scholarly notes. His other works include *Juvenilia et poemata varia, orationes* and *epistolae.*

See monograph by C. Dejob (Paris, 1881); J. E. Sandys, *Hist. Class. Schol.* (2nd ed., 1908), ii. 148–152.

MUREXIDE, an organic nitrogenous substance which crystallizes from water or alcohol in deep red plates or prisms with green metallic reflex. It owes its importance to the fact that it dissolves in water to a purple red solution or in aqueous caustic potash to a bluish purple. These colorations constitute the murexide test for uric acid. The reaction is effected by evaporating either uric acid or urinary calculi containing this acid with dilute nitric acid. The residue is treated with ammonia and aqueous caustic potash, when the foregoing colorations are developed. Murexide, $NH_4{\cdot}C_8H_4O_6N_5,H_2O$, is the ammonium salt of purpuric acid, $C_8H_5O_6N_5$, its constitution being expressed by the following formula (M. Slimmer and J. Stieglitz, 1904):



it is prepared by heating alloxantin (*q.v.*) with alcoholic ammonia (W. N. Hartley, 1905).

MURFREESBORO, a city of central Tennessee, U.S.A., 32 m. S.E. of Nashville, near the Stone river, at an altitude of 616 ft.; county seat of Rutherford county. It is on Federal highways 41 and 270 and the Nashville, Chattanooga and St. Louis railway. Pop. (1920) 5,367 (37% negroes); 7,993 in 1930 by the Federal census. Murfreesboro is the seat of Tennessee college (Baptist; 1906), the Middle Tennessee State Teachers college (1911), and one of the "child health demonstrations" of the Commonwealth fund. For half a century it has been the largest red-cedar market of the world, and is an important shipping point for cotton, live stock and dairy products and a large wholesale distributing centre for groceries and general merchandise. There are five cotton gins, a co-operative creamery making 2,000,000 pounds of butter in a year, and 27 diversified manufacturing plants. A city-manager form of government has operated since 1920. Murfreesboro was named after Col. Hardy Murfree, a Revolutionary officer who lived in Tennessee after 1807. It was incorporated in 1811, and from 1819 to 1825 was the capital of the State, which was then moved to Nashville by a majority of only one vote in the legislature. The battle of Murfreesboro (Stone's river) was fought on Dec. 31, 1862, and Jan. 2, 1863, about 2 m. N.W. of the city. The battlefield is now a national military park. On July 13, 1862, Gen. Nathan B. Forrest, in one of his brilliant raids, captured the city from the Federals. It was the birthplace of "Charles Egbert Craddock" (Mary N. Murfree).

MURGER, HENRY (1822–1861), French man of letters, was born in Paris. His father was a German *concierge* and a tailor. Murger became secretary to Count Alexei Tolstoi. In 1848 appeared his collected sketches called *Scènes de la vie de Bohême.* This book describes the fortunes and misfortunes, the loves, studies, amusements and sufferings of a group of impecunious students, artists and men of letters, of whom Rodolphe represents Murger himself. Murger belonged to a clique of so-called Bohemians, the most remarkable of whom, besides himself, were Privat d'Anglemont and Champfleury. *La Vie de Bohême,* arranged for the stage in collaboration with Théodore Barrière, was produced at the Variétés on Nov. 22, 1849, and was a triumphant success; it formed the basis of Puccini's opera, *La Bohême* (1898). Murger was a fastidious and capricious worker, and his years of hardship and dissipation had impaired his health. He published among other works *Claude et Marianne* in 1851; a comedy, *Le Bonhomme Jadis* in 1852; *Le Pays Latin* in 1852; *Adeline Protat* (one of the most graceful and innocent if not the most original of his tales) in 1853; and *Les Buveurs d'eau* in 1855. Some years before his death, which took place in a *maison de santé* near Paris on Jan. 28, 1861, Murger went to live at Marlotte, near Fontainebleau, where he wrote *Le Sabot rouge* (1860).

See an article by A. de Pontmartin in the *Revue des deux mondes* (Oct., 1861).

MURGHAB, a river of Afghanistan, which flows into Russian territory. It rises in the Firozkhoi highlands, the northern scarp of which is defined by the Band-i-Turkestan, and after traversing that plateau from east to west it turns north through deep defiles to Bala Murghab. Beyond this, in the neighbourhood of Maruchak, it forms for a space the boundary-line between

Afghan and Russian Turkestan; then joining the Kushk river at Pul-i-Khishti (Tash Kupri) it runs north to Merv, losing itself in the sands of the Merv desert after a course of about 450 m., its exact source being unknown.

MURIATIC ACID: *see* Hydrochloric Acid.

MURILLO, BARTOLOME ESTEBAN (1617–1682), Spanish painter, son of Gaspar Esteban Murillo and Maria Perez, was born at Seville in 1617, and baptized on Jan. 1, 1618. His parents (the father an artisan of a humble class), placed him under the painter Juan de Castillo, who was an imitator of the Italian School. Castillo's removal to Cadiz in 1639–1640 threw his pupil upon his own resources. He was compelled to earn his bread by painting rough pictures for the "feria" or public fair of Seville. The religious daubs exposed at that mart were generally of as low an order as the prices paid for them. This rough and ready practice, partly for the market-place, partly for converts in Mexico and Peru, for whom Madonnas and popular saints were produced and shipped off by the dozen, doubtless increased Murillo's dexterity. To this early period belong the Madonna giving the rosary to St. Dominicus in the Archbishop's palace at Seville; a "Madonna" in the Seville Museum, dark in colour and "Fray Lauterio before the Madonna" in the Fitzwilliam Museum, Cambridge. Murillo's works at this period are somewhat harsh in execution, but above the average reached by his contemporaries at Seville. Struck by the improvement which travel had wrought upon the style of his brother artist Pedro de Moya, Murillo in 1642 resolved to make a journey to Flanders or Italy. He placed his sister, who was dependent on him, under the care of some friends, and set out for Madrid. On reaching the capital he waited on Velazquez, his fellow-townsman—then at the summit of his fortune—and asked for introduction to friends in Rome. The master offered him lodging in his own house, and procured him admission to the royal galleries of the capital. Murillo here enjoyed the masterpieces of Italy and Flanders. The next two years were chiefly spent in copying from Ribera, Vandyck and Velazquez; and in 1644 Velazquez submitted some of Murillo's efforts to the king.

His patron urged him to go to Rome, but Murillo preferred to return to his sister and his native Seville. The friars of the convent of San Francesco in Seville had about this time determined to adorn the walls of their small cloister. But the brotherhood had no money, and found themselves incapable of employing an artist of name. Murillo offered his services, and covered the walls with eleven large pictures of remarkable power and beauty. Among them were representations of San Francisco, of San Diego, of Santa Clara and of San Gil. These pictures were executed in his earliest style, commonly called his *frio* or cold style. It is remarkable for solidity of workmanship, and in certain passages recalls the realism of Zurbaran and the young Velazquez.

In 1648 Murillo married a wealthy lady of rank, Doña Beatriz de Cabrera y Sotomayor, and his house soon became the favourite resort of artists and connoisseurs. Murillo now painted the well-known "Flight into Egypt," and shortly afterwards developed his *calido* or warm style. His outlines became softer and his figures rounder, and his colouring gained in warmth and transparency. In 1655 he executed his two famous paintings of "San Leandro" and "San Isidoro" at the order of Don Juan Federigo, archdeacon of Carmona, which are now in the cathedral of Seville. These are two noble portraits, finished with great care and admirable effect. His next picture, the "Nativity of the Virgin," painted for the cathedral, is one of the most delightful specimens of his *calido* style. It was taken by Marshal Soult, and is now in the Louvre. In the following year (1656) he painted a vast picture of San Antonio de Padua, one of his most celebrated performances, which still hangs in the baptistery of the cathedral.

The year 1665 saw him engaged on two large semicircular pictures, designed by his friend and patron Don Hustino Neve y Yevenes, to adorn the walls of the church of Santa Maria la Blanca. The first two (now in Madrid) were meant to illustrate the history of the Festival of Our Lady of the Snow, or the foundation of the Roman basilica of Santa Maria Maggiore. They belong to the first productions of the master, and denote the commencement of Murillo's third and last style, known as the *vaporoso* or vapoury. It should be noted, however, that the three styles are not strictly separable into date-periods. In the *vaporoso* method the well-marked outlines and careful drawing of his former styles disappear, the outlines are lost in the misty blending of the light and shade. The remaining pieces executed for this small church were a "Virgin of the Conception" and an "Allegory of Faith." Soult laid his hands on these also, and the former is now in the Louvre, the latter with Mr. Lyne Stephens, Lynford Hall, Norfolk.

HIS GREATEST WORKS

In 1658 Murillo consummated a task which had hitherto baffled all the artists of Spain, and even royalty itself. This was the establishing of a public academy of art. By superior tact he overcame the vanity of Valdes Leal and the presumption of the younger Herrera, and secured their co-operation. The Academy of Seville was accordingly opened for the first time in January 1660, and Murillo and the second Herrera were chosen presidents. Passing over some half-length pictures of saints and a dark-haired Madonna, painted in 1668 for the chapter-room of the cathedral of his native city, we enter upon the most splendid period of Murillo's career. In 1661 Don Miguel Mañara Vicentelo de Leca resolved to raise money for the restoration of the dilapidated Hospital de la Caridad. Mañara commissioned Murillo to paint eleven pictures for this edifice of San Jorge.

Three of these pieces represented the "Annunciation," the "Infant Saviour," and the "Infant St. John"; the remaining eight are considered Murillo's masterpieces. They consist of "Moses striking the Rock," the "Return of the Prodigal" (now at Stafford House), "Abraham receiving the Three Angels" (also at Stafford House) and "The Charity of San Juan de Dios," the "Miracle of the Loaves and Fishes," "Our Lord healing the Paralytic" (now at Orwell Park), "St. Peter released from Prison by the Angel" (now at the Hermitage, Leningrad) and "St. Elizabeth of Hungary." These works occupied the artist four years, and in 1674 he received for his eight great pictures 78,115 reals. The "Moses," the "Loaves and Fishes," the "San Juan," and the three subjects which we have named first, are still at Seville, the French carried off the rest, but the "St. Elizabeth" is now back in Spain. For compass and vigour the "Moses" stands first; but the "Prodigal's Return" and the "St. Elizabeth" were considered by Bermudez the most perfect of all as works of art. The front of this famous hospital was also indebted to the genius of Murillo; five large designs in blue glazed tiles were executed from his drawings.

He had scarcely completed the undertakings for this edifice when his favourite Franciscans again solicited his aid. He accordingly executed 18 paintings for the humble little church known as the Convent de los Capuchinos. Most of these Capuchin pictures are preserved in the Museum of Seville; the "Charity of St. Thomas of Villanueva" is reckoned the best. Murillo himself was wont to call it "su lienzo" (his own picture). One of this series "The Young St. Thomas of Villanueva distributing his Garments" is now in the Cincinnati Museum; and the altar piece representing "The Rose of St. Francis" is at the Cologne Museum. Another piece of extraordinary merit, which once hung in this church, is the "Virgin of the Napkin," believed to have been painted on a "servilleta" and presented to the cook of the Capuchin brotherhood as a memorial of the artist's pencil. In 1678 his friend the canon Justino again employed him to paint three pieces for the Hospital de los Venerables; the "Mystery of the Immaculate Conception" (taken by Marshal Soult and now in the Louvre), "St. Peter Weeping," and the "Blessed Virgin." As a mark of esteem Murillo next painted a full-length portrait of the canon (now with Lord Lansdowne); the spaniel at the feet of the priest has been known to call forth a snarl from a living dog. His portraits generally, though few, are of great beauty. One of the finest is the full-length portrait of his son now with the Duke of Alva at Madrid. The portrait of King Ferdinand the Saint is in the Elkins Collection, New York.

Towards the close of his life Murillo executed a series of pic-

tures illustrative of the life of "the glorious doctor" for the Augustinian convent at Seville. Mounting a scaffolding one day at Cadiz (in 1681) to execute the higher parts of a large picture of the "Espousal of St. Catherine," on which he was engaged for the Capuchins of that town, he stumbled, and received a hurt from which he never recovered. He died on April 3, 1682, in the arms of Pedro Nuñez de Villavicencio, one of his best pupils. Another of his numerous pupils was Sebastian Gomez, named "Murillo's Mulatto." Murillo left two sons (one of them at first an indifferent painter, afterwards a priest) and a daughter. He was buried in the Santa Cruz church near a picture by Pedro de Compaña where he was wont to pray.

Murillo has always been one of the most popular of painters—nor in Spain alone. His art was in accord with the taste of the mystical and devout people of his provincial neighbourhood; and his ecstasies of Madonnas and Saints are the themes of some of his most celebrated achievements. His subjects may be divided into two great groups—his street children, and the legendary and religious works. The former, of which some salient specimens are in the Dulwich Gallery, are delightful genre pictures.

Seville must still be visited by persons who wish to study Murillo thoroughly. A large number of the works which used to adorn this city have, however, been transported elsewhere. In the Prado Museum at Madrid are forty-five specimens of Murillo —the "Infant Christ and the Baptist" (named "Los Niños della Concha"), "St. Ildefonso vested with a Chasuble by the Madonna," etc.; in the Museo della Trinidad, "Christ and the Virgin appearing to St. Francis in a Cavern" and various others. In the National Gallery, London, the chief example is the "Holy Family"; this was one of the master's latest works, painted in Cadiz.

See Stirling, *Annals of the Artists of Spain* (3 vols., London, 1848); Richard Ford, *Handbook for Spain* (London, 1855); Curtis, *Catalogue of the Works of Velasquez and Murillo* (1853); L. Alfonso, *Murillo, el hombre,* etc. (1886); C. Justi, *Murillo* (illustrated, 1892); P. Lefort, *Murillo et ses élèves* (1892); F. M. Tubino, *Murillo, su epoca,* etc. (1864, Eng. trans., 1879); Dr. G. C. Williamson, *Murillo* (1902); C. S. Ricketts, *The Prado* (1903); A. L. Mayer, *Murillo* (Stuttgart Berlin, 1913).

MURMANSK, a port on the Kola inlet of the Murmansk coast of the Barents sea in the Russian S.F.S.R. in 69° 10′ N., 33° 30′ E. Pop. (1926) 8,777. In 1916 it was merely a few log huts, but the completion of a railway line linking it with Leningrad has led to a remarkably rapid development, since it is the only northerly port of the U.S.S.R. which is ice-free all the year round. There is sheltered anchorage for large vessels and its loading and unloading capacity is 3,000 tons per day. It has ample storehouses and railway sidings, tugs, water-boats, lighters, etc. Workmen's dwellings of modern type are being erected and there is a municipal electricity and water-supply, and a hospital. Its industries are mainly dependent on the fishing industry, and cod liver oil, fish-guano, and shagreen from shark skin are produced. A carpentry industry is carried on in winter to supply barrels and boxes for fish. Prospects of an import trade from Great Britain, U.S.A. and Canada are good, and American cotton for Moscow already comes via Murmansk.

The Murmansk coast extends from the Russian frontier to Cape Svyatoi Nos. It is a region of granitic cliffs 1,000 ft. in the west and 300 ft. at Svyatoi Nos, indented by deep gulfs and inlets with tundra and stunted bushes, and has many excellent harbours. The Atlantic drift warms the coast and west of Litski point there is little pack-ice and, though a thin ice crust may form, it does not impede navigation, and thus this coast, lying within the Arctic circle, is open all the year round. Ice-breakers are rarely needed. There are telegraph lines, wireless stations and lighthouses. Fishing is the main occupation, and the season lasts from March to August. The fish comes from Norway and so the fishing moves from west to east. Not only are the local inhabitants employed, but about 3,000 men from the Kem and Onega district come for the season, and need no longer endure a long sledge journey.

The chief fish caught are cod (treska), turbot, haddock, coal fish or saith, wolf-fish, flat fish, comber or sea perch, eel and pout. Herrings are common but are not in much demand. Sharks are caught and oil extracted from their liver is used for medicinal purposes, and their skin is dressed. Deficiency of salt gave Murmansk fish a bad name, but government salt depôts now exist and the fish is satisfactorily cured. Alexandrovsk, at the mouth of the Kola inlet, on the western side, was opened as a port in 1899, but its site proved unsuitable owing to its single inlet and to the steep rocks near the harbour, and Murmansk has displaced it. The Murmansk administrative district includes the Kola peninsula and is part of the Leningrad Area, though it is divided from it by the Karelian A.S.S.R.; it has an area of 128,600 sq.km. and a population (1926) of 23,016.

MURNER, THOMAS (1475–1537?), German satirist, was born on Dec. 24, 1475 at Oberehnheim near Strasbourg. In 1518–19 he studied law at Basel. He entered the Franciscan order in 1490, and in 1495 wandered over Europe, making enemies by his scurrilous tongue. In 1533 he was appointed priest of Oberehnheim, where he died about 1537.

There is not a trace of human kindness in Murner's satires; they were directed against the corruption of the times, the Reformation, and especially against Luther, and the most powerful—the most virulent German satire of the period—is *Von dem grossen lutherischen Narren, wie ihn Dr. Murner beschworen hat.* Among others are *Die Narrenbeschwörung* (1512); *Die Schelmenzunft* (1512); *Die Gäuchmatt,* which treats of enamoured fools (1519), and a translation of Virgil's *Aeneid* (1515) dedicated to Maximilian I. Murner also wrote the humorous *Chartiludium logicae* (1507) and the *Ludus studentum freiburgensium* (1511), besides a translation of Justinian's *Institutiones* (1519).

All Murner's more important works have been republished in critical editions; a selection appeared in Kürschner's *Deutsche Nationalliteratur* (1890). *Cf.* W. Kawerau's *Murner und die Kirche das Mittelalters* (1890), and *Murner und die deutsche Reformation* (1891); also Liebenau, *Der Franziskaner Dr. Th. Murner* (1913).

MUROM, a town of Russia in the Vladimir province, in 55° 32′ N., 42° 2′ E., on the Oka, near its confluence with the Tesha. It is on the railway from Moscow to the east, and has a branch going north to Kovrov. Its pop. (1926) 22,621, has nearly doubled in the last 25 years. It has iron smelting works, a railway repairing yard, leather, oil-pressing, cotton and flax-spinning and brandy factories. Grain is unloaded from the lower Oka. The district is famous for its kitchen gardens and cucumbers.

MURPHY, ARTHUR (1727–1805), Irish actor and dramatist, son of a Dublin merchant, was born at Clomquin, Roscommon, on Dec. 27, 1727, and studied at the English college at St. Omer. He went on the stage in 1754. He appeared in the title-rôles of *Richard III.* and *Othello;* as Biron in Southerne's *Fatal Marriage;* and as Osmyn in Congreve's *Mourning Bride.* His first farce, *The Apprentice,* was given at Drury Lane on Jan. 2, 1756. It was followed, among other plays, by *The Upholsterer* (1757), *The Orphan of China* (1759); *The Way to Keep Him* (1760), *All in the Wrong* (1761), *The Grecian Daughter* (1772), and *Know Your Own Mind* (1777). Most of these were adaptations from the French. Murphy edited a political periodical, called the *Test,* in support of Henry Fox, by whose influence he was called to the bar at Lincoln's Inn, although he had been refused at the Middle Temple in 1757 on account of his connection with the stage. Murphy also wrote a biography of Fielding, an essay on the life and genius of Samuel Johnson and translations of Sallust and Tacitus. Towards the close of his life the office of a commissioner of bankrupts and a pension of £200 were conferred upon him by Government. He died on June 18, 1805.

MURPHY, JOHN B. (1857–1916), American physician, was born in Appleton, Wis., on Dec. 21, 1857. He graduated at Rush Medical college in 1879 and studied in Europe from 1882 to 1884. He invented the anastomosis button (1892), which simplified the technique of abdominal operations and so reduced their danger. Dr. Murphy also attained eminence at a teacher of surgery. He taught successively at Rush Medical college, the College of Physicians and Surgeons and at Northwestern University Medical school. In 1911 he was president of the American Medical Association. He wrote *General Surgery,* which is vol. ii. of the Practical Medical Series, and numerous articles for medical journals.

MURPHY, JOHN FRANCIS (1853–1921), American landscape painter, was born at Oswego, N.Y., on Dec. 11, 1853. He first exhibited at the National Academy of Design in 1876, and was made an associate in 1885, and a full academician two years later. He became a member of the Society of American Artists (1901) and of the American Water Color Society. He died in New York city on Jan. 10, 1921.

MURPHYSBORO, a city of south-western Illinois, U.S.A., on the Big Muddy river, 10 m. from the Mississippi; the county seat of Jackson county. It is served by the Illinois Central, the Missouri Pacific and the Mobile and Ohio railways. Pop. (1920) 10,703 (85% native white, 10% negro); and 8,182 in 1930 by the Federal census. It is in a rich agricultural region; coal, shale and silica are mined in the vicinity; and the city has various manufacturing industries, with an output in 1925 valued at $2,850,769. Murphysboro was settled in 1850 and incorporated in 1867. It was the birthplace of General John A. Logan.

MURRAIN, *see* Rinderpest; Pleuro-pneumonia; Anthrax; and Foot and Mouth Disease. *See* also Veterinary Science.

MURRAY or **MORAY, EARLS OF.** The earldom of Moray was one of the seven original earldoms of Scotland, its lands corresponding roughly to the modern counties of Inverness and Ross. Little is known of the earls until about 1314, when Sir Thomas Randolph, nephew of King Robert Bruce, was created earl of Moray (*q.v.*). When the childless John Randolph, 3rd earl, was killed at the battle of Neville's Cross in 1346, it is not certain who held the earldom until 1359 when Henry Plantagenet, duke of Lancaster (d. 1361), was made earl of Moray by King David II. In 1372, however, John Dunbar (d. 1391), a grandson of Sir Thomas Randolph and a son-in-law of Robert II., obtained the earldom. The last of the Dunbar earls was James Dunbar, who was murdered in August 1429, and after this date his daughter Elizabeth and her husband, Archibald Douglas (d. 1455), called themselves earl and countess of Moray.

James IV. created his natural son, James Stuart (*c.* 1499–1544), earl of Moray, and after the title had been borne for a short time by George Gordon, 4th earl of Huntly (*c.* 1514–1562), it was bestowed in 1562 by Mary Queen of Scots upon her half-brother, an illegitimate son of James V. This was the famous regent, James Stuart, earl of Moray, or Murray (*q.v.*), murdered, Jan. 1570.

See vol. vi. of R. Douglas's *Peerage of Scotland,* new ed. by J. B. Paul (1909).

MURRAY, SIR DAVID (1849–), Scottish painter, was born in Glasgow. He became A.R.A. in 1891, and R.A. in 1905, and was a member of many important societies. In 1917 he was made president of the Royal Institute of Painters of Water Colours, and in the following year he was knighted. Two of his pictures, "My Love is gone a-sailing" (1884) and "In the Country of Constable" (1903), are in the National Gallery of British Art. "Young Wheat," painted in 1890, is one of his most noteworthy works. Among his other pictures are: "River Road"; "Mangolds"; "Gorse"; "Hampshire"; a series of pictures in Picardy, the Italian lakes, Venice, the Trossachs, the Isle of Lewis, and sea-pieces from the Dorset coast.

MURRAY, EUSTACE CLARE GRENVILLE (1824–1881), English journalist, was born in 1824, the natural son of the 2nd duke of Buckingham. Educated at Magdalen hall (Hertford college), Oxford, he entered the diplomatic service. He was attaché at Vienna, where he lost his post for arranging to act as correspondent to a London paper. In 1868 he returned to England, and devoted himself to journalism. He founded (1869) an abusive society paper, the *Queen's Messenger.* For a libel published in this paper Lord Carrington horsewhipped him on the doorstep of a London club. Murray was subsequently charged with perjury for denying on oath his authorship of the article. Remanded on bail, he escaped to Paris, where he acted as correspondent to London papers. In 1874 he helped Edmund Yates to found the *World.* Murray died at Passy on Dec. 20, 1881.

MURRAY, LORD GEORGE (1694–1760), Jacobite general, fifth son of John, 1st duke of Atholl, was born at Huntingtower, near Perth, on Oct. 4, 1694. He joined the army in Flanders in 1712 and in 1715 the Jacobite rebels under the earl of Mar. Wounded at the battle of Glenshiel in 1719, he escaped to Rotterdam some months later. In 1724 he returned to Scotland, and on being granted a pardon, settled at Tullibardine until 1745, when on the eve of the Jacobite rising the duke of Perth approached him on behalf of the Pretender; but his attitude was doubtful. He paid his respects to Sir John Cope, the commander of the government troops, and permitted his brother, the duke of Crieff, to appoint him deputy-sheriff of Perthshire. He received a commission in the Jacobite army and the victory at Prestonpans, on Sept. 21, was practically due to his able generalship. After opposing the invasion of England, he prevailed on the prince to march into Cumberland. When Carlisle was lost, he resigned his command, but the dissatisfaction of the army with his successor, the duke of Perth, compelled Charles to reinstate Murray. Obliged to retreat from Derby, his army reached Carlisle safely and in January 1746 entered Stirling.

The prince laid siege to Stirling Castle, while Murray defeated General Hawley near Falkirk; but the losses of the Jacobites by sickness and desertion, and the approach of Cumberland, made retreat to the Highlands an immediate necessity. The battle of Culloden, where the Stuart cause was ruined, was fought on the 16th of April 1746. On the following day the duke of Cumberland intimated to his troops that "the public orders of the rebels yesterday was to give us no quarter"; and Hanoverian news-sheets printed what purported to be copies of such an order. The original copies of Lord George Murray's "orders at Culloden" which are in existence, contain no injunction to refuse quarter. After the defeat Murray conducted a remnant of the Jacobite army to Ruthven, but Prince Charles had determined to abandon the enterprise, and dismissed Murray from his service. Charles's belief in the general's treachery was shared by several leading Jacobites, but there appears no ground for the suspicion. Murray escaped abroad and died in Holland on Oct. 11, 1760.

See *A Military History of Perthshire,* ed. by the marchioness of Tullibardine (2 vols., 1908); *The Atholl Chronicles,* ed. by the duke of Atholl (privately printed); The Chevalier James de Johnstone, *Memoirs of the Rebellion in 1745* (3rd ed., 1822); J. Ray, *Complete History of the Rebellion, 1745–1746* (1754); R. Patten, *History of the late Rebellion* (2nd ed., 1717); *Memoirs of Sir John Murray of Broughton,* ed. by R. F. Bell (Edinburgh, 1898); A. Henderson, *History of the Rebellion, 1745–1746* (2nd ed., London, 1748); W. Duke, *Lord George Murray and the Forty-five* (1927).

MURRAY, GILBERT (1866–), British classical scholar, was born at Sydney, N.S.W., Jan. 2, 1866, but left Australia at the age of 11. He was educated at Merchant Taylors' school, London, and St. John's college, Oxford. At Oxford he won the Hertford and Ireland scholarships (1885), the Craven scholarship (1886), the prize for Latin verse (1886) and the Gaisford prizes for Greek verse and prose (1886–87). He was elected to a fellowship at New college, Oxford, in 1888, and next year to the professorship of Greek at Glasgow university, a position he held till 1899. In 1908 he was appointed Regius professor of Greek at Oxford. In 1889 he had married Lady Mary Howard, daughter of the 9th earl of Carlisle. He contested Oxford university several times in the Liberal interest, but it was a forlorn hope. He is a member of the British Academy and of many foreign learned societies.

Murray was a keen worker for international understanding, and after the World War he sat in the Foreign Office committee concerned with drafting the Covenant of the League of Nations. He attended the Assembly in 1921, 1922 and 1923 as a member of the South African delegation, and in 1924 as a member of the British delegation. He has been, from the beginning, the British member of the committee of intellectual co-operation, and was its president in 1928. Among other departments of the work of the League he was specially interested in the protection of minorities. He was one of the promoters of the League of Nations Union, of which he was chairman from 1918 to 1919, and again from 1923 onwards.

Murray published a *History of Ancient Greek Literature* in 1897. He is best known to the general reader by his incomparable renderings of the plays of Euripides into English verse. Several

of his versions were acted in England and America. Indeed he may be said to have brought Greek drama back to the modern stage. He also published *The Rise of the Greek Epic* (1907; 2nd ed., 1911, 3rd ed., 1924) and *Four Stages of Greek Religion* (1913, 2nd ed., under the title *Five Stages . . .*, 1925). Amongst his works on other subjects are *The Foreign Policy of Sir Edward Grey* (1915); *Faith, War and Policy* (1918); *Religio Grammatici* (1918); and *Problem of Foreign Policy* (1921); *Euripides and his Age* (1918); *The Stoic Age* (1915); *The Classical Tradition in Poetry* (1927); *Ordeal of This Generation* (1929), etc. He wrote for the present edition of the *Encyclopædia Britannica* the articles: EURIPIDES, HOMER and DRAMA, *Greek* (in part).

MURRAY, JAMES (*c.* 1719–1794), British governor of Canada, was a younger son of Alexander Murray, 4th Lord Elibank (d. 1736). He commanded a brigade at the siege of Louisburg, was one of Wolfe's three brigadiers in the expedition against Quebec, and commanded the left wing of the army in the famous battle in Sept. 1759. After the British victory and the capture of the city, Murray was left in command of Quebec, which he defended in April and May 1760 against the attacks of the French, forcing them to raise the siege.

In Oct. 1760 Murray was appointed governor of Quebec, and he became governor of Canada after its formal cession to Great Britain in 1763. In this year he quelled a dangerous mutiny. In 1766 he retired owing to charges of partiality to the French Canadians but was exonerated in the House of Lords. In 1774 Murray was sent to Minorca as governor, where he was besieged in Fort St. Philip by a large force of French and Spaniards in 1781, and was obliged to surrender after seven months' resistance. On his return to England he was tried by a court-martial, at the instance of Sir William Draper, who had served under him in Minorca as lieutenant-governor. He was acquitted and he became a general in 1783. He died on June 18, 1794.

MURRAY, SIR JAMES AUGUSTUS HENRY (1837–1915), British lexicographer, was born at Denholm, near Hawick, on Feb. 7, 1837. After a local elementary education he proceeded to Edinburgh, and thence to the University of London, where he graduated in 1873. Sir James Murray, who received honorary degrees from several universities, both British and foreign, was engaged in teaching for 30 years, from 1855 to 1885, chiefly at Hawick and Mill Hill. During this time his reputation as a philologist was increasing; in 1878 he wrote his famous article on English Language for the *Encyclopædia Britannica,* and he was president of the Philological Society of London from 1878 to 1880, and again from 1882 to 1884. It was in connection with this society that he undertook the chief work of his life, the editing of the *New English Dictionary,* based on materials collected by the society (*see* DICTIONARY). These materials, which had accumulated since 1857, when the society first projected the publication of a dictionary on philological principles, amounted to an enormous quantity, of which an idea may be formed from the fact that Dr. Furnivall sent in "some ton and three-quarters of materials which had accumulated under his roof." The contracts between the society, the delegates of the Clarendon Press, and the editor, were signed on March 1, 1879, and Murray began the examination and arrangement of the raw material, and the still more troublesome work of re-animating and maintaining the enthusiasm of "readers." In 1885 he removed from Mill Hill to Oxford, where his *Scriptorium* came to rank among the institutions of the university city. The first volume of the dictionary was printed at the Clarendon Press, Oxford, in 1884. Murray himself was personally responsible only for about one-half of the dictionary, covering A–D, H–K, O, P, T. But he created the organization which made the undertaking possible, and inspired both his colleagues and successors. In 1885 Murray received the honorary degree of M.A. from Balliol college; he was an original fellow of the British Academy, and in 1908 he was knighted. He died at Oxford on July 26, 1915.

See a memoir by Henry Bradley in *Proceedings of the Brit. Acad.* (vol. viii., 1917–18).

MURRAY or **MORAY, JAMES STUART,** EARL OF (*c.* 1531–1570), regent of Scotland, was an illegitimate son of James V. of Scotland by Margaret Erskine, daughter of the earl of Mar. In 1538 he was appointed prior of the abbey of St. Andrews in order that James V. might secure its funds, and later, he also received those of Pittenweem and Mâcon in France, but manifested no vocation for a monastic life. In fact, shortly after the return of Knox to Scotland in 1559, he joined the lords of the congregation, who resolved to abolish forcibly the Roman service. In 1562 he was created earl of Murray, a dignity also held by George Gordon, earl of Huntly, who, however, had lost the queen's favour. Only a few days later he was made earl of Mar, but as this title was claimed by John, Lord Erskine, Stuart resigned it.

Murray displeased the queen, his half-sister, by his efforts in behalf of Knox now accused of high treason; and as he was also opposed to her marriage with Darnley, he was after that event declared an outlaw and took refuge in England. Returning to Scotland after the murder of Rizzio, he was pardoned by the queen. After her abdication in 1567, he was appointed regent of Scotland, and defeated the queen's forces at Langside, near Glasgow (May 13, 1568). He baffled Mary's schemes, suppressed the border thieves, and ruled firmly, resisting the temptation to place the crown on his own head while Mary remained a captive under suspicion of complicity in the murder of Darnley.

Several events occurred for which Murray has been censured, but which were necessary for his security: the betrayal to Elizabeth of the duke of Norfolk and of the secret plot for the liberation of Mary; the imprisonment of the earl of Northumberland, who after the failure of his rising in the north of England had taken refuge in Scotland; and the charge brought against Maitland of Lethington of complicity in Darnley's murder. Lethington was committed to custody, but was rescued by Kirkaldy of Grange, who held the castle of Edinburgh. Murray was afraid to proceed with the charge on the day of trial, while Kirkaldy and Maitland held the castle, which became the stronghold of the deposed queen's party. It has been suspected that Maitland and Kirkaldy were cognizant of the design of Hamilton of Bothwellhaugh to murder Murray, for he had been with them in the castle. As he rode through Linlithgow Murray was shot on Jan. 21, 1570, from a window by Hamilton.

See the various *Calendars of State Papers* and the general bibliography for Mary, Queen of Scots given in *Camb. Mediaeval Hist.* (vol. 3, chap. 8, 1904).

MURRAY, SIR JOHN (1841–1914), British geographer and naturalist, was born at Coburg, Ontario, Canada, on March 3, 1841. In 1868 he visited Spitsbergen on a whaler, and in 1872 he was appointed one of the naturalists to the "Challenger" expedition. He drew up the scientific results, and in 1882 he became editor of the *Reports* of the expedition. He compiled a summary of the results, and was part-author of the *Narrative of the Cruise* and of the *Report on Deep-sea Deposits.* He also published important papers on oceanography and marine biology. Murray took part in 1880 and 1882 in an exploration of the Faeroe Channel, and between 1882 and 1894 was the prime mover in various biological investigations in Scottish waters. In 1897, with the financial assistance of Laurence Pullar and a staff of specialists, he began a bathymetrical survey of the fresh-water lochs of Scotland. He took part in the expedition (1910) for the physiological and biological investigation of the North Atlantic Ocean. He was accidentally killed near Kirkliston, in Scotland on March 16, 1914.

MURRAY, JOHN, the name for several generations of a great firm of London publishers, founded by John McMurray (1745–1793), a native of Edinburgh and a retired lieutenant of marines, who in 1768 bought the book business of William Sandby in Fleet Street, and, dropping the Scottish prefix, called himself John Murray. He was one of the twenty original proprietors of the *Morning Chronicle,* and started the monthly *English Review* (1783–1796). Among his publications were Mitford's *Greece,* Langhorne's *Plutarch's Lives,* and the first part of Isaac D'Israeli's *Curiosities of Literature.* He died on Nov. 6, 1793.

JOHN MURRAY (2) (1778–1843), his son, was then fifteen. During his minority the business was conducted by Samuel Highley, who was admitted a partner, but in 1803 the partner-

ship was dissolved. Byron called him "the Anak of publishers." In 1807 he took a share with Constable in publishing *Marmion,* and became part owner of the *Edinburgh Review,* although with the help of Canning he launched in opposition the *Quarterly Review* (Feb. 1809), with William Gifford as its editor, and Scott, Canning, Southey, Hookham Frere and John Wilson Croker among its earliest contributors. Murray was closely connected with Constable, but, to his distress, was compelled in 1813 to break this association on account of Constable's business methods, which, as he foresaw, led to disaster. In 1811 the first two cantos of *Childe Harold* were brought to Murray by R. C. Dallas, to whom Byron had presented them. Murray paid Dallas 500 guineas for the copyright. In 1812 he bought the publishing business of William Miller (1769–1844), and migrated to 50 Albemarle street. Literary London flocked to his house, and Murray became the centre of the publishing world. It was in his drawing-room that Scott and Byron first met, and here, in 1824, after the death of Lord Byron, his memoirs manuscript, considered by Gifford unfit for publication, was destroyed. A close friendship existed between Byron and his publisher, and their correspondence is one of the chief literary documents of the period. For political reasons business relations ceased after the publication of the 5th canto of *Don Juan.* Murray paid Byron some £20,000 for his various poems. To Thomas Moore he gave nearly £5,000 for writing the life of Byron, and to Crabbe £3,000 for *Tales of the Hall.* He died on June 27, 1843.

His son, JOHN MURRAY (3) (1808–1892), began the famous series "Murray's Handbooks" for travellers; he himself wrote several volumes. (*See* his article on the "Handbooks" in *Murray's Magazine,* November 1880.) He published many books of travel; also Campbell's *Lives of the Chancellors, The Speaker's Commentary,* Smith's *Dictionaries;* and works by Hallam, Gladstone, Lyell, Layard, Dean Stanley, Borrow, Darwin, Livingstone and Samuel Smiles. He died on April 2, 1892, and was succeeded by his eldest son, SIR JOHN MURRAY (4) (1851–1928), under whom, in association with his brother, A. H. Hallam Murray, the firm was continued. Sir John Murray edited Gibbon's Autobiography and Byron's Correspondence. He died Nov. 30, 1928.

See Samuel Smiles, *A Publisher and his Friends, Memoirs and Correspondence of the late John Murray* . . . (1891), for the second John Murray; a series of three articles by F. Espinasse on "The House of Murray," in *The Critic* (Jan. 1860); and a paper by the same writer in *Harper's New Monthly Magazine* (Sept. 1885). *See* the *Letters and Journals* of Byron (ed. Prothero, 1898–1901).

MURRAY, LINDLEY (1745–1826), Anglo-American grammarian, was born at Swetara (Penn.), on April 22, 1745. He practised law until the Revolution; then made a fortune with his father's aid by catering to the British during their occupation of New York. After his retirement to Holdgate, England, he devoted himself to writing until his death on Feb. 16, 1826. His *Grammar of the English Language* (1795) and the corresponding *English Exercises* and *Key* (both 1797) as well as his other texts had an extraordinary sale, some of them running into scores of editions of ten or twelve thousand each. The Grammar was studied by the historian Prescott as a literary preparation.

BIBLIOGRAPHY.—*See* the *Memoir,* autobiographical letters completed by Elizabeth Frank (1826), and the biography by W. H. Egle (1885).

MURRAY (or MORAY), SIR ROBERT (*c.* 1600–1673), one of the founders of the Royal Society, was the son of Sir Robert Murray, of Craigie, Ayrshire. He was educated at St. Andrew's, served in the French army, and in the Royalist ranks during the Civil War. In 1650 he was named lord justice clerk and a privy councilor, titles which were confirmed at the Restoration. Through his influence with the king he secured the incorporation by charter of the Royal Society on July 15, 1662. Murray was its first president. He died in London on July 4, 1673, and was buried in Westminster Abbey.

MURRAY COD (*Oligorus macquariensis*), one of the largest of the fresh-water perciform fishes of Australia, celebrated for its excellent flavour. It belongs to the family *Serranidae.* The shape is that of a perch, and the dorsal fin consists of two portions, spiny and rayed, the number of spines being eleven. The scales are small. The colour varies in different localities; it is generally brownish, with a greenish tinge and numerous small dark green spots. This fish has its headquarters in the Murray river and its tributaries, but occurs also in northern New South Wales. It is the most important food fish of these rivers, and may attain a length of more than 3ft. and a weight of 120 pounds.

MURRAY RIVER AND BASIN: *see* AUSTRALIA: *Drainage.* (*See* also ALEXANDRINA LAKE, ALBURY and RIVERINA.)

MURRE, the common name in U.S.A. for the guillemot (*q.v.*).

MÜRREN (5,415 ft.), a village in the Bernese Oberland, on the slopes of the Jungfrau, Switzerland. It is reached by a funicular railway and light railway, from Interlaken and Lauterbrunnen. The population is German-speaking and Protestant. The place is a famous health resort and winter sport centre.

MURSA, BATTLE OF (351 A.D.). In January 350, Magnentius the usurper deposed the Emperor Constans, and a little while after was opposed by Constantius, who decisively defeated him near Mursa in Pannonia on September 28, 351, and finally destroyed him two years later. The battle is of interest because the Romans adopted new tactics.

Behind Constantius flowed the Danube, and on his right lay the Drave; consequently flight was out of the question. On both wings he posted his mounted archers, and in the forefront his mailed cavalry organized after the Persian model. In the centre he drew up his heavy armed infantry, and in rear of them deployed his bowmen and slingers. His attack was made against the enemy's right wing, the whole of his left wing cavalry advancing in oblique order. When well on the outer flank of the enemy's right wing the cavalry wheeled inwards and charged with great effect, for the whole of Magnentius's line was thrown into confusion. The action now became general, and, though Magnentius fled, Marcellinus continued the fight, the Gauls of the Western Roman army refusing to surrender. It has been estimated that Magnentius lost 24,000 and Constantius 30,000. So great was the loss of the victor in veteran troops that after this battle it was not possible to find a sufficiency of trained men to defend the frontiers, let alone add new triumphs to Rome.

BIBLIOGRAPHY.—E. Gibbon, *The History of the Decline and Fall of the Roman Empire,* chap. xviii.; *The Cambridge Mediaeval History,* vol. i. (J. F. C. F.)

MURSHIDABAD, a town and district of British India, in the Presidency division of Bengal. The administrative headquarters of the district are at Berhampore (*q.v.*). The town of Murshidabad is on the left bank of the Bhagirathi, an old and sacred channel of the Ganges. Pop. (1921) 10,669. It was the latest Mohammedan capital of Bengal. In 1704 the nawab Murshid Kuli Khan changed the seat of government from Dacca to Maksudabad, which he called after his own name. Even after the conquest of Bengal by the British, Murshidabad remained for some time the seat of administration. The town is still the residence of the descendant of the Nawab Nazims of Bengal, who ranks as the first nobleman of the province, with the style of nawab bahadur of Murshidabad. His palace, dating from 1837, is a fine building in Italian style. A cemetery on the right bank of the river contains the tombs of Ali Vardi Khan and Sirajuddaula. The Imambara, built in 1847, is the largest in Bengal. Murshidabad still retains such industries as carving in ivory, gold and silver embroidery, and silk-weaving.

The DISTRICT OF MURSHIDABAD has an area of 2,121 sq.m. and a population (1921) of 1,487,572. It is divided into two nearly equal portions by the Bhagirathi. In the tract to the west, known as the Rarh, the general level is high, but interspersed with marshes and seamed by hill streams. The Bagri, or eastern half, is a low-lying alluvial plain liable to annual inundation. The principal industry is that of silk, but it is now declining.

MUS, the name of a Roman family of the plebeian Decian gens. (1) PUBLIUS DECIUS MUS in 343 B.C. rescued the Roman army from a difficulty in the Samnite War (Liv. vii. 34). In 340, as consul with T. Manlius Torquatus as colleague, he commanded in the Latin War. The decisive battle was fought near Mt. Vesuvius. The consuls, in consequence of a dream, had agreed that the general whose troops first gave way should devote himself to destruction, and so ensure victory. The left wing under

Decius became disordered, whereupon, repeating after the chief pontiff the solemn formula of self-devotion he dashed into the ranks of the Latins, and met his death (Livy viii. 9). (2) His son, also called PUBLIUS, consul for the fourth time in 295, followed the example of his father at the battle of Sentinum, when the left wing which he commanded was shaken by the Gauls (Livy x. 28).

MUSACEAE, in botany, the banana family, monocotyledonous plants divided into six genera and about 70 species, all tropical and mostly gigantic herbs. *Ravenala madagascariensis* is called the traveller's tree, as water accumulates in the leaf-bases and can be used for drinking. *Musa* includes the banana and plantain and also Manila hemp (*qq.v.*).

MUSAEUS, the name of three Greek poets. (1) The first was a mythical seer and priest, the pupil or son of Orpheus, who was said to have been the founder of priestly poetry in Attica. He composed hymns and prose treatises, and oracular responses, which were collected in the time of Peisistratus by Onomacritus. The mystic and oracular verses and customs of Attica, especially of Eleusis, are connected with his name (Herod. vii. 6; viii. 96; ix. 43). A *Titanomachia* and *Theogonia* are also attributed to him (G. Kinkel, *Epicorum graecorum fragmenta,* 1878). (2) The second was an Ephesian attached to the court of the kings of Pergamum, who wrote a *Perseis,* and poems on Eumenes and Attalus (Suïdas, *s.v.*). (3) The third (called Grammaticus in all the mss.) is of uncertain date, but probably belongs to the beginning of the 6th century A.D., as his style and metre are evidently modelled after Nonnus. He is possibly to be identified with the friend of Procopius who wrote a poem on Hero and Leander (editions by F. Passow, 1810; G. H. Schäfer, 1825; C. Dilthey, 1874; vl. by E. Sikes, London, 1920). It was imitated by Marlowe, among others, and has been translated into many languages. The little love-poem *Alpheus and Arethusa* (*Anthol. pal.* ix. 302) is also ascribed to Musaeus.

MUSÄUS, JOHANN KARL AUGUST (1735–1787), German author, was born at Jena. His first work, *Grandison der Zweite* (1760–62) afterwards (1781–82) rewritten and issued with a new title, *Der deutsche Grandison,* is a satire on Samuel Richardson's hero, who had many sentimental admirers in Germany. In 1763 Musäus was made master of the court pages at Weimar, and in 1769 he became a master at the Weimar gymnasium. His second book, *Physiognomische Reisen* (1778–79), was directed against Lavater. From 1782–86 he published his best work, *Volksmärchen der Deutschen.* Even in this series of tales, the substance of which Musäus collected among the people, he could not refrain from satire. The stories, therefore, lack the simplicity of genuine folk-lore. In 1785 was issued *Freund Heins Erscheinungen in Holbeins Manier* by J. R. Schellenberg, with explanations in prose and verse by Musäus. A collection of stories entitled *Straussfedern* (1787) was left unfinished at his death on Oct. 28, 1787.

The *Volksmärchen* have been frequently reprinted (Düsseldorf, 1903, etc.). They were translated into French in 1844, and three of the stories are included in Carlyle's *German Romance* (1827); Musäus's *Nachgelassene Schriften* were edited by his relative, A. von Kotzebue (1791). *See* M. Müller, *J. K. A. Musäus* (1867), and an essay by A. Stern in *Beiträge zur Literaturgeschichte des 18. Jahrhunderts* (1893).

MUSCAT, a town on the south-east coast of Arabia, capital of the independent State of Oman. It commands the entrance to the Persian gulf. In geographical position it is isolated from the interior of the peninsula as the mountains rise behind it in a rugged wall. It is only from Matrah, a northern suburb shut off by an intervening spur which reaches to the sea, that land communication with the rest of Arabia can be maintained. Both Muscat and Matrah are defended on the landward side by a wall with towers at intervals.

The early history of Muscat is the history of Portuguese ascendancy in the Persian gulf. When Albuquerque burnt the place after destroying Karyāt in 1508, Kalhat was the chief port of the coast and Muscat was comparatively unimportant. Kalhat was subsequently sacked and burnt. For 114 years Muscat was held as a naval station and factory during a period of local revolts, Arab incursions, and Turkish invasion by sea; but it was not till 1622, when the Portuguese lost Hormuz, that Muscat became the headquarters of their fleet and the most important place held by them on the Arabian coast. In 1650 the Portuguese were finally expelled from Oman. Muscat had been reduced after a siege in 1648. The Persians next occupied Oman, but left it in 1741. Under the great ruler of Oman, Said ibn Sultan (1804–1856), the fortunes of Muscat attained their zenith; but on his death, when his kingdom was divided and the African possessions were parted from western Arabia, Muscat declined. In 1883–84, when Turki was sultan, the town was unsuccessfully besieged by the Indabayin and Rehbayin tribes, led by Abdul Aziz, the brother of Turki. The sultan's palace is near the centre of the town, a relic of Portuguese occupation, called by the Arabs El Jereza, a corruption of Igrezia (church). This term is probably derived from the chapel once attached to the buildings which formed the Portuguese governor's residence and factory.

The towns of Muscat and Matrah have a very small Arab population, Baluchis and negroes being by far the most numerous. Muscat and Matrah have together about 20,000 inhabitants. Muscat imports rice, coffee and cotton goods and exports dates, pomegranates and dried fish. The British residency stands on a low sandy isthmus which connects the fortress of Jalāli with the mainland.

MUSCATINE, a city of eastern Iowa, U.S.A., on the Mississippi river, at the southern end of the "big bend"; the county seat of Muscatine county. It is on the Mississippi river scenic highway; has an airport; and is served by the Chicago, Milwaukee, St. Paul and Pacific, the Clinton, Davenport and Muscatine, the Burlington, Muscatine and Northwestern, and the Rock Island railways, and river barges. Pop. (1920) 16,068 (89% native white); 1930 Federal census 16,778. The city has an area of 7 sq.m., rising from the river to the bluffs which here make a semicircular détour away from the river banks. Its most distinctive industry (established in 1891 by J. F. Boepple, a German) is the manufacture of pearl buttons (over 17,000,000 gross annually) from the shells of the mussels found in the neighbourhood, now supplemented by shipments from a wide area. Other important products are catsup, sauerkraut and preserves, dehydrated horse-radish, sash and doors, butter, automatic button machines, pressed steel pulleys, steel dies, canning machinery, packed meats and poultry, and air calliaphones. The aggregate factory output in 1925 was valued at $13,659,188. Muscatine was founded as a trading post in 1833, incorporated as a town ("Bloomington") in 1839, and chartered as a city under its present name in 1851.

MUSCICAPIDAE: *see* FLYCATCHER.

MUSCLE, STRUCTURE OF. Muscle is the tissue by which the various parts of the body are moved. Thus it forms the main bulk of the limbs, back, neck and body wall. Most of the viscera too possess well developed muscular coats. Muscle in all instances is built up of a number of long fibres. These are of three well defined types. Those forming the skeletal muscles are of large size, even in some instances up to 12cm. in length, their diameter varying from 0·01 to 0·1mm. Microscopically, these are characterized by a decided transverse marking, and they are therefore known as *striated muscle* fibres. From the fact that they comprise those muscles which are under the control of the will they are also called *voluntary muscle* fibres. The second variety of muscle is made up of much smaller fibres varying in different parts from 0·05 to 0·15mm. in length and about 0·005mm. in diameter. These fibres show no transverse striations nor are they directly under the control of the will. They are therefore termed *smooth* or *involuntary muscle.* Lastly, there is a third type of muscle found in the heart which lies intermediate in structure between these two varieties. In this the fibres are small and show distinct transverse striations. Longitudinal striations are also present though somewhat less marked. In most respects this form of muscle fibre resembles smooth muscle more closely than striated muscle.

Voluntary or Striated Muscle.—Each muscle fibre of which this is composed is a syncytium or plasmodium, *i.e.,* a structure containing a number of nuclei, which has been formed from a single cell by proliferation of its nucleus without subdivision of

the protoplasm. It is thus an assemblage of cells possessing a common protoplasm. Each fibre generally runs parallel to the length of the muscle and if this is short extends the whole length. Thus the one end of the fibre may be attached to tendon when the end is rounded off. The other end may also terminate in tendon or in the fibrous covering of bone in which case it is again rounded. In long muscles, however, the fibre may only extend a certain distance along the muscle, and it is then found to terminate in a tapering or bevelled end. In some of the long muscles some fibres may both arise and terminate in the substance of the muscles. In such a case both ends are bevelled. All the fibres in a muscle are arranged parallel to one another.

The outer surface of each muscle fibre consists of a tough homogeneous membrane called the *sarcolemma.* The main muscle substance is composed of several parts, viz., the *fibrillae,* the sarcoplasm and the nuclei. Under the action of reagents the muscle fibre may be split into a number of longitudinal elements. These are the fibrillae. They possess alternate bands of light and dark substance which give them a striated appearance. When viewed under polarized light the dark substance is found to be doubly refracting or anisotropic, the light band is singly refracting or isotropic. According to many observers, in the centre of each isotropic segment there is a thin transverse disc of anisotropic material and in the centre of each anisotropic segment a thin disc of isotropic substance. The fibrillae are arranged in the muscle fibre parallel to one another and with the alternate light and dark bands at approximately the same level across the fibre, thus giving to the whole muscle fibre its typical transverse striation. The fibrillae are united by interfibrillar substance to form bundles, of which there may be a considerable number in each muscle fibre. The bundles lie in a surrounding layer of sarcoplasm which apparently represents the remaining portion of unaltered protoplasm of the syncytium. This structure of muscle is best seen in the transverse sections of the fibres. A number of areas separated by a clear protoplasm are then to be seen. The areas are formed by the bundles of fibrillae seen in transverse section, the intermediate substance is the sarcoplasm. In some muscles, apparently, each fibrilla is surrounded by sarcoplasm, in which case the fibrillae are easily isolated from one another and can be readily examined. This is the case in the wing muscles of insects. The nuclei of the fibre are arranged close under the sarcolemma. Each is surrounded by a small quantity of sarcoplasm and in shape is an elongated ellipse. In most cases the muscle fibres do not branch, though in a few instances, such as the superficial muscles of the tongue, branching is found.

Involuntary or Smooth Muscle.—This particular form of muscle tissue when separated into its single constituents is seen to consist of fibres possessing a typical long spindle shape. The central part is somewhat swollen and contains an elongated nucleus centrally placed. The ends of the fibres are drawn out and pointed sharply. There is no definite surrounding membrane to each cell. In most of the cells, especially the larger, a distinct longitudinal marking can be seen. This is due to the presence of the fibrils which run the length of the fibre and are probably the essential contractile elements.

In most instances the cells are arranged to form bundles or sheets of contractile substance. In each bundle or sheet the cells are cemented to one another so that they may all act in unison. The cementing material is apparently membranous and is so arranged that contiguous fibres are only separated by a single layer of membrane. According to some, neighbouring fibres are connected to one another by minute offshoots, and these communications serve to explain the manner in which the contraction is observed to pass from fibre to fibre along a sheet composed of the muscles.

Involuntary muscle is the variety of muscle tissue found in the walls of the hollow viscera, such as the stomach, intestines, ureter, bladder, uterus, etc., and of the respiratory passages, in the middle coats of arteries, in the skin and the muscular trabeculae of the spleen. The arrangement is very typical, for instance, in the small intestine. Here the muscular coat consists of two layers of muscle. Each is in the form of a sheet which varies greatly in thickness in different animals. In the inner sheet the fibres, all parallel to one another, are disposed with their long axis transverse to the direction of the gut. In the outer layer, the direction of the fibres is at right angles to this. In a viscus with thick muscle walls the fibres are bound into bundles and the bundles may run in all directions. In some instances the bundles may form branching systems, thus constituting a network, notably in the bladder. In other instances, *e.g.,* the villi of the small intestine, the muscle fibres are separate, forming a felt-work with wide meshes.

Heart Muscle.—The fibres of which the muscular walls of the heart are composed though cross-striated are not voluntary. Each fibre is an oblongated cell possessing distinct transverse and less distinct longitudinal striations. There is no sarcolemma, and the nucleus of each fibre is placed in the centre. The longitudinal striation is due to the presence of fibrillae, each of which is cross striated. These lie parallel to one another in the cell, the sarcoplasm surrounding them being much more abundant in these fibres than in striated muscle. The fibrillae are arranged in rows, and when a transverse section of one of these fibres is examined it is seen that the rows radiate away from the centre of the cell. A further distinctive character of cardiac muscle fibres is that they frequently branch, the branches uniting with others from neighbouring cells. Moreover, the ends of the fibres are attached to corresponding faces of other cells, and through these attached faces the fibrillae pass, so that there is an approximation to the formation of a syncytium. (T. G. B.)

MUSCLE AND MUSCULAR EXERCISE. Muscle makes up a considerable, often a major fraction of the body, and many of the other functions are devoted to its service. It consists essentially of fibres, complete living units which are frequently of considerable length and about 0·05mm. in diameter. These fibres contain numerous minute fibrils embedded in the semi-liquid "sarcoplasm" inside the "sarcolemma." They are bound together by a connective tissue framework, and in the case of most voluntary muscles form anatomical units which are connected by tendons to the bony levers. Involuntary muscle, serving the "domestic" arrangements of the body (digestion, excretion, circulation, etc.), is usually in a sheet-like form, the fibres being mosaiced or cemented together to cover the organ operated. Cardiac muscle, intermediate between the other two types, consists of shorter fibres, apparently in direct physiological connection with one another, thus ensuring a co-ordinated response.

Animal movement is due to the shortening and thickening of these fibres, not to changes in their volume. This shortening is initiated, in the case of voluntary muscle, by an impulse from a nerve, but may be produced artificially by various means, chief of which is the electric shock. In cardiac muscle there is an inherent tendency to beat, and any piece of a heart, removed from contact with the rest, will proceed to shorten in its own intrinsic rhythm. In the normally functioning heart the speed is set by the quickest portion, viz., that near the entrance of the great veins, whence the beat is conducted rapidly from fibre to fibre so that the whole contracts approximately together. In involuntary muscle the fibres may show a rhythm of their own; more usually, like those of voluntary muscle, they require an impulse from a nerve; sometimes, as in the intestine, they possess also a primitive local nervous system co-ordinating their activity.

Voluntary muscle is richly supplied with blood vessels, bringing it fuel and oxygen. Even at rest the muscles require materials for combustion; they are the chief source of animal heat. If the resting heat production be insufficient, the animal either takes voluntary exercise or shivers, so increasing the output of heat from its muscles. At rest the majority of the blood capillaries are closed; during activity these open up and allow more blood to pass; this is supplied by the greater activity of the heart, and provided with oxygen by the enhanced efforts of the respiratory system.

The Mechanical Response.—The fundamental unit of muscular response is the twitch, contraction followed by relaxation. It is possible (though not certain) that in some muscles, *e.g.,* those holding closed the shells of bivalves, relaxation may not necessarily ensue; a semi-permanent change in length may occur on stimulation, the change requiring an expenditure of energy, but

the maintenance of the new length requiring none. In the vast majority of muscles, however, the unit of response involves relaxation as well as contraction, and a prolonged contraction can be maintained only by the fusion of a number of twitches in succession, so requiring a prolonged expenditure of energy. There are vast differences in the speed of the single twitch, which may occupy a few thousandths of a second in insects, and minutes, or even hours in some smooth muscles. A single twitch of given strength in a given length of muscle is associated always with a fairly constant liberation of total energy. If T dynes be the tension developed in the "isometric" twitch of a muscle fibre $l$cm. long, and if H ergs be the total energy set free (initial plus recovery) we have approximately, for all muscles, $\frac{H}{Tl}=\frac{1}{3}$. This relation is independent of the speed of response, so that in setting up a tension all muscles work similarly efficiently. In maintaining a tension for a given time, however, there are vast differences between muscles of different speed: those giving the quickest twitch require the highest frequency of stimulation to produce a properly fused summation, and expend correspondingly more energy. A muscle capable of giving a twitch in 0·003 second will liberate 20,000 times as much energy per second in maintaining a contraction as one whose twitch lasts for one minute. When, therefore, a force has to be maintained over long intervals a slow-moving muscle is essential. Ordinary voluntary movements are due to a fusion of twitches evoked by a rapid succession of impulses along the nerves.

The effect of a rise of temperature is to quicken the twitch and the rising phase of a tetanus. One effect of this quicker response is to make the maintenance of a contraction more expensive.

Much use has been made of the fact that muscles removed from the body may, under proper conditions, contract practically normally for many hours. The thinner the excised muscle the more satisfactory is its survival, since the usual provision of oxygen *via* the circulation must be replaced by diffusion from outside, which is a slow process over greater distances. It is common to immerse such muscles in "Ringer's fluid," a watery solution of salts in approximately the same concentrations as the blood.

The intrinsic strength of muscles is considerable. A frog's sartorius may exert a force of 2·5kilog. per sq.cm. of section, but this is small compared with the force of human muscles. In the human arm, for example, at a mechanical disadvantage of about 6:1, a force of 40 kilograms may be exerted at the hand by the biceps and brachialis muscles, with a cross-section of about 25sq.cms., which is about 10kilog. per square centimeter or approximately 10 atmospheres.

The "All-or-None" Principle.—It was shown by Keith Lucas that the twitch of a muscle fibre is independent of the strength of the impulse which evokes it, though dependent upon the condition of the fibre in its external and internal relations (temperature, length, preceding twitch, condition of fatigue, etc.). Strictly defined, this principle is universal and has the consequence that a muscular effort can be graduated in intensity only by adjusting the number of fibres employed in it, and not by adjusting the response of the individual fibres.

The Electric Response.—When a muscle fibre is excited a wave of negative potential, a few hundredths of a volt in magnitude and a few cms. in length, starts off in both directions from the stimulated point. The wave can be recorded, either in an excised muscle, or during voluntary movements in the body. This "electro-myogram" has been used very largely in investigations of the heart ("electrocardiogram") and considerably in studies of natural muscular movement. By means of it all voluntary and most reflex contractions have been shown to be of a discontinuous tetanic nature, due to a rapid succession of impulses reaching the muscle from the nerve; while a few reflex contractions, chiefly "tendon-jerks," have been found to be single twitches.

Tonic Contraction.—In the maintenance of body posture, and in preserving a readiness for instant action, a certain amount of muscle "tone" is necessary. When a muscle contracts, the tone of its antagonist is inhibited. It has been supposed that tone represents a different type of contraction, not of a tetanic nature, and it is reported that muscle fibres are doubly innervated, by voluntary and by sympathetic nerves; section of the sympathetic has been stated to cause a loss of tone. The evidence is not yet conclusive and there seems to be at present insufficient reason to regard tonic contraction as different, in principle, from ordinary tetanus; it is merely weaker, only a small fraction of the fibres being active at any given moment. Perhaps the fibres which are normally concerned with maintenance of tone are naturally slower than their fellows, and so more economical in maintaining a tension. Differences in speed in the different fibres of an individual muscle group are known to occur.

The Thermal Response.—When a muscle contracts it liberates heat. This can be measured directly by placing an isolated muscle on a thermopile connected to a sensitive galvanometer, when a rise of about 0·003° C. is found in a single twitch: or it can be studied by placing a complete animal in a calorimeter and causing it to work. "Myothermic" experiments have thrown much light on the internal mechanism of the muscle.

Fatigue.—When a muscle deprived of oxygen is given a succession of shocks it gradually weakens and finally ceases to respond. When a muscle with its circulation intact, or adequately supplied with oxygen, is similarly treated, its response diminishes at first, but finally reaches a "steady state," in which recovery balances breakdown. The first case corresponds to very violent exercise in man, where energy requirement is far in excess of possible oxygen supply; the second corresponds to steady work of moderate intensity where oxygen supply rapidly rises to meet energy requirement.

The Elastic Properties and Viscosity of Muscle.—A resting muscle possesses characteristic elastic properties, tension rising more than in proportion to extension. It shows also the phenomenon of "after-extension," continuing to lengthen (or shorten) for some time after being loaded (or released). An active muscle is different in its elastic properties, but shows a phenomenon analogous to the after-extension of resting muscle, viz., a "viscosity" which largely reduces, at high speeds of shortening, the amount of work which the muscle can perform. This viscosity, which is an essential factor in all muscles, greatest in those which move most slowly, acts in the sense of a "governor" or "automatic brake," preventing the animal from attaining speeds of movement sufficient to threaten the integrity of its structure.

The Chemistry of Muscle.—Muscle is about 75% water. Its fibres are imbedded in a connective tissue framework; protein forms their chief chemical constituent. Their contents are semi-fluid and can be squeezed out as "muscle plasma"; the residue, consisting chiefly of "sarcolemma," connective tissue and nuclei, contains keratin, mucin and nuclein. The ash of muscle forms 1% to 1·5% and consists chiefly of potassium and phosphates, with traces of calcium, magnesium, chlorine and iron. Of nitrogenous substances the most important is creatine: of non-nitrogenous bodies fat glycogen and lactic acid must be mentioned.

Lactic Acid and Glycogen in Muscle.—It has long been known that a muscle in fatigue or rigor becomes acid. The classical work of Fletcher and Hopkins (1907) placed the subject of lactic acid in muscle on an exact basis and established:—(i.) That lactic acid is formed during rest without oxygen, during activity or rigor, or after injury; (ii.) that its formation in an injured muscle can be delayed or prevented by sufficient oxygen; (iii.) that once formed it may disappear in the presence of oxygen.

These facts led to the work of A. V. Hill on heat-production during the recovery phase, by which it was shown that lactic acid formed during activity is not removed by oxidation but in some other way, presumably by resynthesis to a precursor. Meyerhof established glycogen (a carbohydrate $[C_6H_{12}O_6]_n$ discovered by Bernard in 1857) as this precursor, and it now seems clear that all, or nearly all, the energy exchanges of active muscle can be described as follows:—

A. Initial non-oxidative phase (yielding mechanical energy)

Glycogen—>unknown intermediary—>lactic acid—>K-lactate, the neutralization of the acid being effected by the alkali of the tissue itself:

B. Recovery oxidative phase (following activity and lasting

for 5 to 80 minutes).

K-lactate—>lactic acid—>intermediary—>glycogen, the energy for this endothermic reaction being derived, at any rate in the isolated muscle, from the oxidation of glycogen in amount about 22% of that restored from lactate.

This division of activity into two phases, (A) work without oxygen and (B) recovery with oxygen, is very important, and is found as a general phenomenon in living tissues. The rate of supply of oxygen *via* the circulation is necessarily limited, and this arrangement allows temporarily for much greater rates of expenditure of energy than would be possible were the muscle dependent on contemporary combustion. The mechanism is essentially that of an accumulator, a charge being stored and capable of release at a high rate for a time without oxidation, a recharge being necessary later, with the expenditure of energy derived from combustion of food material.

Fatigue appears to be due to the accumulation of lactic acid inside the muscle fibres, and further activity becomes impossible when its concentration reaches about 0·3%. Glycogen is necessary for activity.

Phosphates in Muscle.—The rôle of phosphates, although not yet clear, is obviously important. The total phosphorus in muscle varies widely but does not exceed 0·25%. Of this a certain variable fraction is combined with protein and fat-complexes, but probably plays no part in the chemical exchanges of activity. The remainder ("acid-soluble") has been studied under four heads:—A. Inorganic phosphate; B. Organic phosphate; i. rapidly hydrolysed by acid; ii. hydrolysed slowly by incubation of the muscle in alkali, but not rapidly by acid; iii. unaffected by treatment (i.) or (ii.).

(A) is small in resting muscle, but increases largely in fatigue and rigor; (B) (i.), which has often been mistaken for (A), is a compound of creatine and phosphate ("phosphagen"—Eggleton) which breaks down during stimulation and rigor, is restored in the presence of oxygen, but is not a source of lactic acid; (B) (ii.) is possibly a hexose-diphosphate; it breaks down during rigor, but may increase during activity; its usual connotation "lactacidogen" is quite unfortunate, since in activity at least it is not the immediate source of lactic acid. (B) (iii.) is probably a chemically stable hexose-monophosphate. These two hexose-phosphates have been isolated from muscle, the diphosphate being identical with that produced by yeast fermentation. Muscles are capable of synthesising hexosephosphates from glycogen and phosphoric acid. These phosphate compounds probably act as intermediaries in the breakdown of glycogen to lactic acid, the monophosphate perhaps being the immediate source of lactic acid in contraction.

There is a small but definite rise in blood phosphate following exercise; this, however, is not comparable in magnitude with that of blood lactic acid under similar conditions.

Muscular Exercise in Man.—Many of the factors described above are found in the case of muscular exercise in man. For example, muscle "viscosity" is very obvious in the case of movements made at high speed and explains the very exhausting nature of such exercise; while, together with the fact of energy expenditure during the maintenance of a contraction, it serves to determine an "optimum speed" for many types of movement. Recovery after exertion is well known, and its rate and extent can be measured by the amount of oxygen consumption which it occasions. Lactic acid is found in large quantities in the blood after exertion, and the "oxygen debt" allows its amount in the body as a whole to be calculated. Strong evidence has been found that in man glycogen is used preferentially as the immediate fuel of muscular exercise, as it is in laboratory experiments on isolated muscles. Recent applications indeed of academic muscle physiology have afforded an interesting and gratifying page in the history of applied science.

The Energy Exchanges of Exercise.—Various methods have been employed of measuring the energy liberated in the body, which of course all comes from the combustion of foodstuffs in the active tissues. A man has been placed in a calorimeter and his energy output determined directly; but, except for special purposes, this method is laborious and inadaptable. The most convenient procedure is to measure the oxygen consumption (O_2) and the carbon dioxide production (CO_2), which can be done by a collection, analysis and measurement of the air breathed out. Tables have been constructed from which, knowing the (O_2) and the (CO_2), the energy value of 1 litre of oxygen can be read off: or, in exercise of short duration, it is usually simpler and just as accurate to assume that 1 litre of oxygen corresponds to the following amount of energy (calculated for the combustion of glycogen). 1 litre of oxygen=5·14 calories=15,860 foot-pounds.

The oxygen consumption can be measured during exercise of all kinds, even running, skating, ski-ing and swimming.

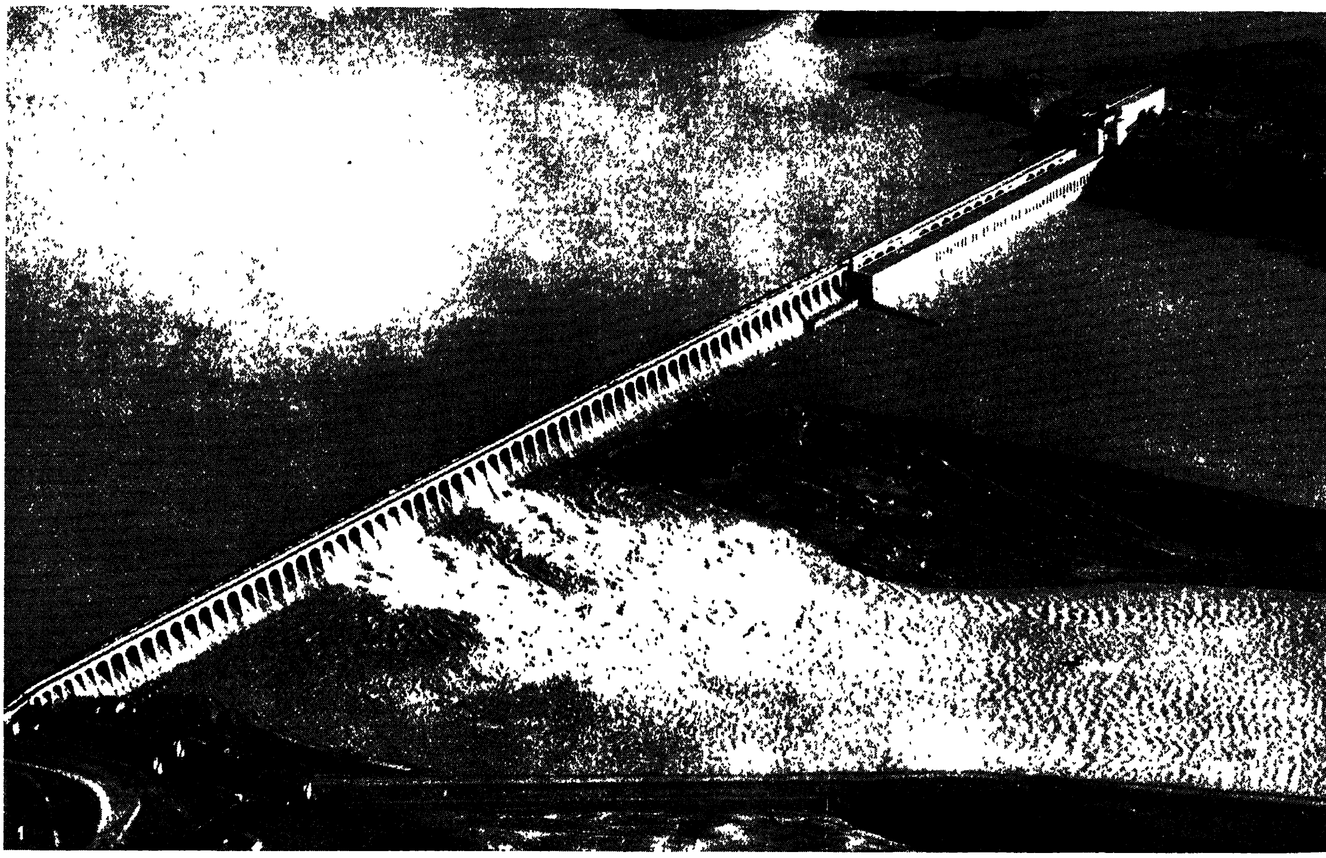
The "Oxygen Income."—When exercise commences the oxygen consumption begins to rise, and in two or three minutes (sooner in some, later in other forms of exercise) it attains its full value. This gradual rise is occasioned, or accompanied, by several events:— (i.) the acceleration of the heart and the quickening of the circulation; (ii.) the deepening and quickening of respiration; (iii.) the gradual accumulation of lactic acid in tissues and blood.

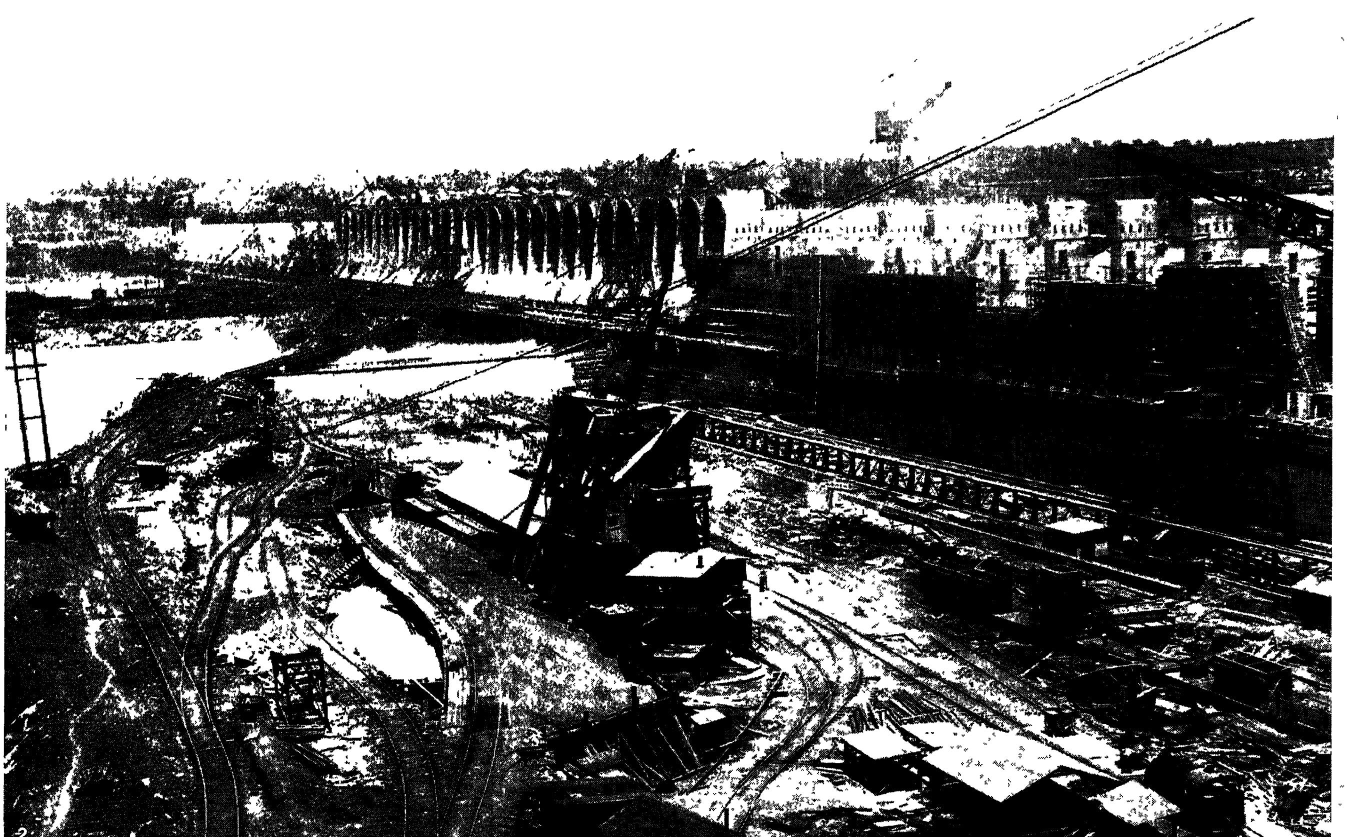
When exercise ends the oxygen consumption begins to decrease, and in 5 to 80 minutes, depending on the violence and duration of the preceding exercise, it falls to its original value again. During this fall (i.) the heart and circulation return to their previous rate; (ii.) the respiration reverts to its resting condition; (iii.) the excess of lactic acid in the blood and tissues disappears.

During the exercise, if moderate, a "steady state" may be attained, the increasing rate of oxygen consumption leading to an increasing rate of lactic acid removal, until finally a balance is struck at levels of lactic acid concentration and of oxygen consumption which are characteristic of the exercise. If, however, the exercise be too intense no balance is possible, since there is a strict limit to the rate at which oxygen can be supplied to the muscle fibres, even with the most strenuous efforts of heart and lungs to cope with the situation. The rate of lactic acid formation is then never balanced by that of its removal, and fatigue and exhaustion gradually set in. Thus the limit of prolonged exertion is set by the "maximum oxygen income" of the body. This in athletic men of ordinary size is usually about 4 litres per minute, corresponding to a total energy liberation of about 63,400ft.lb. per minute. It is found that, under good conditions, the "mechanical efficiency" of a man at work, viz. (work done)÷(total energy used), may rise as high as 25%, so that, during prolonged work the greatest possible mechanical output of a man is about 15,860ft.lb. per minute, or just under ½ horse-power.

In less athletic individuals the maximum oxygen income is smaller and the upper limit of exertion lower; it is smaller also during exercise in which the body is held in a constrained position, or part only of it used. The rôle played by the heart in severe exercise should be noted. To distribute 4 litres of oxygen at least 30 litres of blood must be pumped round the body every minute; the whole of the blood must circulate six times.

Recovery from Exertion.—In the isolated muscle suspended in oxygen recovery from considerable exertion takes many hours, owing to the slowness of the oxygen supply by diffusion alone. In the intact animal at rest after exercise the supply of oxygen, except in the earliest moments of recovery, is more than adequate and recovery goes on at its own intrinsic rate, unaffected by considerations of oxygen supply. After moderate exertion recovery is quick—there has been no considerable accumulation of lactic acid, and the body returns rapidly to its resting state. The "oxygen debt" at the end of the exercise may be of the order of 1 or 2 litres but not more; and this is soon paid off. After harder exercise, however, in which the oxygen requirement has been considerably in excess of the maximum oxygen supply, there may be large quantities (up to 100gms. or more) of lactic acid in the tissues, and this will require large quantities of oxygen for its removal. The highest recorded value of the "oxygen debt" at the end of exercise is nearly 20 litres, but one of 15 litres is a very fair performance. It will be seen at once that this possibility of "running into debt" for a large quantity of the oxygen required has a considerable influence on the degree of strenuousness of the exercise which can be undertaken for a limited period. Without this "accumula-





BY COURTESY OF (1) THE U.S. ARMY AIR CORPS, OFFICIAL PHOTOGRAPH, (2) THE U.S. CORPS OF ENGINEERS

VIEWS OF THE WILSON DAM, MUSCLE SHOALS, ALABAMA

1. Aeroplane view of Wilson dam, 4,300 ft. in length, in the Muscle Shoals section of the Tennessee river, Alabama

2. Wilson dam, seen from the south bank on the down stream side, showing construction work in progress

tor function" in muscle, no effort of any considerable severity could be made.

After violent exertion, recovery may take a considerable time, up to 80 minutes for the case when exercise was prolonged as well as strenuous. Even 100 yards run at top speed may require 50 minutes for complete recovery. Fitter individuals tend to have a higher recovery rate.

The Effect of Breathing High and Low Pressures of Oxygen.—During prolonged and strenuous exertion unpleasant subjective feelings may be much relieved by breathing oxygen instead of air, and measurement shows that under such conditions a considerable rise in the oxygen intake may take place. The blood, rushing at high speed through the lung capillaries, apparently does not collect its full quota of oxygen unless diffusion through the lung membranes is quickened up. Conversely, by low oxygen pressures the unpleasant subjective feelings may be aggravated and the rate of oxygen intake diminished. This is of great importance at high altitudes; no amount of "acclimatisation" will compensate completely for the lower pressure of oxygen in the lung alveoli. At high altitudes dyspnoea more rapidly sets in, the tendency to work by incurring an oxygen debt is more insistent, while at extreme heights the rests for recovery become more frequent since the oxygen income is so largely diminished. The administration of oxygen brings immediate relief, by quickening the passage of oxygen into the blood, as well as by supplying the brain and heart with oxygen at a higher partial pressure.

Muscular Training.—Very little physiological knowledge exists as to the nature of the changes that come over the body during muscular training. There are many possibilities: (1) Better muscular co-ordination, involving more economical and better directed movement; (2) an improvement in those chemical relationships of the tissues which determine the speed of recovery; (3) greater mechanical strength in the connective tissue of the muscles and in the sarcolemma of the fibres; (4) an increased oxygen carrying power of the blood; (5) a more complete capillary circulation, and a better lymph supply; (6) an increase in the alkali-reserve of the blood and muscle fibres, resulting in a greater lactic acid tolerance; (7) an increase in muscle glycogen, and possibly in the phosphate intermediaries of the lactic acid breakdown; (8) a more powerful heart beat, perhaps due to improvements in the coronary circulation.

The list might be extended considerably, but to little purpose. To illustrate the inadequacy of present knowledge the case of muscular stiffness may be cited. Some individuals readily become stiff, others do not. A fit and healthy man may be reduced to the extremity of stiffness by a few seconds of unaccustomed exercise: yet, on another occasion, having been "trained" by a few previous bouts of the same exertion, he is completely unaffected. This case is mentioned specifically because the layman, discussing muscular exercise with a physiologist, often tends to ask the cause of muscular stiffness, to which, at present, if he be honest, the physiologist must reply that he does not know.

BIBLIOGRAPHY.—Publications of the Industrial Fatigue Research Board, H.M. Stationery Office, London; Publications of the Nutrition Laboratory, Carnegie Institution, Washington; F. A. Bainbridge, *The Physiology of Muscular Exercise* (2nd ed. rev. 1923); Sir W. M. Bayliss, *Principles of General Physiology* (1924); J. Barcroft, *The Respiratory Function of the Blood;* Part I. "Lessons from High Altitudes" (1925); J. F. Fulton, *Muscular Contraction and the Reflex Control Movement* (1926); J. J. R. Macleod, *Physiology and Biochemistry in Modern Medicine* (1926); E. H. Starling, *Principles of Human Physiology* (1926); A. V. Hill, *Muscular Activity;* Lectures on the Herter Foundation, 1924 (1926), *Muscular Movement in Man;* George Fisher Baker Lectures in Chemistry, Vol. III. (1927), *Living Machinery: Lectures before a "juvenile auditory" at the Royal Institution* (1927). (A. V. H.)

MUSCLE SHOALS, a name given to a section of the Tennessee river, approximately 37 m. long, above Florence, Alabama. In this distance the river drops 132 ft. when it is discharging its average flow. The above section of the river is made up of rapids and connecting pools that collectively make navigation of the river in its natural state impossible. The first part of the name is probably the obsolete form of mussel, which is derived from Lat. *musculus,* dim. of *mus,* mouse.

The discharge of the Tennessee river in the Muscle Shoals section is produced by an average annual rainfall of about 45 in., falling on a catchment basin 30,800 sq.m. in area. The volume of water thus created, uninfluenced by artificial storage, has varied from 5,000 cu.ft. per second to a maximum of 500,000 cu.ft. In the earlier colonial days the Tennessee river was considered of sufficient importance by the Federal Government to receive more or less continuous engineering study from the time of George Washington down to 1918, when President Wilson ordered the building on Muscle Shoals, near Florence, of the structures shown in the Plate as a war and national defence measure.

As a result of the various navigation surveys and studies of Muscle Shoals, made between 1828 and 1889, a small and incomplete set of lateral canals and locks were completed in 1890 by the Federal Government. These locks and canals proved of practically no value because of the absence of sufficient tonnage either up or down the river. In 1907 the Federal Government ordered the chief of army engineers to make a new examination of Muscle Shoals for the purpose of ascertaining its navigation and hydro-electric power possibilities. As a result of these examinations and of succeeding official and private studies, sufficient engineering data of a reliable character had been assembled to warrant President Wilson in 1918 ordering the construction of what was then named dam No. 2 on the Tennessee river, as a part of the general plan prepared by the U.S. army engineers for the improvement of the entire Muscle Shoals stretch of the river. Actual construction of dam and power-house No. 2 was begun by the war department in April, 1918, as an emergency war measure, to aid in the supply of nitric acid for war needs in lieu of Chilean nitrate of soda. The termination of the war in 1918 found the plant only about 30% completed, and the question then arose as to whether to complete or abandon the power-plant and navigation work at Muscle Shoals. The plan to finish the structure prevailed, and the initial installation shown in the figure was placed in practical commission in Sept. 1925.

The entire length of dam and power-house is 4,300 ft., divided by expansion joints into 90 sections. Field measurements showed that the aggregate of the temperature and other changes in the lengths of these 90 sections was over 9 inches. The masonry crest of the dam is surmounted by flood gates, by the operation of which a uniform pool level can be maintained above the dam independent of the quantity of water flowing through the pool, and independent of the amount of water used for power purposes. The capacity of the flood gates is any discharge up to a maximum of one million cu.ft. per second, or three times the maximum discharge of the St. Lawrence river in the International section.

When the economically feasible storage basins officially planned for the valley of the Tennessee river above dam No. 2 are in commission, the Tennessee river as a whole will add 3,000,000 hydro-electric horse-power to the industrial resources of over twelve million people in seven Southern States. Dam No. 2 at Florence, Ala., will be the major unit upon which will be founded a superpower system of great value to the South. (H. Co.)

MUSCOVITE, a rock-forming mineral belonging to the mica group (*see* MICA). It is also known as potash-mica, being a potassium, hydrogen and aluminium orthosilicate, $H_2KAl_3(SiO_4)_3$. As the common white mica obtainable in thin, transparent cleavage sheets of large size it was formerly used in Russia for window panes and known as "Muscovy glass"; hence its name. It crystallizes in the monoclinic system; distinctly developed crystals, however, are rare and have the form of rough six-sided prisms or plates; thin scales without definite crystal outlines are more common. The most prominent feature is the perfect cleavage parallel to the basal plane, on which the lustre is pearly in character. The hardness is 2–2½, and the specific gravity 2·8–2·9.

Muscovite frequently occurs as fine scaly to almost compact aggregates, especially when, as is often the case, it has resulted by the alteration of some other mineral, such as felspar, topaz, kyanite, etc. Varieties depending both on differences in structure and in chemical composition have been distinguished. Scaly varieties are damourite, gilbertite, sericite (Gr. σηρικός, silky), etc. In sericite the fine scales are united in fibrous aggregates

giving rise to a silky lustre: this variety is a common constituent of phyllites and sericite-schists. Several compact minerals, included together under the name pinite, have resulted by the alteration of cordierite, spodumene and other minerals. Fuchsite or "chrome-mica," is a bright green variety containing chromium.

Muscovite is of wide distribution and is the commonest of the micas. In igneous rocks it is found only in granite, never in volcanic rocks; but it is abundant in gneiss and mica-schist, and in phyllites and clay-slates, where it has been formed at the expense of alkali-felspar by dynamo-metamorphic processes. In pegmatite-veins traversing granite, gneiss or mica-schist it occurs as large sheets of commercial value, and is mined in India, East Africa, the United States and Brazil.

MUSCULAR SYSTEM, ANATOMY OF (*see* also MUSCLE, STRUCTURE OF). Here only the voluntary muscles, under the control of the will, are considered.

The voluntary muscles form the red flesh of an animal, and are the structures by which one part of the body is moved at will upon another. Each muscle is said to have an origin and an insertion, the former being that attachment which is usually more fixed, the latter that which is more movable. This distinction, though convenient, is arbitrary, as an example will show. The *pectoralis major* being attached to the front of the chest and to the upper part of the arm bone its contraction draws the arm towards the chest, whereas, when, in climbing a tree, the hand grasps a branch above, contraction will draw the chest towards the arm. Generally, a muscle is partly fleshy and partly tendinous; the fleshy contractile part is attached at one or both ends to cords or sheets of white fibrous tissue, which in some cases pass round pullies and so change the direction of the muscle's action. The other end of these cords or *tendons* is usually attached to the periosteum of bones, with which it blends. In some cases, when a tendon passes round a bony pulley, a sesamoid bone is developed in it which diminishes the effects of friction. A good example of this is the patella in the tendon of the *rectus femoris* (fig. 1).

Every muscle is supplied with blood vessels and lymphatics (fig. 1), and with one or more nerves. The nerve supply is very important both from a medical and a morphological point of view. The attachments are also important, as determining the action of the muscle. This action cannot be understood by reference to the dead body alone, for every movement expresses the balanced contractions of numerous muscles. (*See* C. E. Beevor, *Croonian Lectures for 1903,* London, 1904.)

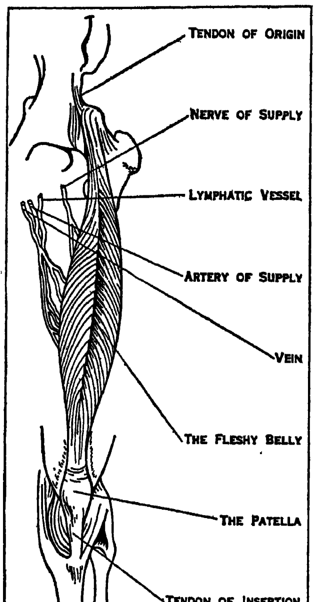
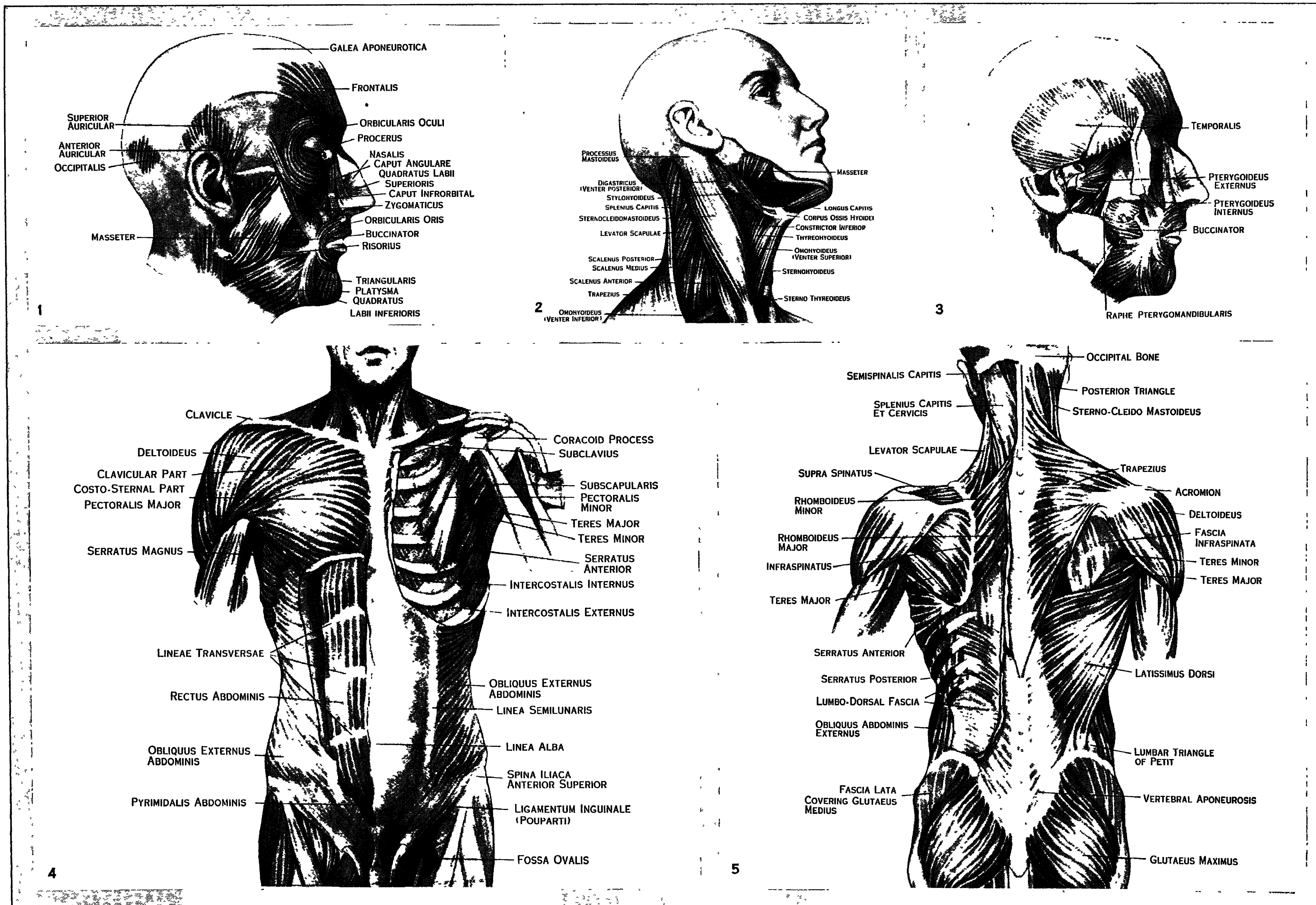


FIG. 1.—THE RECTUS MUSCLE OF THE THIGH, SHOWING THE CONSTITUENT PARTS OF A MUSCLE

Muscles may be fusiform, as in fig. 1, conical, riband-like, or flattened into triangular or quadrilateral sheets. They may also be attached to skin, cartilage or fascia instead of to bone, while certain muscles surround openings which they constrict and are called *sphincters.* The names of the muscles have gradually grown up, and no settled plan has been used in giving them. The German anatomists at the Basle conference lately proposed a uniform Latin and Greek nomenclature, which, though not altogether satisfactory, is gaining ground on the European continent. As there are some four hundred muscles on each side of the body it will be impossible here to attempt more than a mere sketch; for the details the anatomical textbooks must be consulted.

Muscles of the Head and Face (Pl. I.–1).—The scalp is moved by a large flat muscle called the *occipito-frontalis,* which has two muscular bellies, the *occipitalis* and *frontalis,* and an intervening *epicranial aponeurosis;* this muscle moves the scalp and causes the transverse wrinkles in the forehead. The *anterior, posterior* and *superior auricular muscles* are present but are almost functionless in man. The *orbicularis palpebrarum* forms a sphincter round the eyelids, which it closes, though there is little doubt that parts of the muscle can act separately and cause various expressions. The side of the nose has several muscles, the actions of which are indicated by their names; they are the *compressor,* two *dilatores* and the *depressor alae nasi,* while the *levator labii superioris et alae nasi* sometimes goes to the nose. Raising the upper lip, in addition to the last named, are the *levator labii superioris proprius* and the *levator anguli oris,* while the *zygomaticus major* draws the angle of the mouth outward. The lower lip is depressed by the *depressor labii inferioris* and *depressor anguli oris,* while the *orbicularis oris* acts as a sphincter to the mouth. The *buccinator muscle* in the substance of the cheeks rises from the upper and lower jaws and runs forward to blend with the *orbicularis oris.* All the foregoing are known as muscles of expression and all are supplied by the seventh or facial nerve. The *temporal muscle* at the side of the cranium (Pl. I.–3) and the *masseter* (Pl. I.–2), which rises from the zygoma, close the mouth, since both are inserted into the ramus of the mandible; while, rising from the pterygoid plates, are the *external* and *internal pterygoid muscles* (Pl. I.–3), the former of which pulls forward the condyle, and so the whole mandible, while the latter helps to close the mouth by acting on the angle of the lower jaw. This group of muscles forms the masticatory set, all of which are supplied by the third division of the fifth nerve. For the muscles of the orbit, *see* EYE; for those of the soft palate and pharynx, *see* PHARYNX; and for those of the tongue, *see* TONGUE.

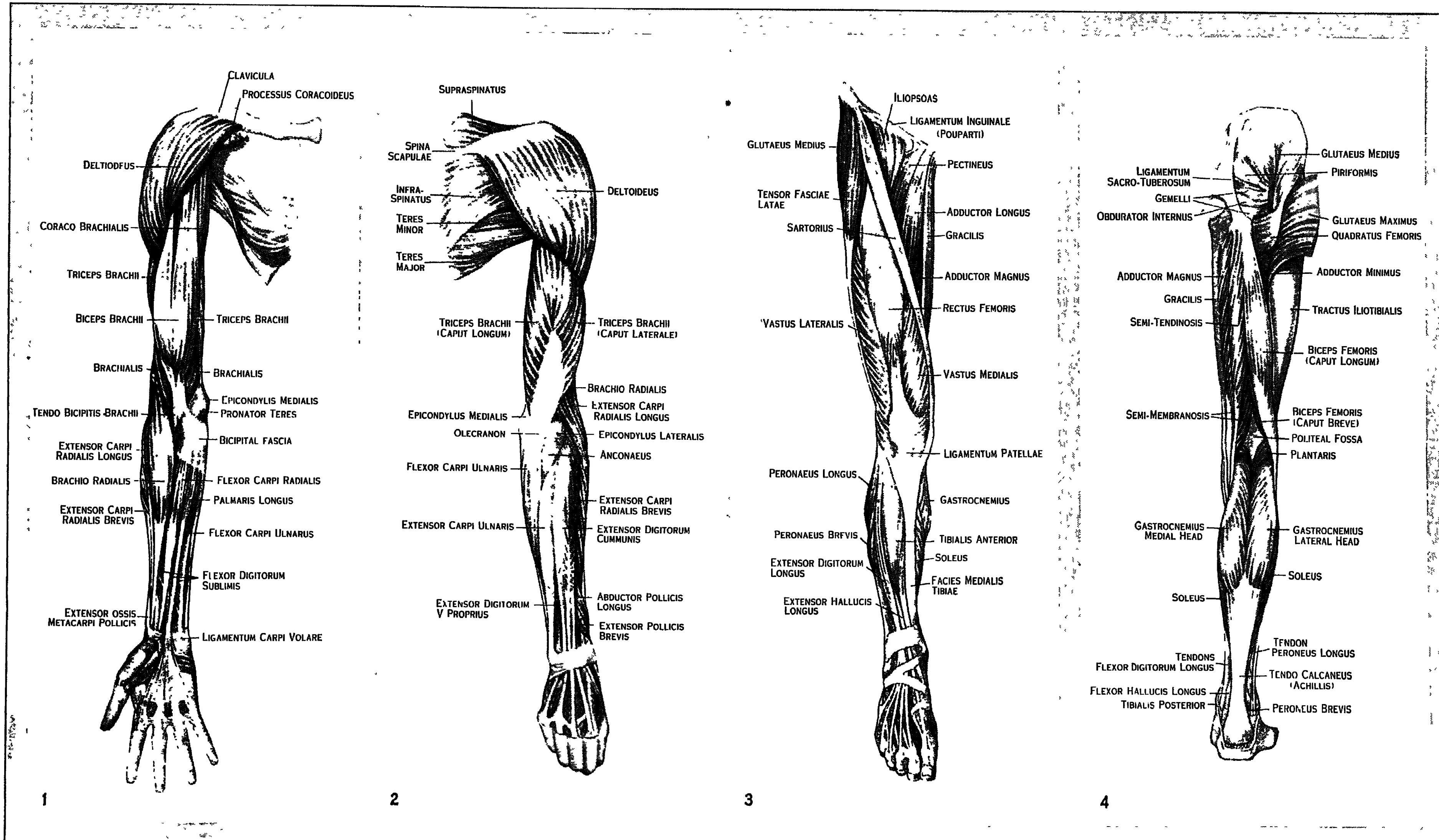
Muscles of the Neck (Pl. I.–2).—Just below the mandible is the *digastric,* which, as its name shows, has two bellies and a central tendon; the anterior belly, supplied by the fifth nerve, is attached to the mandible near the symphysis, the posterior supplied by the seventh of the mastoid process, while the central tendon is bound to the hyoid bone. Stretching across from one side of the lower jaw to the other and forming a floor to the mouth is the *mylo-hyoid muscle;* posteriorly this reaches the hyoid bone, and in the mid-line has a tendinous raphe separating the two halves of the muscle. Rising from the manubrium sterni and inner part of the clavicle is the *sterno-cleido-mastoid,* which is inserted into the mastoid process and superior curved lines of the occipital bone; when it contracts it makes the face look over the opposite shoulder, and it is supplied by the spinal accessory nerve as well as by branches from the cervical plexus. It is an important surgical landmark, and forms a diagonal across the quadrilateral outline of the side of the neck, dividing it into an anterior triangle with its apex downward and a posterior with its apex upward. In the anterior triangle the relative positions of the hyoid bone, thyroid cartilage and sternum should be realized, and then the *hyo-glossus, thyro-hyoid, sterno-hyoid* and *sterno-thyroid* muscles are explained by their names. The *omo-hyoid* muscle rises from the upper border of the scapula and runs across both triangles to the hyoid bone. Where it passes deep to the sterno-mastoid it has a central tendon which is bound to the first rib by a loop of cervical fascia. Rising from the styloid process are three muscles, the *stylo-glossus, stylo-hyoid* and *stylo-pharyngeus,* the names of which indicate their attachments. Covering these muscles of the anterior triangle is a thin sheet, close to the skin, called the platysma, the upper fibres of which run back from the mouth over the cheek and are named the *risorius* (Pl. I.–1); this sheet is one of the few remnants in man of the skin musculature or *panniculus carnosus* of lower mammals. With regard to the nerve supply of the anterior triangle muscles, all those which go to the tongue are supplied by the hypoglossal or twelfth cranial nerve, while the muscles below the hyoid bone are apparently supplied from this nerve but really from the upper cervical nerves (*see* NERVE, CRANIAL; and NERVE, SPINAL). The posterior triangle is formed by the *sterno-mastoid* in front, the *trapezius* behind, and the clavicle below; in its floor from above downward part of the following muscles are seen: *complexus, splenius, levator anguli scapulae, scalenus medius* and *scalenus anticus.* Sometimes a small piece of the *scalenus posticus*



MUSCULAR CONSTRUCTION OF HEAD, NECK AND TRUNK

1. Muscles of the face and scalp (muscles of expression)
2. The triangles of the neck
3. Pterygoid region (base of skull)
4. Anterior muscles of the trunk
5. Posterior muscles of the trunk

MUSCULAR SYSTEM



MUSCULAR CONSTRUCTION OF THE ARMS AND LEGS

1. Muscles of the arm and forearm (front)
2. Muscles of the arm and forearm (back)
3. Muscles of the thigh and leg (front)
4. Muscles of the thigh and leg (back)

is caught sight of behind the scalenus medius. The splenius rotates the head to its own side, the levator anguli scapulae raises the upper angle of the scapula, while the three scalenes run from the transverse processes of the cervical vertebrae and fix or raise the upper ribs. The trapezius (Pl. I.–5) arises from the spines of the thoracic vertebrae and the ligamentum nuchae, and is inserted into the outer third of the clavicle and the spine of the scapula; it is used in shrugging the shoulders and in drawing the upper part of the scapula toward the mid-dorsal line. Its nerve supply is the spinal accessory and third and fourth cervical nerves. When the superficial muscles and complexus are removed from the back of the neck, the *sub-occipital* triangle is seen beneath the occipital bone. Externally it is bounded by the *superior oblique,* running from the transverse process of the atlas to the lateral part of the occipital bone, internally by the *rectus capitis posticus major,* passing from the spine of the axis to the lateral part of the occipital bone, and inferiorly by the *inferior oblique* joining the spine of the axis to the transverse process of the atlas. These muscles move the head on the atlas and the atlas on the axis. They are supplied by the posterior branch of the first cervical nerve.

Muscles of the Trunk.—The trapezius has already been described as a superficial muscle of the upper part of the back; in the loin region the *latissimus dorsi* (Pl. I.–5) is the superficial muscle, its origin being from the lower thoracic spines, lower ribs and lumbar fascia, and it is inserted into the upper part of the arm bone. When the trapezius is cut, the *rhomboid muscles* (major and minor) passing from the upper thoracic spines to the vertebral border of the scapula are seen, and deep to these is the *serratus posticus superior* passing from nearly the same spines to the upper ribs. On reflecting the latissimus dorsi the *serratus posticus inferior* is seen running from the lower thoracic spines to the lower ribs. When these muscles are removed the great mass of the *erector spinae* is exposed, familiar to every one as the upper cut of the sirloin or ribs of beef; it runs all the way up the dorsal side of the vertebral column from the pelvis to the occiput, the complexus already mentioned being its extension to the head. It is longitudinally segmented into many different bundles to which special names are given, and it is attached to the various vertebrae and ribs as it goes up, thus straightening the spinal column. Deep to the erector spinae are found shorter bundles passing from one vertebra to another and forming the *semispinalis* and *multifidus spinae* muscles. The latissimus dorsi and rhomboids are supplied by branches of the brachial plexus of nerves, while the deeper muscles get their nerves from the posterior primary divisions of the spinal nerves (*see* NERVE, SPINAL). On the anterior part of the thoracic region the *pectoralis major* runs from the clavicle, sternum and ribs, to the humerus (Pl. I.–4); deep to this is the *pectoralis minor,* passing from the upper ribs to the coracoid process. The *serratus magnus* is a large muscle rising by serrations from the upper eight ribs, and running back to the vertebral border of the scapula, which it draws forward as in the fencer's lunge. Between the ribs are the *external* and *internal intercostal* muscles; the former beginning at the tubercle and ending at the junctions of the ribs with their cartilages, while the latter only begin at the angle of the ribs but are prolonged on to the sternum, so that an interchondral as well as an intercostal part of each muscle is recognized. The fibres of the external intercostals run downward and forward, those of the internal downward and backward (*see* RESPIRATION). The abdominal walls are formed of three sheets of muscle, of which the most superficial or *external oblique* (Pl. I.–4) is attached to the outer surfaces of the lower ribs; its fibres run downward and forward to the pelvis and mid-line of the abdomen, the middle one or *internal oblique* is on the same plane as the ribs, and its fibres run downward and backward, while the *transversalis* is attached to the deep surfaces of the ribs, and its fibres run horizontally forward. Below, all these muscles are attached to the crest of the ilium and to Poupart's ligament, which is really the lower free edge of the external oblique, while, behind, the two deeper ones, at all events, blend with the fascia lumborum. As they approach the mid-ventral line they become aponeurotic and form the *sheath of the rectus.* The *rectus abdominis* (Pl. I.–4) is a flat muscular band which runs up on each side of the linea alba or mid-ventral line of the abdomen from the pubis to the ribs and sternum. This muscle has certain tendinous intersections or *lineae transversae,* the positions of which are noticed in the article ANATOMY (*Superficial and Artistic*), and the morphology of which is referred to later. In front of the lowest part of the rectus is sometimes a small triangular muscle called the *pyramidalis.* The *quadratus lumborum* is a muscle at the back of the abdominal wall which runs between the last rib and the crest of the ilium. In front of the bodies of the vertebrae is a prevertebral or hypaxial musculature, of which the *rectus capitis anticus major* and *minor* muscles and *longus colli* in the neck and the *psoas* in the loins form the chief parts, the latter being familiar as the undercut of the sirloin of beef, while the pelvis is closed below by a muscular floor formed by the *levator ani* and *coccygeus* muscles. The diaphragm is explained in a separate article.

Muscles of the Upper Extremity.—The *deltoid* (see Pl. I.–4 and 5) is the muscle which forms the shoulder cap and is used in abducting the arm to a right angle with the trunk; it runs from the clavicle, acromial process and spine of the scapula, to the middle of the humerus, and is supplied by the circumflex nerve. Several short rotating muscles pass from the scapula to the upper end of the humerus; these are the *subscapularis* passing in front of the shoulder joint, the *supraspinatus* above the joint, and the *infraspinatus* and *teres minor* behind. The *teres major* (Pl. I.–4 and 5) comes from near the lower angle of the scapula, and is inserted with the latissimus dorsi into the front of the surgical neck of the humerus. The *coracobrachialis* (Pl. II.–1) passes from the coracoid process to the middle of the humerus in front of the shoulder joint, while the *brachialis anticus* passes in front of the elbow from the humerus to the coronoid process of the ulna. Passing in front of both shoulder and elbow is the *biceps* (Pl. II.–1), the long head of which rises from the top of the glenoid cavity inside the joint, while the short head comes from the coracoid process. The insertion is into the tubercle of the radius. These three muscles are all supplied by the same (musculo-cutaneous) nerve. At the back of the arm is the *triceps* (Pl. II.–2) which passes behind both shoulder and elbow joints and is the great extensor muscle of them; its long head rises from just below the glenoid cavity of the scapula, while the inner and outer heads come from the back of the humerus. It is inserted into the olecranon process of the ulna and is supplied by the musculo-spinal nerve. The muscles of the front of the forearm form superficial and deep sets (Pl. II.–1). Most of the superficial muscles come from the internal condyle of the humerus. From without inward they are the *pronator radii teres* going to the radius, the *flexor carpi radialis* to the base of the index metacarpal bone, the *palmaris longus* to the palmar fascia, the *flexor sublimis digitorum* to the middle phalanges of the fingers, and the *flexor carpi ulnaris* to the pisiform bone. The important points of practical interest about these muscles are noticed in the article ANATOMY (*Superficial and Artistic*). In addition to these the brachio-radialis is a flexor of the forearm, though it arises from the outer supracondylar ridge of the humerus. It is supplied by the musculo-spiral nerve, the flexor carpi ulnaris by the ulnar, the rest by the median. The deep muscles of the front of the forearm consist of the *flexor longus pollicis* running from the radius to the terminal phalanx of the thumb, the *flexor profundus digitorum* from the ulna to the terminal phalanges of the fingers, and the *pronator quadratus* passing across from the lower third of the ulna to the same amount of the radius. These three muscles are supplied by the anterior interosseous branch of the median nerve, but the flexor profundus digitorum has an extra twig from the ulnar. The extensor muscles at the back of the forearm are also divided into superficial and deep sets (see Pl. II.–2). The former rise from the region of the external condyle of the humerus, and consist of the *extensor carpi radialis longior* and *brevior* inserted into the index and medius metacarpal bones, the *extensor communis digitorum* to the middle and distal phalanges of the fingers, the *extensor minimi digiti,* the *extensor carpi ulnaris* passing to the metatarsal bone of the minimus, and the *supinator brevis* wrapping round the neck of the radius to which it is inserted. The *aconeus* which runs from the external condyle to the olecranon process is really a part of the triceps. The deep mus-

cles rise from the posterior surfaces of the radius and ulna, and are the *extensor ossis metacarpi pollicis,* the name of which gives its insertion, the *extensor brevis pollicis* to the proximal phalanx, and the *extensor longus pollicis* to the distal phalanx of the thumb, while the *extensor indicis* joins the extensor communis slip to the index finger; all these posterior muscles are supplied by the posterior interosseous nerve. In front and behind the wrist the tendons are bound down by the anterior and posterior annular ligaments, while on the flexor surface of each finger is a strong fibrous sheath or *theca* for the flexor tendons. The ball of the thumb is occupied by short muscles called the *thenar* group, while *hypothenar* muscles are found in the ball of the little finger. The four *lumbrical* muscles (fig. 2) run from the flexor profundus digitorum tendons to those of the extensor communis between the heads of the metacarpal bones while, rising from the shafts of these bones, are the three *palmar* and four *dorsal interosseous* muscles (fig. 2) which also are inserted into the extensor tendons. The two outer lumbricals and the *thenar* muscles are supplied by the median nerve; all the other hand muscles by the ulnar.

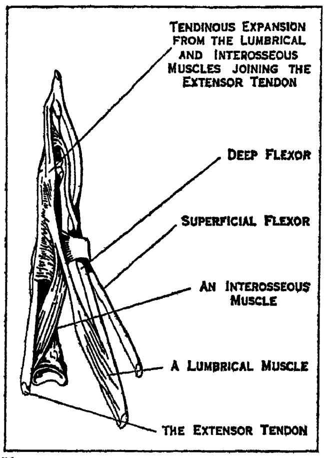


FIG. 2.—FIGURE SHOWING TENDONS ATTACHED TO A FINGER

Muscles of the Lower Extremity.—On the front of the thigh the *quadriceps extensor* muscles are the most important: there are four of these, the *rectus femoris* (fig. 1) with its straight and reflected heads rising from just above the acetabulum, the *crureus,* deep to this, from the front of the femur, and the *vastus externus* and *internus* wrapping round the femur on each side from the linea aspera. All these are inserted into the patella, or rather the patella is a sesamoid bone developed where their common tendon passes round the lower end of the femur when the knee is bent. The distal part of this tendon, which passes from the patella to the tubercle of the tibia, is the *ligamentum patellae.* The *sartorius* is a long riband-like muscle running from the anterior superior spine of the ilium to the inner surface of the tibia, obliquely across the front of the thigh. It forms the outer boundary of *Scarpa's triangle,* the inner limit of which is the adductor longus and the base Poupart's ligament. The floor is formed by the *iliacus* from the iliac fossa of the pelvis, which joins the psoas, to be inserted with it into the lesser trochanter, and by the *pectineus* running from the upper ramus of the pubis to just below the insertion of the last muscles. The *adductor* muscles, *longus, brevis* and *magnus,* all rise from the subpubic arch, and are inserted into the linea aspera of the femur, so that they draw the femur toward the middle line. The *gracilis* (Pl. II.–3) is part of the adductor mass, though its insertion is into the upper part of the tibia. The extensor muscles of the front of the thigh are supplied by the anterior crural nerve, but the adductor group on the inner side from the obturator. The pectineus is often supplied from both sources. On the back of the thigh the *gluteus maximus* (Pl. I.–5 and Pl. II.–4) plays a great part in determining man's outline (*see* ANATOMY: *Superficial and Artistic*). It rises from the sacral region, and is inserted into the upper part of the femur and the deep fascia of the thigh, which is very thick and is known as the *fascia lata;* the muscle is a great extensor of the hip and raises the body from the stooping position. The *gluteus medius* rises from the ilium, above the hip joint, and passes to the great trochanter; it abducts the hip and enables the body to be balanced on one leg, as in taking a step forward. The *gluteus minimus* is covered by the last muscle, and passes from the ilium to the front of the great trochanter, thus rotating the hip joint inward. Some of its anterior fibres are sometimes separate from the rest, and are then called the *scansorius.* When the gluteus maximus is removed, a number of short externally rotating muscles are seen, rising from the pelvis and inserted into the great trochanter (Pl. II.–4); these are, from above downward, the *piriformis, gemellus superior, obturator internus, gemellus inferior* and *quadratus femoris.* They are all supplied by special branches of the sacral plexus. On cutting the quadratus femoris a good deal of the *obturator externus* can be seen, coming from the outer surface of the obturator membrane and passing to the digital fossa of the great trochanter. Unlike the rest of this group, it is supplied by the obturator nerve. Coming from the anterior part of the crest of the ilium is the *tensor fasciae femoris,* which is inserted into the fascia lata, as is part of the gluteus maximus, and the thickened band of fascia which runs down the outer side of the thigh from these to the head of the tibia is known as the *ilio tibial band.* The tensor fasciae femoris, gluteus medius and minimus, are supplied by the superior gluteal nerve, the gluteus maximus by the inferior gluteal. At the back of the thigh are the *hamstrings* rising from the tuberosity of the ischium (Pl. II.–4); these are the *semimembranosus* and *semitendinosus,* passing to the inner part of the upper end of the tibia and forming the internal hamstrings, and the *biceps femoris* or external hamstring, which has an extra head from the shaft of the femur and is inserted into the head of the fibula. These muscles are supplied by the great sciatic nerve and extend the hip joint while they flex the knee. In the leg, as distinguished from the thigh, are three groups of muscles, anterior, external and posterior. The anterior group (Pl. II.–3) all come from the front of the tibia and fibula, and consist of the *extensor longus digitorum,* extending the middle and distal phalanges of the four outer toes, the *extensor proprius hallucis,* extending the big toe, and the *peroneus tertius,* a purely human muscle inserted into the base of the fifth metatarsal bone. All these are supplied by the anterior tibial nerve.

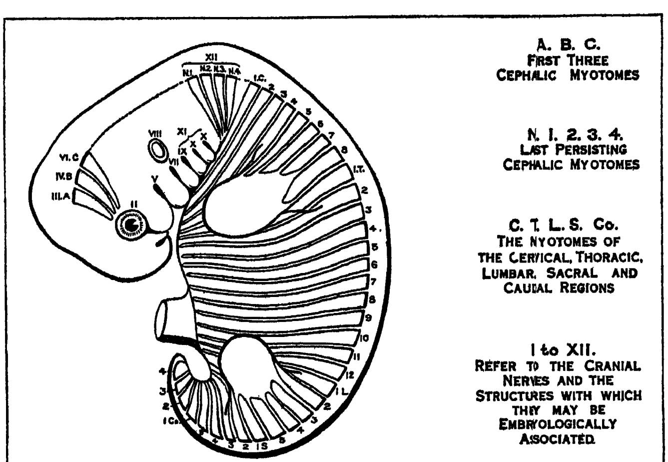
The external group comprises the *peroneus longus* and *brevis,* rising from the outer surface of the fibula and inserted into the tarsus (Pl. II.–3), the longus tendon passing across the sole to the base of the first metatarsal bone, the brevis to the base of the fifth metatarsal. These are supplied by the musculo-cutaneous nerve.

The posterior group is divided into a superficial and a deep set. The superficial is composed of the *gastrocnemius,* the two heads of which rise from the two condyles of the femur, the *soleus,* which rises from the upper parts of the back of the tibia and fibula, the *plantaris,* which comes from just above the external condyle of the femur, and the *popliteus* which, although on a deeper plane, really belongs to this group and rises by a tendon from the outer condyle while its fleshy part is inserted into the upper part of the back of the tibia. The gastrocnemius and soleus unite to form the *tendo Achillis,* which is attached to the posterior part of the calcaneum, while the plantaris runs separately as a very thin tendon to the same place. These muscles are supplied by the internal popliteal nerve. The deep set is formed by three muscles which rise from the posterior surfaces of the tibia and fibula, the *flexor longus digitorum,* the *tibialis posticus,* and the *flexor longus hallucis* from within outward. Their tendons all pass into the sole, that of the flexor longus digitorum being inserted into the terminal phalanges of the four outer toes, the flexor longus hallucis into the terminal phalanx of the big toe, while the tibialis posticus sends expansions to most of the tarsal bones. The nerve supply of this group is the posterior tibial. On the dorsum of the foot is the *extensor brevis digitorum,* which helps to extend the four inner toes, while in the sole are four layers of short muscles, the most superficial of which consists of the *adductor hallucis,* the *flexor brevis digitorum,* and the *adductor minimi digiti,* the names of which indicate their attachments. The second layer is formed by muscles which are attached to the flexor longus digitorum tendon; they are the *accessorius,* running forward to the tendon from the lower surface of the calcaneum, and the four *lumbricales,* which rise from the tendon after it has split for the four toes and pass between the toes to be inserted into the tendons of the extensor longus digitorum on the dorsum. The third layer comprises the *flexor brevis hallucis, adductor obliquus* and *adductor transversus hallucis* and the *flexor brevis minimi digiti.* The fourth layer contains the three *plantar* and four *dorsal interosseous muscles,* rising from the metatarsal bones and inserted into the proximal phalanges and extensor tendons in such a way that the plantar muscles

draw the toes towards the line of the second toe while the dorsal draw them away from that line. Of these sole muscles the flexor brevis digitorum, flexor brevis hallucis, adductor hallucis and the innermost lumbrical are supplied by the internal plantar nerve, while all the rest are supplied by the external plantar.

EMBRYOLOGY

The development of the muscular system is partly known from the results of direct observation, and partly inferred from the study of the part of the nervous system whence the innervation is derived. The unstriped muscle is formed from the mesenchyme cells of the somatic and splanchnic layers of the mesoderm (*see* VERTEBRATE EMBRYOLOGY), but never, as far as we know, from the mesodermal somites. The heart muscle is also developed from mesenchymal cells, though the changes producing its feebly striped fibres are more complicated. The skeletal or real striped muscles are derived either from the mesodermic somites or from the branchial arches. As the mesodermal somites are placed on each side of the neural canal in the early embryo, it is obvious that the greater part of the trunk musculature spreads gradually round the body from the dorsal to the ventral side and consists of a series of plates called *myotomes* (fig. 3). The muscle fibres in these plates run in the long axis of the embryo, and are at first separated from those of the two neighbouring plates by thin fibrous intervals called *myocommata*. In some cases these myocommata persist and even become ossified, as in the ribs, but more usually they disappear early, and the myotomes then unite with one another to form a great muscular sheet. In the whole length of the trunk a longitudinal cleavage at right angles to the surface occurs, splitting the musculature into a dorsal and ventral part, supplied respectively by the dorsal and ventral primary divisions of the spinal nerves. From the dorsal part the various muscles of the erector spinae series are derived by further longitudinal cleavages either tangential or at right angles to the surface, while the ventral part is again longitudinally split into mesial and lateral portions. A transverse section of the trunk at this stage, therefore, would show the cut ends of three longitudinal strips of muscle: (1) a mesial ventral, from which the rectus, pyramidalis sterno-hyoid, omo-hyoid and sterno-thyroid muscles are derived; (2) a lateral ventral, forming the flat muscles of the abdomen,



FROM A. M. PATTERSON, "CUNNINGHAM'S TEXTBOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG. 3.—SCHEME ILLUSTRATING THE DISPOSITION OF MYOTOMES IN THE EMBRYO IN RELATION TO THE HEAD, TRUNK AND LIMBS

intercostals and part of the sternomastoid and trapezius; and (3) the dorsal portion already noticed. The mesial ventral part is remarkable for the persistence of remnants of myocommata in it, forming the linae transversae of the rectus and the central tendon of the omo-hyoid. The lateral part in the abdominal region splits tangentially into three layers, the external and internal oblique and the transversalis, the fibres of which become differently directed. In the thoracic region the intercostals probably indicate a further tangential splitting of the middle or internal oblique layer, because the external oblique is continued headward superficially to the ribs and the transversalis deeply to them. The more cephalic part of the external oblique layer probably disappears by a process of pressure or crowding out owing to the encroachment of the serratus magnus, a muscle which, as its nerve supply indicates, is derived from the lower cervical myotomes. The deeper parts of the lateral mass of muscles spread to the ventral surface of the bodies of the vertebrae, and form the *hypaxial muscles*—such as the psoas, longus colli and recti capitis antici. The nerve supply indicates that the lowest myotomes taking part in the formation of the abdominal walls are those supplied by the first and second lumbar nerves, and are represented by the cremaster muscle in the scrotum. In the perineum, however, the third and fourth sacral myotomes are represented, and these muscles are differentiated largely from the primitive sphincter which surrounds the cloacal orifice, though partly from vestigial tail muscles. In the head no distinct myotomes have been demonstrated in the mammalian embryo, but as they are present in more lowly vertebrates, it is probable that their development has been slurred over, a process often found in the embryology of the higher forms. Probably nine cephalic myotomes originally existed, of which the first gives rise to the eye muscle supplied by the third nerve, the second to the superior oblique muscle supplied by the fourth nerve, and the third to the external rectus supplied by the sixth nerve. The fourth, fifth and sixth myotomes are suppressed, but the seventh, eighth and ninth possibly form the muscles of the tongue supplied by the twelfth cranial nerve.

Turning now to the branchial arches, the first branchiomere is innervated by the fifth cranial nerve, and to it belong the masseter, temporal, pterygoids, anterior belly of the digastric, mylo-hyoid, tensor tympani and tensor palati, while from the second branchiomere, supplied by the seventh or facial nerve, all the facial muscles of expression and the stylo-hyoid and posterior belly of the digastric are derived, as well as the platysma, which is one of the few remnants of the panniculus carnosus or skin musculature of the lower mammals. From the third branchiomere, the nerve of which is the ninth or glossopharyngeal, the stylo-pharyngeus and upper part of the pharyngeal constrictors are formed, while the fourth and fifth gill arches give rise to the muscles of the larynx and the lower part of the constrictors supplied by the vagus or tenth nerve. It is possible that parts of the sternomastoid and trapezius are also branchial in their origin, since they are supplied by the spinal accessory or eleventh nerve, but this is unsettled. The limb musculature is usually regarded as a sleeve-like outpushing of the external oblique stratum of the lateral ventral musculature of the trunk, and it is believed that parts of several myotomes are in this way pushed out in the growth of the limb bud. This process actually occurs in the lower vertebrates, and the nerve supplies provide strong presumptive evidence that this is the real phylogenetic history of the higher forms, though direct observation shows that the limb muscles of mammals are formed from the central mesoderm of the limb and at first are quite distinct from the myotomes of the trunk. A possible explanation of the difficulty is that this is another example of the slurring over of stages in phylogeny, but this is one of many obscure morphological points. The muscles of each limb are divided into a dorsal and ventral series, supplied by dorsal and ventral secondary divisions of the nerves in the limb plexuses, and these correspond to the original position of the limbs as they grow out from the embryo, so that in the upper extremity the back of the arm, forearm and dorsum of the hand are dorsal, while in the lower the dorsal surface is the front of the thigh and leg and the dorsum of the foot.

For further details *see* J. P. McMurrich, *Development of the Human Body* (London, 1923), and the writings of L. Bolk, *Morphol. Jahrb.* vols. xxi.–xxv.

COMPARATIVE ANATOMY

In the Acrania (*e.g., Amphioxus*) the simple arrangement of myotomes and myocommata seen in the early human embryo is permanent. The myotomes or muscle plates are < shaped, with their apices pointing toward the head end, each being supplied by its own spinal nerve. In the fishes this arrangement is largely

persistent, but each limb of the $<$ is bent on itself, so that the myotomes have now the shape of a ≶ the central angle of which corresponds to the lateral line of the fish. In the abdominal region, however, the myotomes fuse and rudiments of the recti and obliqui abdominis muscles of higher types are seen. In other regions too, such as the fins of fish and the tongue of the Cyclostomata (lamprey), specialized muscular bundles are separated off and are coincident with the acquirement of movements of these parts in different directions. In the amphibia the limb musculature becomes much more complex as the joints are formed, and many of the muscles can be homologized with those of mammals, though this is by no means always the case, while, in the abdominal region, a superficial delamination occurs, so that in many forms a *superficial* and *deep rectus abdominis* occurs as well as a *cutaneus abdominis* delaminated from the external oblique. It is probable that this delamination is the precursor of the panniculus carnosus or skin musculature of mammals. The branchial musculature also becomes much more complex, and the mylo-hyoid muscle, derived from the first branchial arch and lying beneath the floor of the mouth, is very noticeable and of great importance in breathing.

In the reptiles further differentiation of the muscles is seen, and with the acquirement of costal respiration the external and internal intercostals are formed by a delamination of the internal oblique stratum. In the dorsal region several of the longitudinal muscles which together make up the erector spinae are distinct, and a definite sphincter cloacae is formed round a cloacal aperture. In mammals certain muscles vary in their attachments or presence and absence in different orders, sub-orders and families, so that, were it not for the large amount of technical knowledge required in recognizing them, they might be useful from a classificatory point of view. There is, however, a greater gap between the musculature of man and that of the other Primates than there is between many different orders, and this is usually traceable either directly or indirectly to the assumption of the erect position.

The chief causes which produce changes of musculature are: (1) splitting, (2) fusion, (3) suppression either partial or complete, (4) shifting of origin, (5) shifting of insertion, (6) new formation, (7) transference of part of one muscle to another. In many of these cases the nerve supply gives an important clue to the change which has been effected. Splitting of a muscular mass is often the result of one part of a muscle being used separately, and a good example of this is the deep flexor mass of the forearm. In the lower mammals this mass rises from the flexor surface of the radius and ulna, and supplies tendons to the terminal phalanges of all five digits, but in man the thumb is used separately, and, in response to this, that part of the mass which goes to the thumb is completely split off into a separate muscle, the flexor longus pollicis. The process, however, is going farther, for we have acquired the habit of using our index finger alone for many purposes, and the index slip of the flexor profundus digitorum is in us almost as distinct a muscle as the flexor longus pollicis. Fusion may be either collateral or longitudinal. The former is seen in the case of the flexor carpi ulnaris. In many mammals (*e.g.*, the dog), there are two muscles inserted separately into the pisiform bone, one rising from the internal condyle of the humerus, the other from the olecranon process, but in many others (*e.g.*, man) the two muscles have fused. Longitudinal fusion is seen in the digastric, where the anterior belly is part of the first (mandibular) branchial arch and the posterior of the second or hyoid arch; in this case, as one would expect, the anterior belly is supplied by the fifth nerve and the posterior by the seventh. Partial suppression of a muscle is seen in the rhomboid sheet; in the lower mammals this rises from the head, neck and anterior (cephalic) thoracic spines, but in man the head and most of the neck part is completely suppressed. Complete suppression of a muscle is exemplified in the omo-trachelian, a muscle which runs from the cervical vertebrae to the acromian process and fixes the scapula for the strong action of the triceps in pronograde mammals; in man this strong action of the triceps is no longer needed for progression, and the fixing muscle has disappeared. Shifting of origin is seen in the short head of the biceps femoris. This in many lower mammals (*e.g.*, rabbit) is a muscle running from the tail to the lower leg; in many others (*e.g.*, monkeys and man) the origin has slipped down to the femur, and in the great anteater it is evident that the agitator caudae has been used as a *muscle slide,* because the short head of the biceps or tenuissimus has once been found rising from the surface of this muscle. Shifting of an insertion is not nearly as common as shifting of an origin; it is seen, however, in the peroneus tertius of man, in which part of the extensor longus digitorum has acquired a new attachment to the base of the fifth metatarsal bone. The new formation of a muscle is seen in the *stylo-hyoideus alter,* an occasional human muscle; in this the stylo-hyoid ligament has been converted into a muscle. The transference of part of one muscle to another is well shown by the human adductor magnus; here the fibres which pass from the tuber ischii to the condyle of the femur have a nerve supply from the great sciatic instead of the obturator, and in most lower mammals are a separate part of the hamstrings known as the *presemimembranosus.*

For further details *see* Bronn *Classen und Ordnungen des Thierreichs;* F. G. Parsons, "The Muscles of Mammals," *Jour. Anat. and Phys.* xxxii. 428; also accounts of the musculature of mammals, by Windle and Parsons, *Proc. Zool. Soc.* (1894, *seq.*); Humphry, *Observations in Myology* (1874). (F. G. P.)

MUSES, goddesses presiding over song and ultimately over the liberal arts generally (Μοῦσαι, originally *Μόντιαι, Μόνσαι "the mindful ones"). In Homer, they are represented as singing to the gods, to the accompaniment of Apollo, and as jealous of the attempt of Thamyris the Thracian bard to rival them (*Il.* i, 604; ii., 594 ff.), also as inspiring or instructing poets generally; sometimes a single Muse is invoked for that purpose (as *Od.*, i., 1), sometimes all (as *Il.*, ii., 484); but nothing is said of their number or names. In Hesiod there are nine Muses, daughters of Zeus and the Titaness Mnemosyne (Memory); their names are Clio, Euterpe, Thalia, Melpomene, Terpsichore, Erato, Polyhymnia, Urania, and Calliope. This is the canonical list; but there were many local variants; for example, it was said that originally but three Muses were worshipped on Helicon, and their names were *Melete, Mneme, Aoide* (Practice, Memory, Song). At Delphi also there were three, worshipped in connection with Apollo, who is often called *Musagetes,* or leader of the Muses; at Sicyon there were three, of whom one was called *Polumatheia* ("much learning"). We may, therefore, conclude that their names are much later than their cult. From the beginning they are associated with Thrace; Orpheus and Rhesus are sons of Muses, Thamyris is their unsuccessful rival, they are traditionally associated with Pieria, Leibethra, and Pimpleia, and the cult of their father Zeus is in very ancient times situated on Olympus. But quite early a cult almost more famous was established at Helicon in Boeotia. We may reasonably suppose that the worship of the Muses entered Greece with the Greeks and moved southward with them. As to their original functions, it has been suggested that they began as water-deities, a theory plausible enough in itself, since water is closely associated with inspiration, prophetic or poetical. But this does not account for the name [why should a deity of water be called "mindful"?] nor for the fact that in our earliest authorities the Muses are definitely goddesses of song, not water. They are, however, associated with holy streams or springs, Castalia, Hippocrene, and Aganippe.

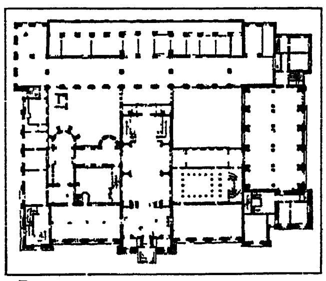
The assigning of different functions to individual Muses (*see* CALLIOPE) is late and erratic. The Romans often identified the Muses with the Camenae, who appear to have been deities of water; also perhaps connected with prophecy (*see* G. Wissowa, *Religion und Kultus,* 2nd ed., p. 219).

See Roscher's *Lexikon, s.v.*; L. R. Farnell, *Cults of the Greek States* (1896) v., p. 434 (references, p. 469).

MUSEUM ARCHITECTURE. Both art and scientific museums have the primary purpose of displaying collections of objects; consequently, certain features of architectural planning are common to both. Essentially, the plan of each must provide for the free and comfortable circulation of the public, an easy access to the various sections of the building and a coherent arrangement of rooms and galleries. An adequate lighting system

and an appropriate setting for the objects displayed must also be provided. It should be remembered that whereas in the plan of a museum of science the principal object is the logical sequence of exhibition groups, in a museum of art, the paintings and sculpture displayed require, in addition, a setting that will contribute to the awakening of a powerful and lasting impression in the spectator.

Art Museums.—The art museum is the modern development of the private art collections of older times. When, in due course, the State became the owner of such collections—by request, purchase or the fortunes of political upheavals—and when the democratic spirit of the 19th century impelled the owners of private collections to offer their treasures to public view, the original housing of these works of art was soon found to be inadequate, both for the increasing size of the collections and for their suitable display. The problem then confronting the architect was how to design buildings in which art collections could be enjoyed by the public, without making too great a demand on the exigencies of space. In many cases, existing buildings that no longer served their original purposes, were resorted to, the interiors being remodelled to meet the new requirements. Of this type are museums such as the Cluny, Carnavalet and Louvre in Paris, most of the Italian museums, the Belvedere in Vienna, and the museum of Nuremberg. Historical reconstitutions of interiors sometimes developed themselves, as though out of the abundance of arts and crafts materials such as were possessed by museums like the Cluny, in Paris, and the municipal museums in Florence, Venice, Belgium and Holland; sometimes they were designed intentionally, as in the museums of Munich, Darmstadt and Nuremberg; the Ryks museum, Amsterdam; Carnavalet, Paris; and the Markisches museum, Berlin. They were found not only to make a special appeal to the public, but also to add a new interest to the works exhibited.

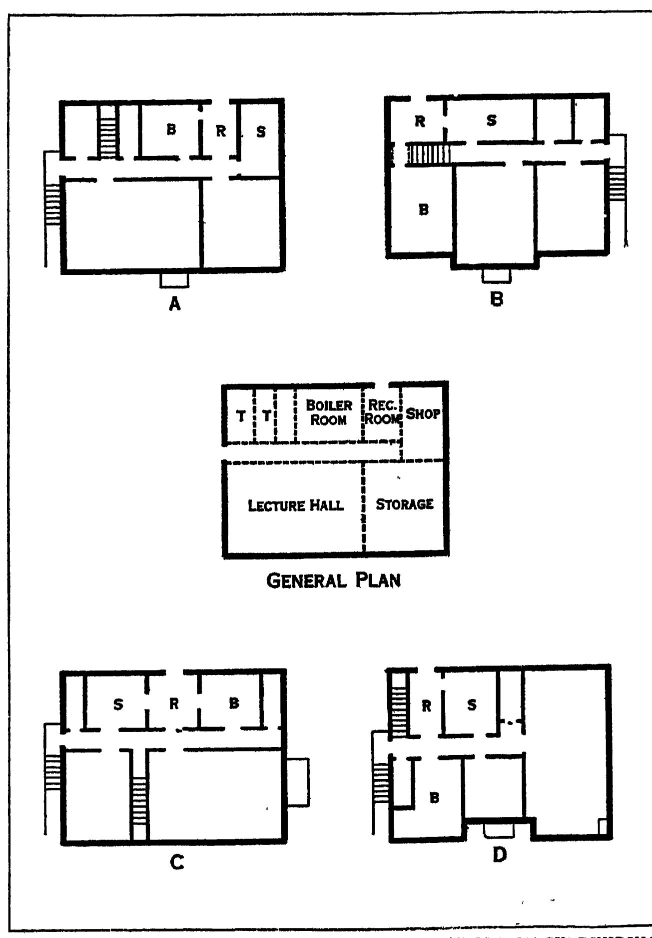


PLAN OF MUSEUM IN DARMSTADT

The museum of the 19th century was usually two storeys high, with services in the basement, and with an entrance hall leading to a monumental stairway. On the entrance floor were the collections of sculpture, though these were occasionally placed in a courtyard covered by a glass roof, and the collections of medals, furniture, pottery and textiles, all lighted by windows. The main floor was devoted to the picture galleries, uniformly lighted by skylights; the circulation flowed, usually, from room to room. The general architecture of the building was often in the Greek tradition, in homage to the century of Phidias. Representative museums of this type are: the old museum of Berlin, by Schenkel (1824), the Glyptothek at Munich, by Von Klenze (1830), the British museum, by Sir Charles Barry (1825–27), the National Gallery in London (1838), Dresden museum (1850), and the group of art and scientific museums at Vienna and Marseilles, France. This type is also the basis, in the United States, for such museums as the original unit of the Metropolitan Museum in New York, by Hunt, the Brooklyn Institute of Arts and Sciences, by McKim, Meade and White, the Museum of Toledo, and the Corcoran Art Gallery, Washington, D.C.

Recent Innovations.—One of the principal innovations of late years in museum planning is the provision of smaller rooms, suitable to the display of various works of art, classified according to the periods of their production. This feature is exemplified in the museums of Munich and Darmstadt (Alfred Messel, architect), and, in the United States, by the Detroit Institute of Arts (Paul Cret and Zantzinger, Borie and Medary, architects). In these museums, the formality of composition desirable for a public building is combined with some informality in the treatment of certain portions, thus allowing for the varied fenestrations belonging to the period rooms, and for picturesque courtyards for outdoor displays. Some recent museums provide also a covered courtyard, treated as an indoor garden, where visitors can find relaxation after their tour of the exhibition rooms, as in the Cleveland Museum of Art, the Detroit Institute of Arts, and the Freer Art Gallery, Washington, D.C., by Charles Platt. Other features which have developed in the best museum arrangements are: the displaying of selected exhibits in the main galleries and the relegation of exhibits of a merely historical or technical interest for students to special study-rooms; the equipment of services for storage; and the accommodations for educational work in lecture rooms, libraries, etc. These principles of museum planning are applicable to small town museums and private galleries, as well as to large State institutions. The various methods of lighting art galleries have excited wide controversy. Bad lighting may distort the room or make it necessary for the visitor, in order to avoid a glare, to remain at a fixed distance from a picture.

Scientific Museums.—Architecturally, the scientific museum makes much simpler demands than the art museum, the essentials of its plan being provisions for easy circulation, convenient and logical grouping of sections and good lighting. The problem of lighting is the most difficult to solve, owing to the prevalence of glass specimen cases, which, if the proper lighting is not effected, cause a glare that prevents a view of the contents. An interesting arrangement of zoological galleries has been made by Messel in the rear galleries of the Darmstadt museum. The National Museum (Hornblower and Marshall, architects) in Washington, D.C., also has a simple and effective plan; the entrance, in a rotunda, gives access to the three principal sections—biology, anthropology and geology—while minor galleries connect the branches of the "T." The Field Museum of Natural History, recently completed in Chicago (Graham, Anderson, Probst and White, architects, 1927), is one of the largest, occupying a rectangle of about 350 by 700 feet. Its floor space has been utilized intensively, and in it every effort is being made to present the specimens realistically by means of habitat groups whose settings and arrangements are not only accurate but works of art. In



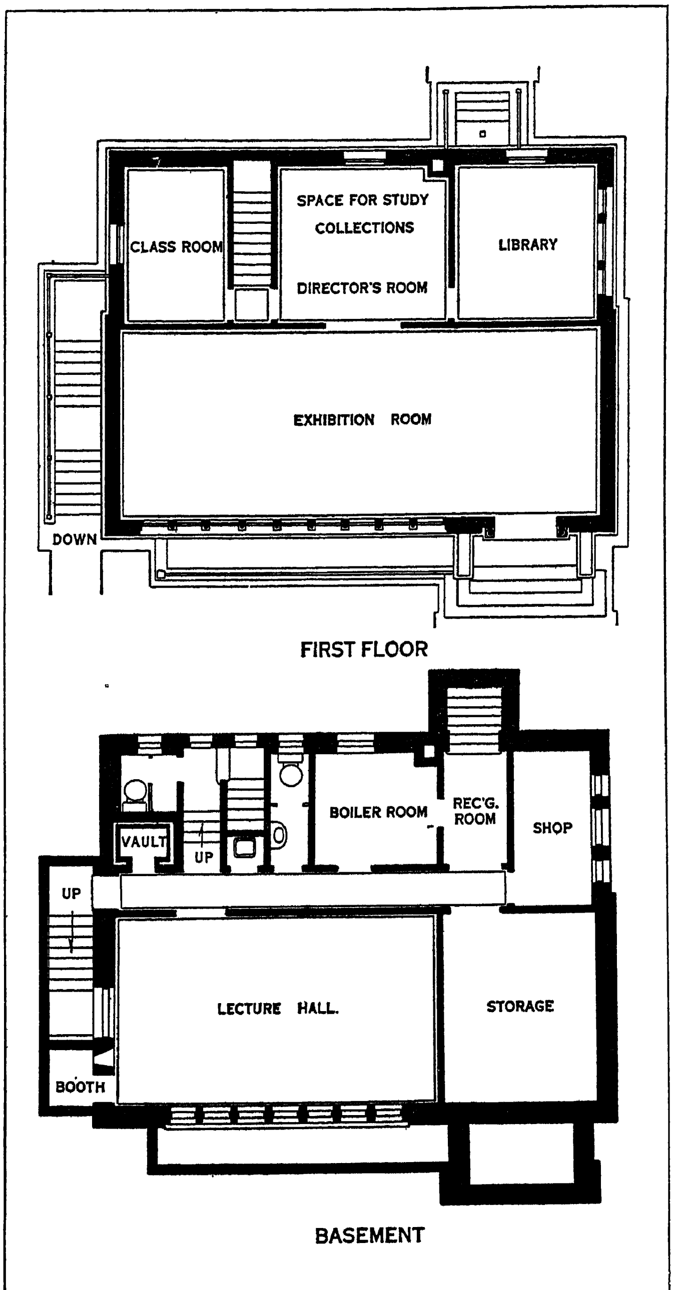
PLAN FOR SMALL MUSEUM SHOWING SEVERAL METHODS OF SUBDIVIDING THE GROUND OR BASEMENT FLOOR

Europe alone there are more than 2,000 scientific museums, few of which, however, rise to architectural distinction.

(P. P. Cr.)

MODERN MUSEUM PLANNING

Originally museums were thought of, planned, and built as storehouses for specimens, but with the recent, almost complete

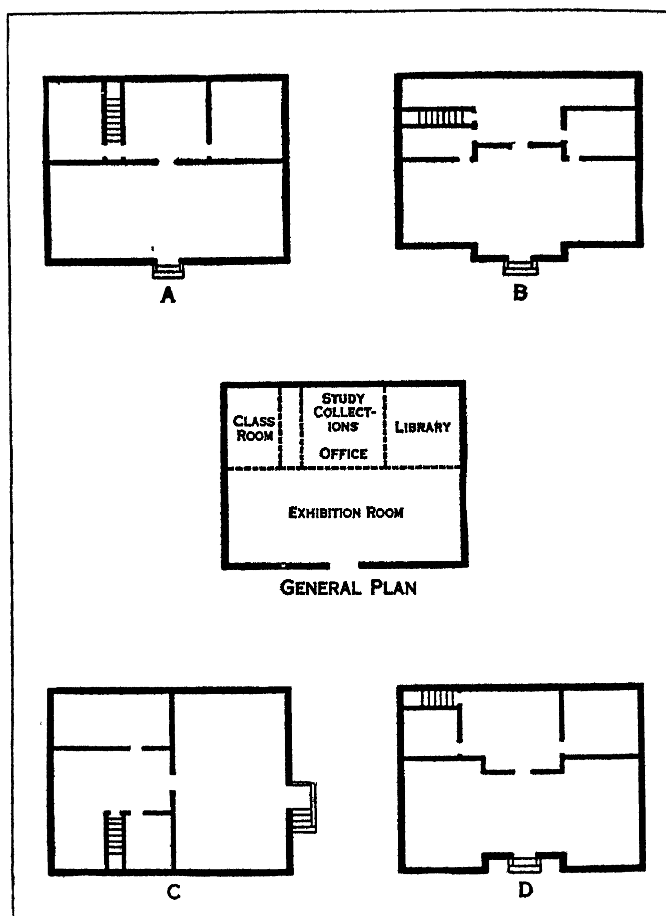


TOP, PLAN FOR FIRST FLOOR; BOTTOM, PLAN FOR BASEMENT

reversal of plan and scope, specimens now may even hold a relatively unimportant position as compared with other activities. Educational functions now tend to predominate and the curio type of collection is rapidly being replaced with material capable of instructing the museum visitor along sound cultural and practical lines. Carefully selected series of specimens illustrating the essential facts to be brought out have taken the place of closely packed rows of science museum material and of galleries of paintings hung row above row. The excess material, of little interest to the casual visitor, but often of value to the serious student, is segregated into well organized study or reserve collections, which may be examined on request.

The modern museum no longer restricts its activities to interesting the casual visitor who comes to its doors but organizes a constructive educational programme extending to the schools and many types of civic organizations. It supplies loan collections of specimens, sends out lecturers, furnishes motion pictures and other lecture material for outside use. It organizes and conducts excursions to nearby points where nature may be closely studied, and it even permits the public to engage in certain collecting and excavating projects. Within its own building it maintains an efficient guide service to its collections, appointing certain hours for children and young people. Its lecture halls and auditoriums furnish opportunities for talks illustrated by the surrounding museum material. Chamber music, organ recitals and theatrical productions have all been provided by museums. Organizations working along similar lines are encouraged to use museum facilities and many types of nature, art and hobby clubs, have been promoted by museums. The active modern museum presents to its public a constantly changing panorama of exhibits drawn from its own collections and from the many types of loan material which are circulated nationally.

New Needs Affect Design.—These changes in the basic theory of museum practice have been accompanied by altered conceptions of the architecture and arrangement of museums. Monumental architecture still has a strong appeal but there is increasing regard for improved internal arrangements. Most modern museums are built with a definite programme of expansion in view.

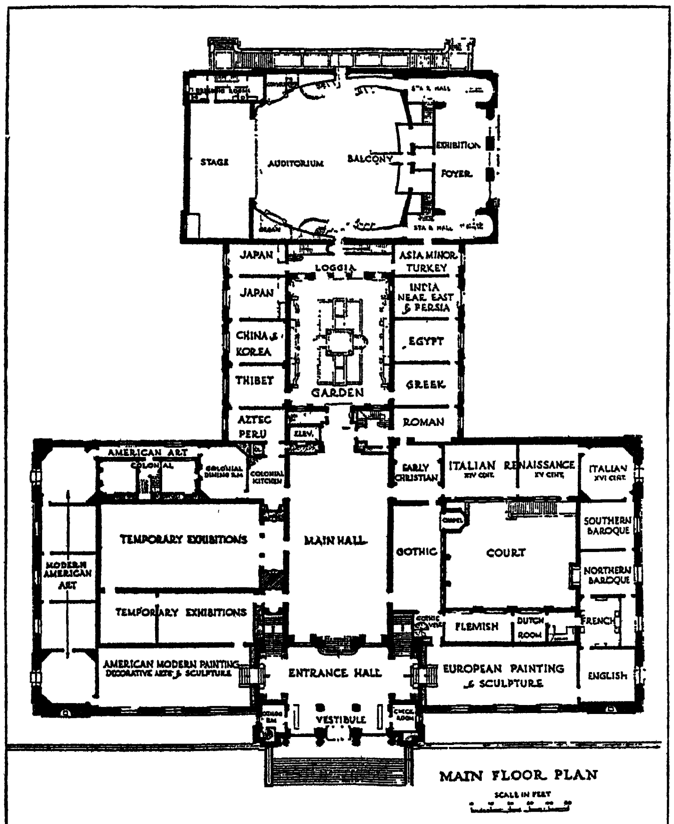


PLAN FOR SMALL MUSEUM SHOWING SEVERAL METHODS OF SUBDIVIDING THE MAIN FLOOR

Additions, as they become possible, are made with little disturbance of the original building. Wings or other prolongations provide additional exhibition space and make possible an increase in the number of activities. These principles may be applied as readily to the very small museum as to the institution starting with a substantial building fund In the case of a small museum a single façade may be completed, including the main entrance and making available one or two exhibition halls, moderate office space and service facilities. All furniture and cases are movable and partitions are of temporary nature wherever possible, so that adjust-

ments to changing conditions can be made easily.

Although excellent results are obtained with artificial lighting, museums are usually planned to utilize all daylight available. Careful experiments have shown that certain types of side and top lighting or combinations of the two meet practically every requirement. However, artificial lighting of the indirect variety makes it possible for a museum to be open in the evenings.



MAIN FLOOR PLAN OF DETROIT INSTITUTE OF THE FINE ARTS SHOWING THE WINDOW LIGHTING OF ROOMS AND THE GEOGRAPHIC AND CHRONOLOGICAL DISTRIBUTION OF EXHIBITS

Good planning of a museum, whether large or small, dictates a simple and readily understandable arrangement of exhibition halls, easily accessible from the main entrance and preferably laid out so that an orderly tour of the building or of individual sections is possible. Offices should be so placed that the public may reach them quickly and easily. Mechanical shops, usually occupying the ground floor or basement, are arranged with regard for the transferring of bulky objects from the shipping platform to any of the exhibition halls. Preparation departments should be near mechanical shops and accessible from the curatorial offices without traversing exhibition halls. Lecture halls and auditoriums should be provided with separate entrances from the street so that they may be used when other parts of the museum are closed.

In the case of a museum erected unit by unit the same general arrangements may be secured ultimately. The adding of a wing may extend the main exhibition floor and add one or more new galleries, the new basement space permitting expansion of store and mechanical space. An addition to the rear often contains an auditorium with small lecture halls or galleries below. Through this gradual expansion a museum may come to have a central courtyard which can be utilized in a variety of ways.

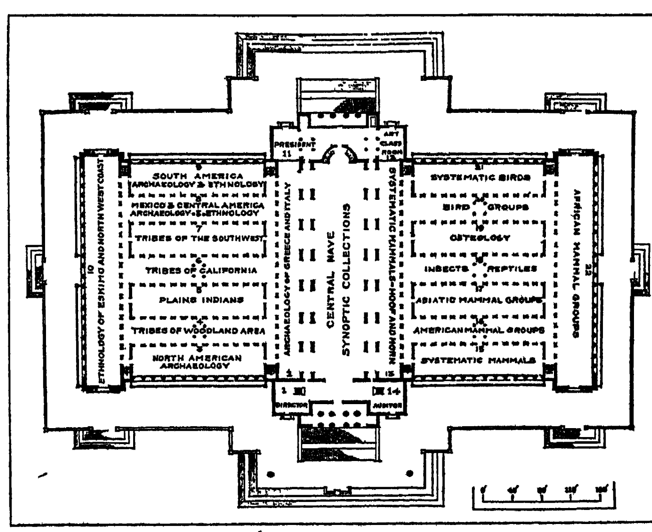
Except in the case of very small museums, most institutions are divided into departments, each of which is allotted certain exhibition space, curatorial offices, study rooms, work rooms, storage space and mechanical shops, when appropriate. A central library may be open to both visitors and the museum staff or a series of sectional libraries may place all publications on a single subject in close proximity to collections of the same nature.

Special activities of museums often include the printing of extensive series of publications, for which printing plants are installed. Photographic record work requires special equipment and many museums are prepared to sell at small cost a photograph of any object in their collections. Large museums find it economical to build their own exhibition cases and furniture and install woodworking shops for the purpose. Art museums have facilities for restoring paintings, casting and cleaning sculpture and renovating other objects. Science museums require taxidermists' shops and model making plants.

In addition to the well known museums of the world, such as the Louvre, Paris; the National Gallery, London; the British Museum, London; the Prado, Madrid; the Vatican Gallery, Rome; the Metropolitan Museum of Art, New York; the American Museum of Natural History, New York; the United States National Museum, Washington, D.C.; the Art Institute of Chicago; the Field Museum, Chicago; and the Museum of Fine Arts, Boston, there are many museums specializing in particular fields, and these often have buildings of special design.

Special Services.—School museums, of which there are several types, may require relatively little exhibition space but should have a large number of classrooms and laboratories, and a very complete library service. If the museum is engaged chiefly in supplying material for use in the schools its building may consist almost entirely of the workshops in which these collections are prepared and of facilities for handling and shipping. University museums usually have special facilities for class instruction in the museum and rearrange their exhibition cases as often as class requirements dictate.

Outdoor collections and outdoor museums are increasing in number and vary from the supplementary collection in a museum courtyard to the completely detached museum in the open air. Examples of the supplementary collections are the gardens of growing plants maintained by the Agricultural and Commercial Museum, Rio de Janeiro, Brazil, and the extensive garden of trees, plants and flowers which were utilized by the American Indians which has been planned by the Museum of the American Indian in New York. The outstanding example of this idea applied to the field of art is the Cloisters, of the Metropolitan Museum of Art, in New York, an extensive open air collection of sculpture and architectural details. The earliest open air museum is that



FIRST FLOOR PLAN OF THE FIELD MUSEUM, CHICAGO

known as Skansen, in Stockholm, Sweden, where, situated on a hillside overlooking the city, there is a group of peasant cottages, barns, sheds, windmills, belfries of churches and other pieces of native architecture. All are completely furnished and surrounded with appropriate things, such as carts and farm implements.

Certain large museums, such as the Toledo (Ohio) Museum of Art, have installed organs and give programmes of chamber music. The Art Institute of Chicago has a theatre of the drama. Astronomy has become susceptible of museum treatment through the recent invention, in Germany, of apparatus for projecting the

images of the stars and planets on the inner surface of a large dome. The interior of the dome, in which the audience is seated, resembles a large auditorium, the projection apparatus occupying a raised platform. The American Museum of Natural History, New York, is planning to erect such a planetarium as a part of its astronomical hall. Chicago is also to have a planetarium and several have already been put in operation in Germany and Russia.

Realistic Exhibits.—In addition to these special facilities of modern museums, which have a decided effect on the planning of buildings, the main exhibition halls of museums are also undergoing certain changes. Many art museums no longer arrange their objects by schools or countries but are constructing so-called period rooms. These interiors often consist of the original woodwork removed from celebrated buildings and re-erected in the museum. Such interiors act as a background for the arrangement of contemporary furniture, paintings and other objects. Excellent examples of this method are to be found in the Victoria and Albert Museum, London; the Municipal Museum, Amsterdam, Holland; the American wing of the Metropolitan Museum of Art; and the newly constructed Philadelphia Museum of Art.

Science museums are replacing exhaustive scientific series with habitat groups (*q.v.*), both in miniature and full scale. These show mammals, birds and fishes in their natural environment, and are often prepared on such a large scale as to fill whole exhibition halls. The industrial museums of Munich and Vienna have adopted the same principles in their field, erecting full scale models of mines and industrial plants and period rooms showing ancient shoemakers' shops, apothecaries' stores and similar industries. The arrangement of museum collections in this manner calls for either special planning or extensive alterations.

Extra-mural museum efforts have gone even further than the collecting and installing of museum material in more or less natural surroundings. There are now many instances of museums applying instructive labelling and supplemental exhibits to nature itself. An experiment of this type is the nature trail in the Palisades Interstate park, New York and New Jersey. A mile or more of path leading through the woods is lined with signs and labels directing attention to natural phenomena visible from the trail. Tracks of small animals, nests of birds, burrowings of insects, flowering plants and many similar things are marked for the benefit of the visitor in such a manner that specimens are utilized without removing them from their natural environment or resorting to such artificial expedients as stuffing and mounting. A modification of this idea, used in conjunction with small museums scattered through the park, is the placing of outdoor markers indicating important geological features.

As practically no two museums are alike either as to size or scope, the planning of each museum becomes a special problem solved best by a careful study of existing buildings and of the lessons learned by their use.

BIBLIOGRAPHY.—*Proceedings of the American Association of Museums*, vol. i. to xi. (1906–17); M. T. Jackson, *The Museum* (1917); S. Hurst Seager, "The Lighting of Picture Galleries and Museums," *Journal Royal Institute of British Architects*, vol. xxiii. (1922–23); *Museum Work*, vol. i. to viii. (1919–25); C. R. Richards, *The Industrial Museum* (1925); J. Rowley, *Taxidermy and Museum Exhibition* (1925); *Museums Journal* vol. xxv. (1926); L. V. Coleman, *Manual For Small Museums* (1927); R. C. Smith, *A Bibliography of Museums and Museum Work* (1928). (R. C. S.)

MUSEUMS AND ART GALLERIES. These two subjects are treated under the same heading because of their common aims and similar activities. (*See* also MUSEUMS OF SCIENCE.)

The public art gallery is a creation of the nineteenth century. Unconsciously, it is an assertion of the collecting instinct of the community; consciously, it has been designed to instruct the public, to educate artists, to encourage contemporary art by purchase, and to provide material for historical research.

ARRANGEMENT AND PLANNING

The method of housing and arranging picture collections has changed with changes in the purpose they are intended to serve. Broadly, until the last quarter of the nineteenth century, pictures were treated mainly as material for the decoration of walls; and the ideal picture gallery was regarded as a palatial building, containing a series of vast rooms on whose walls pictures were hung in tiers, according to size, shape and colour. This theory of arrangement was pushed to its extreme point, when in 1720–28 the Imperial collections were brought together in the Palace at Vienna, and the pictures were ruthlessly cut down, or added to, to fit the walls. Generally, however, its limitations were admitted by the provision of a series of cabinets for showing smaller pictures, though in each cabinet the pictures might be close packed in several rows. Another modification sometimes adopted (as in the Salon Carré of the Louvre, and the Tribuna of the Uffizi) was the hanging in one room, in comparative isolation, of a few selected pictures. In private galleries, the obvious drawback of such methods could to some extent be overcome by the use of ladders, or temporary removal of a picture from the wall; in public galleries such devices were impracticable. The first breach with established custom was largely due to the growing size of collections and took the form of establishing separate collections of modern pictures, and in most cases placing them in separate galleries. Thus came into existence the National Gallery of British Art (generally known as the Tate Gallery from its founder Sir Henry Tate) in London, the Luxembourg in Paris, the Gallery of Modern Art in Madrid, the Neue Pinacothek at Munich and the National Gallery at Berlin. As a rule, these modern galleries were intended for the work of native artists; but most of them now represent painters of all countries. For example, the Tate Gallery, which at one time contained only British work, now includes a large Modern Foreign section. Of specialization in other ways, examples are the National Portrait Galleries in London and in Edinburgh, containing portraits of men and women who figure in the history of the countries concerned. In some cases special galleries have been provided for sculpture; though more frequently this forms a section of a museum or art gallery and occasionally (as in the case of Renaissance Italian sculpture at the Kaiser Friedrich Museum) is exhibited with pictures of the same period and country. Specialization of galleries, however, did not in itself modify methods of arrangement. These have been altered partly by an increasing attention to the claims of students and of historical study; partly by growth of the feeling (largely due to influences from the Far East) that the individual picture was of greater importance than the decorative ensemble. As a result, the director of a modern gallery tries to satisfy four main requirements. (1) Decorative arrangement of the gallery, both on a large scale and in detail. (2) Grouping of pictures according to their country of origin, with subdivisions according to local schools, or according to artists; these groups and subdivisions being arranged within the gallery in chronological order. (3) Chronological arrangement of pictures within each group. (4) Such placing of each picture as will best facilitate its study and appreciation. These requirements are not always easily reconcilable. In particular, arrangement of a group of pictures to secure decorative balance of size and colour, may easily conflict with chronological order, or put a picture into a place where it cannot be well seen. On the other hand, systematic arrangement into schools and periods may prevent a decorative ensemble on a large scale; though often it favours decorative harmony in smaller groups and the appreciation of individual pictures, since works of the same school and period usually are similar in colour and tone, and even tend to conform to set sizes.

Decorative Arrangement and Classification.—Experiment as to the best method of compromise is still proceeding. As regards requirement (1), the general tendency is to abandon large-scale decorative effect, and aim at groups harmonious within themselves. This has in part been due to requirement (2), for which rooms of moderate size are best; since even when a gallery possesses large numbers of one school and period, subdivision on the basis of artists and the different manners of artists is always possible. The large and lofty rooms in which many of the older European collections are housed create difficulties, however; though attempts to overcome these have been made by the use of screens to divide up the rooms, usually at a complete sacrifice to a decorative ensemble. Another and more successful method

is to divide the walls into a series of bays by means of shallow buttresses, as in the new galleries at the Fitzwilliam Museum, Cambridge, thus providing a number of more or less self-contained units of space, while enabling the room itself to be large and imposing. This is a particularly useful device in small collections, where each school or artist is represented only by a few pictures, which do not call for a separate room. The third requirement of chronological arrangement within school or artist groups has rarely been attained, and has been almost invariably sacrificed to decorative arrangement of the pictures concerned, or to the interests of the individual picture. To secure the former, a method usually successful is to select a picture of suitable size or character as centre, and then to group symmetrically about it, by using pairs of pictures similar in size, tone and colour. Occasionally, two or more small pictures may be used to balance a larger one. For the study of individual pictures, hanging on one line level with the eye of the average spectator is generally recognised as most satisfactory. In large and lofty rooms, however, unless the pictures are large, this method leaves a large space of wall which overweights the pictures and spoils the decorative effect. In recently built galleries therefore the tendency has been to keep the rooms comparatively low. In existing high galleries, a useful device is to introduce a moulding along the upper part of the wall, above which the wall is of a lighter tone than that of the part against which the pictures hang; and so reduce the apparent height of the walls. Other important matters which affect both the individual picture and decorative ensemble are those of spacing, framing, background, and the use of accessory objects, such as sculpture and furniture. Too close hanging is admittedly inadvisable, though it may produce a pleasant pattern on the wall. The present tendency is to isolate and emphasize important pictures; sometimes by placing on an easel or screen, a method detrimental to the general appearance of a room, sometimes by careful placing and spacing, with perhaps the use of a special background. Single line hanging and adequate spacing, greatly increase the amount of wall space required, to an extent which in a large collection may often be prohibitive. The problem still waits satisfactory solution. On the Continent extensive loans for long periods (as at Berlin) the creation of subsidiary galleries (*e.g.*, Schleissheim, at Munich), and the use of storerooms, have considerably reduced the number of pictures on exhibition, though somewhat to the inconvenience of the student. The English National Gallery has created a Reference Section, in which the less important pictures are hung, open to the public on request. This method has been considerably explored and developed in the United States. The Boston Museum was a pioneer in placing exhibition and study galleries side by side, the latter being more tightly packed than the former, with the idea that for the specialist student amenities in display are less necessary than for the general public. The Fogg Museum has a similar system. This museum is arranged in the interests of a college community, the building is more than a museum; lectures, research, drawing, painting and all the functions of the Department of Fine Arts of Harvard university are carried on within it. To overcome the difficulty that the public and students are shy of asking admission to the study galleries, the new museum at Philadelphia has arranged the two groups on separate floors, both equally accessible to the public.

Wall Coverings.—Framing and wall covering are both matters into which individual taste enters too markedly to make generalization possible. Broadly, the modern tendency is to use frames either of the period in which the picture was painted, or reproductions of them: and to abandon rich, heavy backgrounds for lighter, neutral tints. The actual material employed varies with the wealth of the gallery concerned. Canvas painted a suitable colour is widely employed for convenience and cheapness, but is apt to have an unpleasant texture. In public galleries, tightly stretched backgrounds are usual, as opposed to the loosely hung material much favoured by private collectors, mainly for convenience in cleaning walls and in rearranging pictures. The use of appropriate accessories is another matter in which taste differs widely. Undoubtedly furniture, sculpture, etc., of appropriate character add greatly to the general decorative effect, and help to induce an atmosphere favourable to appreciation of the picture. On the other hand, many people find them distracting, and that the picture tends to become only one among several *objets d'art.*

Lighting.—Lighting is another problem which still awaits satisfactory solution. Top lighting is generally preferred, as it enables every wall to be utilized, and diminishes the risk of shadows being thrown on the pictures. In some modern galleries, however (*e.g.*, Detroit) and in the cabinets of older galleries, side lighting has been deliberately preferred, on the ground that certain pictures, such as those of the Dutch school, were painted to hang in places where side lighting was the rule. The top lighting of older galleries, conforming to the idea that a picture was primarily a means of decoration, was designed to illuminate the room as a whole, and is often so arranged that more light falls in the middle of the room than on the walls; with the inevitable result of reflections in the pictures, particularly distressing when these are glazed. Various devices, such as a velarium in the middle of the room, have been used to overcome this defect, but without conspicuous success except in countries such as Spain where the light is strong: since their main effect is to reduce the total amount of light in the room, and so to make it gloomy, while the amount falling on the walls still remains inadequate. In more modern galleries, a lantern roof, or a roof with solid centre and sloping glass sides, has met with some success. Excellent examples are the new galleries at the Fitzwilliam Museum, Cambridge, and at Cardiff. At the Tate Gallery, a gallery with one wall lit directly from above, the remainder of the room being in comparative darkness, has provided good visibility on that wall; but has been criticised as a waste of wall space, and as being gloomy. In some modern American galleries, an interesting and promising experiment is the use of a flat glass roof inside an ordinary glazed roof; the middle part of the inner roof being obscured by the use of a paint to a depth and area ascertained by experiment as satisfactory. (W. G. Co.)

BIBLIOGRAPHY.—Information as to the history, contents and buildings of particular galleries is generally given in the prefaces to their respective catalogues, both official and unofficial; but its extent varies considerably with the edition. Among the most useful editions are:—Amsterdam (1920), Antwerp (1920), Berlin (Kaiser Friedrich Museum), 2 vols. (1909), Brussels (1927), Budapest (1910), Dresden (1920), Florence (Uffizi) (1910), The Hague (1914), London (Wallace Collection) (1928), Madrid (Prado) (1922), ed. A. L. Mayer; Milan (Brera) (1908), ed. Ricci; Munich (Alte Pinacothek) (1925), New York (Metropolitan Museum) (1922), Paris (Luxembourg) (1913), ed. Benedite; Paris (Louvre) (N.D.), ed. Lafenestre and Richtenberger; Venice (Academia) (1924), Vienna (1925), ed. Glück.

The Making of the National Gallery, Sir Charles Holmes and C. H. Collins Baker; official history, *The Foundation of the National Gallery,* Burlington Magazine, April 1924, W. G. Constable. Information on the construction, organization and arrangement of art galleries, has appeared in the monthly bulletins of the American Museums, notably those of the Metropolitan Museum, Boston, Philadelphia and Detroit; also in *The Museums Journal* (Great Britain), *Proceedings of the American Association of Museums,* and *Museum Work* (Published by the American Association). Summaries of American experience, with suggestions, are: *Manual for Small Museums* (1927); Lawrence Vaile Coleman, and *The Museum* (1917), M. J. Talbot. Lighting methods (with diagrams and photographs) are treated in the *Journal of the R.I.B.A.*, 3rd Series, vols. xx., xxx., xxxii., J. Hurst Seager, *Country Life,* September 8 (1928), W. G. Constable.

HISTORY

The word "museum" is much older than the thing which it now denotes. Its meaning (Gr. μουσεῖον) is "a temple of the Muses." It could be applied metaphorically to any place where literature and the arts were cultivated, and its most famous use in antiquity was as the title of the Museum of Alexandria, founded and endowed by Alexander as a great library and home for scholars and for literary study. Its application to a collection of antiquities or natural history or science is necessarily quite modern, because the thing itself is modern. In antiquity and in the middle ages private individuals may occasionally have gathered together objects of art or of curiosity; but it was not a common custom, nor were museums recognized institutions until quite modern times. Their present status has been the work of the last two or three generations.

Origins.—The origin of museums, as we now know them, may be found in the Renaissance. The revival of interest in the classics led to an interest in the relics of classical antiquity which impelled individuals to collect them; while the growth of the spirit of curiosity, likewise the result of the Renaissance, led to the collection of objects connected with natural history or with science as then understood. In the collections made by princes, nobles, or humanists in the 16th and still more in the 17th century may be found, not merely the prototypes, but the actual beginnings, of some of the great museums of today. Thus the museum of Bologna may be traced back to the collections of the naturalist U. Aldrovandi (1527–1605); the armour, coins, and other antiquities collected by archduke Ferdinand II. at the end of the 16th century are at Vienna; the coins and natural history collections of Gaston, duke of Orleans (1608–60) are among the origins of the present national museums of these objects in Paris; N. Fabride Peiresc (1580–1637), to whom has been ascribed the foundation of the study of antiquity in France, collected plants and coins as well as books, and some of his medals passed to the Abbey of St. Geneviève; Thomas Howard, Earl of Arundel (1586–1646), collected not only the Arundel mss., now in the British Museum, but the Arundel Marbles, now at Oxford, and the Marlborough gems, now scattered among various collections; the collections of the two Tradescants (d. respectively 1638 and 1662), which constituted the first museum in England, and to which the name of museum seems first to have been applied, were acquired by Elias Ashmole in 1659 and are the basis of the Ashmolean Museum at Oxford. Later in the same century began the collections of Sir Hans Sloane (1660–1753) which, together with the mss. collected earlier by Sir Robert Cotton and later by the two Harleys, are the nucleus of the British Museum.

Very few, however, of the collections made in the 17th century have survived. They were the hobbies of individuals and were generally dispersed at their death. In the 18th century collecting became more methodical. Many of the princes of Germany and Italy formed collections of objects of art which became permanent ornaments of their courts. Young English nobles, making the grand tour, acquired objects of art and antiquity as well as pictures. The Ashmolean museum had become the property of the university in 1677; and in 1753 the bequest of Sir Hans Sloane's great collections to the nation led to the foundation of the British Museum. The great museums of Europe for the most part owe their origin to royal and princely collections, which in the course of political changes have become the property of the greater kingdoms or republics of today. To these must be added the museums belonging to municipalities, which are for the most part the outcome of the 19th century. These, as institutions, are deliberate growths, owing their origin to the spread of the desire for education; but in their contents they are often the victims of haphazard accumulations, being composed partly of local antiquities of all ages found in the neighbourhood, and partly (especially in England) of objects fortuitously collected by travellers and transferred to the local museum when they ceased to interest their owners. Natural history museums have frequently grown up in the same way; but the great national and university museums, together with some that have been formed by scientific societies, have been formed of set purpose and under scientific direction.

Development.—Within the last century progress has been systematized, and museums have acquired a recognized place in the national life.

GREAT BRITAIN

The first Museums Act was passed in England in 1845, and was followed by others; but the majority of the municipal museums owe their origin to the Act of 1891, now repealed and superseded by the Public Libraries Act of 1919. The recent (1928) report of Sir H. Miers to the Carnegie Trustees states that there were then 428 museums in England, 62 in Scotland, 26 in Wales, 8 in Northern Ireland, and 3 each in the Channel Islands and the Isle of Man,—a total of 530, great and small, including the national museums. In size and quality they vary very greatly, from large museums with collections of outstanding importance, such as Liverpool, Glasgow, Birmingham, Bristol, Manchester (where the museum is shared by the university and the city), Norwich, Hull, Exeter, Leicester and Sheffield, or smaller museums distinguished by special collections, such as York, Newcastle, Colchester (shared between a society and the Corporation), Taunton, Ipswich and Shrewsbury, or museums with a special purpose, such as the Horniman museum of ethnology in London or the Tolson museum of local history (natural and human) at Huddersfield, to small, neglected assemblages of fortuitous collections, badly housed, ill arranged and understaffed, which are too frequent throughout the country. An admirable survey of the whole field, with full statistics, is given in Sir H. Miers' report.

THE CONTINENT OF EUROPE

Every European country similarly possesses museums, national and municipal, which have for the most part had their origin in the collections of princes and nobles, supplemented in modern times by the deliberate educational policy of national or local governments.

In France the 12 national museums, including pre-eminently the Louvre, are governed by a Council of National Museums, under a director appointed by the President of the Republic on the recommendation of the Minister of Public Instruction. Museums under municipal or other local management are numerous.

In Italy no less than 71 museums and galleries are classed as national; to these must be added the great papal museums of the Vatican and Lateran and the municipal museums of Rome, Bologna, Ravenna, Siena, Palermo and elsewhere.

In Germany nearly all museums are the property of the several States, having grown up when they were separate kingdoms or principalities. The most important are the great group of museums of art, archaeology and ethnology at Berlin, Munich, Dresden and Nuremberg, with the Roman collections at Mainz and Trier, and museums of industrial art at Berlin and Hamburg. Of the many museums scattered over Europe, northern Africa, and southern Asia, most of them are of national interest only (*see* section IMPORTANT MUSEUMS AND ART GALLERIES).

THE UNITED STATES

In the U.S. the recent growth of museums has been amazing. They illustrate the modern development of museum theory. Instead of having developed fortuitously out of collections originally made to gratify the taste of a prince or the curiosity of a traveller, they have been for the most part deliberately created as part of the educational system of the country. Only a very few are national, namely the small group of museums at Washington administered by the Smithsonian Institution. A few are State museums, but not more than half a dozen of these are said to be well developed. There are some college and private museums, but the large majority, amounting to nearly 1,000 in all, is composed of municipal museums, supported partly by municipal funds but still more by private subscriptions and benefactions, the collection of which by organized propaganda forms an important part of the duties of the administration.

Money for buildings has been contributed with great liberality by private citizens, and since all are of quite recent date it is in America that museum planning and architecture can best be studied.

In respect of contents the American museums started at a disadvantage, for the field of free acquisition of Greek and Roman antiquities was closed before they came into existence. Nevertheless even in these provinces the museums of New York and Boston have succeeded in forming notable collections; while wherever there is an opening either for excavation or for purchase, American museums have been active and successful. The Metropolitan Museum has built up a magnificent Egyptian collection by many years of painstaking and scientific excavation. The American museum of Natural History has sent expeditions into many parts of the world, its most notable recent success having been won in Siberia. Boston and Philadelphia have had expeditions at work in Egypt, Palestine and Mesopotamia; in the

latter country the Philadelphia museum has shared with the British Museum the epoch-making discoveries at Ur. American antiquities are, of course, their natural province (*e.g.*, the Heye museum of the American Indian); but they have also taken advantage of the more recent opening up of the Far East to form the finest collections in existence of Chinese and Japanese art and archaeology. For fine buildings in which first-rate collections are shown with a due allowance of space, the traveller must visit the great cities of America rather than the crowded galleries of London, Paris and Rome.

Educational Value.—American museums, for the reasons given above, form the transition from the older to the more modern conceptions of a museum. A museum is not now regarded as a collection of curiosities, but as an engine of research and of popular education. Its duties are two-fold: to the student and to the general public.

The conception of the museum as the laboratory of the student followed next after the conception of it as a casual collection of objects of beauty or curiosity, and was the result of the spread of archaeological discovery and scientific research, exemplified by the excavations of Layard and Schliemann and the publication of Darwin's *Origin of Species* in the 19th century. The third conception of it, as an instrument for the education of the general public, is of still later growth. If a date is to be indicated, the Great Exhibition of 1851 (out of which grew, in England, the institutions now known as the Victoria and Albert Museum and the Science Museum) may be taken as marking its commencement; but its general recognition and acceptance belongs to the present generation, and perhaps is not fully realized yet. Sir H. Miers' report, already alluded to, shows how much remains to be done in order to qualify most of the local museums of Great Britain to take their place in the educational scheme; but the doctrine is now generally accepted, the press aids with ready publicity, and the public visit the museums in greater numbers and take a more intelligent interest in their contents.

Service to the Public.—The service of the museum to the general public is three-fold. First, it stimulates curiosity, the gratification of which increases knowledge. It makes a man more aware of the world in which he lives; of its extension in time and space, of the materials of which it is composed, of the trees and plants with which it is covered, of the animals that have inhabited it from the remotest ages until now, of the activities of man, of the history of his development, of his achievements in craftsmanship and art. It illustrates written history and enlarges a man's conception of the possibilities of his race; and so it plays its part in enlarging his mind, in multiplying his interests, and in making him a better citizen. Secondly, in some of its departments it ministers to the sense of beauty. It places before him the beautiful products of nature and of art. It shows him what man has been able to create out of clay or stone or metal or by the use of pigments, and so gives him the means of training his taste and developing a cultivated appreciation of the beautiful; a service which, in a world where so many live in the midst of man-created ugliness, is on no account to be minimised. And thirdly it provides a means of refreshing recreation and intellectual and aesthetic enjoyment.

This is the museum ideal: but to realize it conditions are needed which are not always, or indeed often, attainable. To attract and interest the public, not a mass of material is needed, as by the student, but a relatively small number of objects good of their kind, or intrinsically interesting, well displayed and clearly explained. The ideal museum would have one set of galleries for the general public, in which this method would be applied, and another set of rooms for the student, in which objects would be gathered in bulk, with all facilities for their examination. Unfortunately few museums, and none of the older ones, have been built on this principle. The original idea was to show everything; and now the galleries are overcrowded, and there is no adequate accommodation for study-series. The need, however, is now recognized, and there is no doubt that efforts will be made to supply it (*see* MUSEUM ARCHITECTURE).

The educational service of a museum is, or should be, not merely passive but active. It is not enough to build and stock a museum, and to leave the public to find out its value for themselves. That was the older policy, or lack of policy. A live museum now endeavours actively to attract the public and to interest it. The principal means are by labels, by guide-books, by photographs (including the popular picture postcards), by special exhibitions, by articles in the press, and by lectures in the galleries. Peripatetic lectures by educated guide-lecturers (as distinct from mercenary *ciceroni*) were, it is believed, first tried in the United States in 1907 and first systematized in London in 1911. They are now a recognized and popular feature in all the greater museums. Still more recently the use of museums as a regular part of the education of children has been developed, conspicuously so in America, where it has been found a great success.

Present Status.—The present position of museums may be briefly summarized as follows. Everywhere the national museums, the university museums, and a small number of municipal museums are thoroughly established as laboratories of research, with trained staffs and an equipment, more or less complete, of catalogues. Their value in this respect is unquestioned. They are mostly full to overflowing, yet must continue to add to their contents in order to keep abreast of the results of discoveries. Their main problem is the provision of storage and of accommodation for students. As instruments of general education and cultured recreation, their utility has recently been much more fully realized than before; but it cannot be doubted that further developments in this respect are possible and desirable. Public recognition of their value, as manifested in the press and in figures of attendances and sales of publications, is growing rapidly.

BIBLIOGRAPHY.—The only general history of museums is *Museums, their history and their use*, by David Murray (Glasgow, 1904), in three volumes, of which two are occupied by a bibliography, including catalogues and other works relating to particular museums and special collections. Much detailed information about the national museums, both in Great Britain and in other countries, is contained in the volume of evidence and appendices accompanying the Interim Report of the Royal Commission on National Museums and Galleries (1928); and Sir H. Miers' *Report on the Public Museums of the British Isles* (1928), prepared for the Carnegie Trustees, gives the fullest survey of the history and present condition of the municipal and other non-national museums, with a tabulated list of them. E. E. Lowe's *Report on American Museum Work*, for the same Trustees, gives a more summary statement of the position in America. The publications of the American Association of Museums, the *Museums Journal* of the Museums Association of Great Britain, and the *Museumskunde* of Berlin contain much information on both theory and practice. Among other books that may be mentioned are: Sir W. Flower, *Essays on Museums* (1898); M. T. Jackson, *The Museum* (1917); L. V. Coleman, *A Manual for Small Museums* (1927); C. R. Richards, *Industrial Art and the Museum* (1927). Information with regard to particular museums must be sought in their own catalogues and other publications. A series of separate histories of British and American Museums includes *The British Museum*, by H. C. Shelley (1911), *The Boston Museum of Fine Arts*, by J. de W. Addison (revised ed., 1924), the *Metropolitan Museum of New York* by D. L. Preyer (1909), and *The Art Treasures of Washington*, by H. W. Henderson (1912). An investigation into the principles and methods of exhibition in art museums is now being conducted by the Carnegie Corporation of New York. (F. G. K.)

IMPORTANT MUSEUMS AND ART GALLERIES

A short account of the collections, special exhibits and educational activities of the more important art museums of the world is given below.

GREAT BRITAIN

British Museum, The, London, Eng., has two main divisions—the Library and the Departments of Antiquities. The Library of Printed Books is probably the largest in the world: the Department of Manuscripts includes outstanding treasures such as the Codex Alexandrianus of the Greek Bible, the Lindisfarne Gospels of about A.D. 700, Queen Mary's Psalter of the 14th century, the great Cottonian, Harleian and Royal Collections of mss., the best collection of Greek papyrus from Egypt, and vast quantities of mediaeval and modern historical papers and literary autographs. The Print Room contains a large and well-balanced representation of drawings and every kind of print, with a growing Oriental col-

lection which includes the finest representation of Chinese painting in Europe. In the Departments of Antiquities Greek sculpture stands out conspicuous through the possession of the Elgin Marbles from the Parthenon at Athens, together with the Demeter of Cnidus, the Nereid Monument and the remains of the Mausoleum and the temples of Ephesus and Phigalia. The Egyptian collection is as fine as any outside Cairo, including notably the Rosetta Stone and large representative selections of sculpture, mummies, papyri and smaller objects. The Museum contains the recent revelations of Sumerian art of the fourth millenium B.C.

Victoria and Albert Museum, The, is located at South Kensington, London. Its primary object is to provide examples to illustrate the history of art, especially in relation to such manufactures and crafts as are associated with decoration and design. In 1852 the Museum of Ornamental Art was established at Marlborough House, and at that time the collection consisted of specimens, casts, etc., originally purchased for use in the School of Design, with objects acquired from the Great Exhibition of 1851.

The collections are classified by material and arranged in eight departments: (1) Architecture and Sculpture; (2) Ceramics; (3) Engraving, Illustration and Design; (4) Library and Book Production; (5) Metal Work; (6) Paintings; (7) Textiles; (8) Woodwork. The Department of Circulation consists of separate collections, not on exhibition, available for loan to other museums and schools of art. The museum's library contains about 150,000 volumes, dealing with fine and applied art, and a collection of about 250,000 photographs. (*See* LONDON.)

National Gallery, The, London, was founded in 1824, by the purchase of 38 pictures from the collection of J. J. Angerstein. The collection now contains about 1,750 works, exclusive of a considerable number at the National Gallery, Millbank (the Tate Gallery). The Gallery is unexcelled in the uniformly high quality of its pictures, and the number of masterpieces it possesses. Nowhere outside Italy is the Italian school so admirably represented, nor outside Holland, the Dutch school; while the collections of Flemish, Spanish, German and French work, though small, are very choice. The group of English paintings is without an equal. Among the most famous paintings in the gallery are those by Duccio, Masaccio, Piero della Francesca (here represented by an unrivalled group), Leonardo da Vinci ("Madonna of the Rocks"), Michelangelo (notably "The Entombment"), Raphael (including the famous "Ansidei Madonna"), Correggio, Mantegna, Giovanni Bellini, Titian, Tintoretto, Jan van Eyck ("John Arnolfini and His Wife"), Rubens, Rembrandt, De Hooch, Ruisdael, Velásquez, Holbein, Reynolds, Constable and Turner.

Wallace Collection, The, London, was brought together chiefly by the third and fourth Marquesses of Hertford and the natural son of the latter, Sir Richard Wallace. It was bequeathed to the British nation by his widow, who died in 1897. The family residence of the Hertfords and of Wallace, Hertford House in Manchester Square, was subsequently purchased by the Government and, after adaptation, opened to the public in June 1900. The collection is remarkable both for the high quality of its pieces and its variety. The series of revolutions and political upheavals in France (1789–1871) provided the fourth Marquess of Hertford and Sir Richard Wallace, both long residents in Paris, with unique opportunities for acquiring the chief treasures of the royal chateaux and the palaces of a ruined and disappearing nobility. French art of the 18th century is therefore the prevailing note of the collection. But the vigilance of their agents in England and elsewhere enabled them also to secure masterpieces of the first rank of the Italian, Spanish, Flemish, Dutch and English schools. What may be called the mediaeval section was added by Sir Richard Wallace, who bought *en bloc* two famous collections.

Walker Art Gallery, The, named after its donor, was a gift to the Corporation of Liverpool in 1887 by Sir Andrew Barclay Walker, Bart. The collection includes items of outstanding importance, such as: (1) The Roscoe Collection, which illustrates in outline European art from the 13th to the 16th century; (2) The Modern Collection, totalling over 2,000 works and representing the paintings of the Pre-Raphaelites, which include oils, chalk drawings, and water-colours; (3) sculpture; (4) the black and white section, including famous etchings. The only endowment possessed by the Gallery is a capital sum of £2,000 bequeathed by the 15th Earl of Derby, the income to be spent in the purchase of pictures "for the encouragement of rising artists."

Manchester Corporation Art Galleries. The City Art Gallery was originally designed by Sir Charles Barry for the Royal Manchester Institution, and was opened to the public in 1829. In 1882 the sum of £2,000 was set aside as an annual sum with which to purchase works of art. The bulk of the pictures in the collection belong to the English school and mainly cover the 19th century. In 1925 a collection of some 80 paintings, 400 water-colours and drawings, 300 woodcuts and 20 pieces of sculpture by modern artists was presented by Mr. Charles Rutherston of Bradford, who offered it on condition that it should be considered as a nucleus from which various works might be distributed on loan for short periods to the various art galleries and schools of art in Lancashire and Yorkshire. Numerous exhibitions are held in the gallery during the course of the year; lectures on various aspects of the fine and applied arts are given during the winter months; and some 500 elementary school children are brought to the Gallery every week and given instruction in the elementary principles of art. Besides, there are five branch galleries.

Bristol Museum and Art Gallery, The, was founded in 1820. The Art Gallery was presented by Sir William Henry Wills, Bart., in 1905, and has fine art collections of etchings, water-colours, oil paintings and ivories. Lectures and demonstrations are given by members of the staff in outlying parts of the city.

Dublin Museum, The, one of the most suitably housed and organized museums in Great Britain, is remarkable for its collection of Celtic antiquities. It has among its famous specimens of Irish art the shrine and bell of St. Patrick, the Tara brooch, the cross of Cong and the Ardagh chalice. The series of bronze and stone implements is famous.

Birmingham Museum and Art Gallery, The, with perhaps the finest provincial collection of industrial art, has made a reputation for special exhibitions of art.

National Museum of Wales, The, Cardiff, has an extensive department of art which occupies three galleries. The collection of sculpture, mostly by Welsh artists, is of particular interest. The ceramics collection represents the work of almost every Continental and British factory, including beautiful examples of extinct Welsh potteries.

Sir John Soane's Museum, London, in Lincoln's Inn Fields, was presented to the nation in 1835 by Sir John Soane. The collection includes Soane's own drawings, many of Hogarth's paintings, a splendid sarcophagus, sculptured in a single block of translucent Oriental alabaster from Alabastron, and many other valuable pieces. (X.)

THE CONTINENT OF EUROPE

France.—The *Louvre,* founded during the Revolutionary period, is not only noted as having the largest collection of art in the world, but is remarkable for the magnificence of its architecture. (*See* PARIS.) The *Cluny Museum* supplements the mediaeval collections of the Louvre with its select works of art, while the *Luxembourg Museum,* the *Municipal Museum,* the *Rodin Museum* and other smaller groups make Paris outstanding as an art centre. (*See* PARIS.)

Italy.—The *Museo Nazionale* at Naples contains the best arranged and best classified collection in the country. For historical importance its Roman art ranks with the collections of Rome and the Vatican. (*See* NAPLES.) Florence, known as the art capital of Italy, is the home of the famous *Uffizi Gallery,* founded by the Medici and known as one of the largest and choicest collections in the world. The collection is arranged chronologically by Schools, and shows the development of Italian painting from the 14th to the 16th century. The tapestries are also of historical importance. The *Pitti Palace,* the *Picture Gallery,* the *Academy of Fine Arts,* the *Archaeological Museum* and the *National Museum* in the Bargello are other large galleries. (*See* FLORENCE.) The museums of Rome are numerous, the Vatican alone containing at least six remarkable ones. The *Museo Nazionale* (by the

baths of Diocletian), the *Museo Capitolino* and the *Palazzo dei Conservatori* contain innumerable specimens of the finest classical art. (*See* also ROME.)

Germany and Austria.—The *Kaiser Friedrich Museum,* Berlin, has among its collections many antiquities of Babylon, Assyria, Syria and Phoenicia. (*See* BERLIN.) The *Old Museum,* housing only antique works of art, is especially interesting as an artistically unique building dating from 1828, while the *New Museum* contains a superb Egyptian collection, besides large groups of plaster casts, drawings and engravings. Schliemann's discoveries are housed in the *Ethnographic Museum.* The *National Galerie* is outstanding as a museum for paintings, dating from 1780 to the present time. Roman, French and German technical art can best be studied at the *Schloss Museum,* which has nearly 700 rooms. Under the empire it was furnished with quiet magnificence, being the royal palace. It contains the living and state rooms, formerly occupied by royalty, called the *King's Chambers,* the *Gobelin Gallery,* the Majolica Room, and immense collections of the various kinds of art, and well arranged. Dresden has many galleries of importance, as the *Johanneum,* the *Albertinum,* the *Zwinger* and the *Grüne Gewölbe.* (*See* DRESDEN.) The *Old Pinakothek* and the *National Museum* of Bavaria are at Munich (*q.v.*). Prague, Innsbruck and Budapest (*q.v.*) are respectively the homes of the National Museums of Bohemia, Tirol and Hungary. Besides the large natural history museum of Vienna, there is the *Imperial Art-History Museum* with collections of Greek, Roman and Egyptian antiquities, of coins and medals, industrial art, arms and armour, and many military trophies, relics and curiosities. (*See* VIENNA.)

Belgium and Holland.—The *Royal Museum of Fine Arts,* Brussels, has four divisions: (1) The *Musée d'Art Ancien* was established under the French régime, taking form in the eleventh year of the Republic when a group of paintings of the Old Masters was granted by the French administration. In 1841, after the development of the Gallery had been somewhat retarded under Dutch régime, it was purchased by the State. The Gallery is particularly rich in its collection of old paintings. Although the French note predominates, other schools are well represented: the Flemish school, with numerous paintings of Rubens, A. Van Dyck, Jordaens and the Antwerp masters; the Dutch school, with admirable works of Rembrandt, Von Goyen, Frans Hals, Jan Steen, etc.; and many paintings from various other foreign schools. (2) The *Musée d'Art Moderne,* which was founded during the Dutch régime, and which had a remarkable development, was reorganized after the World War with a view to making as excellent a collection of the Belgian school as possible. (3) The *Wiertz Museum* is entirely devoted to the works of painting and of sculpture of the Great Romantic painter, Antoine Wiertz (1806–65). (4) The *Gallery of Sculpture,* which was started in 1836 with the collection of sculpture from the studio of Mathieu Kessels, has considerable interest in the development of sculpture in Belgium, and some works of foreign schools add to the richness of the collection. The great central depository of Dutch art is in Amsterdam, where the *State Museum of the Netherlands,* generally known as the *Ryks Museum,* is located. (*See* AMSTERDAM.) Leyden university, The Hague and Rotterdam also have good collections.

Other Countries of Europe.—Spain has its *Museo del Prado* and the *Archaeological Museum,* of interest only in its collections of Moorish and Spanish art. (*See* MADRID.) The museums of the chief provinces are situated at Barcelona, Valencia, Granada and Seville. The *National Museum* of Portugal is at Lisbon (*q.v.*).

In Greece, the centre of all art and archaeology is Athens (*q.v.*), which has three museums, all devoted to Greek art: that of the *Acropolis,* that of the *Archaeological Society* (vases and terra cotta), and the *National Museum of Antiquities.*

In Switzerland, the *Swiss National Museum,* Zürich, is a model of arrangement and organization. Its collection of stained glass is of general importance, while the arrangement of rooms illustrating the historical progress of art is a special feature. Basle, Geneva, Lausanne and Bern have museums of great value to the Swiss people, keenly interested in art as they are.

Norway, Sweden and Denmark rank high as countries interested in their collections of art and archaeology, despite their reputed leaning toward museums of science and industry. Stockholm has three museums: the *Royal Palace,* with its unusual collection of costume and armour; the *Northern Museum,* which contains a considerable amount of modern and domestic art; the *National Museum of Sweden,* containing a general collection, well classified. The *National Museum of Denmark* at Copenhagen, however, must be classed with the few outstanding national museums of the world. The paintings form a complete record of the work of Danish artists from the end of the 18th century, and the engravings number more than 80,000. The *Thorwaldsen Museum,* named after perhaps the greatest of all northern sculptors, the *Museum of Industrial Art* and the *Danish Folk Museum* are also in Copenhagen. *Oslo* and *Bergen* contain many Norse antiquities.

In Russia, western art is found principally at Moscow and Leningrad. The *Hermitage Palace* in the latter city contains a selection of mediaeval objects of fabulous value, such as the ivories, the gold and silver objects illustrating the primitive arts and ornament of Scythia, Crimea and Caucasia. (*See* LENINGRAD; also MOSCOW.) Russian art predominates in other places, as in Kharkoff and Odessa (the university), Krasnoyarsk, with 12,000 specimens of Buriat art, etc., indicating interest in collecting even in the most remote parts of Siberia.

Various Other Countries.—There are several museums in India, the chief one being at Calcutta, devoted to Indian activities. Mention is only due the ones that are growing up under the direction of the Department of Archaeology, wisely established by Lord Curzon. The *Gizeh Museum of Egyptian Antiquities,* Cairo, is housed in a large building, well classified and liberally supported. Carthage and Tunis have small museums. The *Turkish Museum of Antiquities* at Constantinople has classical sculpture, but little else of significance. In the Orient about the only museums are found in Japan, a fuller description of which follows:

(F. L. D.)

JAPAN

Teishitsu Hakubutsu Kan (Imperial Household Museums) consists of the Tokyo Imperial Household Museum, the Nara Imperial Household Museum, and the Shōsō-in.

The Tokyo Imperial Household Museum, in Uyeno Park, Tokyo, dates from 1872. The main exhibition building, badly damaged by the earthquake in 1923, will be replaced by a new one. At the present time the Hyokeikan, which withstood the earthquake, is the only building now open to the public. The exhibition building contains two rooms for Oriental paintings, which are changed every month, a room for lacquer work, a room for Oriental wood, bamboo, metal, jade and ivory work, a room for the ceramic arts of Japan and China, two rooms for Japanese ancient sculptures, and three rooms devoted to historical and archaeological exhibits.

The Museum holds special exhibitions from time to time, and issues annual reports, reports of investigations, "Zuroku" (collotype reproduction of works of art with explanatory notes), "Gomotsu Jodai Senshokumon" (colour reproductions of 7th, 8th, and 9th century, dyed and textile fabrics in the Imperial Household Collection).

Nara Imperial Household Museum, in Nara Park, was completed in 1894. It contains the most representative collection of early Japanese sculpture, mainly in loan from different temples and shrines. It also contains archaeological and historical exhibits, as well as paintings.

The Shōsō-in (The Imperial Treasure House at Nara): the present wooden building dates from about 752, and contains treasures dedicated to the Great Buddha of Todaiji from the Imperial Household and kept under its supervision. To-day, as has been the practice for nearly 12 centuries, it is only in the presence of a special messenger from the Emperor that the doors are locked and sealed with a piece of paper bearing the Emperor's own signature, or the seals undone to open the doors. Of recent years it has been opened once a year, for about a fortnight, for airing, when accredited persons are allowed to see the treasures in the building. The most important treasures therein preserved are those which once belonged to the Emperor Shōmu, upon whose

death, in 756, his devout consort, the Dowager Empress Kōmyo, collected the things left by the Emperor and dedicated them to the Great Buddha, whose gigantic image the Emperor had caused to be created four years previously. The "Memorandum of Things Dedicated" by the Empress Kōmyo, dated June 21, 756, which marks the inception of the present Shōsō-in collection, is still preserved.

The Kyoto Museum: built in 1895 as one of the Imperial Household Museums, it remained as such for about thirty years, when it was given to the City of Kyoto. While it contains a good section of sculpture, it specializes more or less in paintings, mostly borrowed from different temples and shrines, and those exhibited are changed from time to time. (J. Har.)

THE UNITED STATES

Metropolitan Museum of Art, The, of New York City, was incorporated on April 13, 1870, "for the purpose of establishing and maintaining . . . a Museum and library of art, of encouraging and developing the study of the fine arts, and the application of arts to manufacture and practical life, of advancing the general knowledge of kindred subjects, and, to that end, of furnishing popular instruction." Its collections include Egyptian and classical antiquities, painting, sculpture and architecture, the decorative arts (furniture, metal-work, ceramics, glass, textiles, costumes, etc.), musical instruments, and arms and armour. Among the valuable gifts are the Altman collection and the Pierpont Morgan collection of European decorative arts, chronologically arranged from the Merovingian period to the 19th century. The latter collection occupies an entire wing, and another wing, the gift of Mr. and Mrs. Robert W. de Forest, is devoted to early American art. The Museum is owned and administered by a board of 21 elective trustees, and 4 ex-officio, representing the City of New York and the National Academy of Design. Its building, containing exhibition floor space of over 280,000 sq.ft., was erected by and leased from the City of New York. The yearly cost of administration is met by interest on endowment funds, an appropriation from the city for upkeep and salaries, membership dues, sale of publications and fees for admission, instruction, lecture courses, etc. The membership of the museum in 1928 was about 14,000.

Museum of Fine Arts, The, Boston, Mass., was incorporated on February 4, 1870, for the purpose of collecting and exhibiting works of art and of affording instruction in the fine arts. It was created by a group of private citizens and has always been supported by private gifts, bequests and annual subscriptions, without aid from the city or the State. In this respect it occupies a unique position among the greater museums of the world. It is administered by a board of trustees including representatives from Harvard university, the Boston Athenaeum, the Massachusetts Institute of Technology, the city, and the State. The museum maintains permanent free public exhibitions of original works of the art of Egypt, Greece, Rome, the Orient, modern Europe and America, supplemented to a limited extent by reproductions. Its outstanding collections are those of Chinese and Japanese, East Indian, Egyptian and Classical art; its print collection ranks first in America.

For *Art Institute of Chicago, The, see* vol. XI.

Brooklyn Museum, The, see Brooklyn Institute of Arts and Sciences.

Peabody Museum of American Archaeology and Ethnology, a museum founded by George Peabody at Harvard university in 1866, was the first anthropological museum in the United States. Its building, begun in 1877, enlarged in 1889 and again greatly enlarged in 1914, forms part of the university museum. Originally founded to comprise collections relating only to the past and present aboriginal peoples of the New World, its scope has been gradually widened, until it now includes archaeological and ethnological collections from all over the world. Aided by generous gifts of funds, it has since 1891 specialized in the archaeological exploration of the Mayan region of Central America, although in addition numerous investigations in various parts of the United States have been carried on, and expeditions to South America, Asia and Africa have also been sent out. The museum library contains complete sets of practically all anthropological and archaeological journals, and comprised in 1928 a total of about 20,000 volumes.

Fogg Museum of Art, The, Harvard University, Cambridge, Mass., was founded by Mrs. Elizabeth Fogg, and bequeathed to the university. The original building was completed in 1895 and used until 1927, when a new and adequate structure, planned by museum specialists working in collaboration with the architects, was dedicated and opened to the university and the public. The museum is a laboratory for the Fine Arts Department of the College, the collections being brought together with the idea of illustrating with original material the work carried on in the courses of study. Among the outstanding collections are those of prints, old masters' drawings and early Italian pictures.

National Gallery of Art, The, Washington, D.C., organized in 1920, as a department of the Smithsonian Institution, comprises two grand divisions: the National Gallery proper, and the Freer Gallery. The former occupies available space in the Smithsonian Institution building and in the old and new museums; the latter occupies exclusively a separate building, and is described below.

Freer Gallery of Art, The, Washington, D.C., is devoted primarily to the study and acquisition of the fine arts of Asia, and, secondarily, to the display and preservation of a group of works by American artists. These collections were brought together by Charles Lang Freer, of Detroit, and, together with the building and a fund for their development, were given by him to the nation, under the trusteeship of the Smithsonian Institution. Most important is a section devoted to the work of Whistler, including oil paintings, water colours, pastels, etchings, lithographs, engravings and drawings. Many American painters are represented. Eastern potteries, sculpture, bronzes, jades, etc., are present, some as early as the Chou Dynasty. The Persian, Mohammedan, Egyptian and Byzantine art collections are outstanding. The Freer Gallery was designed by Charles A. Platt.

Cincinnati Museum Association, Cincinnati, Ohio, is divided into two departments: the Museum proper and the Art Academy, or school. The collections embrace: the graphic arts—painting, drawing, etching, etc., the most notable being the collection of contemporary American paintings; sculpture—casts of Egyptian, Assyrian, Greek, Roman, Gothic, Renaissance and Modern works; metal work—originals and reproductions of silversmiths' and goldsmiths' works; arms and armour; textiles—including an important series of Indian shawls and a large collection of American lace. Besides the interesting groups of ceramics, costumes and musical instruments from all countries, there are over 30,000 specimens of American archaeology and ethnology.

Cleveland Museum of Art, The, Cleveland, Ohio, opened in 1916, is one of the outstanding museums of the United States. Its permanent collections include the Egyptian, classical, mediaeval and modern Western arts, with a notable single group of the decorative arts. The educational work covers a broad field and is an important factor in its success: courses of lectures, children's entertainments, clubs and conventions, exhibits, classes for art students, etc. A publicity department maintains contact between the museum and the local press by furnishing information, news items, photographs and copy.

Pennsylvania Museum, The, Philadelphia, Pa., covers the general field of European, American and Oriental art, chiefly in the periods since the beginning of the Christian era. Special emphasis is laid on the decorative arts, such as woodwork, furniture, textiles and metal work, and particularly important are the collections of ceramics and silver. The School of Industrial Art is a part of the organization, and with special exhibitions and competent instruction in the fine arts, the educational programme fills an important place. The museum is maintained by the city, supplemented by a membership of over 3,000 with annual dues.

Philadelphia Museum of Art, The, with the finest building of the Greek spirit in the modern world, is outstanding in its number of private collections and its importance as an educational institution.

Carnegie Institute, Pittsburgh, Pa., founded 1896, embraces the following departments: library, fine arts, museum, music, library

school, technology. The collections and activities of the museum cover both the natural sciences and the applied arts. Of particular importance is the collection of coins and medals and the various pieces of art work in metals. Considerable interest is manifested in contemporary American paintings, and the International Exhibition of paintings is held here annually. Other special exhibitions are presented throughout the year, and a large educational programme, including children's drawing classes and entertainments and a series of art lectures for adults, is maintained.

Detroit Institute of Arts, The, Detroit, Mich., incorporated in 1885 and reinstalled in an elaborate and modern building in 1927, includes a large collection of art works and a wide scope of educational activities. The museum has an interesting arrangement of the collections on one main floor in a series of period rooms, together with a pleasing semblance of their original setting. This floor is divided into three main sections: European, American and Asiatic. The Institute has provided educational facilities for students of the fine arts, such as study rooms, a lecture hall and a large auditorium equipped with a fine stage and a pipe organ.

Baltimore Museum of Art, The, which was founded in 1923 (Baltimore, Md.) moved into a new and up-to-date building in 1929. The collections are largely loan exhibitions, including paintings and sculpture by both American and foreign artists. Among the permanent treasures is an interesting group of East Indian metal and Cypriote antiquities. The educational work includes lectures, gallery tours for children, and the distribution of art collections and lantern slides among the schools.

City Art Museum of St. Louis, The, founded in 1879 as the St. Louis Museum of Fine Arts and reorganized in 1908, has an interesting group of collections, small but of unusual beauty. American paintings have received special attention, and an exhibition of invited paintings by American artists is assembled annually, selected largely from important exhibitions held at Chicago, Washington, Philadelphia, New York and Pittsburgh. These, with splendid examples of American sculpture, constitute one of the most representative collections of modern American art.

Denver Art Museum, The, Denver, Colo., is specializing in two regional art collections—the American Indian and the Spanish-American art. The Museum is especially interested in fostering the spirit of creative art and encouraging worthy students of art.

Fine Arts Society of San Diego, The, San Diego, Calif., established in 1926, is significant in its unique collection of old and modern Spanish art, as well as contemporary American art, which is almost exclusively in the field of paintings. It has a membership of more than 1,000.

Museum of the American Indian, The, Heye Foundation, New York City, was opened in 1922. It has over 2,000,000 exhibits and can display only about one-quarter of these at one time on the three floors that are devoted to exhibition rooms. The sole aim of the Museum is to gather and preserve for students everything useful in illustrating and elucidating the anthropology of the aborigines of the Western hemisphere. The field work, the publications and the monographs are notable.

Hispanic Society of America, The, was founded in 1904 in New York City. Its library and museum were designed to be a link between the English, Spanish and Portuguese speaking peoples—their languages, literature, art and history. A collection of paintings, manuscripts, maps and coins, and a library of 100,000 books form the most notable Hispanic collection in America. The society has held several outstanding exhibitions, among them the works of Sorolla, Zuloaga, Cervantes and Lope de Vega, as well as of collections of sculpture, photographs, prints, etc., and has issued more than 180 publications in Spanish history, literature and art.

Milwaukee Art Institute, The, Milwaukee, Wis., organized in 1910, is noted for its public activities as a civic centre—its great number of temporary exhibitions, gallery tours for children, entertainments for outside organizations, and free lectures.

Corcoran Gallery of Art, The, Washington, D.C., was founded in 1869. Special attention has of late been given to the acquisition of works by the American painters and sculptors, with a view to making the collection as representative as possible. A free art school is conducted in connection with the gallery.

Toledo Museum of Art, The, Toledo, Ohio, incorporated in 1901, has among its many collections perhaps the finest display of ancient glass in the world. The group of early printed books and manuscripts is also a remarkable one in that it shows the entire evolution of the art of writing and printing. The Museum has a vast educational programme: Sunday concerts, evening lectures, art lectures for children, etc. (F. L. D.)

MUSEUMS OF SCIENCE. The term "museum" originally meant the "Temple of the Muses," but now the conception is entirely altered. In the ancient world there were collections of paintings and statuary in the temples and palaces of Greece and Rome. Alexander the Great gave large sums of money to his illustrious teacher Aristotle and also sent him Natural History collections from the lands he conquered.

The "museum" at Alexandria was composed of a series of associated colleges which dealt with the muses and the arts. When this museum was burnt down the term fell into disuse, and there is nowhere in the world an institute corresponding to it. Not until the 15th century when there was a revival of interest in classical antiquities was any attempt made to "collect," but about this time one of the hobbies of the wealthy was to assemble together collections of statuary, inscriptions, gems, coins, medals, manuscripts and other relics of the past. This was followed by others who took up the task of collecting plants, minerals and curious animals, and among the more famous early collectors of objects of natural history may be mentioned Georg Agricola (1490–1555) who has been styled the "father of mineralogy." By his labours the elector Augustus of Saxony was induced to establish the *Kunst und Naturalien Kammer,* which has since expanded into the various museums at Dresden. One of his contemporaries was Conrad Gesner of Zürich (1516–1565), "the German Pliny," whose writings are still resorted to by the curious. Others whose names are familiar were Pierre Bélon (1517–1564), professor at the Collège de France; Andrea Cesalpini (1519–1603), whose herbarium is still preserved at Florence; Ulissi Aldrovandi (1522–1605), remnants of whose collections still exist at Bologna; Ole Worm (1588–1654), a Danish physician, after whom the so-called "Wormian bones" of the skull are named, and who was one of the first to cultivate what is now known as the science of prehistoric archaeology. The first person to elaborate and present to modern minds the thought of an institution which should assemble within its walls the things which men wish to see and study was Bacon, who in his *New Atlantis* (1627) broadly sketched the outline of a great national museum of science and art.

THE BRITISH EMPIRE

The oldest science museum in Great Britain is the Ashmolean museum which was built in 1679 by the University of Oxford to house the collection of natural history objects and some few archaeological rarities that had been publicly exhibited by the Tradescants in London, and had been made over by deed of gift by the younger Tradescant to his friend Elias Ashmole in 1662. Under the brothers Duncan, in the first half of the 19th century the museum enjoyed a wide reputation as a natural history museum of importance, and it preserved this character until 1860 when the zoological and botanical collections were moved to the New University museum.

In 1925 the old gallery was reopened as a museum for illustrating the history of science, and more especially of science in Oxford, by contemporary scientific instruments. A superb collection of ancient mathematical instruments, astrolabes, sundials and other apparatus was given to the university by Dr. Lewis Evans.

The most famous of English collectors in his time was Sir Hans Sloane (1669–1753), whose vast collections, including those of Pitiver, Courten, Merret, Plukenet and Buddle, were by his will bequeathed to the British nation on condition that parliament paid his heirs the sum of £20,000. The bequest was accepted and with the library of George II., which was also bequeathed to the nation, was the foundation of the British Museum in Bloomsbury, London. It was opened in 1750.

London.—The greatest museum in London is the British Museum, while the Natural History Department at South Ken-

sington with its wealth of types is the most important collection of its kind in the world. The museum of Practical Geology, Jermyn Street, contains an extensive collection and a very complete series of specimens illustrative of the petrography and palaeontology of the British Islands. The most recent museum in London is the Science Museum. In 1856 the collections illustrating science and art which had been brought together at Marlborough House was transferred to the South Kensington Museum which was opened by Queen Victoria in 1857. In 1896 the art collection was transferred to what is known as the Victoria and Albert museum, opened by Edward VII. in 1909; from this date the science collection was styled the Science museum. The main objects of this museum are (1) that so far as possible by means of exhibiting scientific instruments, apparatus, machines and other objects, the collections in the Science museum should afford illustrations and exposition of the various branches of science within this field and by their application in the arts and industries; (2) that the museum should also be a home for the preservation of appliances which hold an honoured place in the progress of science or in the history of invention.

At Kew Gardens there is a wonderful herbarium and general botanical collections very rich in types. The Hunterian museum of the Royal College of Surgeons devotes itself almost entirely to anatomy, both human and comparative and also to pathology. The Horniman museum, Forest Hill, S.E. owes its origin to collections of a miscellaneous character brought together by John E. Horniman. In 1901 he presented to the London County Council, for the use of the people of London, the existing building and the whole of his collections. Since the museum came under the control of the London County Council its character has been transformed, both by the more precise definition of its scope and intention, and by the expansion and re-arrangement of the collections along predetermined lines. It now deals with only two subjects, zoology and anthropology (including archaeology and ethnology). In general, its object may be said to be the illustration of the working of the evolutionary principle in relation to animals and man, and to human artefacts.

Liverpool.—The Liverpool museums are the largest of the provincial museums and owe their origin to two generous benefactors, (1) Lord Derby who presented his natural history collections, and (2) Joseph Mayer who presented his collections of antiques to the corporation. There are six separate departments, viz.:—botany, geology, invertebrate zoology, vertebrate zoology, archaeology and ethnology, while one section contains a large collection of ship models and pictures illustrative of the history of shipping. There is also a large collection of ceramics. The Egyptological collection is very extensive. There is also an aquarium. The zoological collections are extremely important more especially in ornithology which is very rich in types. One section is devoted to "old Liverpool."

Manchester.—The Manchester museum fulfills a dual purpose; it is a municipal museum and also a university museum. Instruction in science is given in the museum to 100 classes of elementary school children every week.

Bristol.—Bristol museum is now very important and contains departments of geology, zoology, botany and archaeology. A section is devoted to Bristol antiquities.

Hull.—Hull is a city of museums; there are the Natural History museum, Wilberforce house, the museum of fisheries and shipping, the Mortimer collection of prehistoric antiquities, the museum of commerce and transport, and the Folk Lore museum in the Tithebarn, Easington.

Two large private museums are worthy of note, the zoological museum, Tring, belonging to Lord Rothschild which deals exclusively with ornithology and entomology, and the Pitt Rivers museum at Farnham, Dorset, which is designed to illustrate the evolution of culture.

Scotland.—The Royal Scottish museum, Edinburgh, dates from 1854 and contains very valuable collections in the following departments, art and ethnography, natural history, technology and geology. The National Museum of Antiquities of Scotland in Edinburgh is the outcome of a donation of a collection of antiquities, coins and manuscripts by the Society of Antiquaries of Scotland in 1851. In the Kelvin Grove art gallery and museum in Glasgow there are extensive collections, the natural history and the shipping being the most important. The museums of the University of Glasgow are also noteworthy, the recently opened Zoological museum being remarkably fine.

Wales.—The National Museum of Wales in Cardiff which was granted its Royal Charter in 1907 and opened by George V. in 1927 is a most remarkable institution. Its purpose is "to teach the world about Wales, and the Welsh people about their own fatherland." This purpose it fulfills by collecting and preserving all kinds of material bearing on the geology, botany, zoology and archaeology of Wales.

Ireland.—The Science museum at Dublin, and the museum at Belfast both contain science collections of importance.

In the British Isles there are about 462 museums; these may be divided into five main groups, (1) those devoted entirely to natural history (22); (2) historical collections including War Memorial houses (30), Roman or Pre-Roman collections (15), Naval and Military museums (10), and period museums (16), total 71; (3) special teaching and research museums (60), and (4) museums of industrial character (16). The remainder to the number of about 300 are museums of general character and the exhibits usually comprise at least something of archaeology, local antiquities, natural history and miscellaneous ethnographical objects, and sometimes war relics.

India.—In Calcutta there are, (1) The Indian museum, which is especially rich in the marine fauna of the Indian Ocean and contains the finest collection of vertebrate fossils from the Siwalik Hills, (2) The Geological museum of the Government Survey of India, and (3) The herbarium of the Royal Botanical gardens. In Bombay there are (1) The Victoria and Albert museum and (2) The museum of the Bombay Natural History Society which is mainly Zoological and contains the finest collection of horned heads in India. The Government museum in Madras is also worthy of note.

Australia.—The Queensland museum, Brisbane, contains large ethnological collections from Papua of outstanding importance and an aboriginal court of great interest. The fauna of Queensland is also well represented. The Geological Survey museum, also at Brisbane, contains extensive geological collections mainly from Queensland. The South Australian museum at Adelaide is devoted specially to collections illustrating the ethnology and natural history of Australia. At Melbourne there are two very important museums, (1) The National Museum of Victoria which contains large collections illustrating the zoology, palaeontology and ethnology of Australia, and (2) the national herbarium of Victoria. The Macleay museum of the university, Sydney, contains a number of special collections, the most noteworthy being the Macleay entomological collection; the Jensen alkaline rock collection; the collection of Antarctic rocks from Shackleton's first expedition, and the Australian palaeontological collection. The Technological museum contains minerals from all sources, *e.g.*, European building and ornamental stones, systematic collections of rocks, timbers and commercial plants from all parts of the world. Australia is represented by industrial minerals and the systematic collection of Australian rocks, building and ornamental stones, also a collection of Australian insect pests Sections include shipping and aeroplane models.

New Zealand.—The Canterbury museum, Christchurch, is specially rich in local collections devoted to the fauna, flora and geology of New Zealand. There are also representative collections of Maori and Polynesian ethnology. The Otago university museum of natural history and ethnology is devoted mainly to the fauna of New Zealand and contains very fine specimens of Moa skeletons. The War Memorial museum at Auckland, the Geological Survey of New Zealand museum, and the Colonial museum at Wellington are also worthy of notice.

Africa.—The South African museums, Capetown, contain general and local natural history collections, also collections illustrating anthropology, ethnology and colonial art. The Durban museum is specially rich in mammals and contains a large amount

BY COURTESY OF THE FIELD MUSEUM OF NATURAL HISTORY, CHICAGO

HABITAT GROUPS OF CROCODILES AND WILD TURKEYS

Museum habitat groups are designed to show specimens in their natural surroundings. The effect of realism is produced by the use of painted backgrounds, wax-modelled foregrounds and skilfully arranged artificial lights. Both groups illustrated above are in the Field Museum of Natural History and were painted by Charles Abel Corwin

Group 1. Crocodiles (*Crocodilus acutus*). This species is found in Lake Ticamaya, Honduras, and averages about ten feet in length

Group 2. Wild turkeys (*Meleagris gallopavo silvestris*), still found in parts of the eastern United States

of anthropological material, one room is devoted to "Old Durban." The Rhodesian museum, Bulawayo, specializes in the zoology, geology and botany of Rhodesia. The Natal museum, Pietermaritzburg, contains an exceptionally fine series of specimens of African mammals mounted in their natural surroundings, and deals mainly with the natural history of South Africa.

There has been recently opened in Zanzibar a local museum. The Egyptological collections at Cairo are unsurpassed in the world. There is also a Geological Survey museum and Zoological gardens and museum at Giza.

Canada.—The National museum in Ottawa is an outgrowth of the Geological Survey. The National museum comprises the divisions of biology and anthropology, geology, palaeontology and mineralogy being maintained by the Geological Survey. The exhibits cover a wide range of Canadian ethnology, archaeology and natural history. The Ontario provincial museum, Toronto, the Natural History museum, Quebec, and the Vancouver museum are all making rapid progress.

THE CONTINENT OF EUROPE

France.—The most important museum in France is the *Muséum d'Histoire Naturelle,* in the *Jardin des Plantes,* Paris. The collections contain many types of specimens the result of the work of French naturalists. Others worthy of mention are the *Musée des Sciences Naturelles* at Lyons, and the *École Nationale Supérieure des Mines,* and the *Institut National Agronomique.*

Monaco.—The *Musée d'Océanographie* is perhaps the finest oceanographical museum in the world, while the *Musée d'Anthropologie Préhistorique* is also an important institution.

Portugal.—The Natural History museum in Lisbon is famous for its ornithological collection, while the museum of the Geological Survey in Lisbon represents the geology of the country.

Spain.—The museum of Natural Science at Barcelona is devoted entirely to biology, while the museum of Natural Science at Madrid contains collections both local and general of minerals, rocks and fossils.

Belgium.—The *Musée Royal d'Histoire Naturelle de Belgique* is specially noted for its palaeontological collections. The *Musée du Congo Belge* is devoted entirely to the natural history, political and social economy, economic products, means of transport and arts and sciences of that colony.

Holland.—In the Rijks Museum of geology, mineralogy and zoology at Leyden there are general and regional collections of considerable importance. The museum attached to the university in Amsterdam is specially rich in teaching collections.

Norway.—The Bergen museum is devoted almost entirely to Scandinavian natural history, and contains a specially fine collection of Silurian fossils from West Norway. The Municipal museum, Stavanger, deals with local zoology and general archaeology. The museum of Northern Antiquities at Oslo is restricted to the collections denoted by its title. The Norwegian People's museum at Oslo is a "folk" museum and is world famous. The Industrial museum at Trondjhem confines its attention to Norwegian industries and is also world famous. The aquarium at Trondjhem biological station, should also be noted, although, strictly speaking, it is not a museum.

Sweden.—The Royal Museum of Natural History at Stockholm is rich in palaeontological, botanical and archaeological material. The Nordiska museum is devoted to Scandinavian ethnology, while the recently built (1923) Natural History museum at Göteborg specializes in local geology, mineralogy, zoology and botany, and contains many type specimens.

Denmark.—The Museum attached to the University of Uppsala contains many great scientific treasures. The National museum at Copenhagen is the most important and is specially rich in Scandinavian and Danish antiquities. There is also a very fine Geological museum in this city with a wonderful collection of precious stones. The Natural History museum, Aarhus, founded in 1920, is devoted to geology, mineralogy and zoology. Several old castles throughout the country house wonderful collections of Danish antiques while there are numerous open air folk museums.

Italy.—There are museums in nearly all the large towns in Italy and attached to the universities. The *Museo Civico* at Genoa, the Geological museum at Bologna and the zoological collection at the aquarium at Naples are the most important.

Greece.—The Geological Survey museum at Athens, the mineralogical, the petrological and the zoological museums of the university at Athens have representative collections.

Switzerland.—The museums of Switzerland deal almost entirely with the natural sciences. The most important are (1) The Natural History museum, Berne, (2) The Natural History museum, Geneva, (3) The Zoology museum, Lausanne, and (4) The Natural History museum, Neuchâtel.

Germany.—In Berlin there are: (1) the *Museum für Naturkunde;* (2) the Ethnological museum; (3) the Anthropological museum; (4) the Mineralogical museum, and (5) the Agricultural museum. The first is rich in classical collections while the contents of the others are denoted by their names. In Hamburg there are a Natural History museum, an Ethnological museum, the Museum Godeffroy and the Museum Umlauff. The municipal museum of Bremen specializes in natural history and ethnology. Dresden contains a number of museums which embrace all the sciences and are extremely important to the specialist. In Leipzig there is an ethnological museum rich in Southern and Central European antiquities; while Munich has a Natural History museum, an Anatomical museum and an Ethnographical museum. The Natural History museum in Stuttgart is noted for its palaeontological collections. The museums at Hildesheim and Lübeck are worthy of special note as they are model provincial museums. The most recent museum in Germany is the *Deutsche Museum* in Munich opened in 1925; it contains a very valuable collection illustrating the history of technology and the exact sciences, physics, chemistry and astronomy and is comparable in some ways to the science museum in London, and the Gallery of Arts and Crafts in Paris.

Austria.—The Imperial Natural History museum in Vienna is one of the finest institutions of its kind in Europe. The mineralogical collection is unrivalled. The botanical and conchological collections are also world renowned. The Technological museum is mainly devoted to mechanical and technological science.

Hungary.—The ethnographical and anthropological collections at Budapest are extremely important. In the *Musée Social* the following departments are worthy of attention, human anatomy, industrial hygiene, prevention of accidents, contagious diseases and other health subjects.

Bulgaria.—The Natural History museum of the King of Bulgaria in Sofia is devoted to the geology, zoology and botany of Bulgaria. The National museum of Bulgaria deals with archaeology, architecture and the fine arts.

Rumania.—The Geological institute of Rumania contains a very fine collection of Rumanian minerals, rocks and fossils. The university laboratory of Rumania is rich in geological phenomena and general stratigraphy. The Natural History museum contains geology, zoology, comparative anatomy, oceanography, anthropology and ethnology. The collections of rare Rumanian fossils including *Dinotherium* and of Rumanian fauna are noteworthy. The museum of the Hermannstadt Natural History Society contains collections exclusively Transylvanian.

Czechoslovakia.—The National Museum of Prague is devoted almost entirely to natural history but there are also collections illustrating ethnology, archaeology and numismatics. The Technology museum of Czechoslovakia, also in Prague, deals with engineering, textiles, mining, chemistry, metallurgy and aeronautics.

Jugo-Slavia.—The Croat National museum contains departments of zoology, geology, palaeontology, archaeology, ethnology and the fine arts.

Poland.—The Industrial museum in Cracow is devoted specially to the arts and crafts. The Museum Dzieduszycki at Lemberg deals mainly with the fauna and flora of Poland and has also general collections of archaeology and ethnology. The museum at Posen is notable for its forestry exhibition. The Polish Museum

of Natural History at Warsaw comprises the collections of the University of Warsaw, the Branick collection, and the malacological collections of Prince Ladislas Lubomirski, brought together in 1919.

Russia (U.S.S.R.).—The Rumiantsov museum in Moscow is specially rich in natural history. The most important museum in Leningrad is the Imperial Academy of Sciences, illustrating the zoology, palaeontology and ethnology, not only of Russia but of foreign lands. There is a Mining Museum in Leningrad, also a museum of the Revolution.

EASTERN MUSEUMS

The American University museum, Beirut, contains zoological, historical and archaeological collections of Syria and Palestine; local Jurassic and Cretaceous fossils of Syria, also a herbarium of Syrian plants. The Constantinople museum is rich in Greek, Assyrian, Chaldean and Egyptian antiquities.

At the Imperial University at Tokio there is a wonderfully equipped museum devoted to the sciences, but more especially zoology. The Museum of Zi-Ka-Wei near Shanghai is confined almost exclusively to the zoology and botany of the valley of the Yang-tse-Kiang. Notable collections are (1) the birds of China, and (2) the mammals of the Far East. This collection contains many type specimens including Cervidae and Suidae.

CENTRAL AND SOUTH AMERICA

The National Mexican Museum of Natural History contains general mineralogical, geological, zoological and botanical collections combined with the Zoological and Botanical Gardens.

The National Museum, Santiago, Chile, is devoted almost entirely to natural history and there is also a department of anthropology. The herbarium contains a type collection of Chilean plants. There is also a Natural History museum at Valparaiso.

The *Museo d'Estado de Bahia,* Brazil, is especially rich in precious stones and fossils, but there are also zoological and botanical collections from the State of Bahia. The National Museum of Natural History is as its name indicates devoted specially to that subject and the local collections are a special feature. There are, however, departments of ethnology and archaeology dealing mainly with the Indians of Brazil, Bahia, and Peru. At Para there is the Museo Paraense or the Museo Goldi. At Sucre, Bolivia, there is a Natural History and Anatomy Museum.

Colombia has the Institute Museum at Bogotá, containing notable collections of quaternary mammals from the Bolivian Savannah, also birds, mammals and lepidoptera from Bolivia.

There is a Natural History museum at San Jose, Costa Rica; and at Montevideo, Uruguay, the Natural History museum contains general geological, zoological and botanical collections, including a herbarium of the flora of Uruguay; there are also departments of archaeology and ethnology.

At Buenos Aires, there is a very progressive institute, the Argentine National Museum of Natural History, while at Cordoba there are two University museums: the Museum of Botany and Zoology, and the Museum of Mineralogy and Geology.

See E. Howarth and H. M. Platnauer, *Directory of Museums of Great Britain and Ireland,* etc. (1911); H. Miers, *Report on the Public Museums of the British Isles* (to the Carnegie United Kingdom Trustees, 1928). (J. J. Sı.)

THE UNITED STATES

Museums of science in the United States are varied in their origin, establishment, purposes and administration; they may be related to the educational or scientific work of some society or college, or to that of a city or State, or, even, as in the case of the United States National Museum, to that of a nation. They may be said to date from the founding of the Charleston museum in 1773 by the Charlestown (*sic*) Library Society. In 1815 it was transferred to the Literary and Philosophical Society of South Carolina, in 1828 to the Medical college, and in 1850 to the College of Charleston; finally (1907) it was embodied in the present Public museum.

The Museum of the Academy of Natural Sciences of Philadelphia, was founded in 1812 in connection with the organization of the society. This was for many years the most important scientific society, so far as natural history was concerned, in the United States, and it still remains in the front rank. It contains much material, including many types, in zoology and palaeontology, studied and described by earlier American naturalists; the collection of molluscs is the finest in the United States.

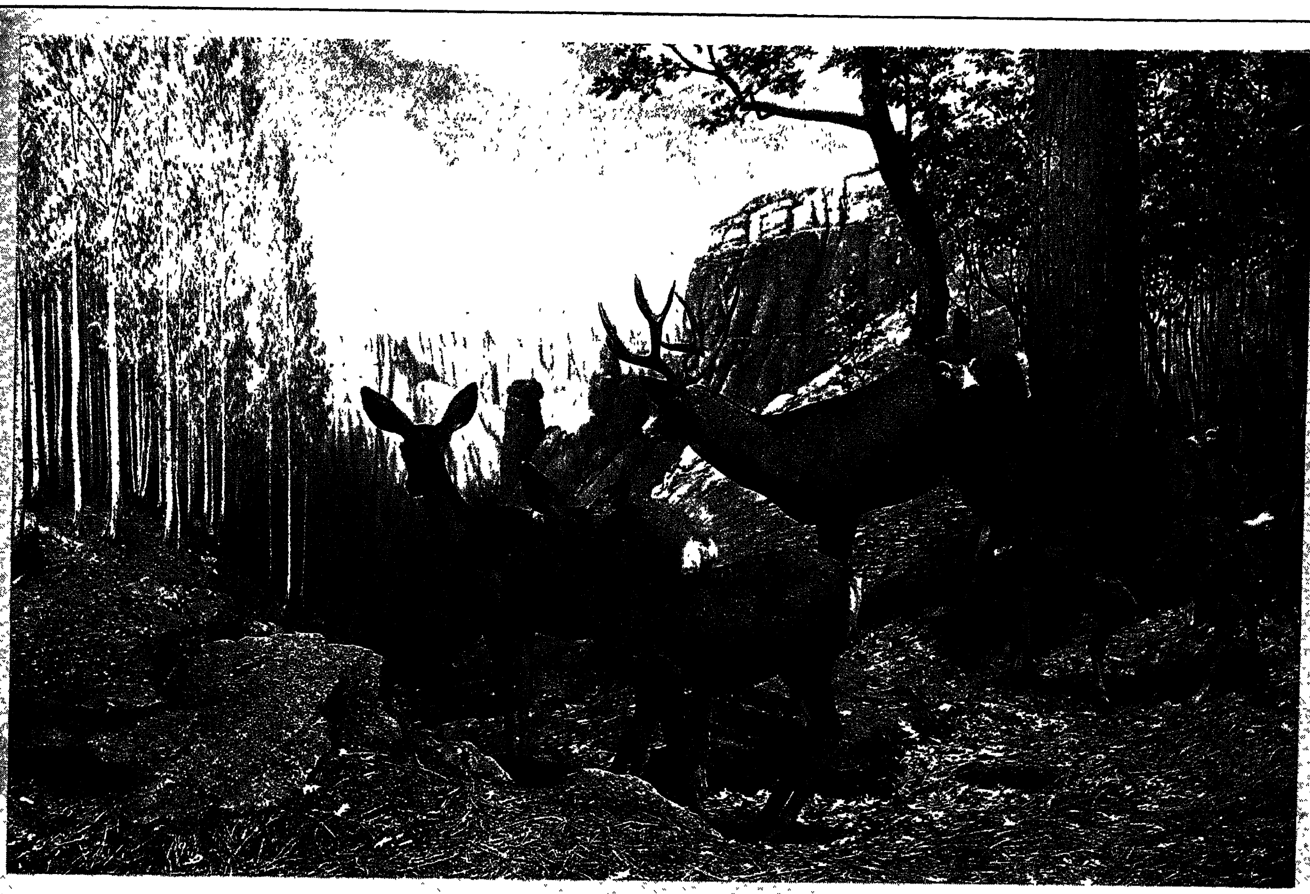
The Boston Society of Natural History was founded in 1830 as an outgrowth of the Linnean Society of New England. Originally, so far as exhibits were concerned, a museum of general zoology, its scope has been restricted to New England. The study collections are large, and include many types and figured specimens in various branches of natural history. The Museum of Comparative Zoology, a part of Harvard University, at Cambridge, Mass., had its origin in the collections purchased from Louis Agassiz for $12,000 in 1852. It was incorporated in 1859 and, later, received most important support from Alexander Agassiz. It was one of the first, possibly the first, of American museums not founded and controlled by a scientific society. Originally mainly a museum of research, its exhibits were arranged to relate to courses of study in the university; recently they have been rearranged to interest and instruct the public. The reserve, or study collections, are large and varied; they are especially rich in birds, reptiles and fishes.

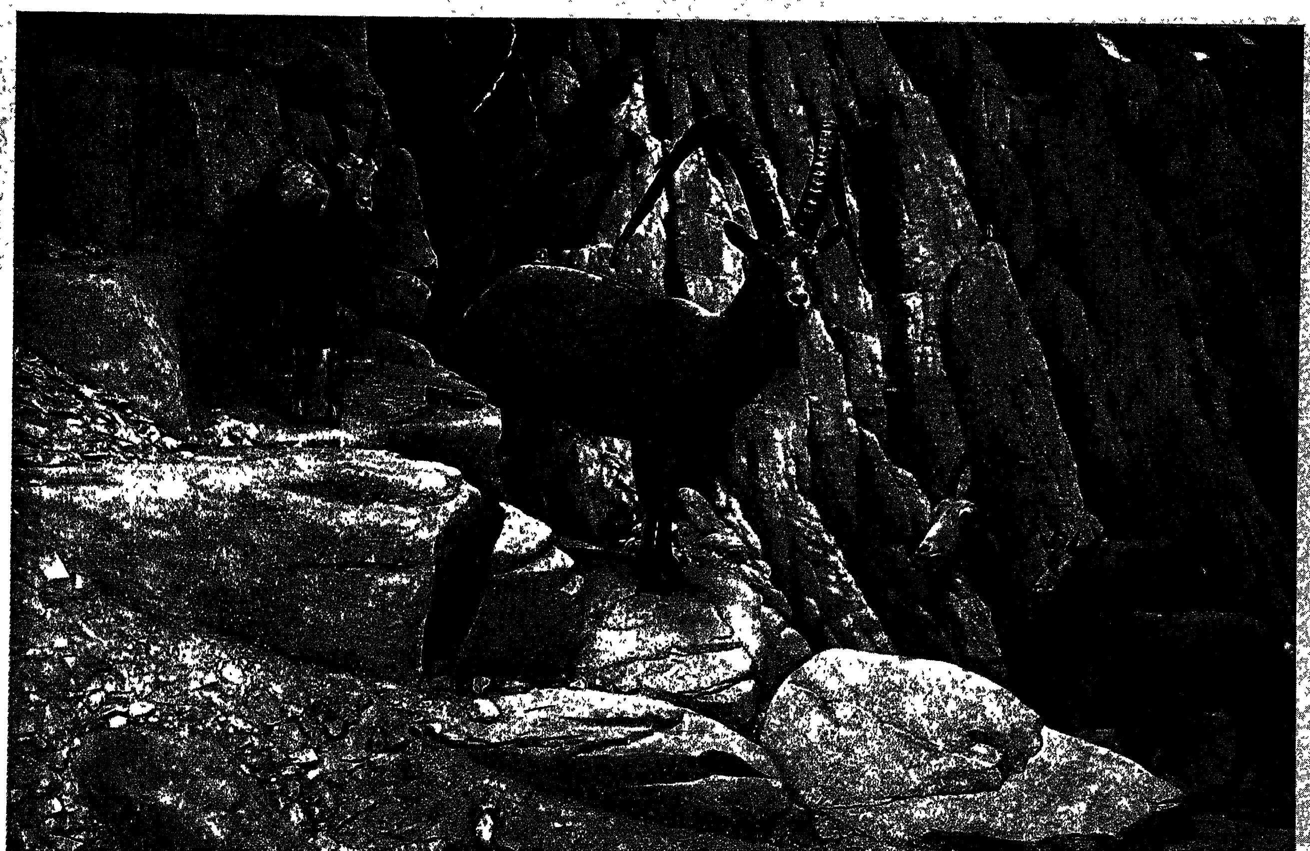
The founding of the American Museum of Natural History, New York, the largest of American museums, in 1869, marked an important step, in that it definitely recognized the interest of the public in museums by providing for the housing and care of the building by the city, while the scientific work of the institution was to be carried on from private funds. This principle of "community of interest" has been widely adopted. It includes all branches of natural history (save botany) and anthropology. There are more complete skeletons of extinct animals, particularly dinosaurs, on exhibition than in any other institution in the world, and the series of reproductions of invertebrates in glass is unique.

The history of the United States National Museum, Washington, D.C., given by Dr. Goode in detail, in the *Report* of the United States National Museum for 1891, is involved. The germs of this institution may be ascribed to the collection of minerals included in the Smithson bequest (1826), and in the National Institution (long defunct) for the Promotion of Science (1840). The term National Museum was first used by Prof. Henry in 1847, but was not legally applied to the Government collections until 1876. Wilkes's exploring expedition gave a great stimulus to the United States National Museum, but the exposition of 1876 was the final cause for its establishment. The collections include, besides natural history in its various branches, anthropology, history, technology and even art. The minerals and molluscs rank with the first. In technology, the material illustrating the development of the telephone, telegraph and electric light is unique.

The acquisition and preservation of material for study was, at first, the main purpose of museums of science, exhibition being a secondary consideration. The gathering of material was largely passive. Museums took such specimens as were brought to them, but as they grew in importance expeditions were sent out for the express purpose of securing material. Among the leaders (aside from the Government exploring expeditions) were the Peabody Museum of Yale University, under Prof. Marsh, and Princeton University, under the direction of Prof. Scott. This has now become an important and essential branch of museum work. That museums of science might be a source of "rational amusement" was recognized by John Edward Gray in his appeal for a new building for the natural history collections of the British Museum; their educational possibilities came later, and were largely due to Sir William Flower, when director of the British Museum. Dr. G. Brown Goode, in charge of the United States National Museum, under Prof. Baird, was an admirer of Flower, and a great believer in the educational value of museums, especially of their exhibition collections, and to him America owes, to a great extent, the "popularizing" of museums of science.

Once fairly started, the movement to make museums educa-





BY COURTESY OF THE FIELD MUSEUM OF NATURAL HISTORY, CHICAGO

HABITAT GROUPS PAINTED BY CHARLES ABEL CORWIN AND ARRANGED BY C. J. ALBRECHT

1. Group of mule deer (*Odocoileus hemionus*) in the Field Museum, Chicago. The species is found in the western United States

2. Group of Asiatic ibex (*Capra sibirica*) in the Field Museum, Chicago. They range in Asia from the Altai to the Himalaya Mountains

tional rapidly gathered weight, until it has become recognized as one of their important objects, and special attention is given to the arrangement and labelling of exhibits and to affiliation with schools. (*See* section on *Visual Education in Museums.*) The most recent instance of the change in policy of a museum of science is the rearranging of the collections of the Museum of Comparative Zoology at Harvard along educational lines, though the first step may be said to have been taken some years ago by the introduction of the Blaschke glass flowers.

There are, great and small, about 325 museums of natural history in the United States, but it is uncertain just how many of these are entitled to be called museums of science. The history of a few of the more important has already been noted; the location of other leading museums, and the more noteworthy of their collections, are as follows:—

The Field Museum of Natural History (originally Field Columbian museum), Chicago, was founded by the gift of collections by Marshall Field at the close of the Columbian Exposition of 1893. It has important collections in natural history and ethnology, being particularly rich in birds of North and South America, and mammals of those continents and Africa. The collection of meteorites is the largest in the world; the exhibits in botany lead all others in the United States. A special gift from N. W. Harris provides for unusually fine circulating exhibits for schools.

The New York State Museum, Albany, was organized as the State Cabinet of Natural History, the original collections being the material gathered in the course of the natural history survey of the State between 1836 and 1843. In 1873 it was established as the State museum, and in 1889 made a part of the University of the State of New York. It is supported entirely by the State, is the largest of the State museums, and its publications the most important. It contains many types and figured specimens of the past and present flora and fauna of the State, and its historical collections are extensive. Other important State museums are those of Pennsylvania (Harrisburg), Illinois (Springfield), New Jersey (Trenton), Indiana (Indianapolis), Georgia (Atlanta) and Florida (Gainesville).

The Public Museum of the City of Milwaukee had its origin, in 1882, in the gift of the collections of the Wisconsin Natural History Society. Its collections include both natural history and history, and special attention is given to work with the schools and to exhibition.

The Carnegie Museum, Pittsburgh, Pa., has important collections of fossil vertebrates, South American birds and *Lepidoptera,* a speciality being African butterflies.

The Colorado Museum of Natural History, Denver, founded in 1902, is supported largely by the city; its scope includes, primarily, the natural history of the State, and also art and industry. It has given much attention to fossil vertebrates.

The Buffalo Society of Natural Sciences, Buffalo, N.Y., organized in 1861, was almost the first museum in which the exhibits were definitely planned and arranged on an educational basis. It is particularly strong in fossil invertebrates from the Devonian near Buffalo.

The California Academy of Sciences, San Francisco, organized in 1853, gives particular attention to the fauna and flora of the Pacific coast and western States, and while the collections were largely destroyed by the fire of 1906, they have again been brought to a high level. It is particularly rich in reptiles, and the series of giant tortoises from the Galapagos islands is unique.

The Peabody Museum of Yale University, New Haven, dates from 1866; it is rich in fossil vertebrates, especially dinosaurs, and possesses the first birds with teeth to be discovered, and important examples of early horses. Its exhibits are arranged with special reference to their educational influence and work with public schools.

The University of Michigan museum, Ann Arbor, Mich., one of the largest and most active of museums connected with colleges, is strong in ethnology, particularly of the East, and in collections representing the resources of the State. A special feature is its work in experimental biology and the problems of conserving natural resources. (F. A. Lu.)

Visual Education in Museums.—In the United States, museums are being utilized to an unprecedented degree for visual education in the public schools and colleges. Scores of museums have arisen in all parts of the country, but their use as a part of the educational system is best exemplified in the larger cities. The American Museum of Natural History in the City of New York may be selected as typifying this movement because of the extent to which it has been developed in connection with the immense school population in that city. The American museum deals with upwards of 1,000,000 school children within the five boroughs of New York. During the year 1927, it made more than 9,900,000 contacts with this clientele by means of lectures in museum class-rooms devoted to the purpose, exhibition hall talks; classes for children with defective eyesight, and by more formal lectures, illustrated by lantern slides and motion pictures dealing with natural history, geography, exploration and kindred topics. Series of nature study collections in cabinets are circulated through the public schools and placed on loan in public libraries throughout the city. Sets of coloured lantern slides are arranged, based on the museum exhibits and explorations, and on various topics suggested by public school teachers. An outdoor museum and a series of nature trails have been established in the Adirondack State park, under the museum's auspices, that school children and others may study animal and plant life in their natural surroundings. In this way 576 schools within the city limits were served during the year 1927.

Within the museum halls themselves, mammals, birds, reptiles, amphibia and fishes are mounted or modelled in lifelike attitudes, grouped as in nature and shown in a setting consisting of a pictorial painted background, reproducing faithfully the natural environment, with trees, shrubbery and other accessories modelled to close similitude with nature. A similar method is followed with the lower forms of life, such as the marine and fresh-water invertebrates. In life, many of these creatures are soft-bodied and often translucent organisms of most beautiful and delicate coloration. In the American Museum of Natural History, they are modelled in glass, wax and other materials, tinted with the colours of the living animal, and often represented in groups having translucent painted backgrounds through which light filters, so as to give the illusion of an undersea environment.

The modern museum spares no pains to secure accuracy as well as beauty in these pictorial exhibits or groups. The work begins with the outfitting of expeditions to study the living creatures in their actual environment. Skilled artists accompany the field parties to make detailed studies of the animals desired. Photographs and moving pictures are secured, and careful notes are made, both of the animals themselves and of the associated animal and plant life, as well as the inanimate features of the environment. Actual specimens are brought back for detailed, scientific study, and even trees, bushes and rock specimens are transported to the museum, when terrestrial groups are concerned. The museum gathers its facts from nature by first-hand exploration. The data are analyzed technically, from a scientific standpoint, to evaluate the new knowledge thus obtained, and finally, by means of lifelike exhibits and the popular explanatory labels and handbooks describing them the results are interpreted to the public at large, as a matter of liberal education.

(R. W. M.)

Museum Habitat Groups.—A term applied to the exhibition in museums of certain forms of natural history specimens in their native habitat or environment, so as to render the display both attractive and informing. This form of exhibit has been mainly developed in America and is the direct outcome of the modern tendency to make museums more effective in popular scientific education. These groups have been principally utilized in zoology and anthropology, but they are also applicable to botany and geology.

Some suggestion of local environment for mounted specimens, usually confined to a simple support or base, has been practised from time immemorial, but the careful rendering of natural conditions, including painted backgrounds, rich and elaborate, or simple, as the subject may require, is a recent development, and

was given special impetus through the initiative and original methods of the late Carl E. Akeley.

In the preparation and installation of this type of exhibition, the possibilities of which are large, peculiar difficulties and limitations arise; each new undertaking presents some new problem of its own, the solution of which may require an unusual degree of adaptiveness and resourcefulness.

General Treatment.—An illusion of nature is the first and basic idea, which calls for a naturalistic treatment of background, even realistic where painting merges into the realism of the foreground. The complex nature of these productions has usually been best attained by the collaboration of two or more artists, sculptor and painter with trained artisan assistants, working with mutual understanding and enthusiasm and an acquaintance as intimate as possible with the particular matter in hand.

The more common forms of installation may be classified in progressive steps as follows: (1) in the open hall; (2) in cases glazed on all sides; (3) with background painted on one side, glass on three; (4) background on two adjacent sides, glass on the other two, presenting two aspects; (5) one glazed side or opening, with curved background, enclosing all sides of the group except the front, thus admitting of a complete illusion, as if one were looking out into the open from a window; (6) the logical last step is the continuous or cycloramic background, viewed from a central vantage point. This form has been successfully applied to certain gregarious groupings. (*See* MUSEUM: *Visual Education.*) (C. A. Co.)

MUSH, a kaza in the Bitlis vilayet of Asiatic Turkey. It is situated at the mouth of a gorge in the mountains on the south side of the plain, the surrounding hills being covered with vineyards and some oak scrub. The castle, of which there are some remains, is said to have been built by Mushig, an Armenian king of the province Daron, who founded the town. Good roads lead to Erzerum and Bitlis. There are 21,414 inhabitants. The winter climate is cold, with a heavy snow fall. Some miles to the west at the edge of the plain is the celebrated monastery of Surp Garabed or St. John the Baptist, an important place of Armenian pilgrimage.

Mush plain, 35 m. long by 12 broad, is very fertile, growing wheat and tobacco. The Murad or eastern Euphrates traverses the western end of the plain and disappears into a narrow mountain gorge there. Wood is scarce and the usual fuel is *tezek* or dried cow-dung. There are several sulphur springs, and earthquakes are frequent and sometimes severe.

MUSHET STEEL, a high carbon manganese-tungsten steel developed about 1868 by the Englishman Robert F. Mushet. Whereas steels known before that time required rapid quenching from a high heat in order to become hard, Mushet's steel was excessively hard after air cooling and retained that hardness even after high tempering. For these reasons it was called "air-hardening" or "self-hardening" steel, and was used for machine tools for cutting the harder steels and cast irons. Owing to the lack of uniform ferro-alloys needed in the manufacture, these early high-alloy steels varied in chemical composition between the following approximate figures: carbon 1·85 to 2·15; manganese 2·5 to 1·5; tungsten 9·0 to 5·5.

Other air-hardening tool steels introduced to compete with Mushet steel without infringement on the patent rights were lower in carbon, contained a few per cent of chromium or substituted molybdenum for the tungsten. Present day representatives of this class of tool steel are the "fast-finishing" steels, an inexpensive quality for cutting hard metal. A typical analysis contains 1·25% carbon, 0·30 manganese, 3·5 tungsten and 0·3 chromium. (E. E. T.)

FOUNDED A·D·1768

END OF FIFTEENTH VOLUME

F

PRINTED IN THE U. S. A. BY R. R. DONNELLEY & SONS CO.